

Renewable Power Generation Cost Trends to 2022

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2022 was the year of:



Predictable Surprises

Four key themes

1 Global RE electricity costs fell, mostly, but cost inflation is real

2 RE competitiveness leaped in 2022

3 2022 spotlighted the energy security benefits of RE

4 2022 was a tipping point for the transition

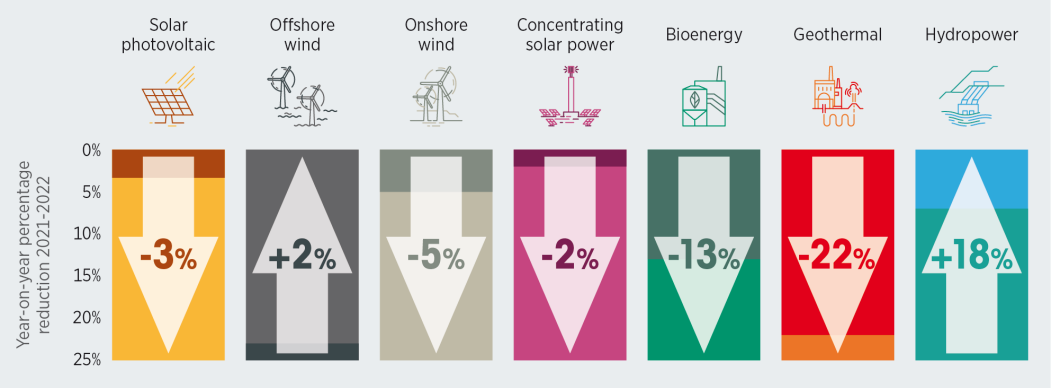
Global average costs, mostly, fell in 2022



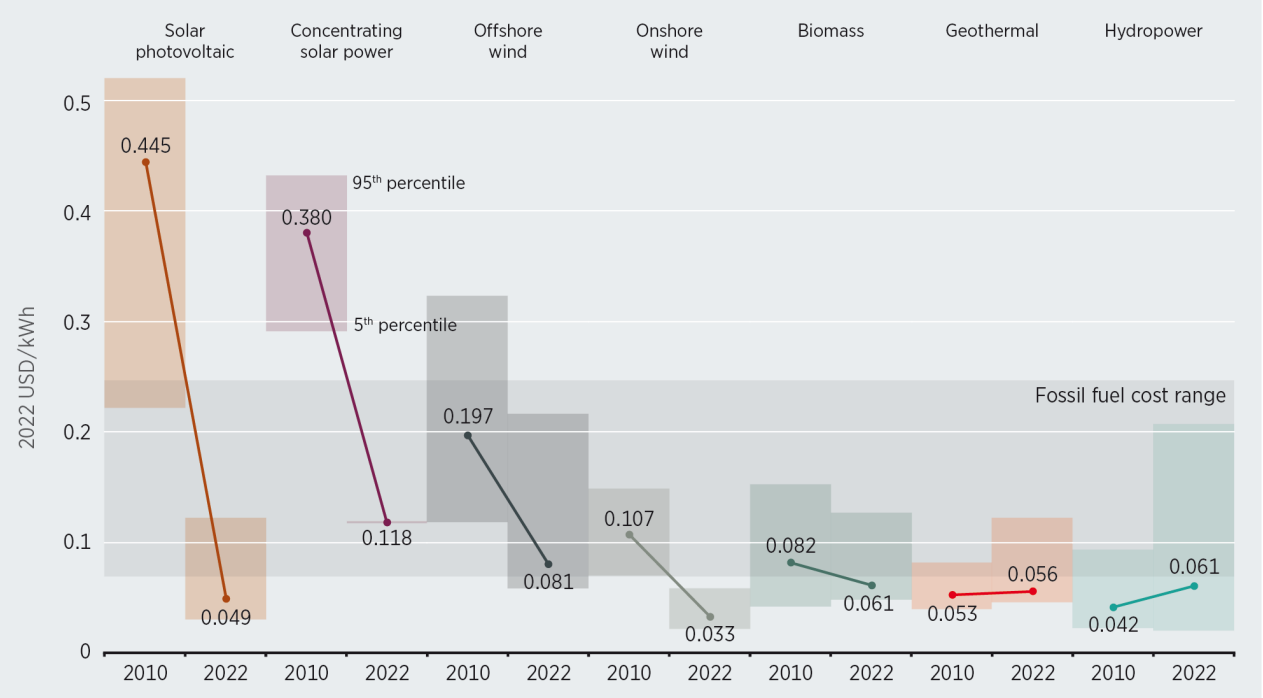
But it's not all good news...

Declines in 2022 - except for offshore & hydropower

Global weighted-average LCOE down in 2022 (mostly)



For PV and onshore wind, this was a story of China’s increased share

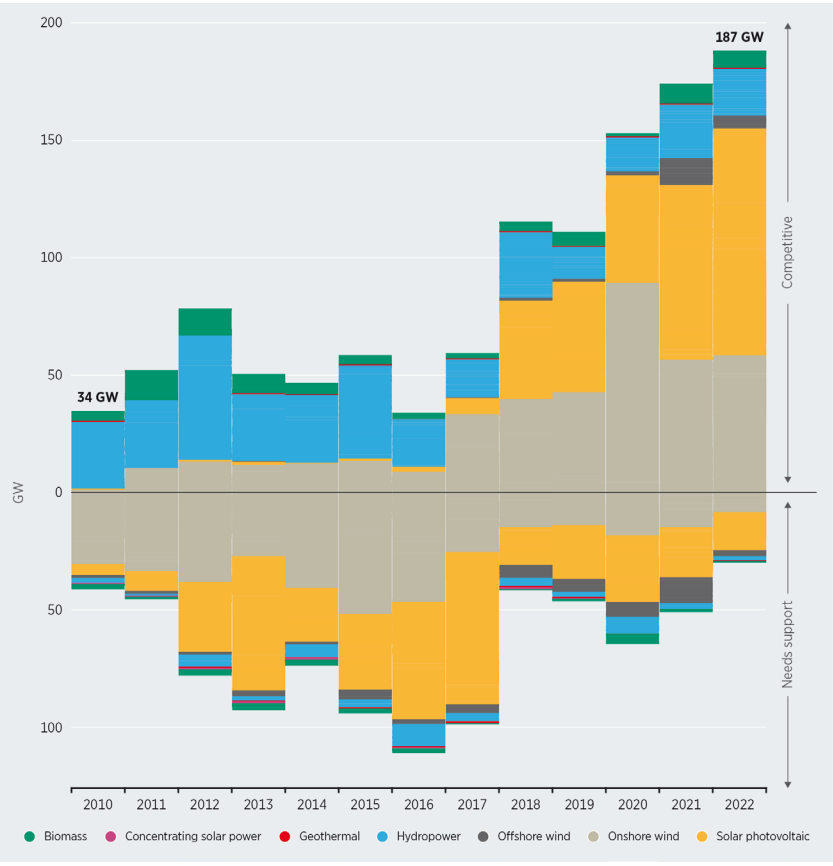
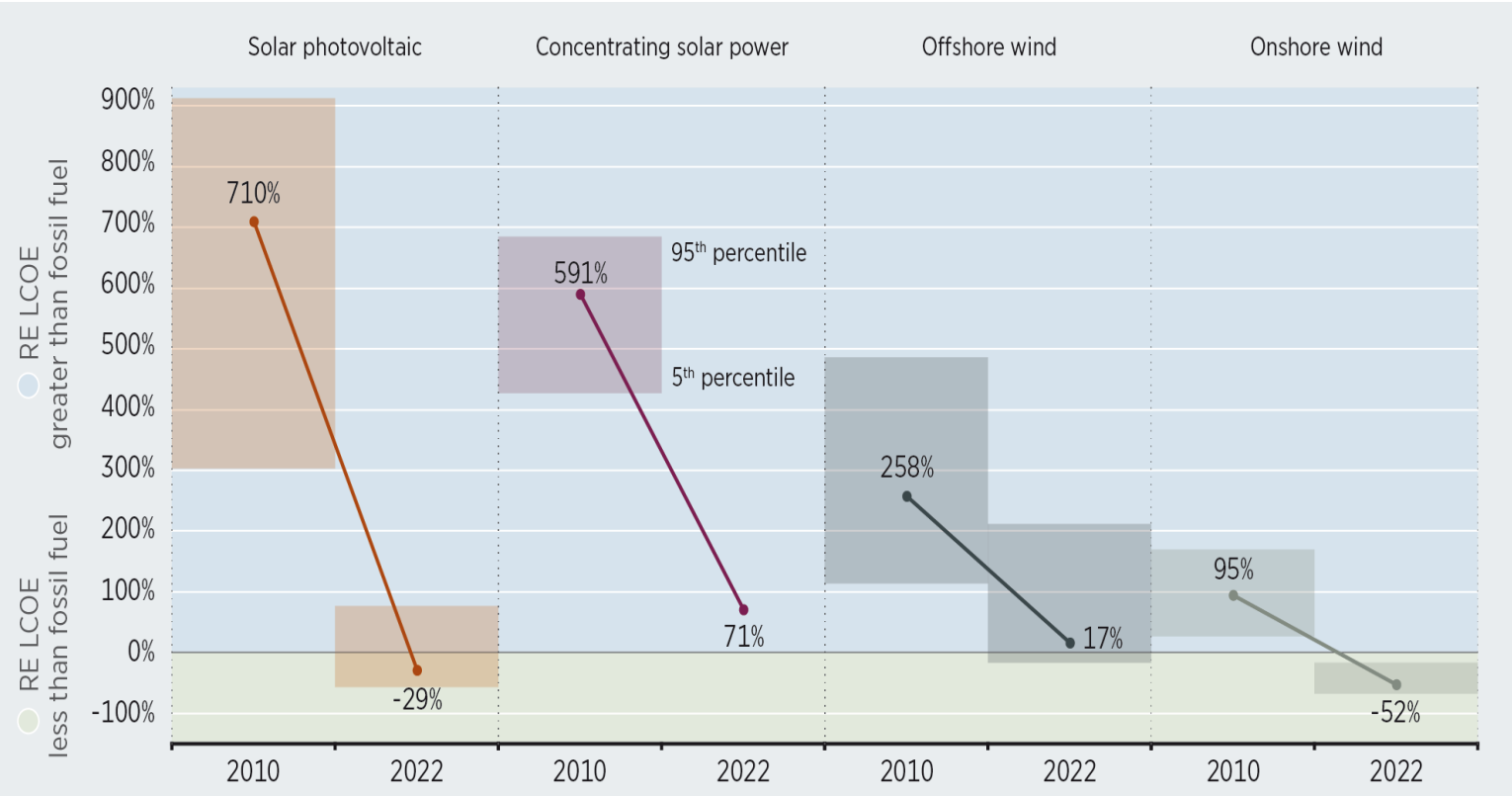


Energy Source	2010-2022 Change
Solar PV	-89%
Onshore wind	-69%
CSP	-69%
Offshore wind	-59%

Solar and wind power now offer very competitive electricity

The global weighted-average LCOE of onshore wind was 52% lower than the cheapest fossil fuel option in 2022...

