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Global Trends in Clean Power

BNEF presentation for California Energy Commission

Helen Kou

Senior Associate at BloombergNEF

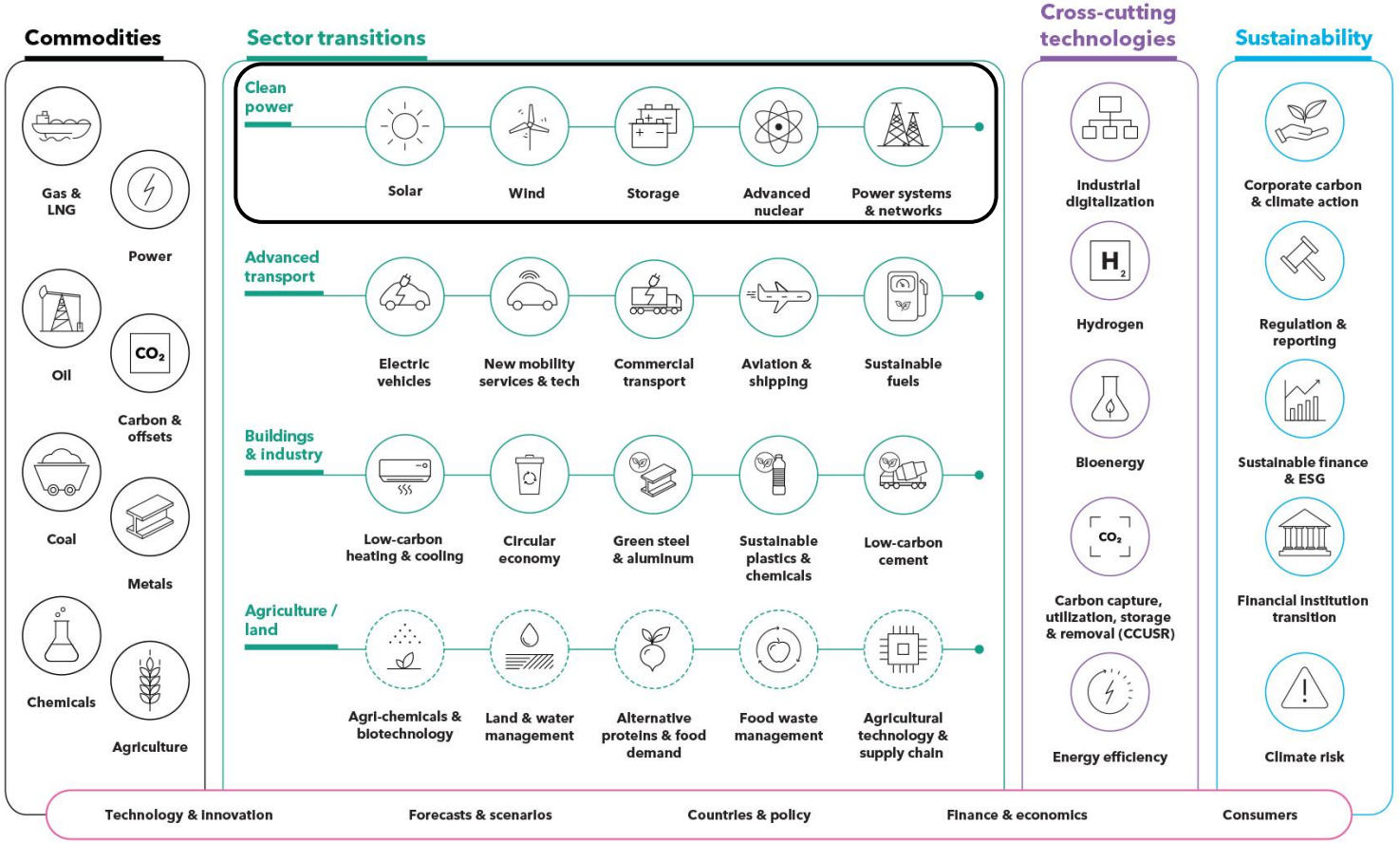
May 12, 2023

BloombergNEF

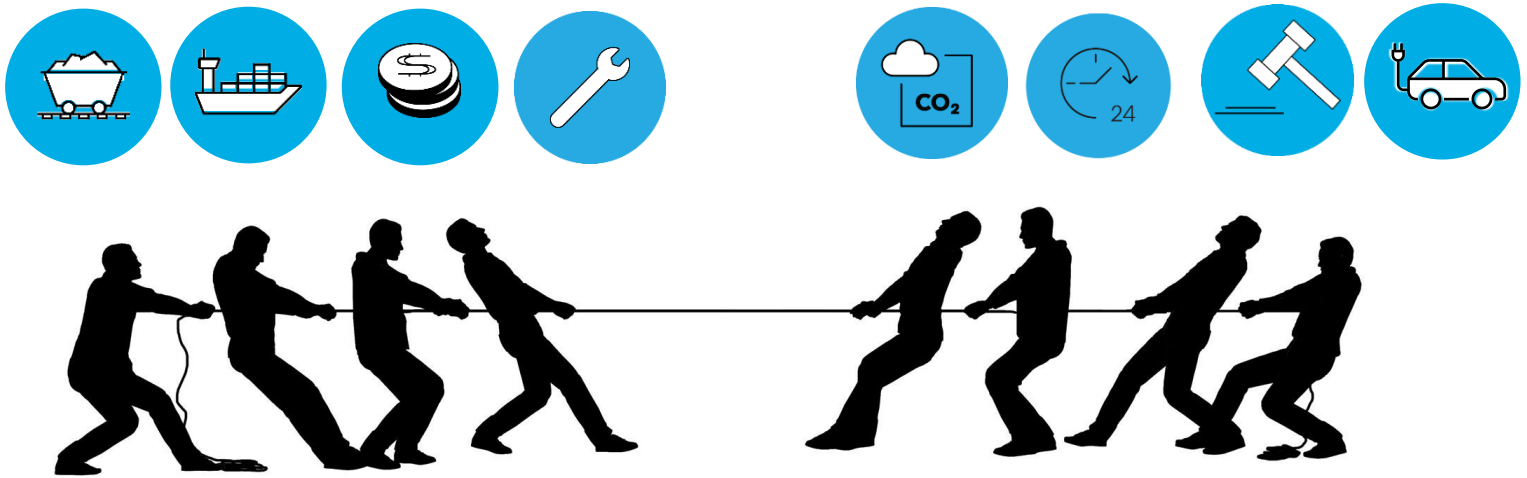
BNEF coverage

BloombergNEF

Strategies for a cleaner, more competitive future



Buffeted by competing forces, where does the momentum lie?



Source: Clipart-Library

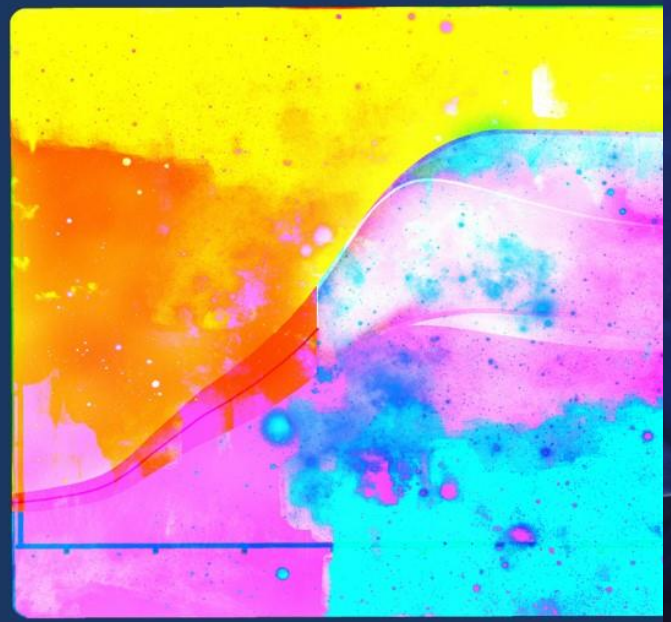
Climate ambition has reached a high point

The past five years

ipcc
INTERGOVERNMENTAL PANEL ON climate change

Global Warming of 1.5°

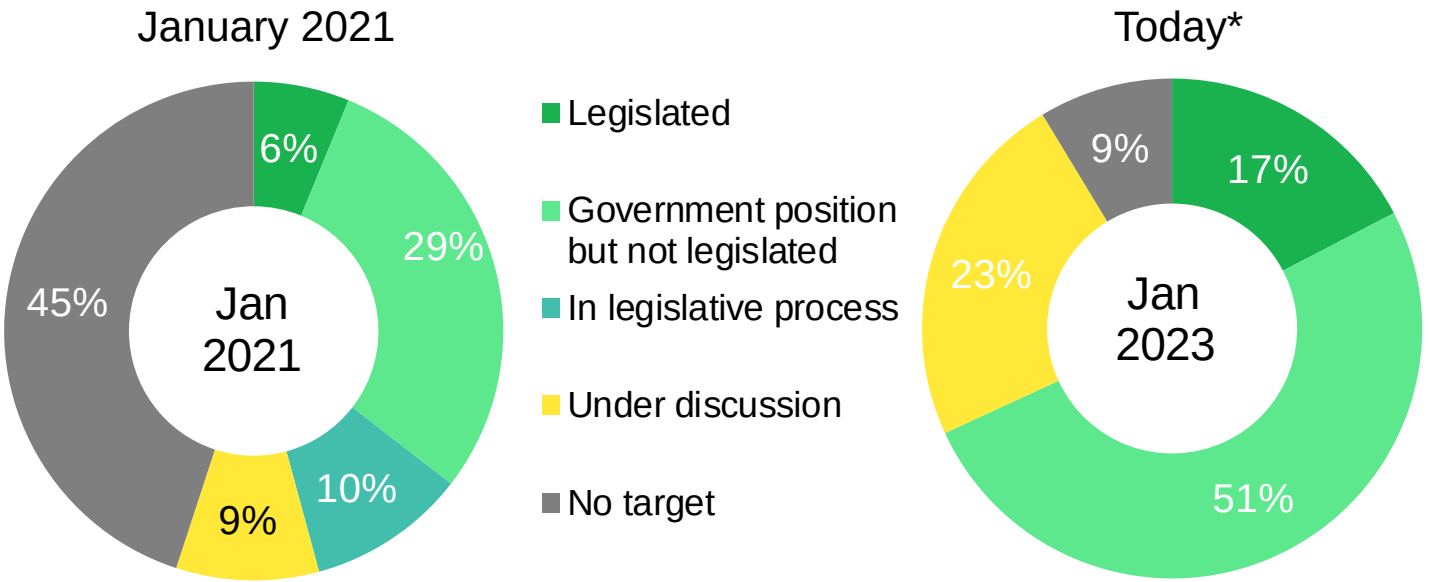
An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathw the context of strengthening the global response to the threat of climate cha sustainable development, and efforts to eradicate poverty.



Source: Intergovernmental Panel on Climate Change, Bloomberg Mercury

Over 90% of global emissions are covered by government net-zero targets

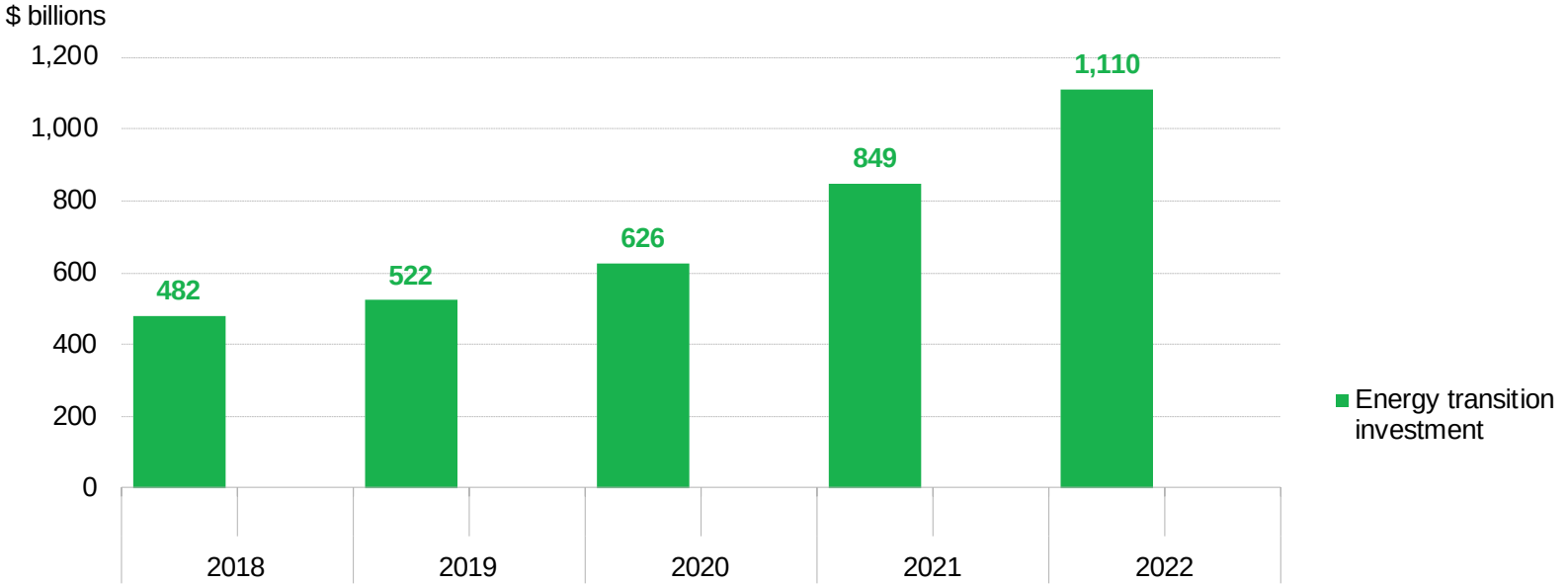
Share of global emissions covered by regional, national and state-level net-zero targets



*Source: BloombergNEF. Note: *As of January 2023. Includes EU emission targets*

Energy transition investment surged past $1 trillion in 2022

Energy transition and fossil fuel investment from 2018-2022

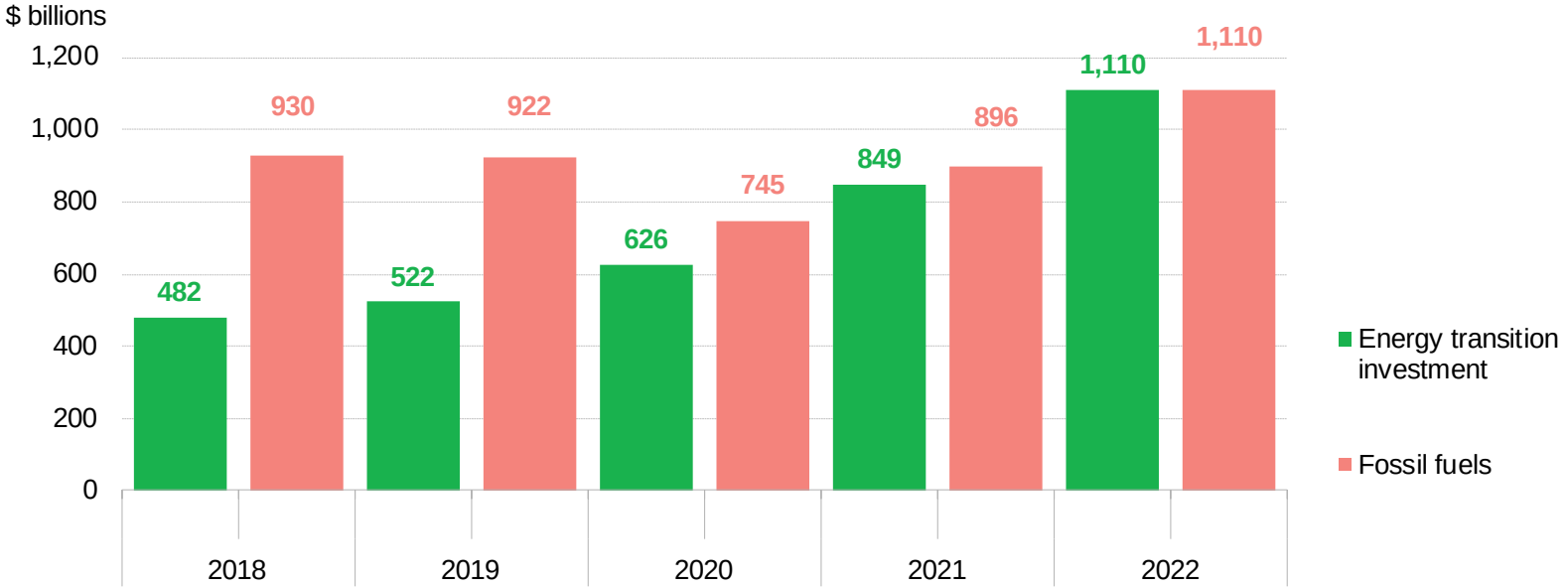


Source: BloombergNEF, IEA. Note: Fossil fuel investment values were derived from the IEA World Energy Investment 2022 report. 2022 fossil fuel investments are BNEF estimates, and include upstream, midstream, downstream sectors and unabated fossil power generation.

Climate ambition has reached a high point

Energy transition investment on par with fossil fuels

Energy transition and fossil fuel investment from 2018-2022



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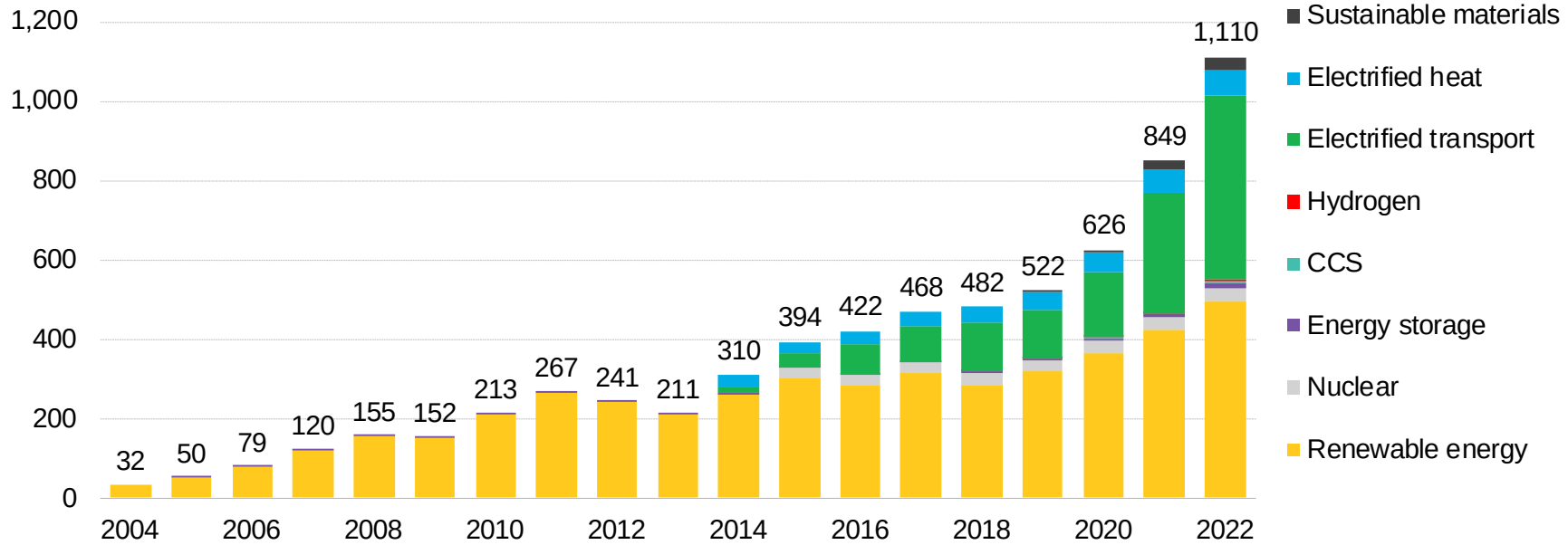
BloombergNEF

Global investment in energy transition by sector

$ billion

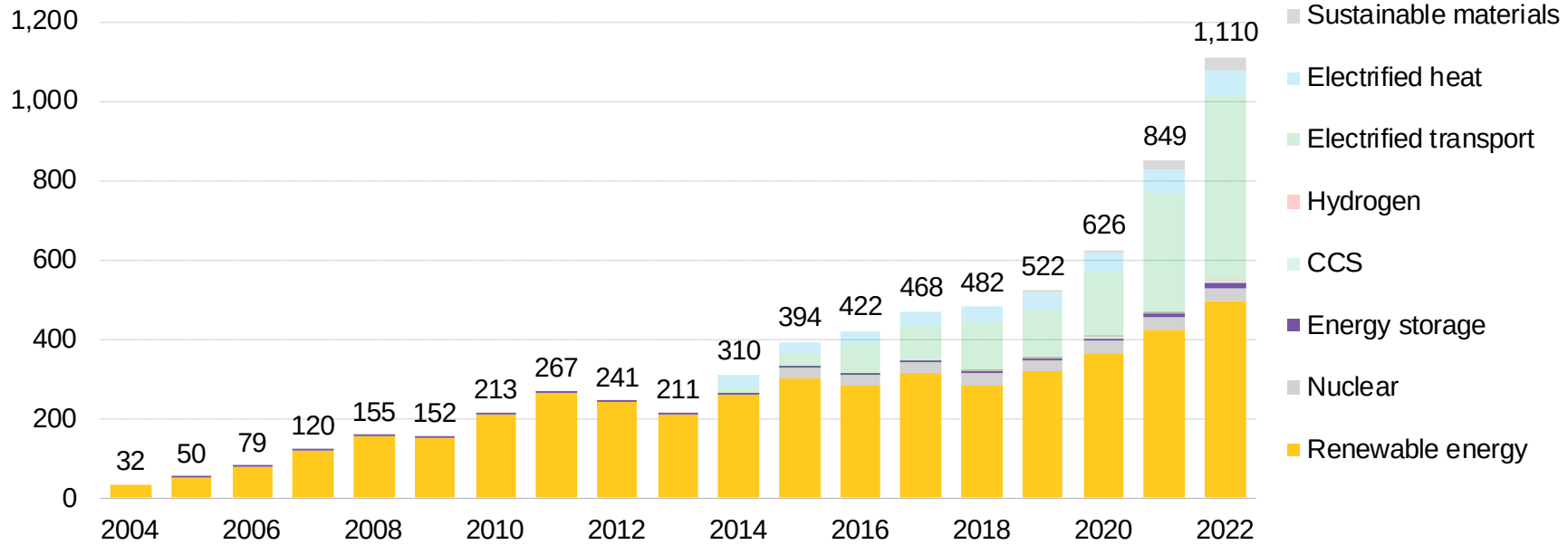


Source: BloombergNEF. Note: Start-years differ by sector but all sectors are present from 2019 onwards; see Appendix for more detail. Nuclear figures start in 2015.

Clean power investment remains strong

Global investment in energy transition by sector

$ billion



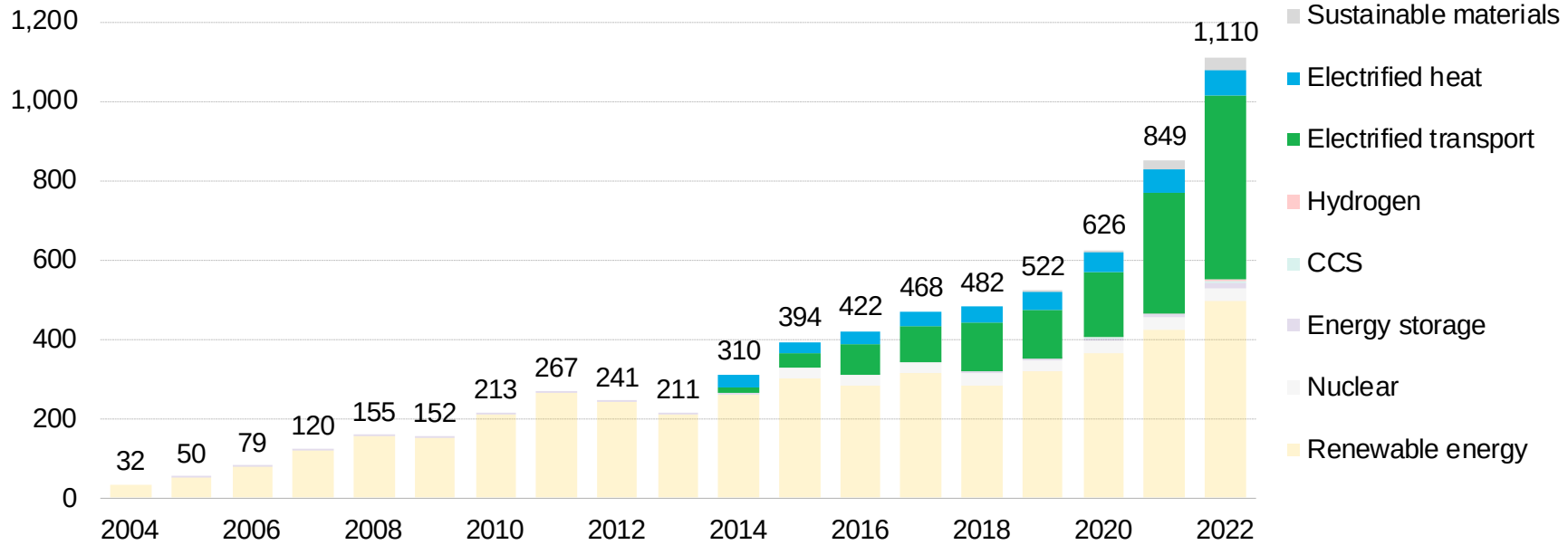
Source: BloombergNEF. Note: Start-years differ by sector but all sectors are present from 2019 onwards; see Appendix for more detail. Nuclear figures start in 2015.