While for utility-scale solar PV, it was 29% lower



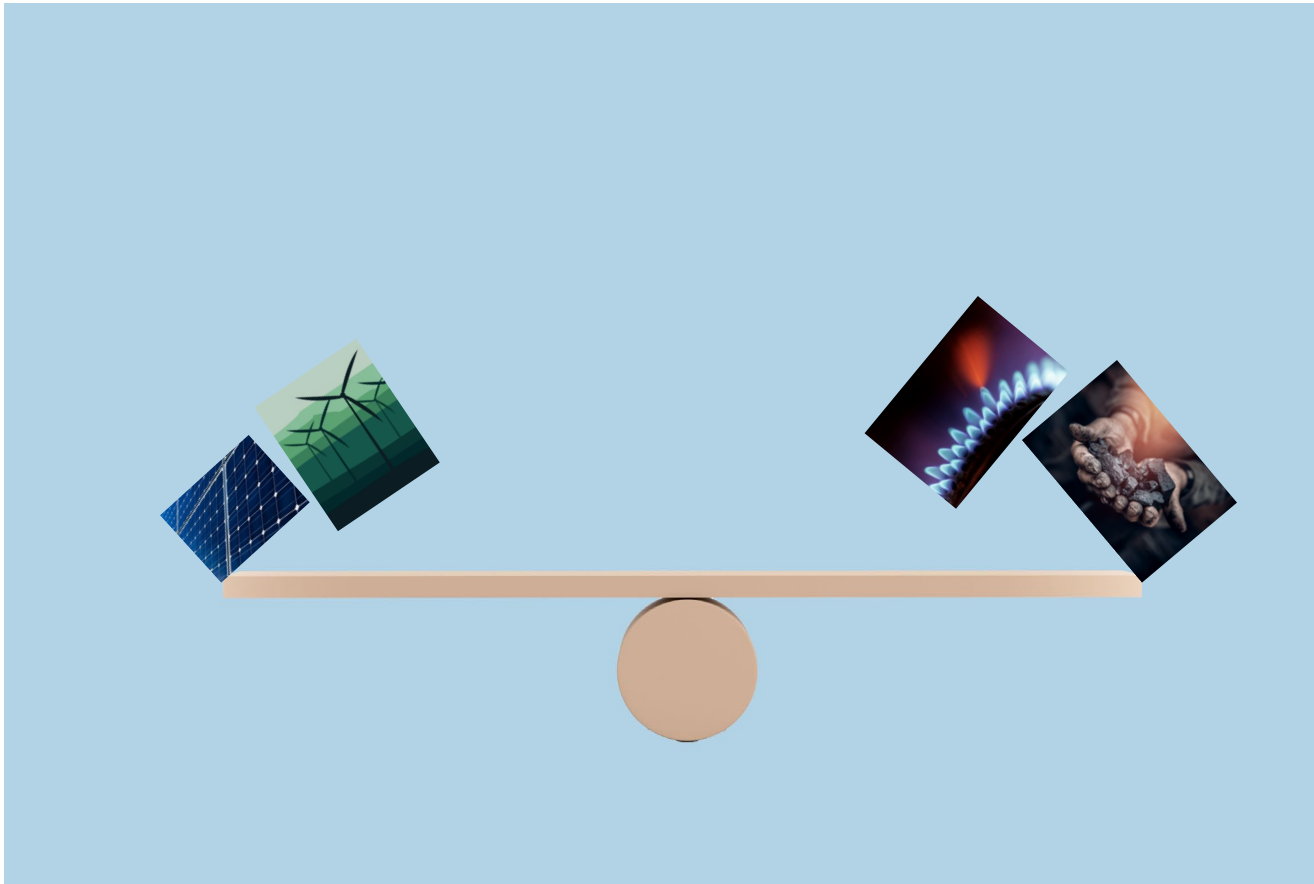
86% of the new utility-scale capacity added in 2022 cost less than cheapest fossil option by country/region

A great bound forward?



Or is it a slippery landing?

RE competitiveness in 2022



RE cost inflation is only part of the story

Trends in fossil fuel costs need to be taken into account

But the situation is complicated by sustained inflationary pressures across the economy

Worth remembering anything less than 7% nominal increase 2021-22 is a fall in real terms...

New for 2022: Detailed fossil fuel LCOE for 20 countries

Project level capital cost data for

496 CCGT/GT/ICE power plants

695 Coal power plants

200 GW of gas/oil capacity

685 GW of coal capacity

42 countries gas/oil

23 countries coal

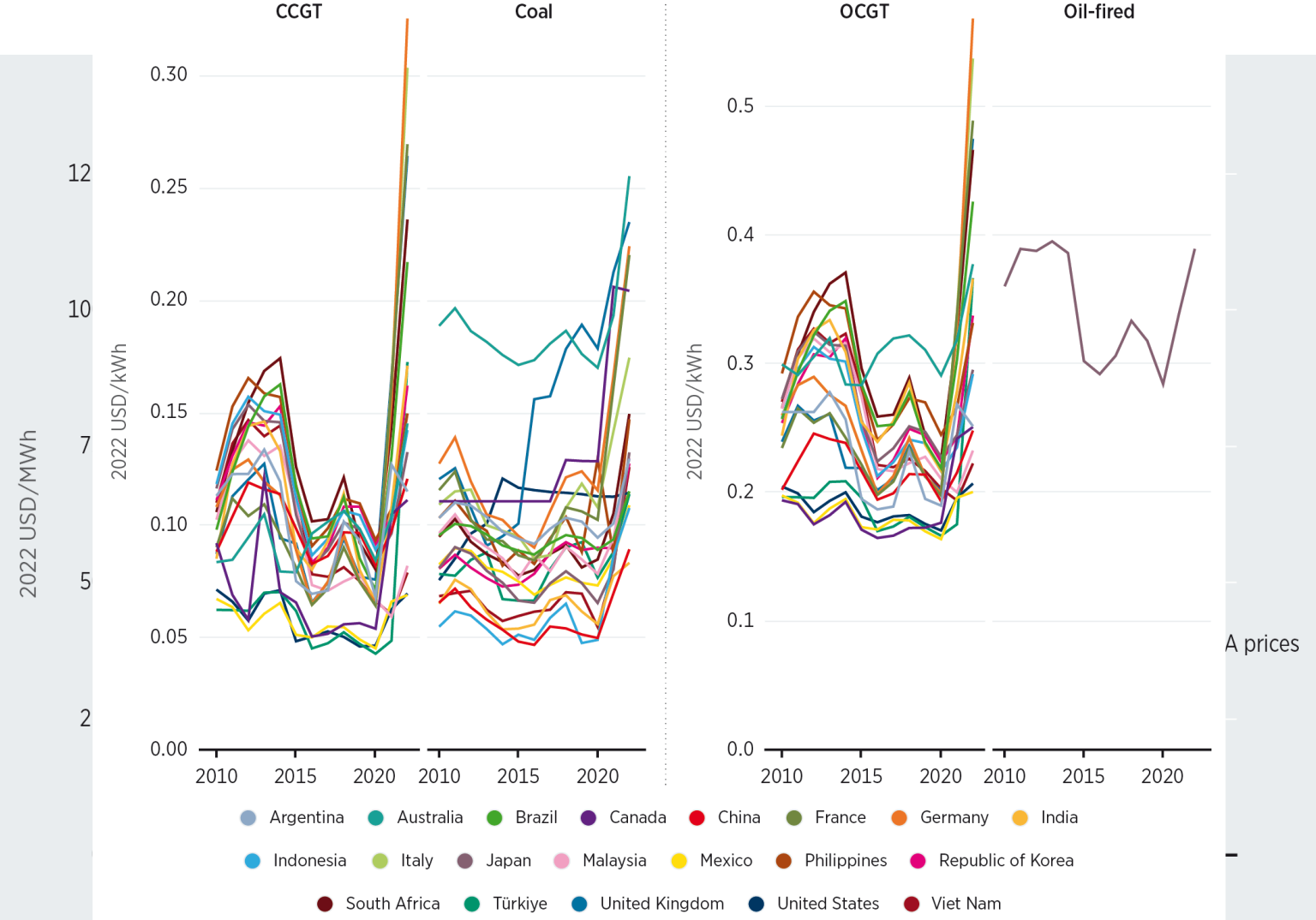


Fossil fuel LCOE increase in 2021 and 2022

Driven by increases in fossil fuel prices, especially for fossil gas in Europe, but also for coal-fired generators globally

Three-fold increase in a new gas-fired generation LCOE in Europe over 2021, SRMC averaged around USD 270/MWh in 2022

2022, hopefully, an aberration, but even with price expectations at 2021 avg. gas-fired power gen proposition is extremely weak



Onshore wind competitiveness trends

Competitiveness is the combination RE LCOE and fossil fuel costs (country avg.)

For onshore wind 2021 and 2022 saw the largest jump in competitiveness since 2010, with the exception of Japan

2021 situation, perhaps more realistic, of current medium-term expectations. But still a period of significant uncertainty



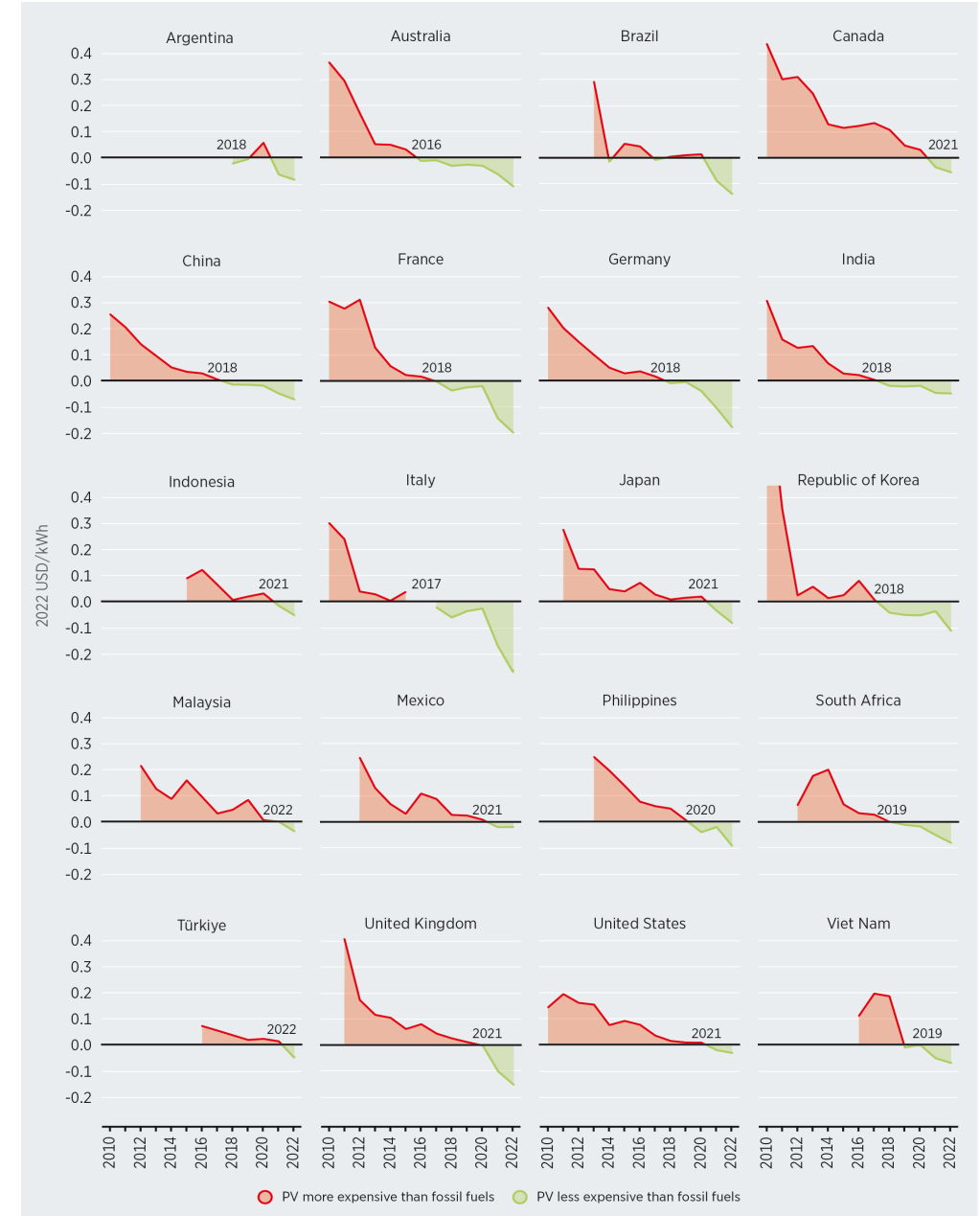
Competitiveness: RE LCOE minus FF LCOE

Utility-scale solar PV competitiveness trends

Different trend for solar PV, given the dramatic module price declines in period 2010 to 2013

2021 therefore saw a range of new markets become competitive with new fossil fuels

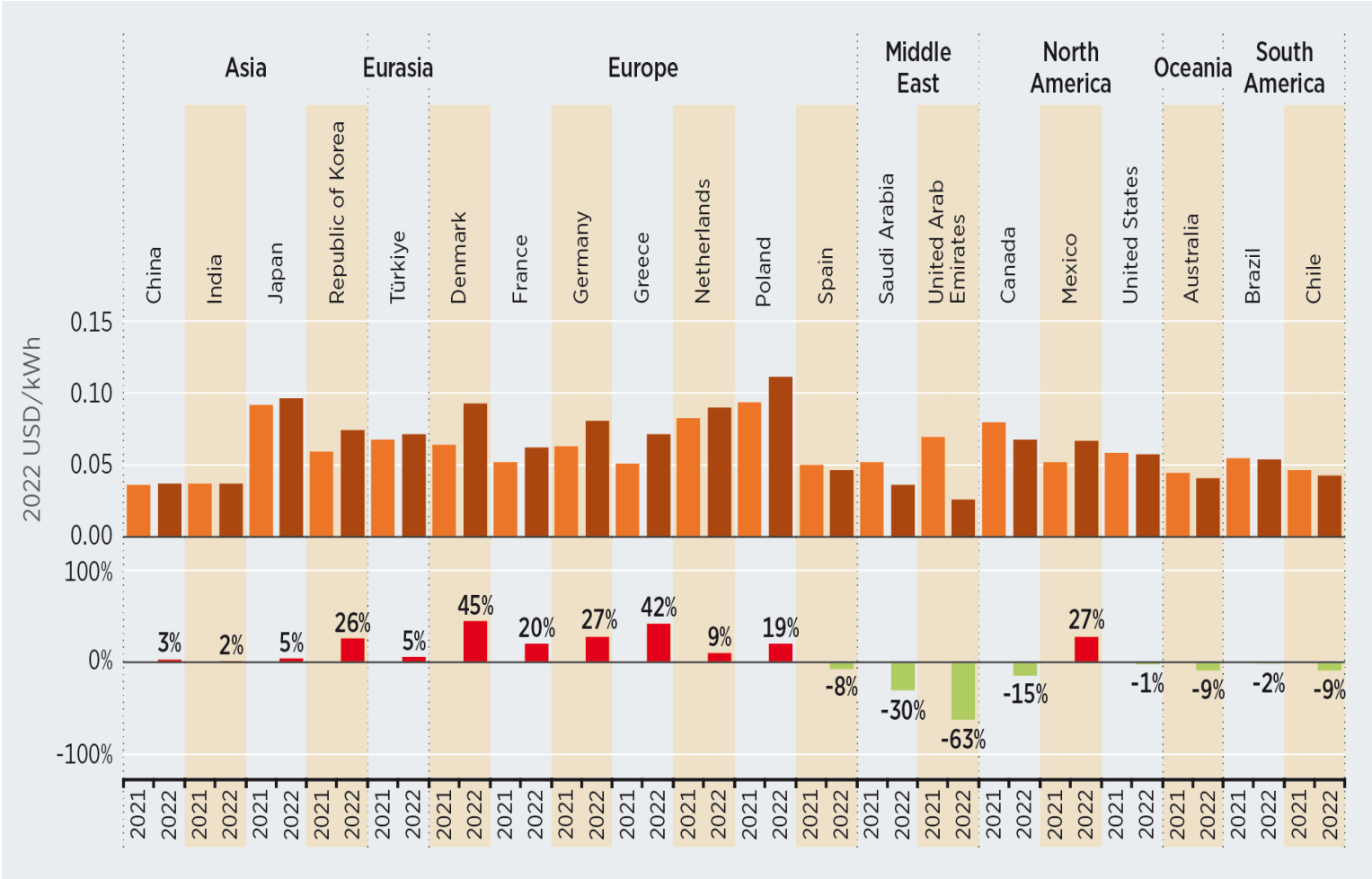
Saw an acceleration in 2021 and 2022, as fossil fuel prices and expectations soared.



Competitiveness: RE LCOE minus FF LCOE
 Note, different Y axis scale compared to onshore wind

Solar Photovoltaics

Utility-scale solar PV in 2022



Cost inflation has not been evenly felt

It's not just equip. costs - labour and bill of materials are under pressure as well

Different market scales & project development lead times played a key role in different market experiences in 2022