Climate ambition has reached a high point

Electrification is driving the acceleration

Global investment in energy transition by sector

$ billion



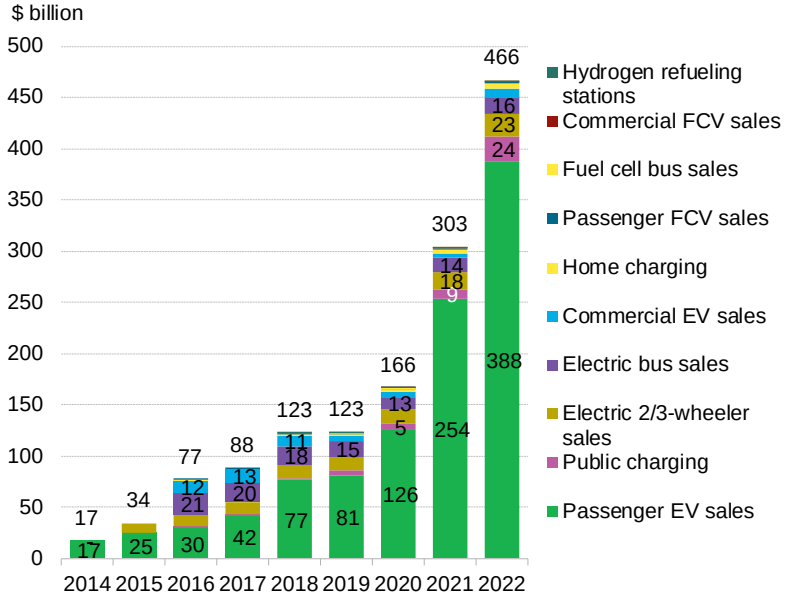
Source: BloombergNEF. Note: Start-years differ by sector but all sectors are present from 2019 onwards; see Appendix for more detail. Nuclear figures start in 2015.

BloombergNEF

Climate ambition has reached a high point

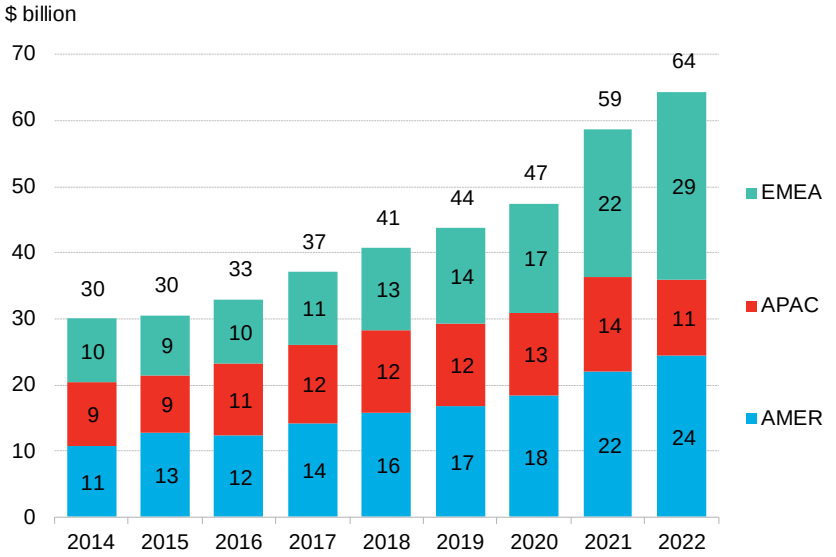
Electrification is driving the acceleration

Electrified transport spending by category



*Source: BloombergNEF. Note: * Electrified transport investment includes spending on vehicles and charging infrastructure. 2022 investment numbers are based on preliminary EV sales data. Totals include estimated vehicle prices. We do not capture private charging investment for commercial vehicles.*

Global investment in heat pumps by region



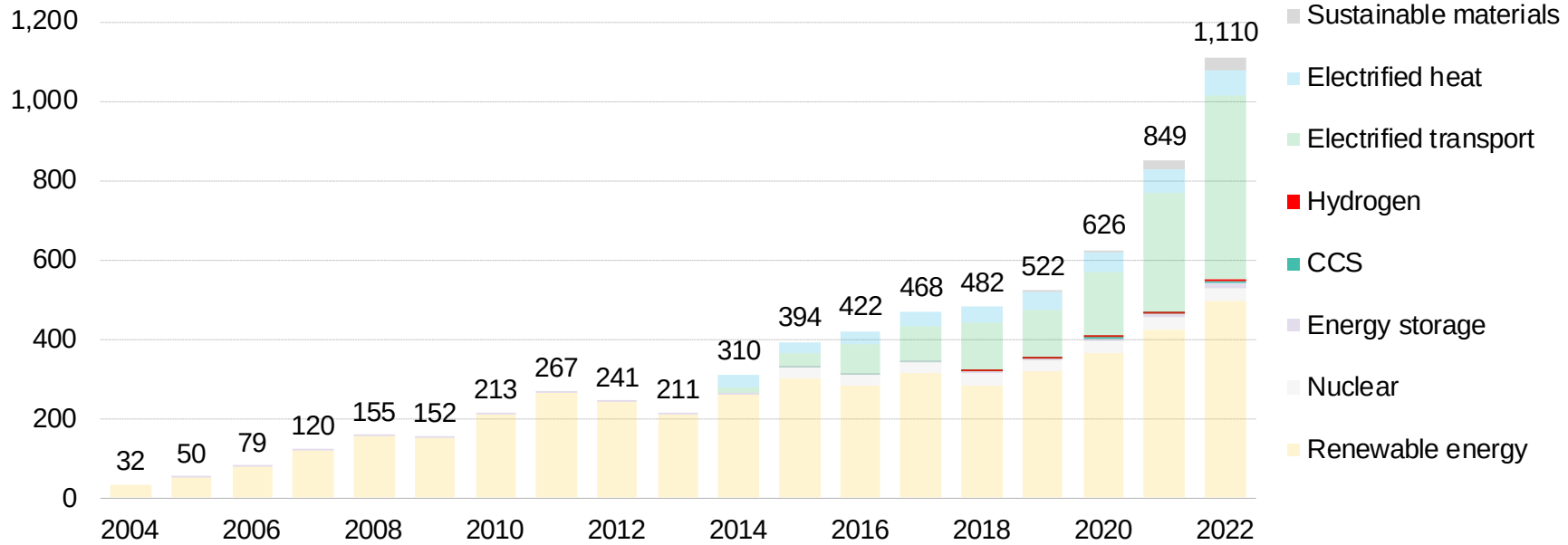
Source: BloombergNEF, European Heat Pump Association, US Air-Conditioning, Heating and Refrigeration Institute (AHRI), Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI), Qianzhan Industry Research Institute, Japan Refrigeration and Air Conditioning Association (JRAIA), consumer websites. Note: Investment calculated as sales multiplied by the average cost for equipment and installation for a typical single-family home. Currency conversion based on average exchange rate over the course of a year.

BloombergNEF

Less-mature technologies are starting to scale

Global investment in energy transition by sector

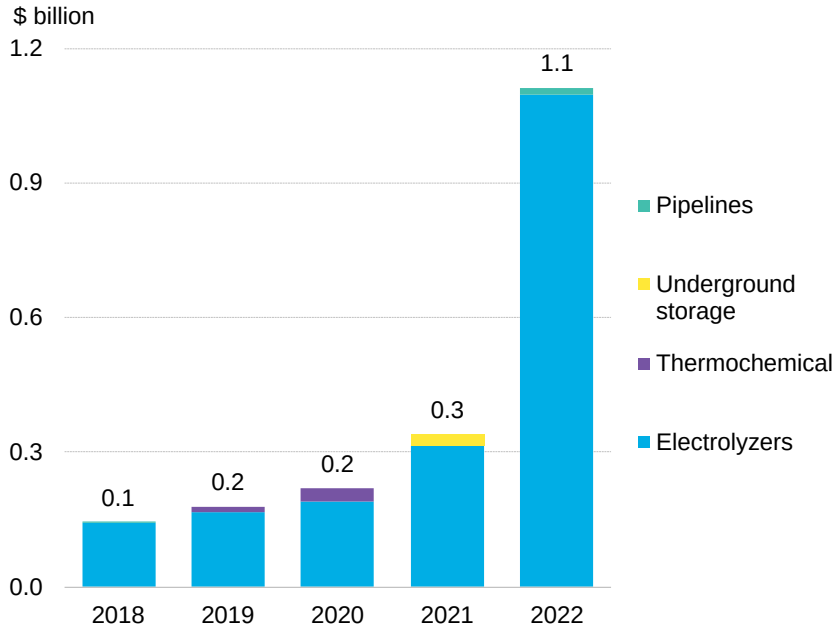
$ billion



Source: BloombergNEF. Note: Start-years differ by sector but all sectors are present from 2019 onwards; see Appendix for more detail. Nuclear figures start in 2015.

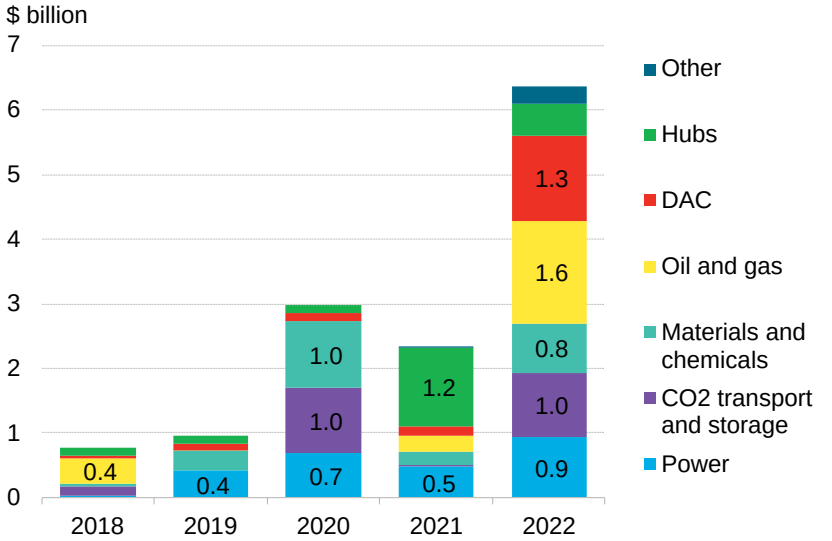
Less-mature technologies are starting to scale

Hydrogen investment by category



Source: BloombergNEF

Carbon capture and storage investment by sector



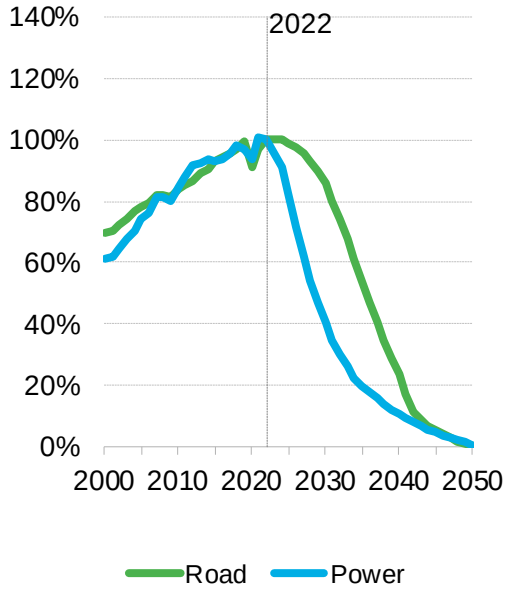
Source: BloombergNEF. Note: includes corporate R&D to develop first phases of specific CCS projects, government R&D, venture capital funding for direct air capture plants and point source technologies.

A net-zero future is still within reach

Electrification, clean power and new technologies are key

Net Zero Scenario: A sector-led approach to carbon budgets based on known technology solutions

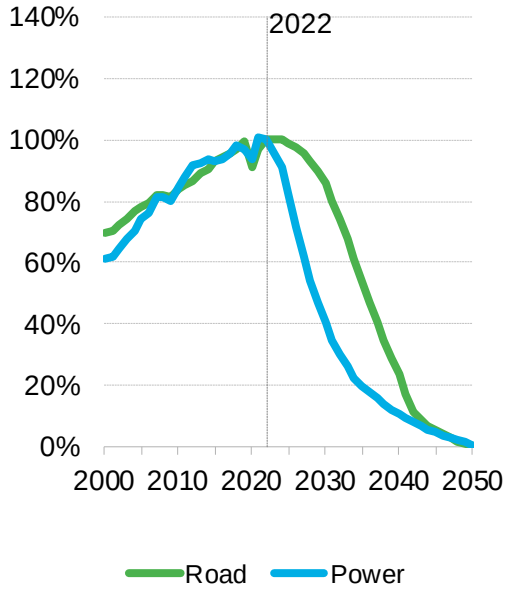
Cost-competitive pathway



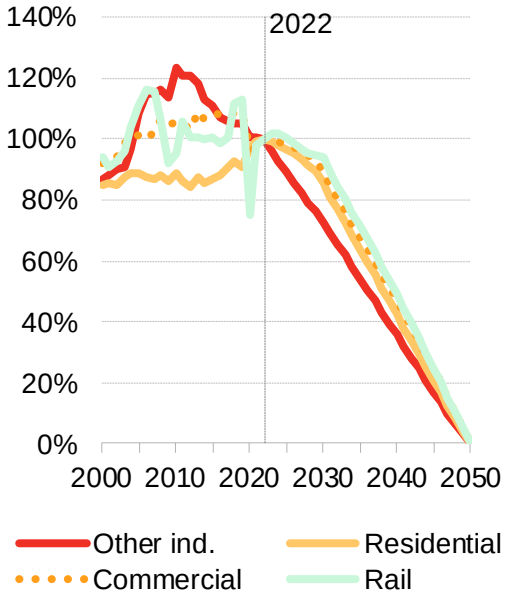
Source: BloombergNEF. Note: Charts rebased to 2022 = 100.