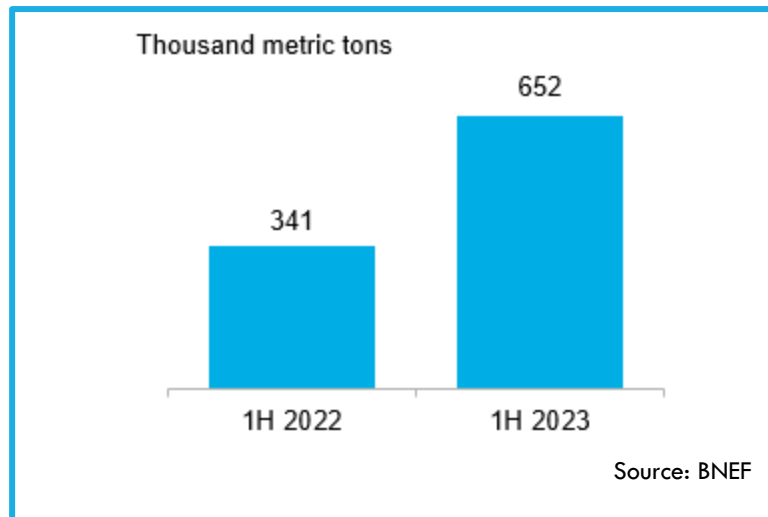
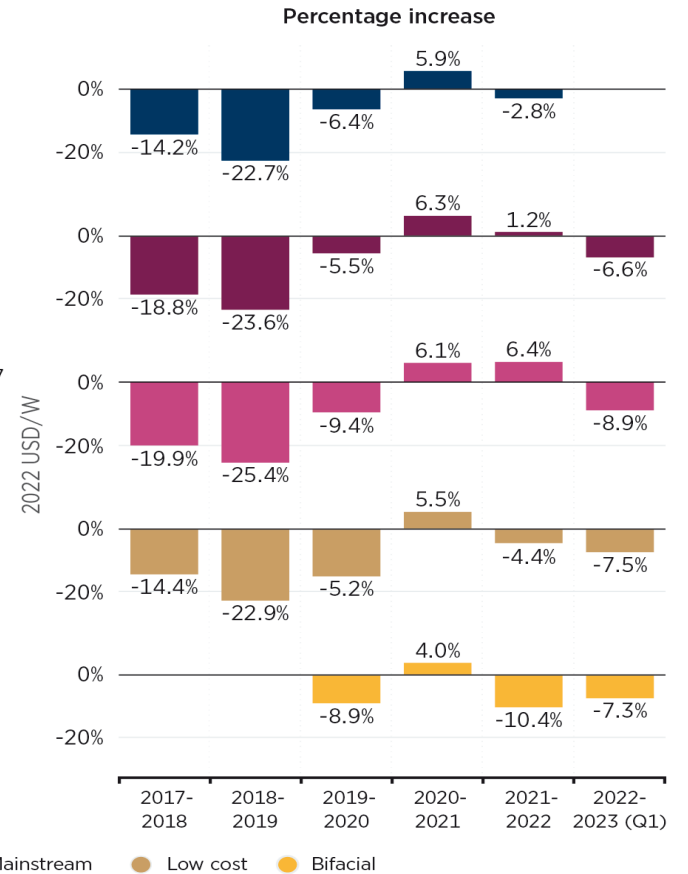
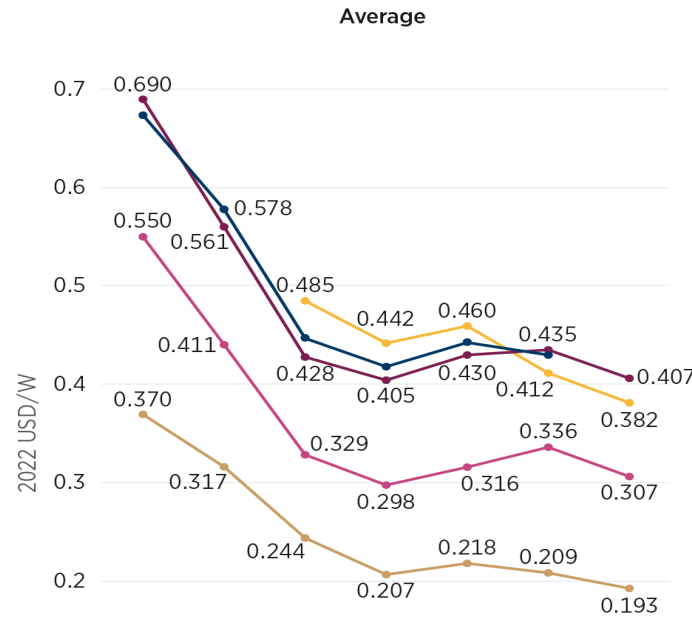
Don't discount economic incentive to deploy rapidly in 2023, it had an impact on costs

Equipment costs increased in 2022: Solar PV modules

Solar PV module prices rose in 2021 and 2022, but not universally

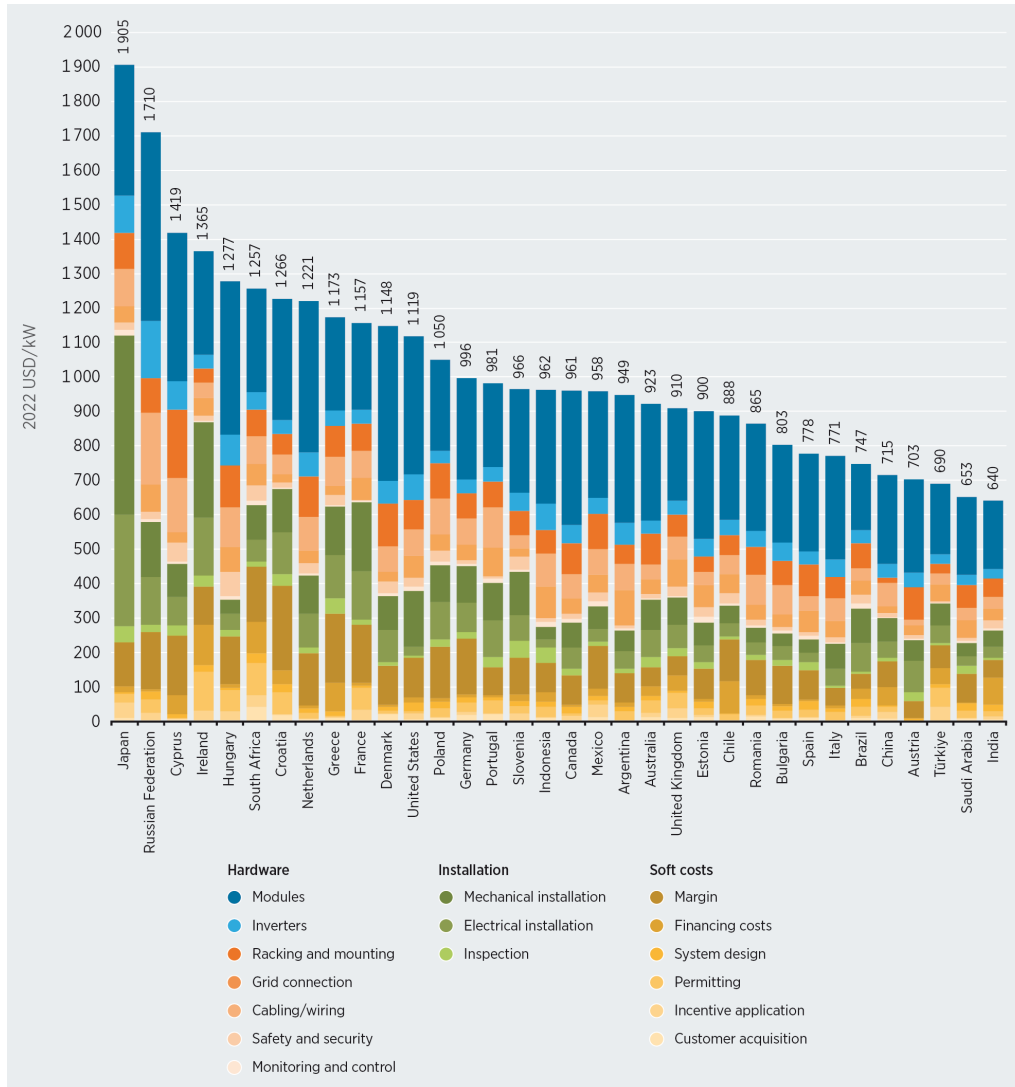
Polysilicon supply growth saw them ease in Q1 2023, falling back to 2020 levels or better

Main driver: Chinese polysilicon production almost doubled in one year...



But it's not just about modules

PV total installed cost breakdown by country, 2022

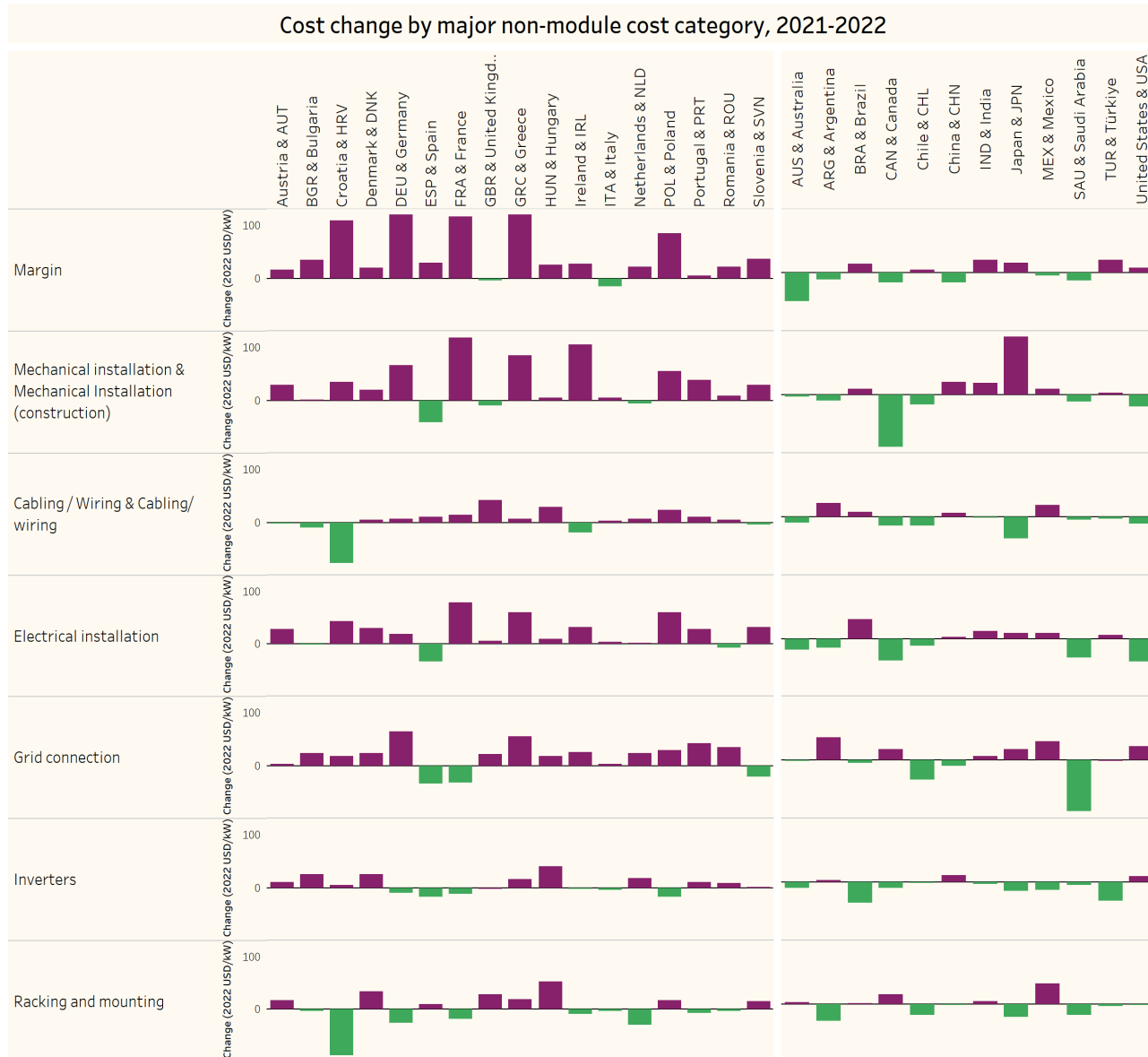


Commodity prices remain above pre-pandemic levels, while general cost inflation remains prevalent

This is putting pressure on many elements of the total project cost

Cost inflation in solar PV has shorter pass-through times, given the relatively short project lead-time from FID to commissioning

Infationary pressures on TIC: Cause for optimism?