Net Zero Scenario: A sector-led approach to carbon budgets based on known technology solutions

Cost-competitive pathway



Known technologies



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Net Zero Scenario: A sector-led approach to carbon budgets based on known technology solutions

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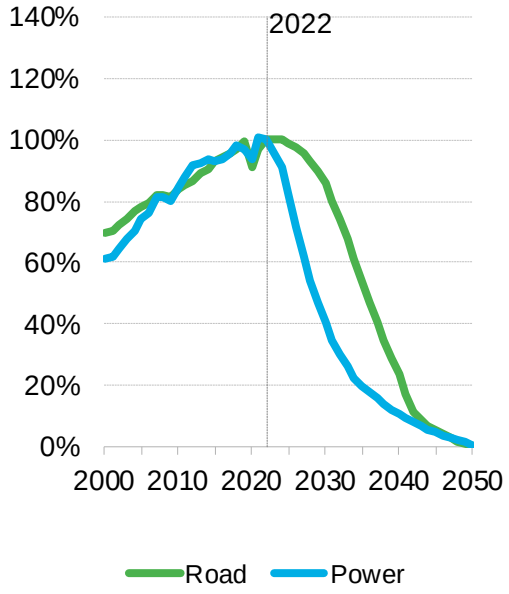
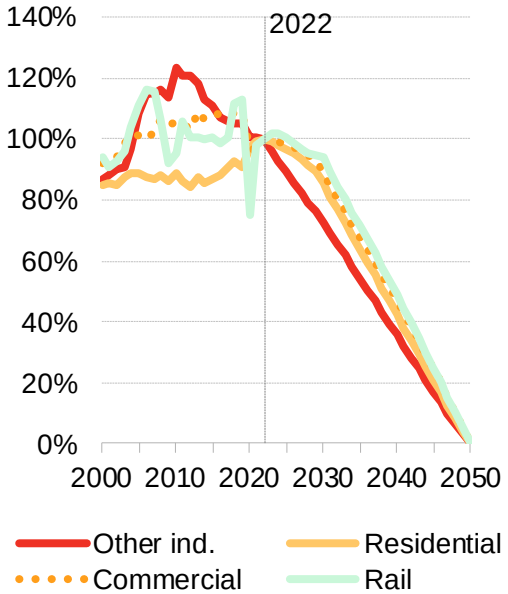
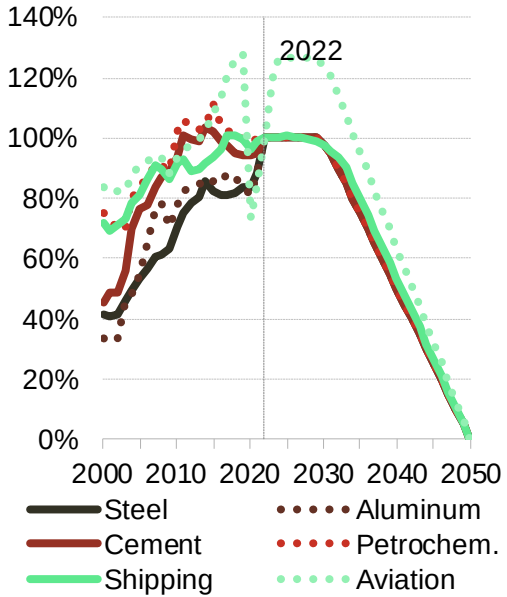


Known technologies



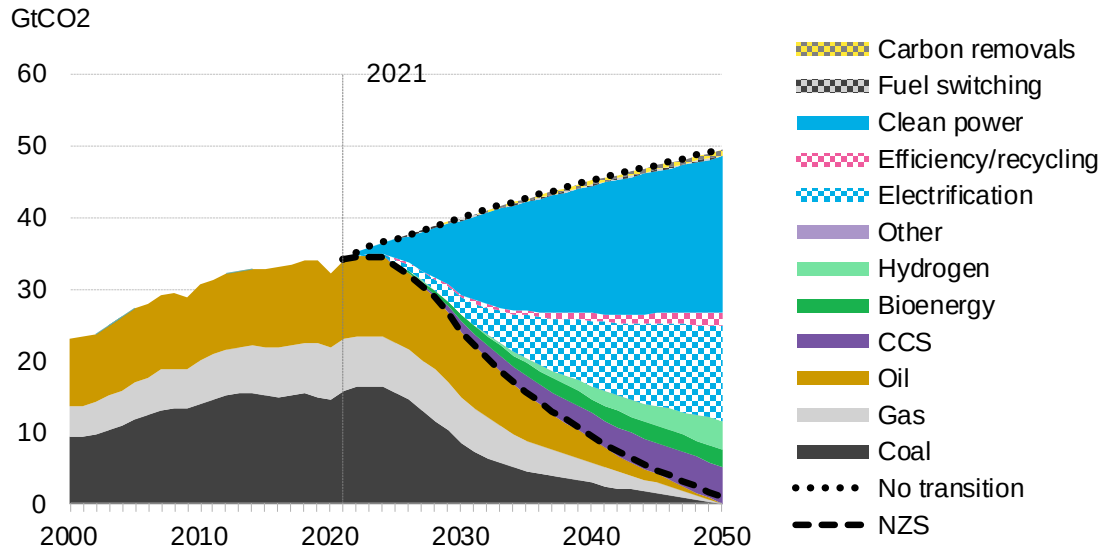
Hard-to-abate



Source: BloombergNEF. Note: Charts rebased to 2022 = 100.

Clean power, electrification, new technologies are key for net zero

CO2 emissions reductions-Net Zero Scenario (NZS) versus a No Transition scenario (ETS)



4x Rise in carbon capture and storage, 2050 vs 2030

5x Rise in final hydrogen consumption, 2050 vs 2022

7x Rise in primary clean power production, 2050 vs 2022

Source: BloombergNEF New Energy Outlook 2022 Net-Zero Scenario.

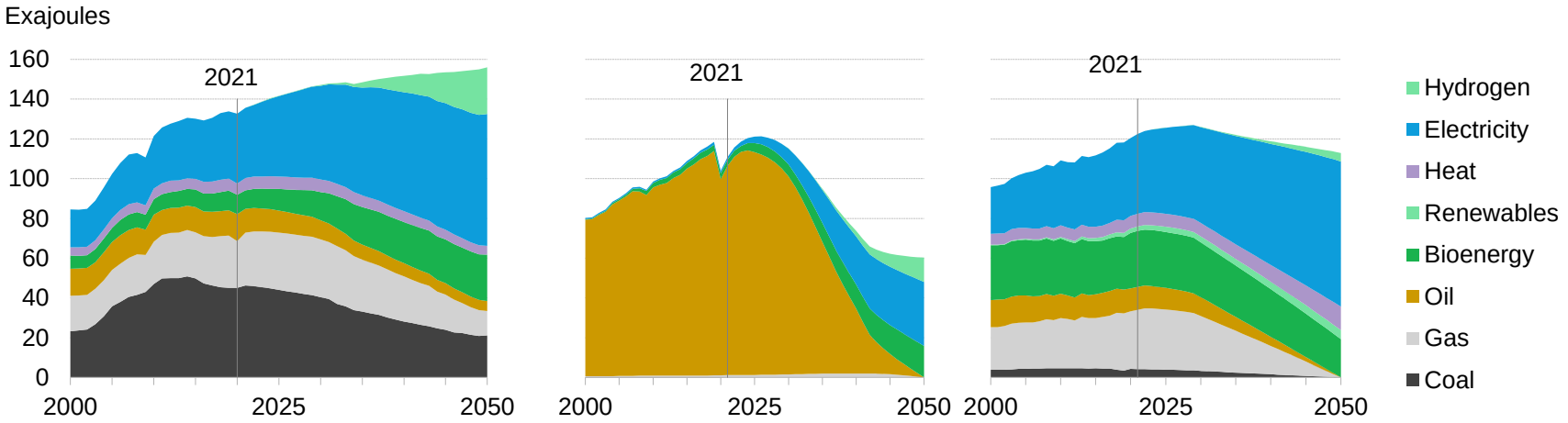
How we make things and consume energy will have to change…

Final energy mix by sector under the Net Zero Scenario

Industry

Transport

Buildings



Source: BloombergNEF.

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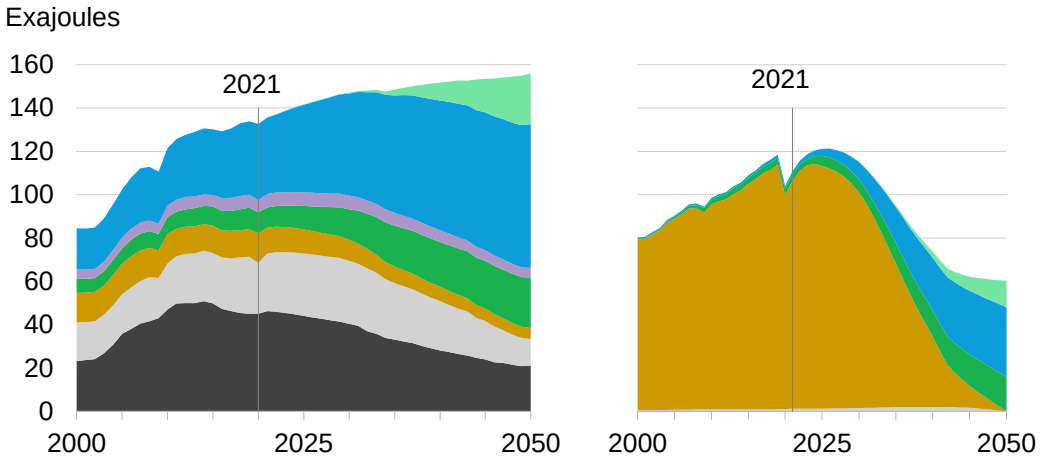

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How we make things and consume energy will have to change…

Final energy mix by sector under the Net Zero Scenario

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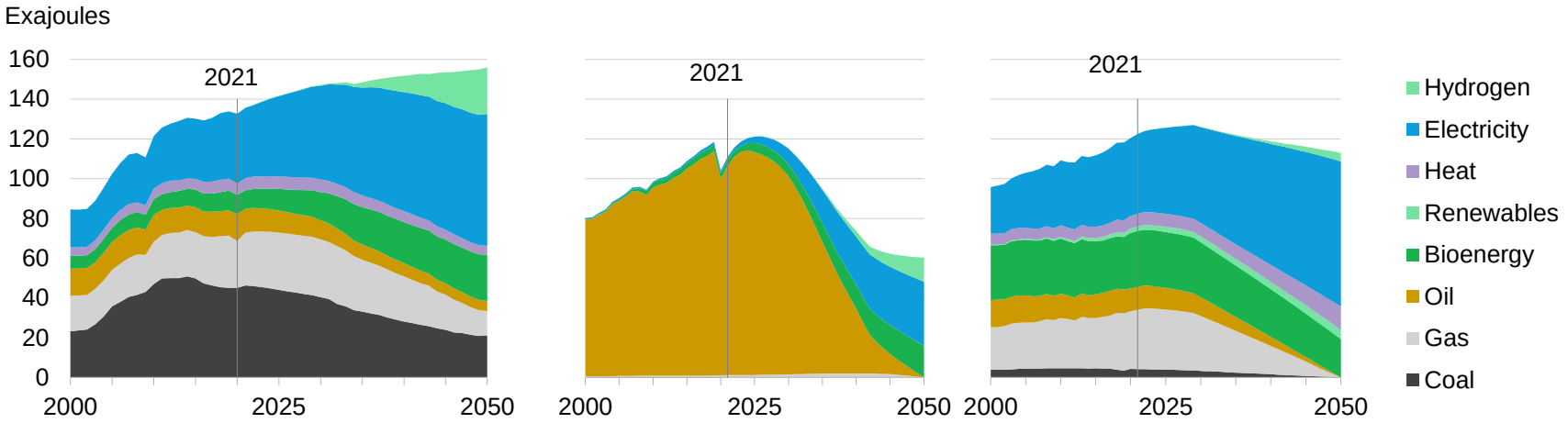
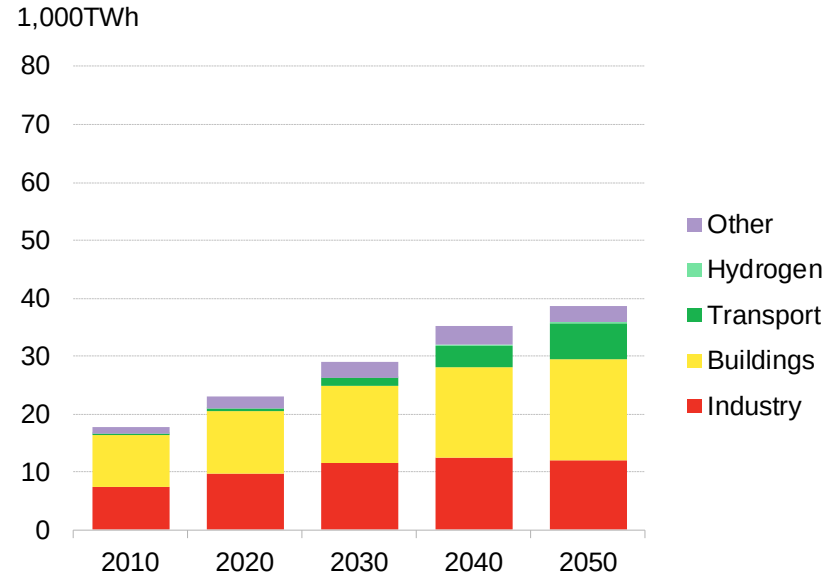


Source: BloombergNEF.