European projects saw large increases in margin component (value pricing)

Other major non-module cost driver: Installation

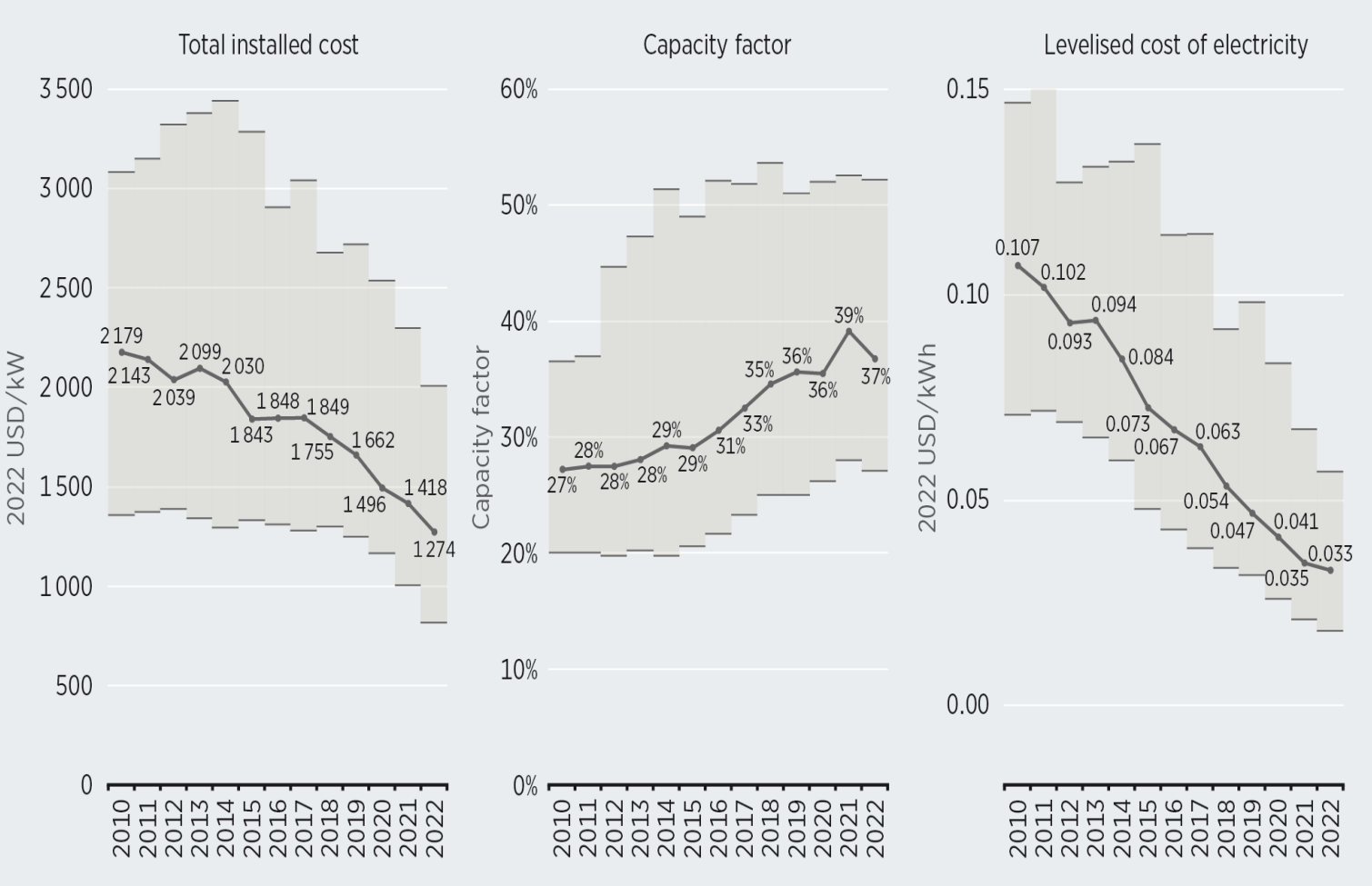
Other items remain an issue, but may see some cost relief end-2023 into 2024

Reasons to be optimistic:

1. Module prices
2. TIC cost component increases in EU
3. Supply chain growth & diversification

Onshore wind

Onshore wind cost trends, 2010 to 2022



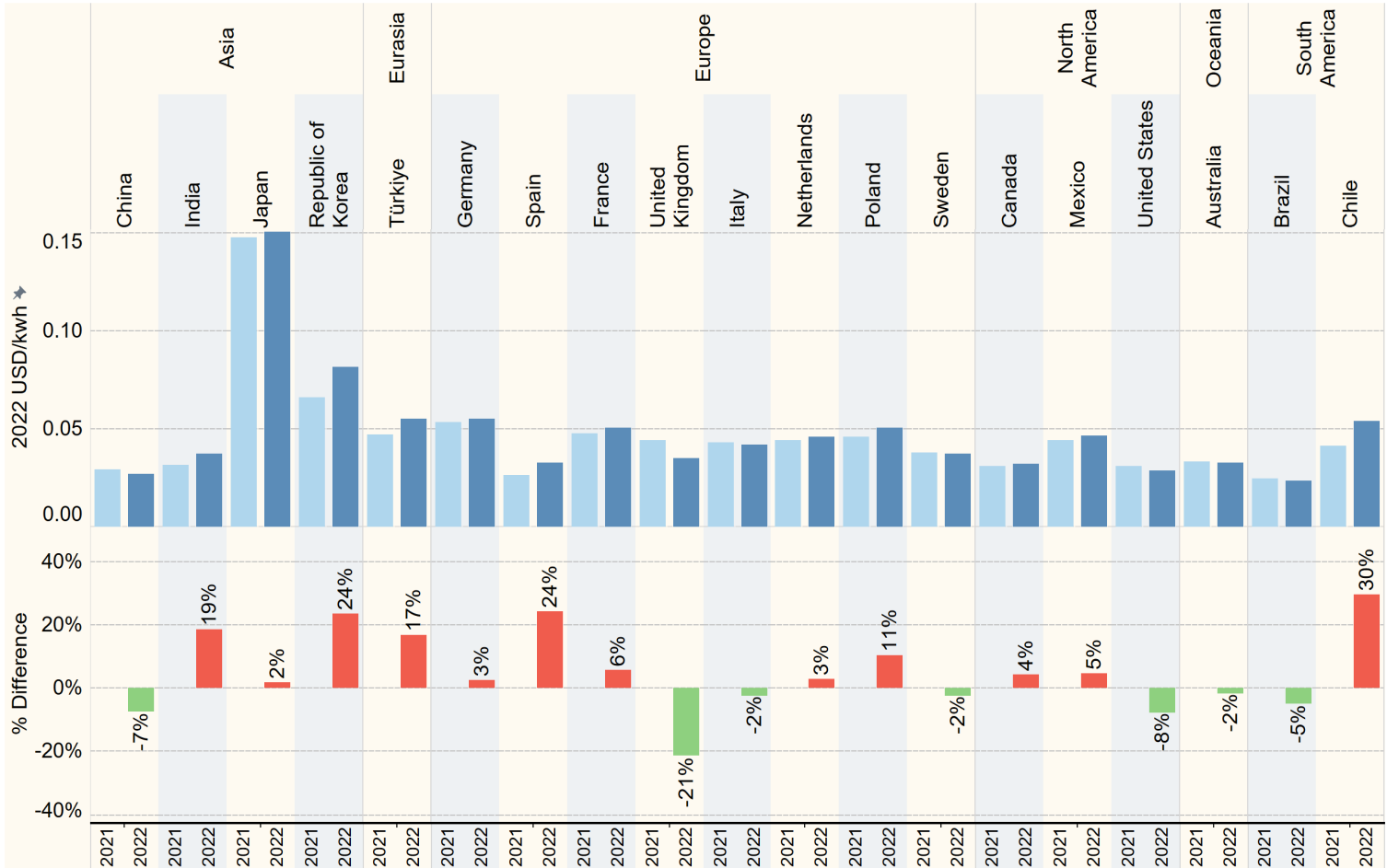
Total installed costs fell by 42%

Very different technology story. Capacity factor, rising on higher hub heights & larger swept areas

Increased volatility in global weighted-avg CF driven by China’s share in deployment

Increased volatility in global weighted-avg CF given China’s share changes

Onshore wind in 2022



Cost inflation has not been evenly felt

Smaller number of projects outside (most of) Europe, so inherently more volatile

Longer project lead times had some impact, mitigating turbine costs, but not BoS and labour.