Electrification will triple the size of the power system in the Net Zero Scenario

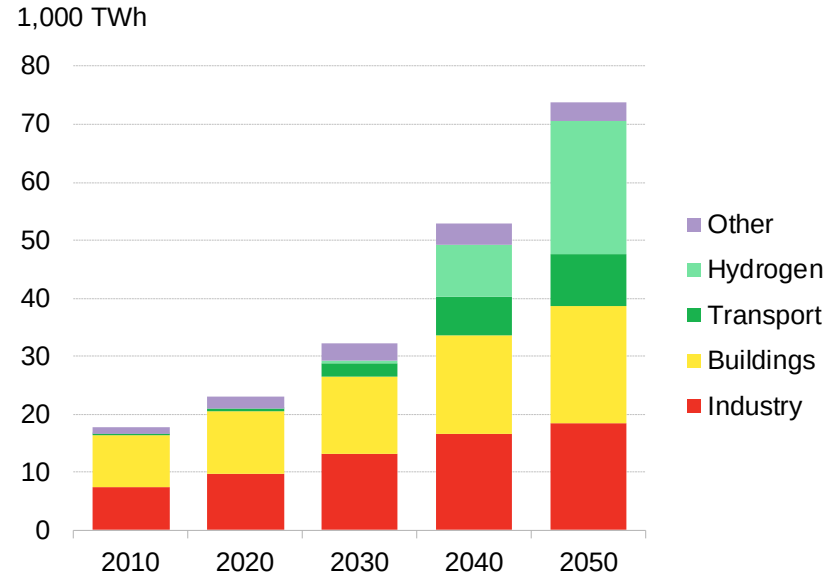
Electricity demand:

Economic Transition Scenario



Source: BloombergNEF. Note: Electricity demand net of generation losses.

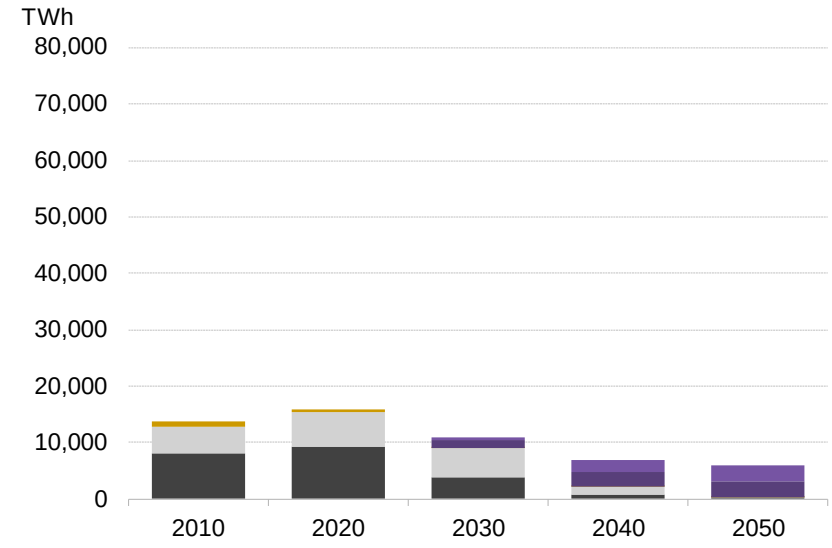
Net Zero Scenario



Source: BloombergNEF. Note: Electricity demand net of generation losses.

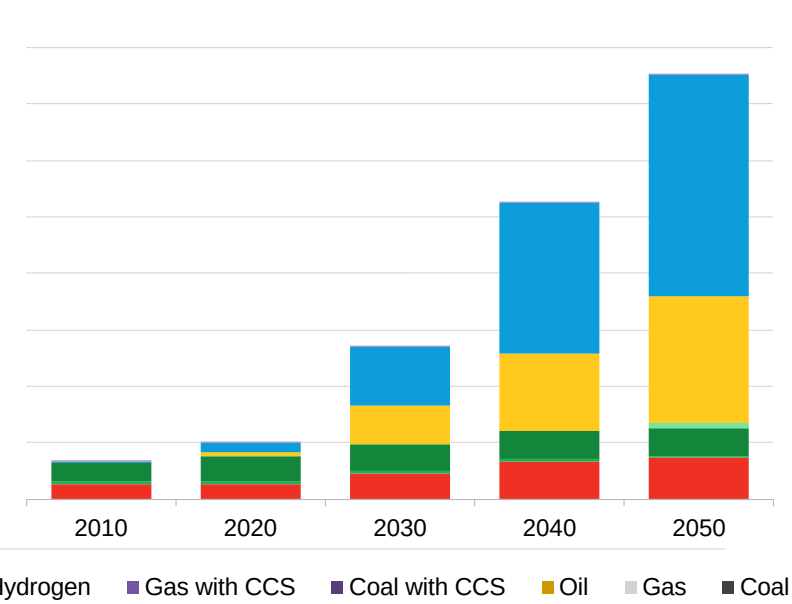
…and the move to clean power will be supercharged

Fossil fuel generation under the NZS



Source: BloombergNEF New Energy Outlook 2022 Net Zero Scenario

Low-carbon generation under the NZS



Source: BloombergNEF New Energy Outlook 2022 Net Zero Scenario

Scaling up clean power deployment remains a challenging

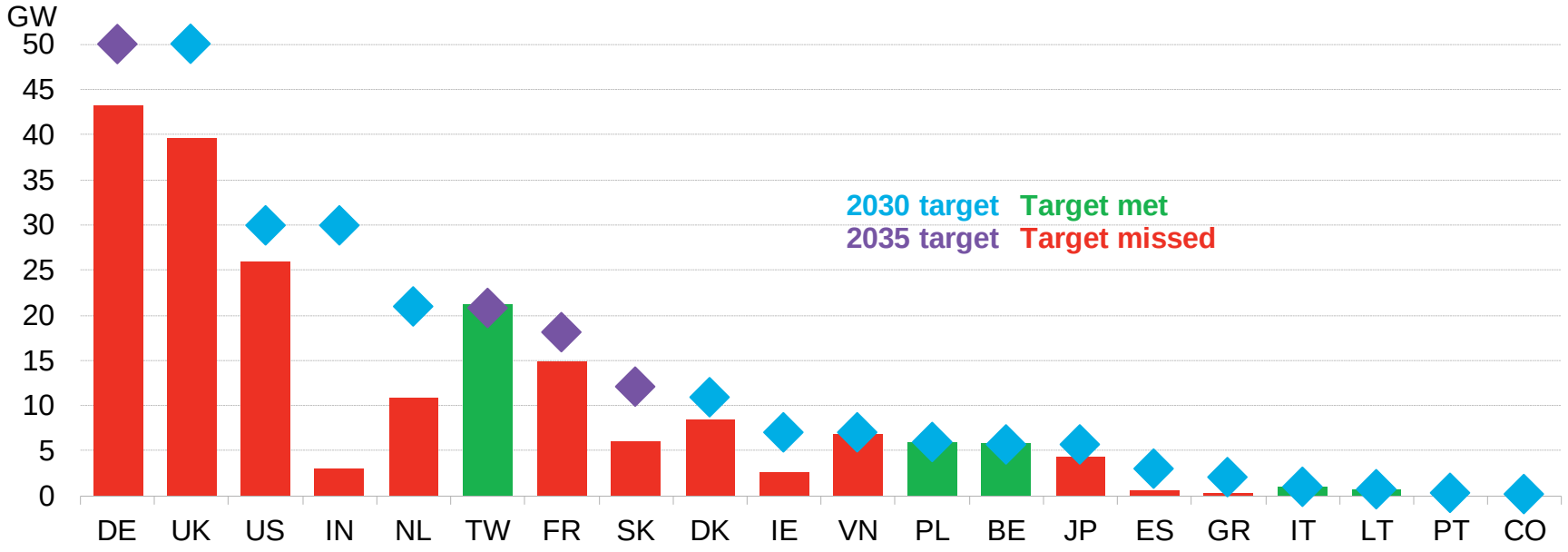
Will government targets outstrip reality?

Ambitious targets

Source: Bloomberg Mercury

Ambitious targets, ambiguous outlook

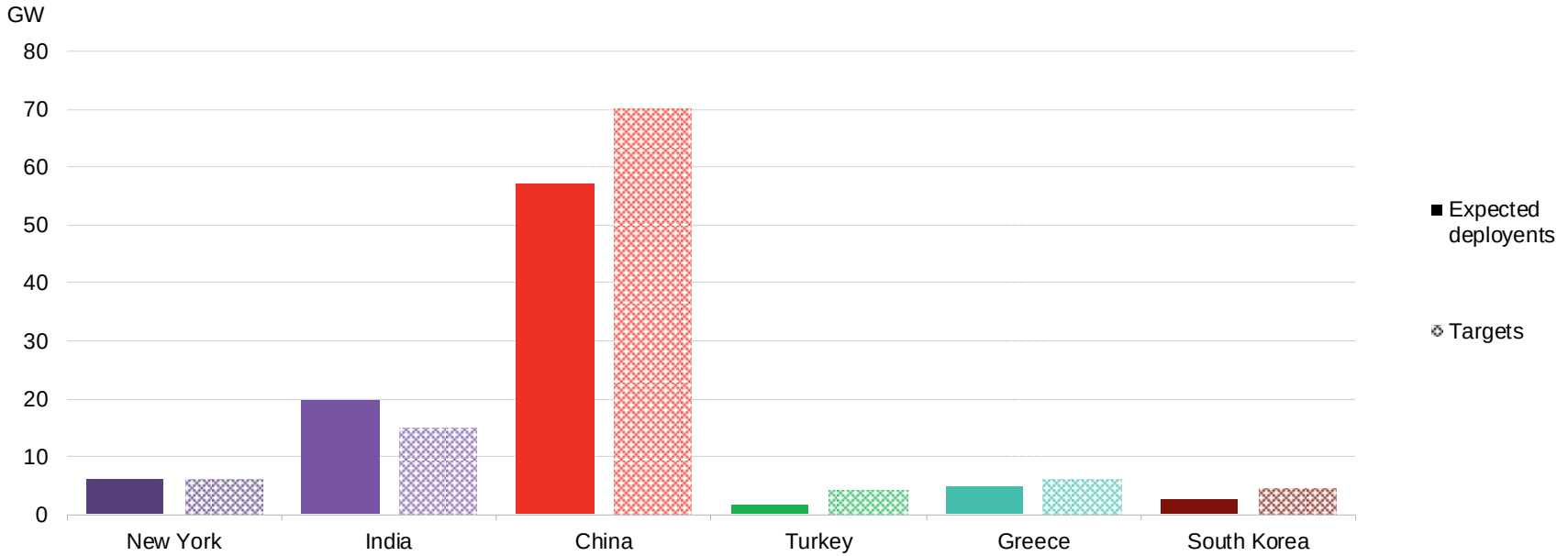
Wind turbine capacity forecast vs government goals



Source: BloombergNEF. Note: Bars show BloombergNEF forecast. Considers announced country-level installation targets for the latest target date within the horizon of BNEF's forecast. We assume the lower end of Colombia's (CO) 0.2 to 1GW-by-2030 target in the chart. Vietnam's offshore wind target has not been finalized and excludes nearshore projects while we include them in our forecast. Norway has an offshore wind target of 30GW by 2040; we forecast that the country will install 4.6GW by 2035.

Ambitious targets, ambiguous outlook

Energy storage targets versus expected deployments by target date



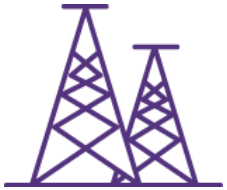
Source: BloombergNEF Note: India's target is estimated, based off our assumptions on expected renewable generation by 2030. Turkey's deployment is calculated based off its 2035 7.5GW target.

BloombergNEF

Thee challenges to overcome for greater renewable energy deployment

Supply chains
(eg, vessels)

Rising costs
(eg, equipment, labor rates, debt, interest rates)



Grids and infrastructure
(eg, interconnection and capacity)

Source: Wikimedia Commons, BloombergNEF

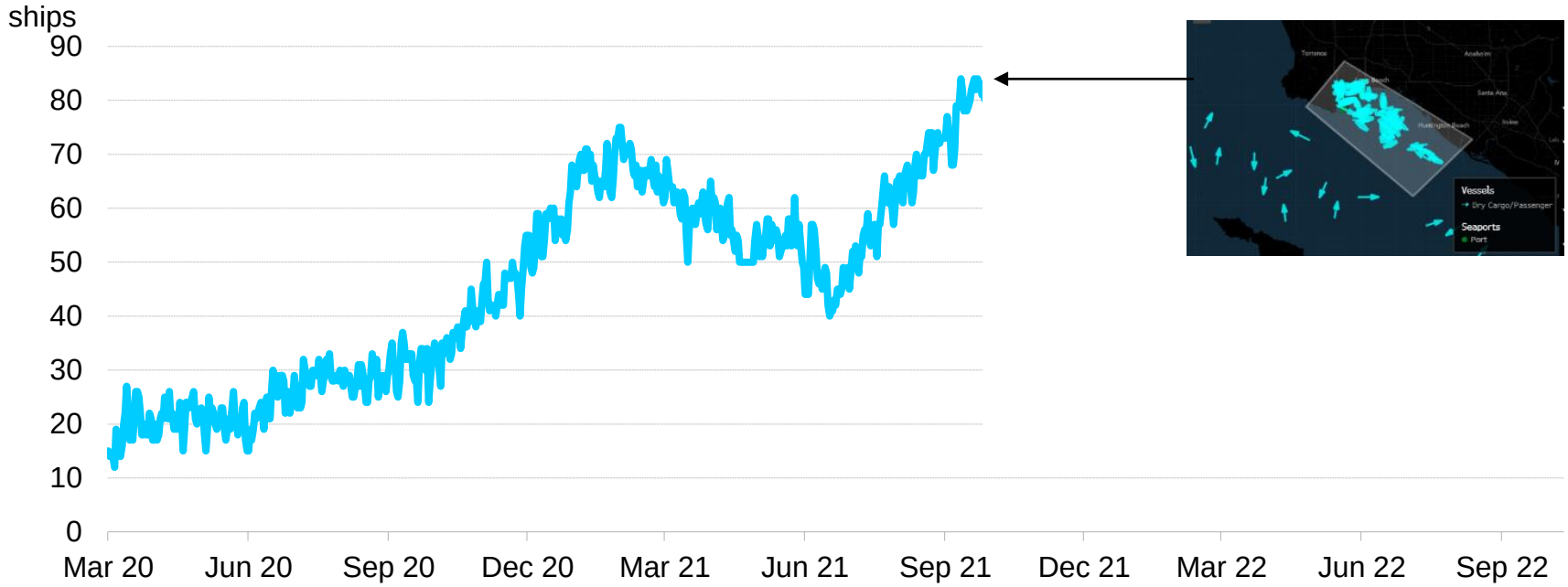
Thee challenges to overcome for greater renewable energy deployment

Supply chains
(eg, vessels)

Source: Wikimedia Commons, BloombergNEF

Ports spent much of the pandemic congested

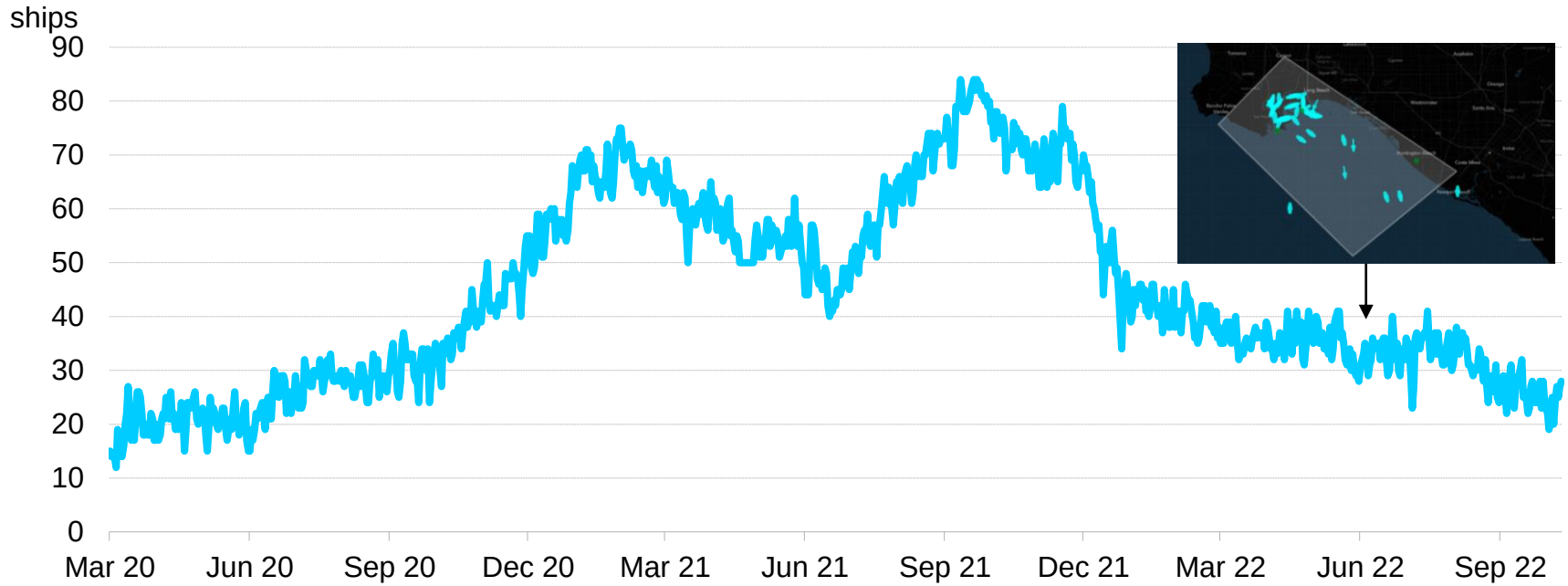
Number of ships at the port of Los Angeles



Source: Bloomberg {WCIDSHLA Index}

Port congestion has been easing throughout 2022, removing another bottleneck

Number of ships at the port of Los Angeles



Source: Bloomberg {WCIDSHLA Index}

Thee challenges to overcome for greater renewable energy deployment

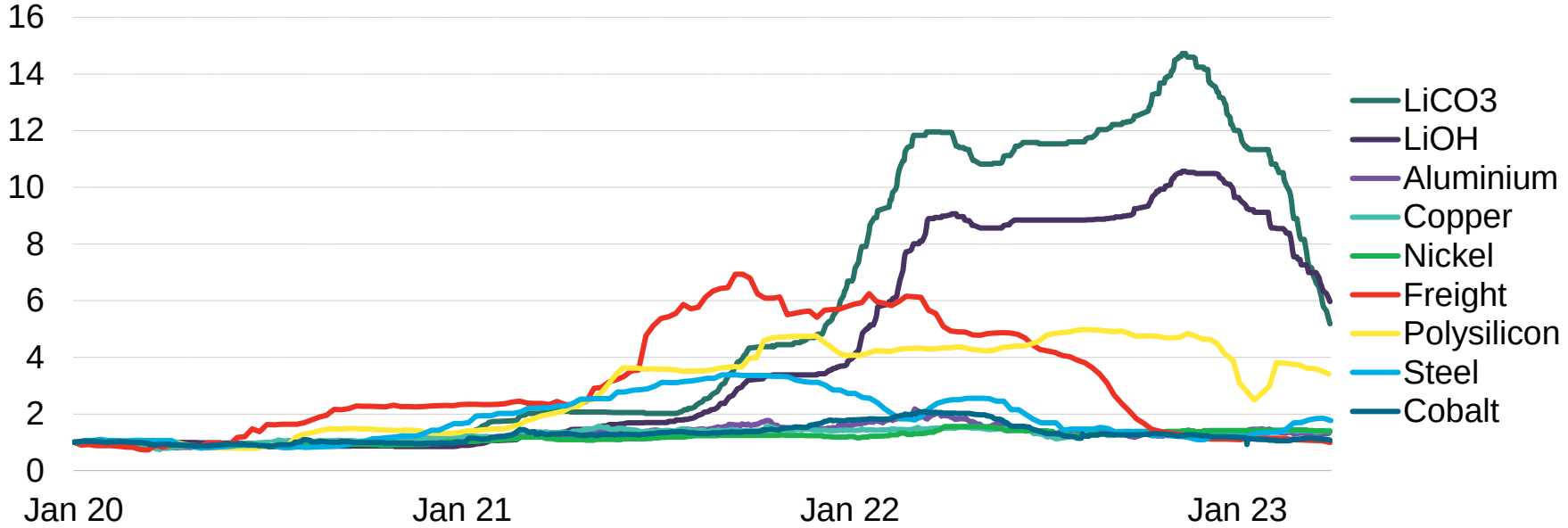
Supply chains
(eg, vessels)

Rising costs
(eg, equipment, labor rates, debt, interest rates)

Source: Wikimedia Commons, BloombergNEF

Rising material spot prices raised clean energy equipment costs

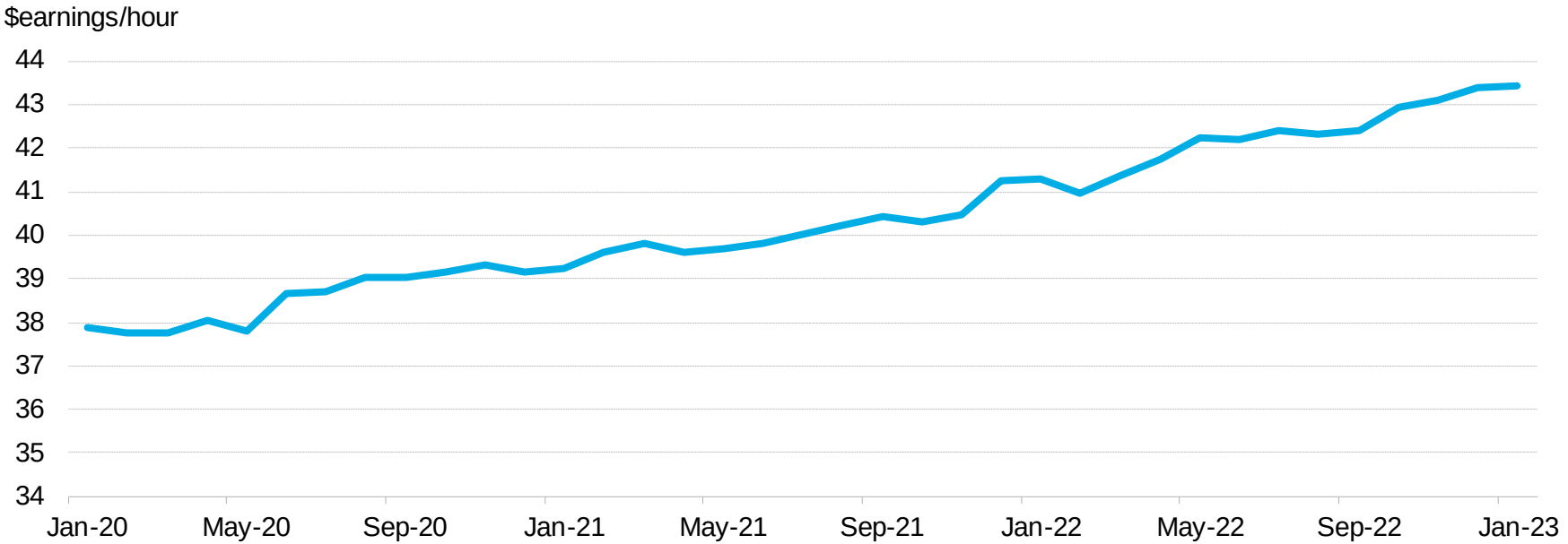
Price movements of key components, rebased to one in January 2020



Source: BloombergNEF, Bloomberg Terminal. Note: Data rebased to 1 on earliest available date in January 2020. Shanghai-LA freight rates used, steel reflects North America costs, while aluminum and copper are China prices – more details as well as Bloomberg Terminal tickers available in the Excel attached to the report. Run {97<GO>} on Terminal or click here to access the Excel.