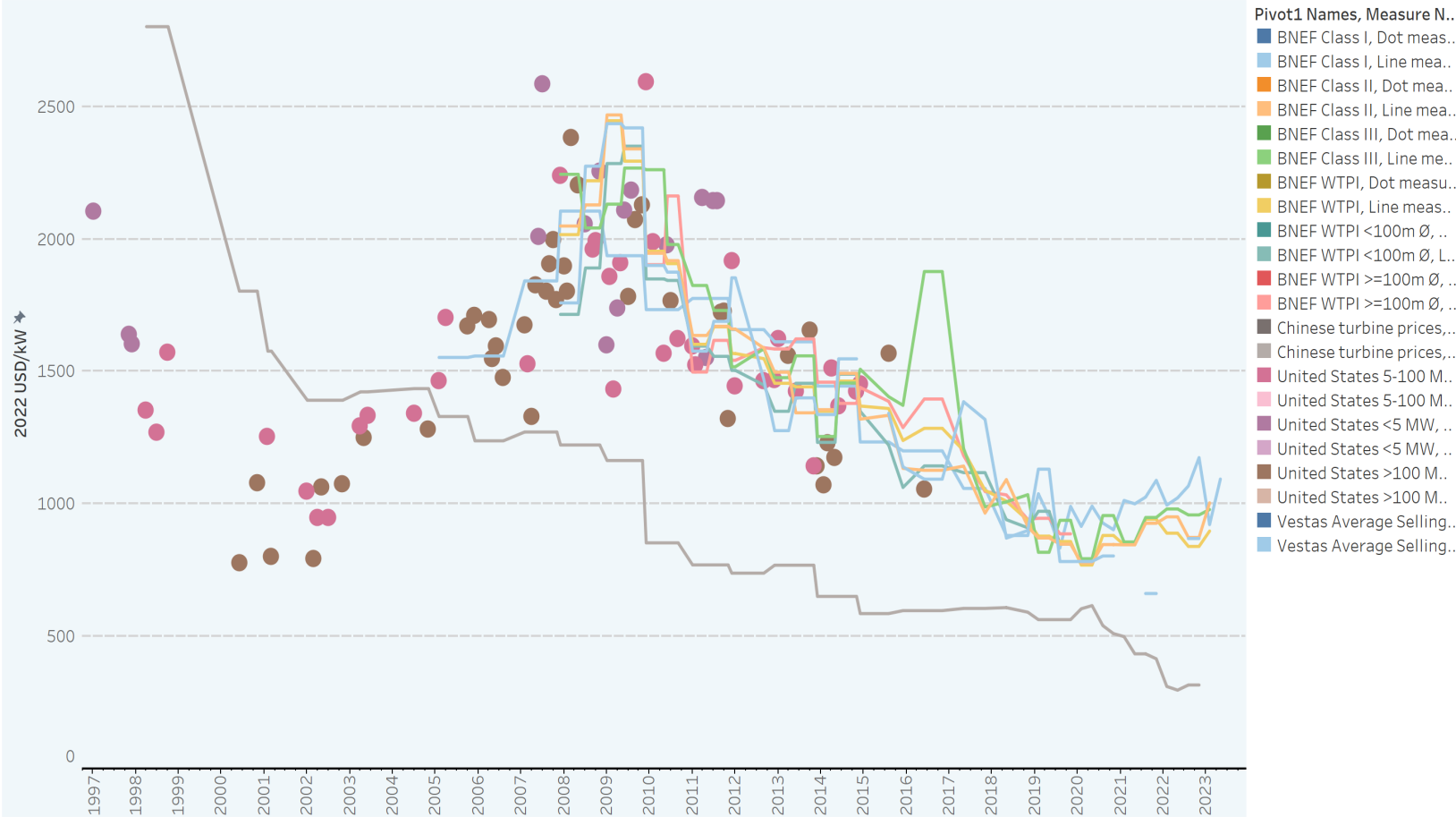
Again, don't discount economic incentive to deploy rapidly in 2023, it had an impact on costs

Equipment costs increased in 2022: Wind turbines

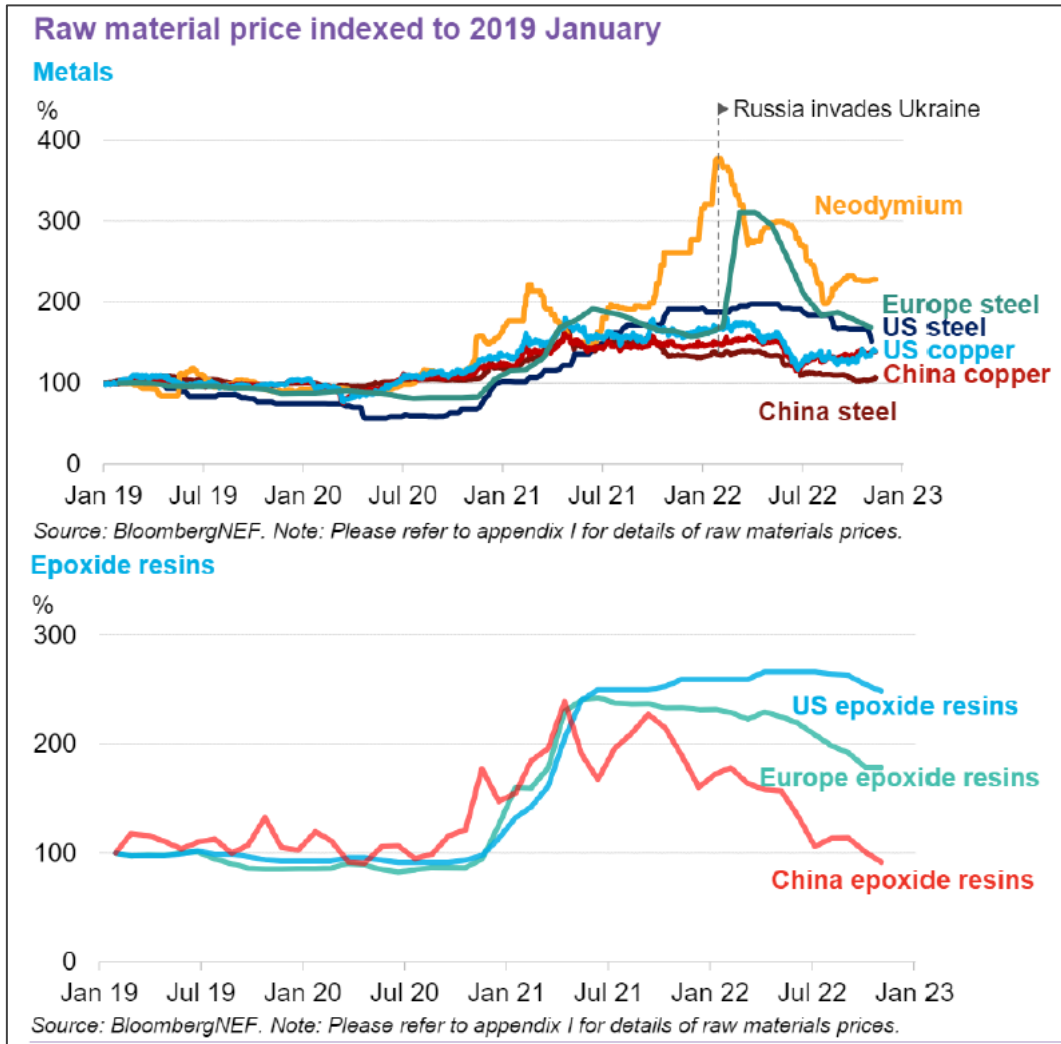
Turbine pricing in 2022, ranged from USD 840/kW to USD 1 175/kW. Materially higher than in 2020

With the end of subsidy support Chinese manufacturers remained under strong pressure to lower prices, but this has bottomed out in last 2 quarters

Outlook for 2023 likely USD 900-1100/kW, but there is significant uncertainty given western turbine manufacturers ongoing financial woes



Materials costs are off their peak, but some still elevated



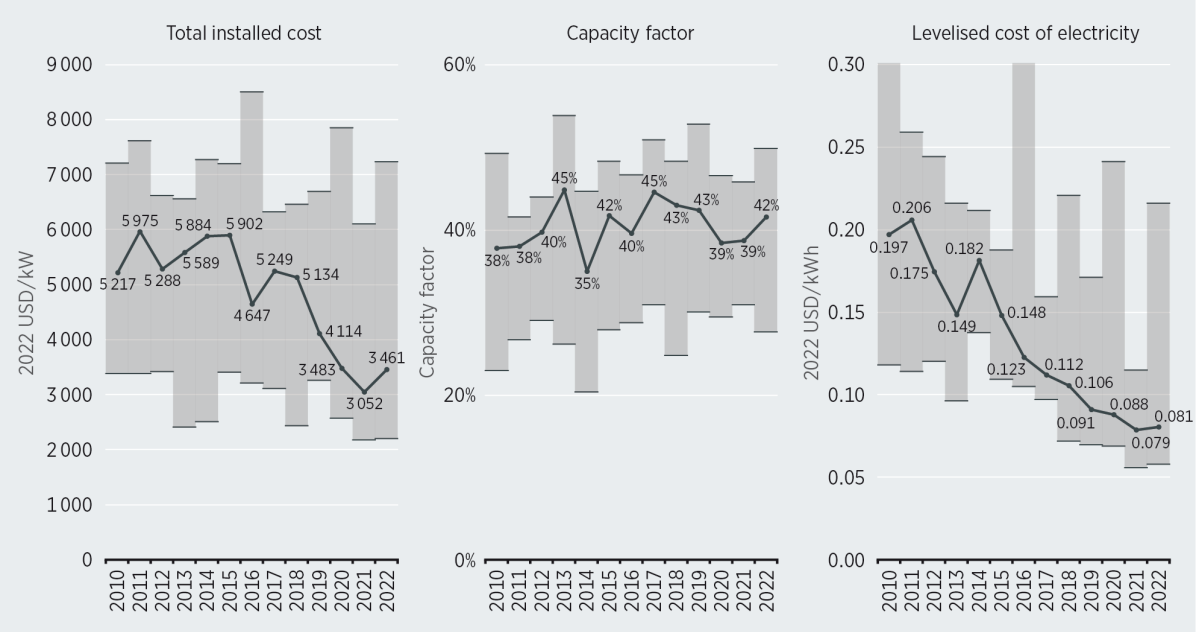
Easing materials prices unlikely to result in fall in pricing in short-term, due to need to rebuild margins

But some potential in 2024 if sustained and competition among manufacturers remains intense

This is not a healthy supply chain situation, some thought should be given to policy measures to ensure continued supply chain resiliency