But it is not just raw materials, labor costs have increased as well

Average hourly earnings of utility production employee

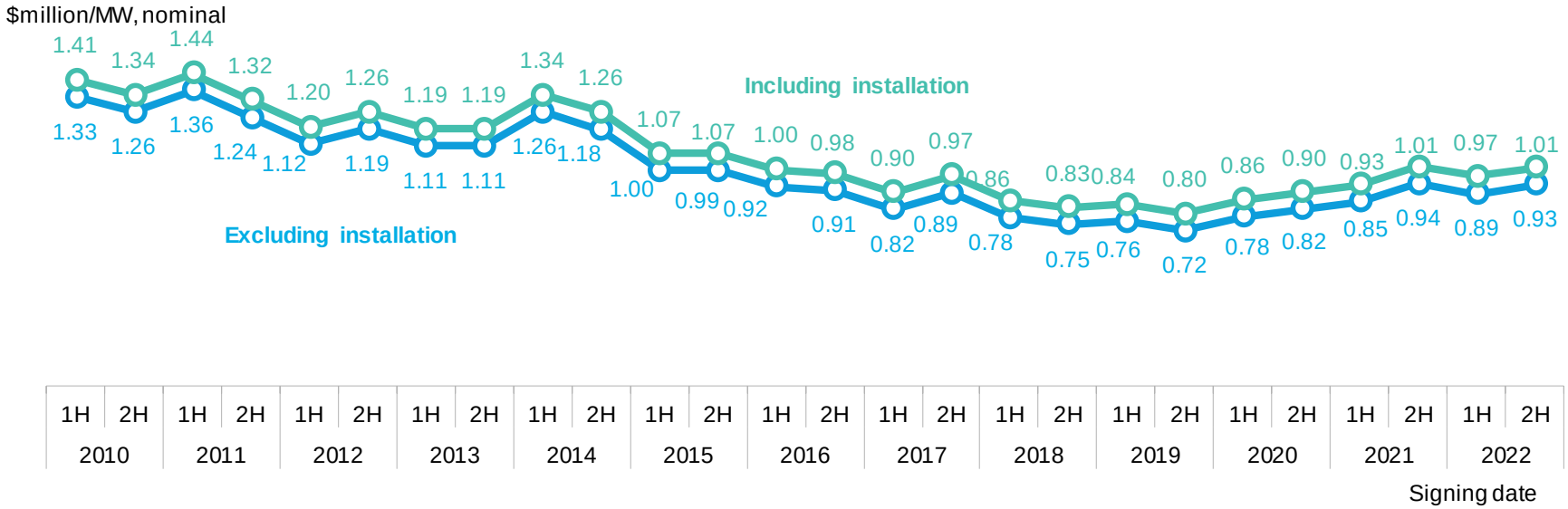


Source: US Bureau of Labor Statistics, BloombergNEF

BloombergNEF

Onshore wind turbine prices have risen 30% from pre-pandemic levels

Onshore wind turbine contract prices

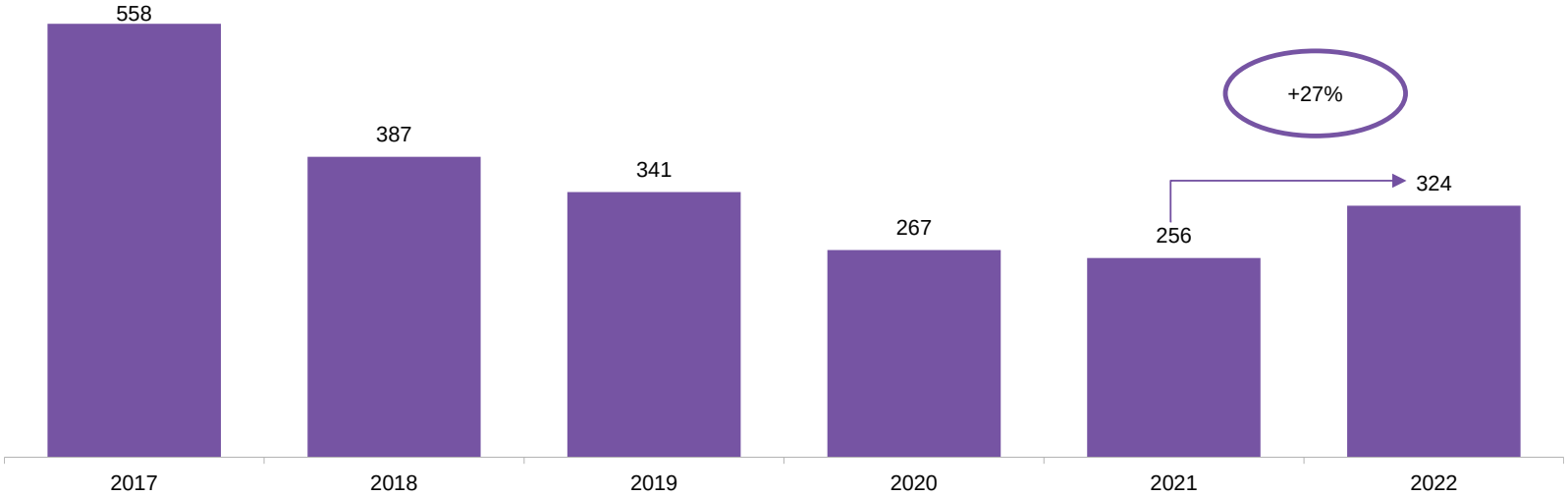


Source: BloombergNEF. Note: U.S. turbine supply contracts typically excludes installation and commissioning cost. European and Latin American turbine supply contracts typically include installation and commissioning costs.

Energy storage system costs rose 27% from 2021-2020

Historical prices for turnkey energy storage systems of four-hour duration

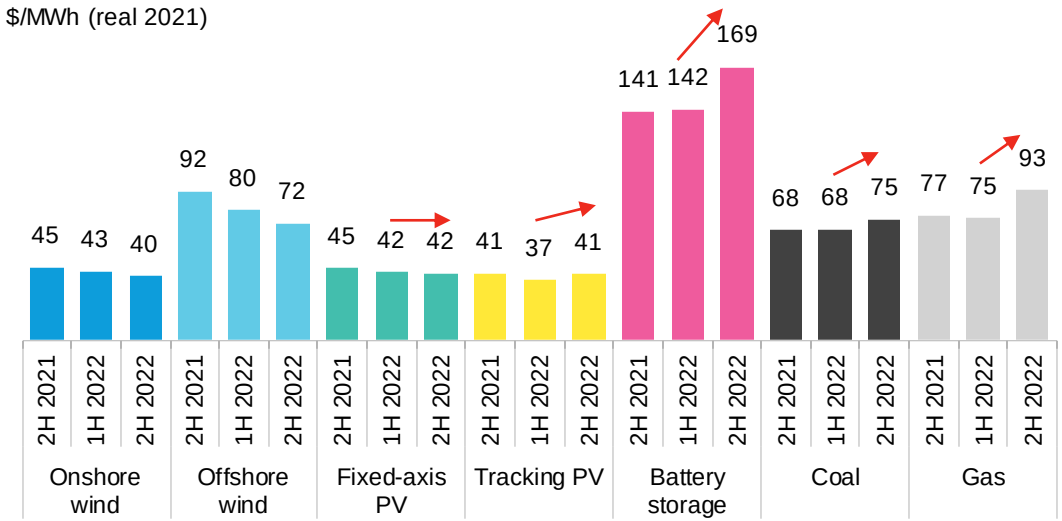
Real 2022 $/kWh, usable



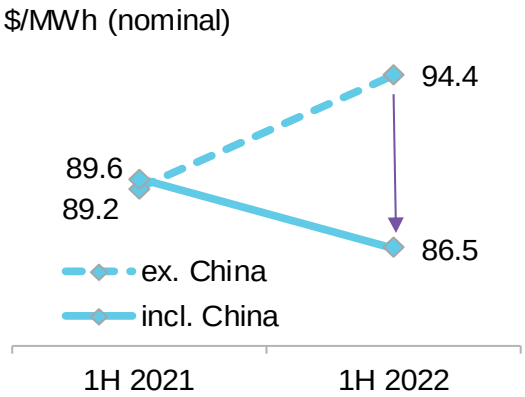
Source: BloombergNEF. Note: Historical prices have been adjusted using June 2021 to June 2022 inflation rates based on US Consumer Price Index (CPI).

LCOEs are rising for the first time in history, driven by supply chains, inflation and pricier debt

Change in global LCOEs, 2H 2021 through 1H 2022



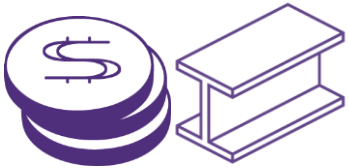
Impact of China on offshore wind LCOE benchmark



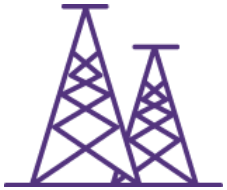
Source: BloombergNEF. Note: The global benchmarks are country-weighted levelized cost of electricity (LCOE) averages using the latest annual capacity additions. Offshore wind includes offshore transmission costs. LCOEs do not include subsidies or tax credits.

Thee challenges to overcome for greater renewable energy deployment

Supply chains
(eg, vessels)



Rising costs
(eg, equipment, labor rates, debt, interest rates)

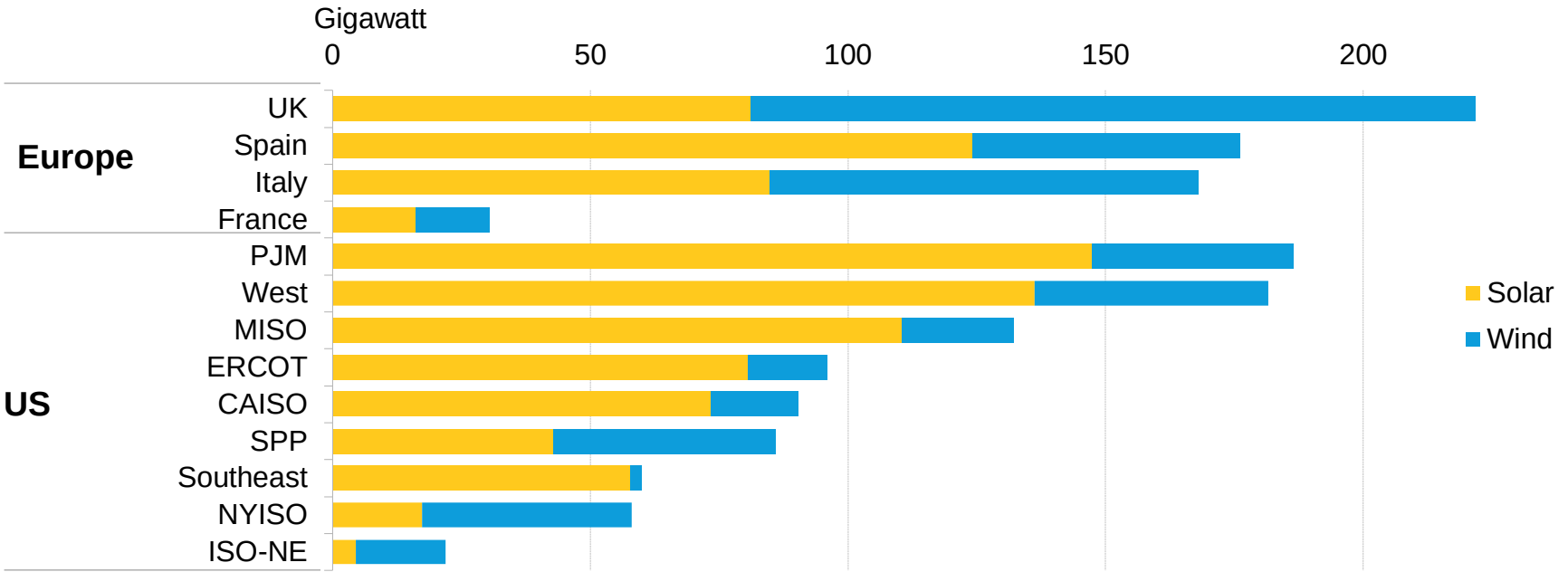


Grids and infrastructure
(eg, interconnection and capacity)

Source: Wikimedia Commons, BloombergNEF

Renewable deployment is stifled by grid connection queues

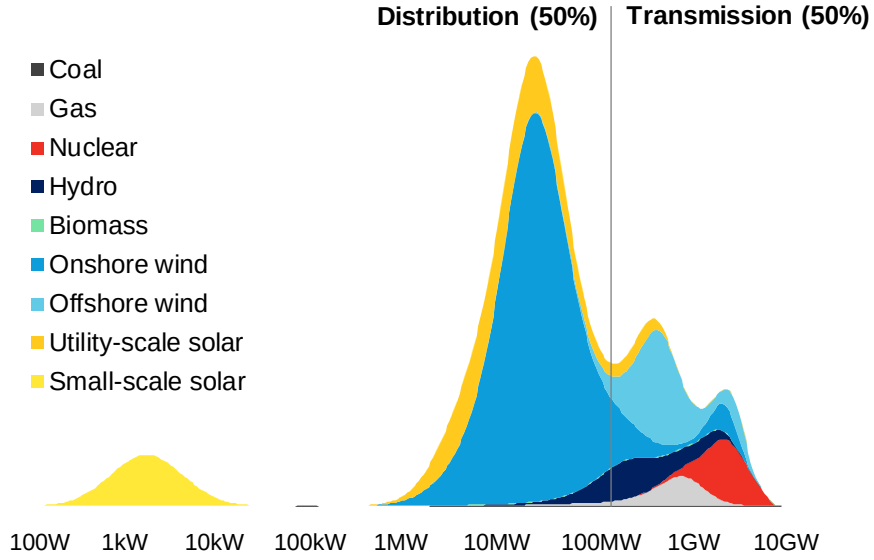
Grid connections queues for wind and solar in select countries



Source: BloombergNEF, Lawrence Berkeley National Lab, National Grid, Electricity Northwest, Northern Powergrid, SSE Networks, Scottish Power Energy Networks, UK Power Networks, Terna, Red Electrica, French Ministry of Ecological Transition. Note: UK data is as of December 2022, Spain as of August 2022, Italy as of end-2021, France as of October 2022 and the US as of end-2021. Battery hybrid projects are included. Wind includes both onshore and offshore sites.

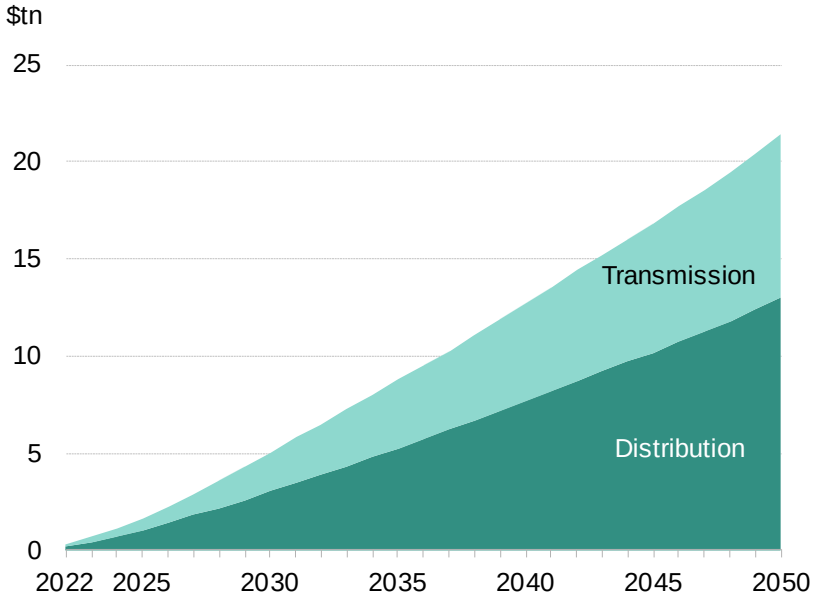
The grid becomes more decentralized, needs $21 trillion of investments

Distribution of generation mix by plant size in 2030, Europe, NZS



Source: BloombergNEF. Note: gas includes some hydrogen.