Offshore wind

Offshore wind 2010 to 2022



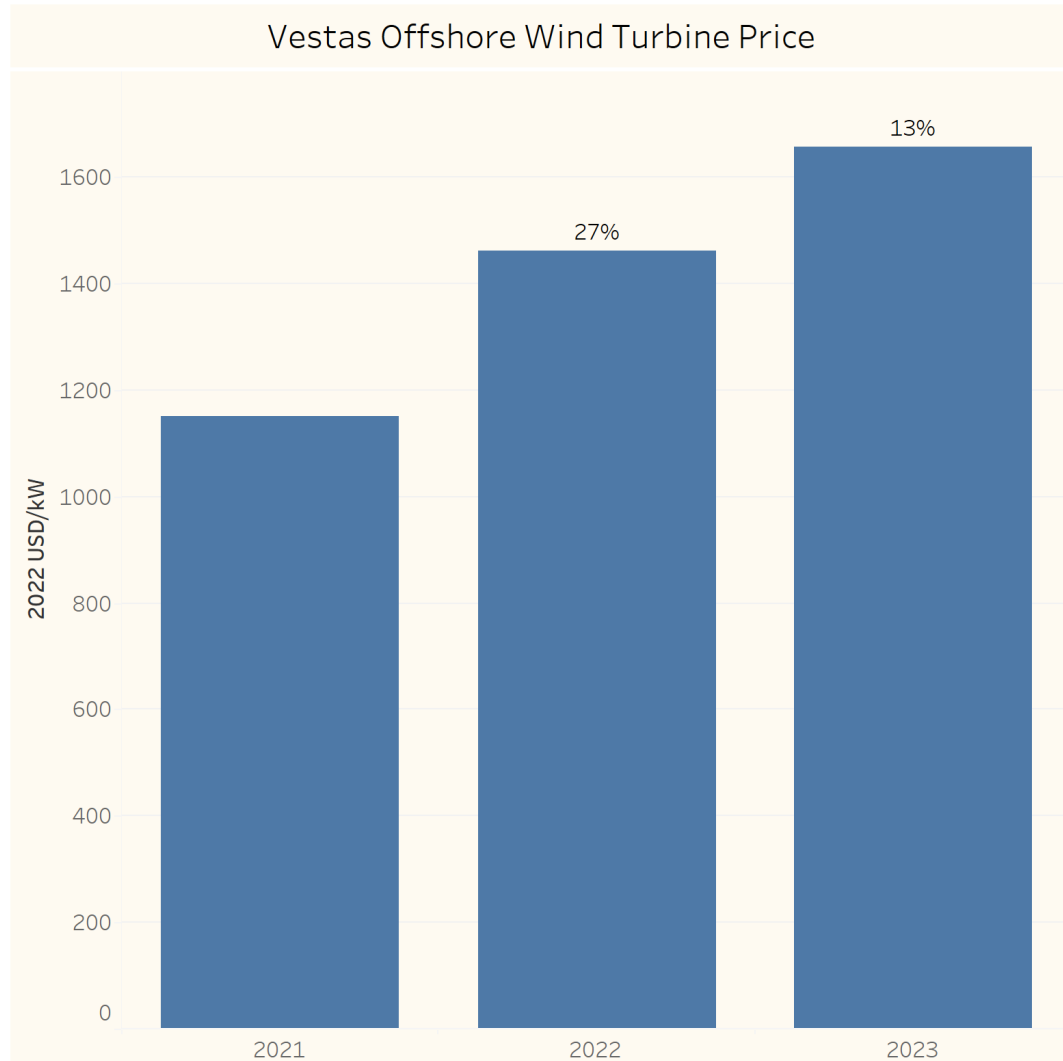
Lumpy investments in different countries/regions cause volatility. Policies to provide a clear path to market and scale-up would help

2022 saw higher share of European market projects and emerging markets with higher cost structures.

Cost inflation is current real challenge for projects at FID.v

Where policy settings remain inflexible, investment will go elsewhere, potentially jeopardizing 2030 targets in some markets

Offshore wind turbines



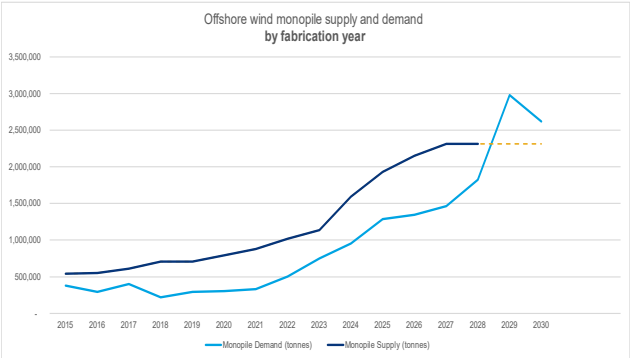
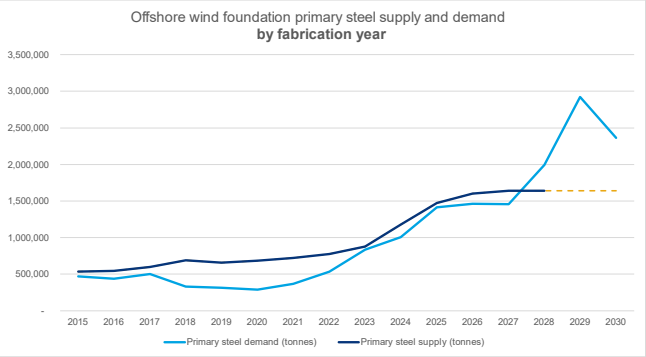
Innovation and market scale-up drove down turbine costs over time

However, implied Vestas offshore wind turbine price increased 44% (~USD 500/kW) in two years

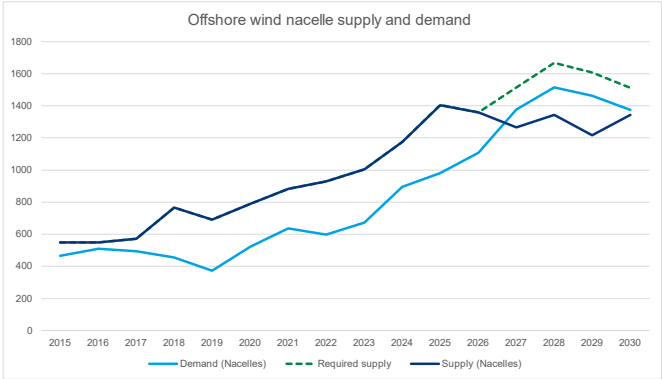
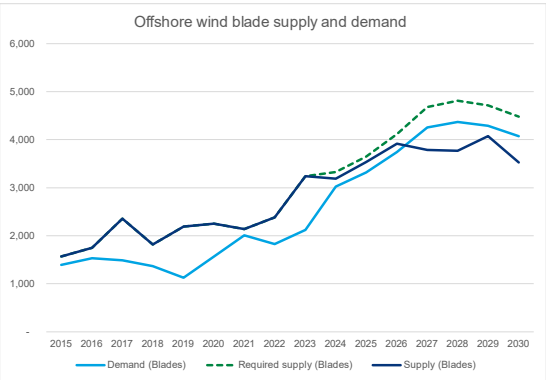
Rapid growth in turbine capacity has stressed supply chain (notably for installation, but its broad)

Long project lead times mean these results will be felt 2026 and beyond

Offshore wind supply chain challenges

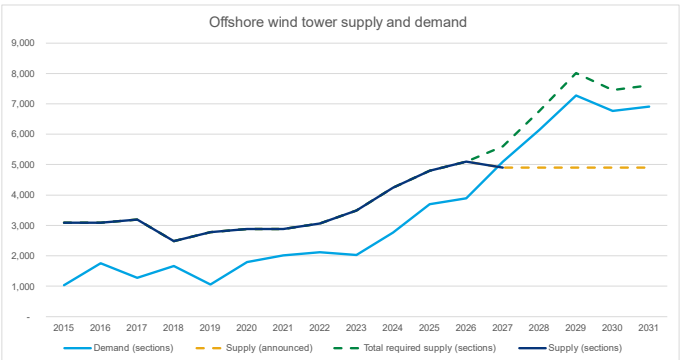


Across the board, expectations are that the supply chain is not scaling quick enough to meet anticipated demand



This is partly chicken-and-egg, partly the challenge of moving to larger turbines

Industry is working hard to create greater supply chain resiliency (leaning on standardisation, modularity, etc.)



Given high ambition by countries, policy settings around remuneration and stable and predictable scale-up need to be refined

Source: Wood Mackenzie



Renewable power

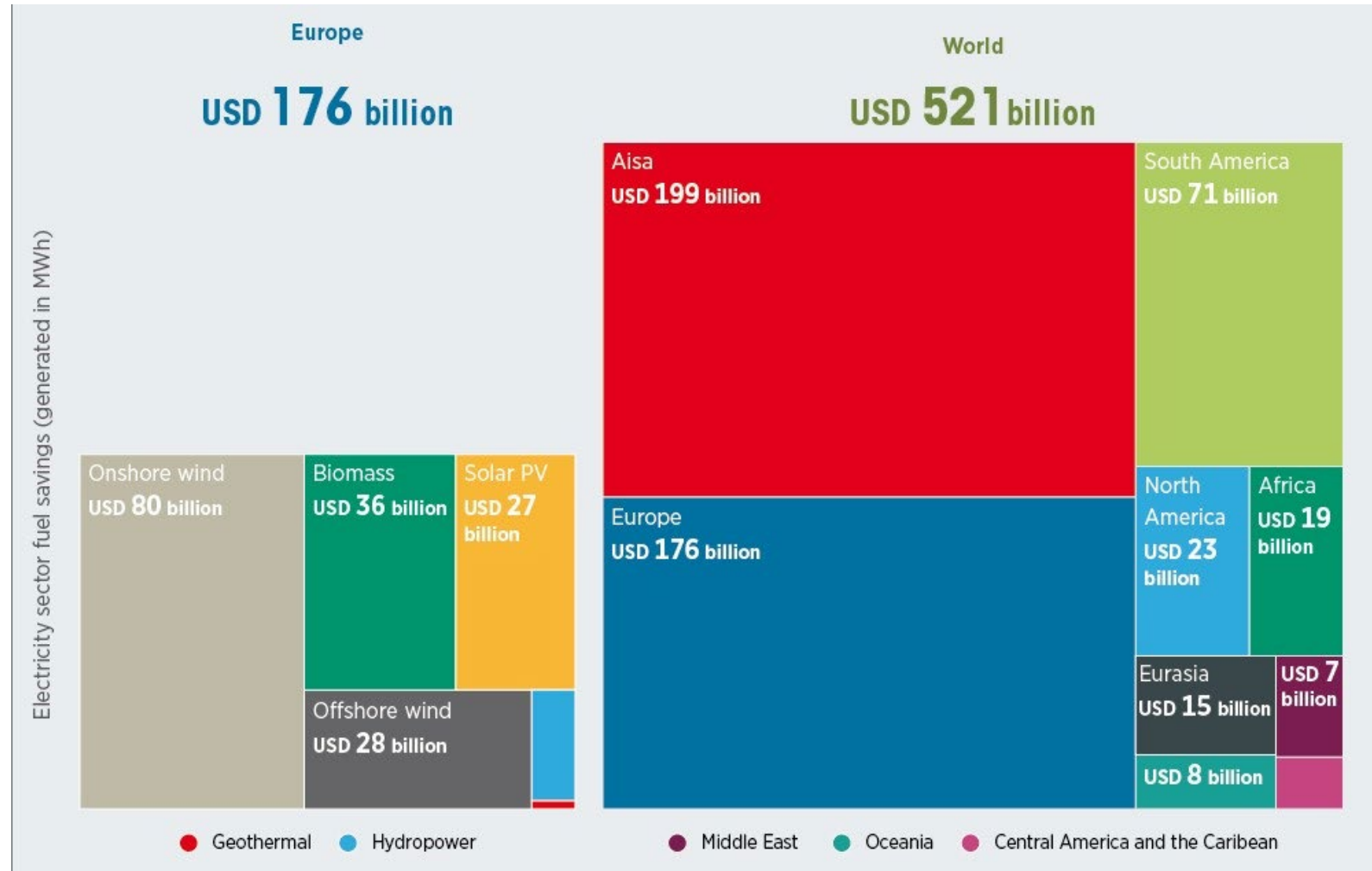
The unsung hero of 2022?

Renewable power saved Europe (& others)

Renewable power added since 2000 saved half a trillion US dollars of fossil fuels for the power sector in 2022

Europe alone, saw reductions of USD 176 billion (assuming gas replacement).

Compare to total of ~USD 370 billion coal and gas imports for EU-27 in 2022





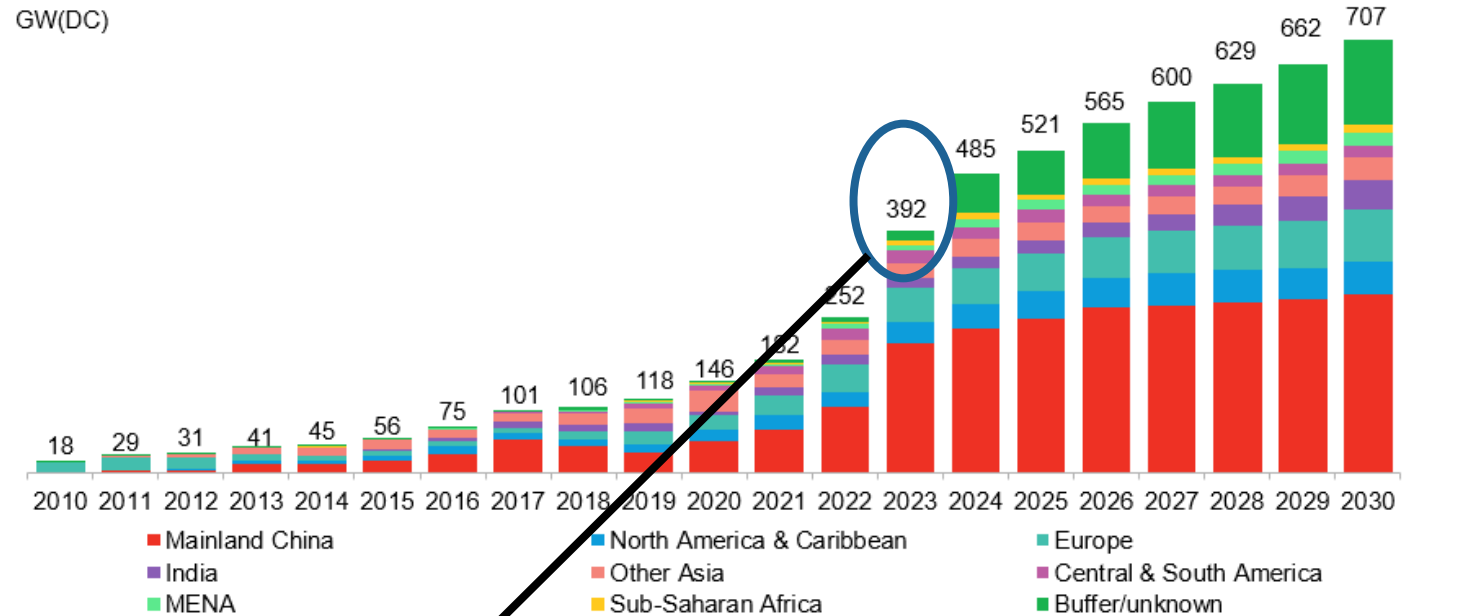
TIPPING POINT

The business case for RE power has been reinforced

Competitiveness leaped, at the same time as the visibility of that business case spread beyond energy intensive sectors

RE and EE provide demonstrably greater energy security than FF supply diversification

Businesses and individuals have responded to this by accelerating deployment



BloombergNEF

392 GW of PV alone

~4% more than TOTAL capacity additions in 2022

The Pledge

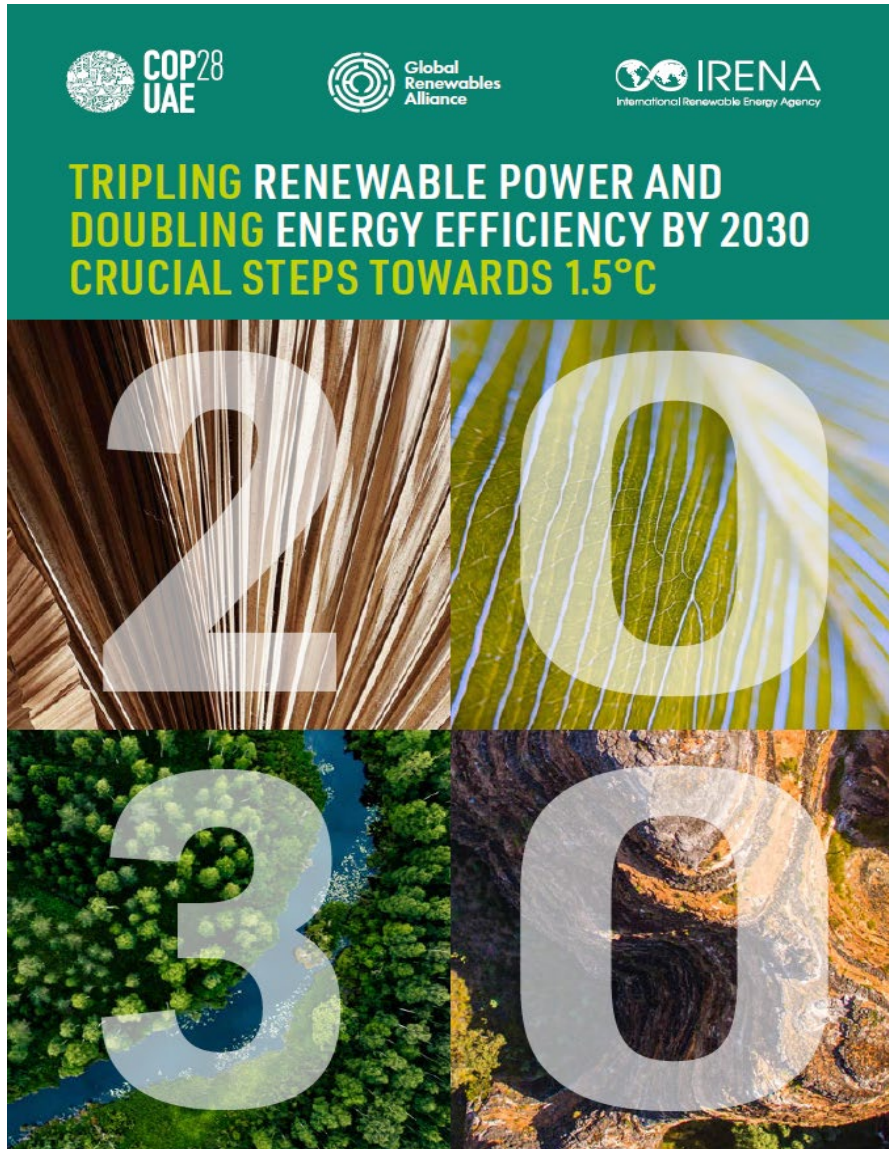
RE Power Capacity **x3**
Three-fold increase by 2030

Energy Efficiency **x2**
Double rate of improvement by 2030



11 174 GW
by 2030






Tripling RE power capacity and doubling EE by 2030



Tripling RE power capacity and doubling EE represent the only realistic options to accelerate energy transition to 2030 and keep Paris Agreement goals alive

But significant work needed required across 5 key enabling pillars



Key enablers: Renewable power and energy efficiency				
 POLICY AND REGULATION	 SUPPLY CHAINS, SKILLS AND CAPACITIES	 FINANCE	 INTERNATIONAL COLLABORATION SUPPLY	 INFRASTRUCTURE AND SYSTEM OPERATION
Energy efficiency standards/phase-out of inefficient equipment Fiscal, financial and regulatory measures to incentivise deployment Socio-economic and environmental policies	Resilient supply chain and responsible procurement Education and training; re-skilling and up-skilling Empowering women and underrepresented groups	Increased public and private financing Access to low-cost financing in the developing world	Collaboration on sustainability, governance, climate finance, supply chains, technology, innovation and regional power grids	Cross-sectoral infrastructure planning Grid modernisation and expansion Supply-side flexibility and demand-side management

Triple RE power & double energy efficiency by 2030

Pledge to keep 1.5°C alive





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