Cumulative global grid investment, NZS

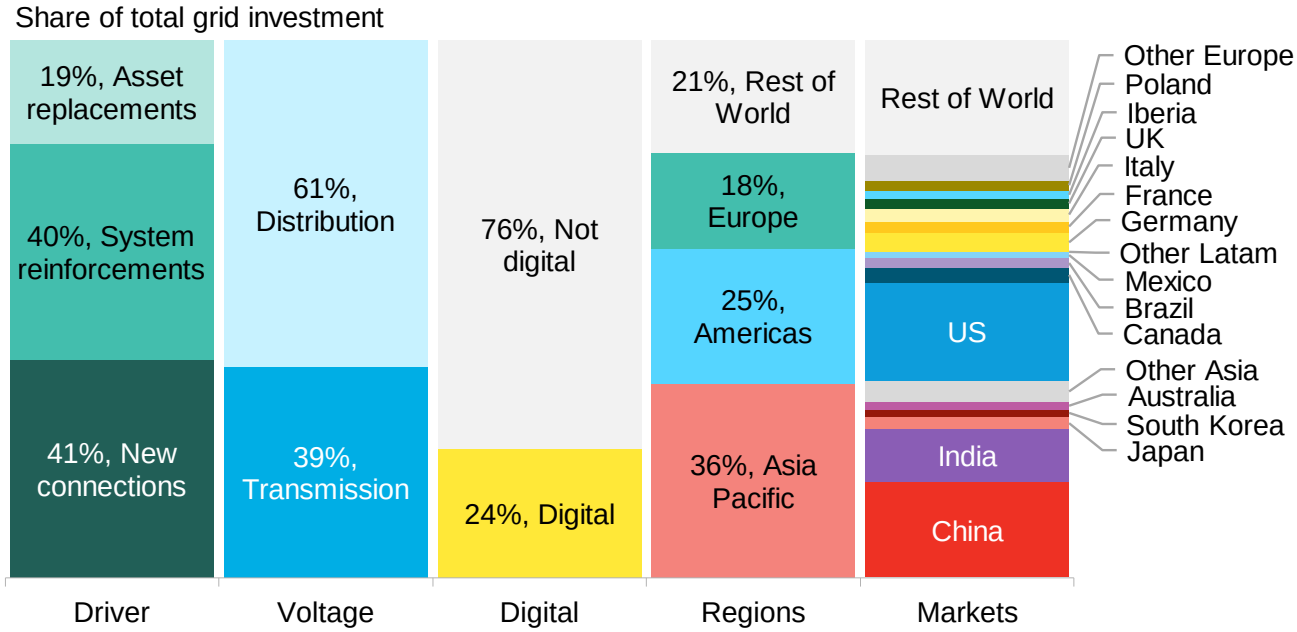


Source: BloombergNEF.

BloombergNEF

At least $21.4 trillion needs to be invested in electricity grids by 2050

Breakdown of global grid investment in net zero scenario 2022-2050

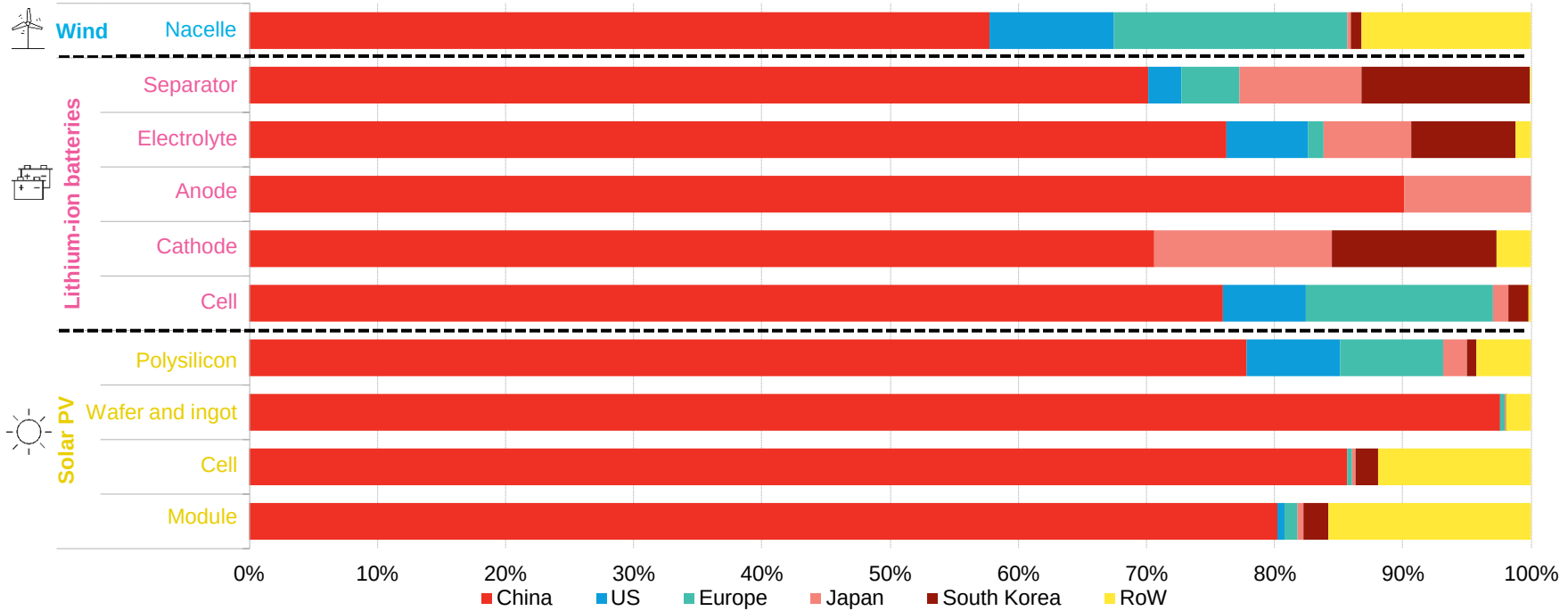


Source: BloombergNEF

Entering a new era for the energy transition

Countries vie for clean power dominance, system volatility rises

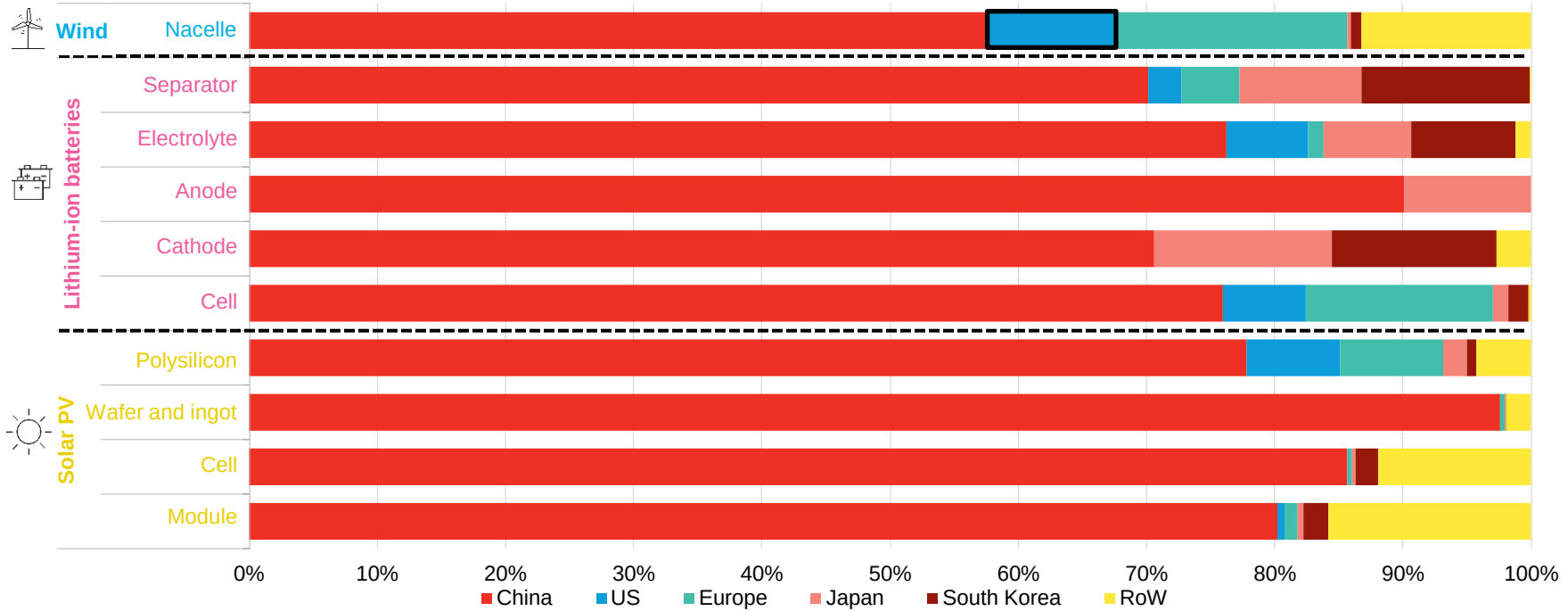
China dominates clean energy manufacturing capacity



Source: BloombergNEF. Note: By factory location. PV, hydrogen and battery components expressed in MW, MWh, m² or tons. Nickel is the class 1 variety, and lithium is in lithium carbonate equivalent. H_2 is hydrogen. Data as of October 2022 except electrolyzers (which refer to 2021) and nacelle data (which are for 2020).

BloombergNEF

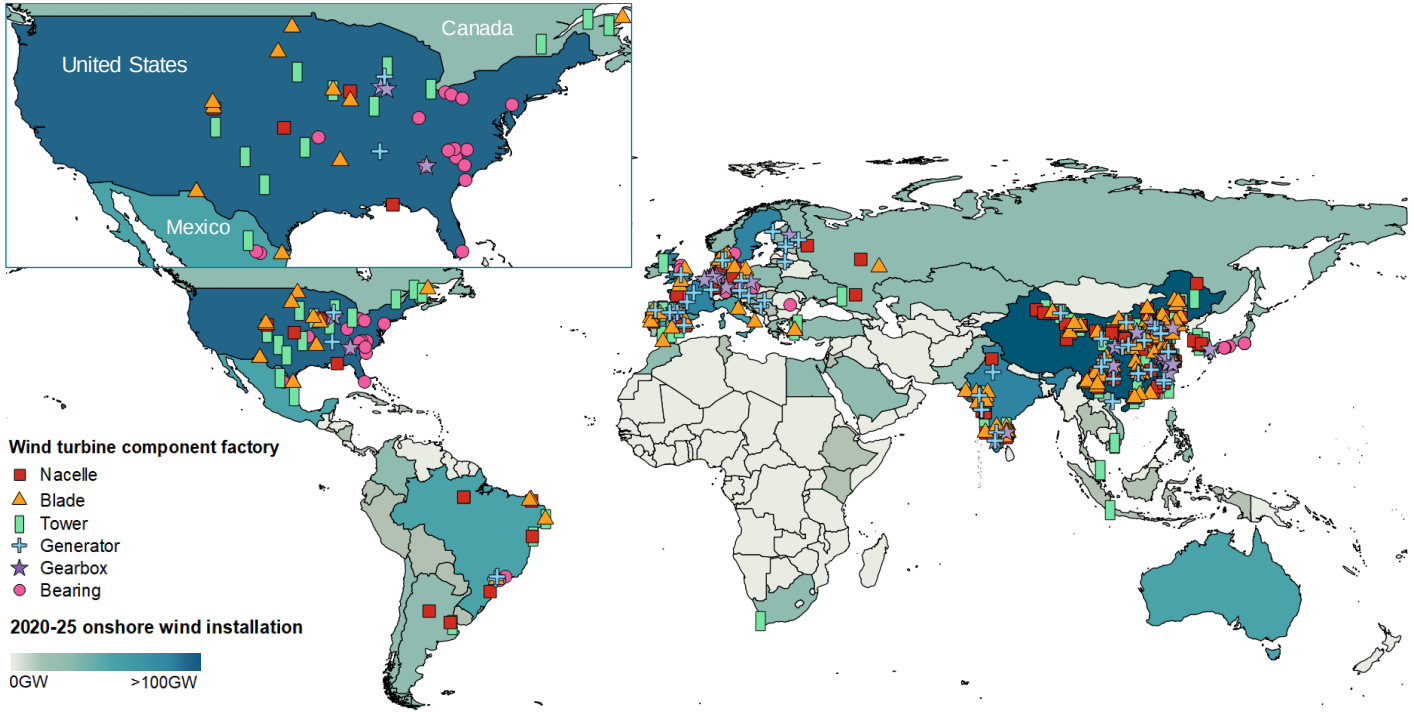
China dominates clean energy manufacturing capacity



Source: BloombergNEF. Note: By factory location. PV, hydrogen and battery components expressed in MW, MWh, m² or tons. Nickel is the class 1 variety, and lithium is in lithium carbonate equivalent. H_2 is hydrogen. Data as of October 2022 except electrolyzers (which refer to 2021) and nacelle data (which are for 2020).

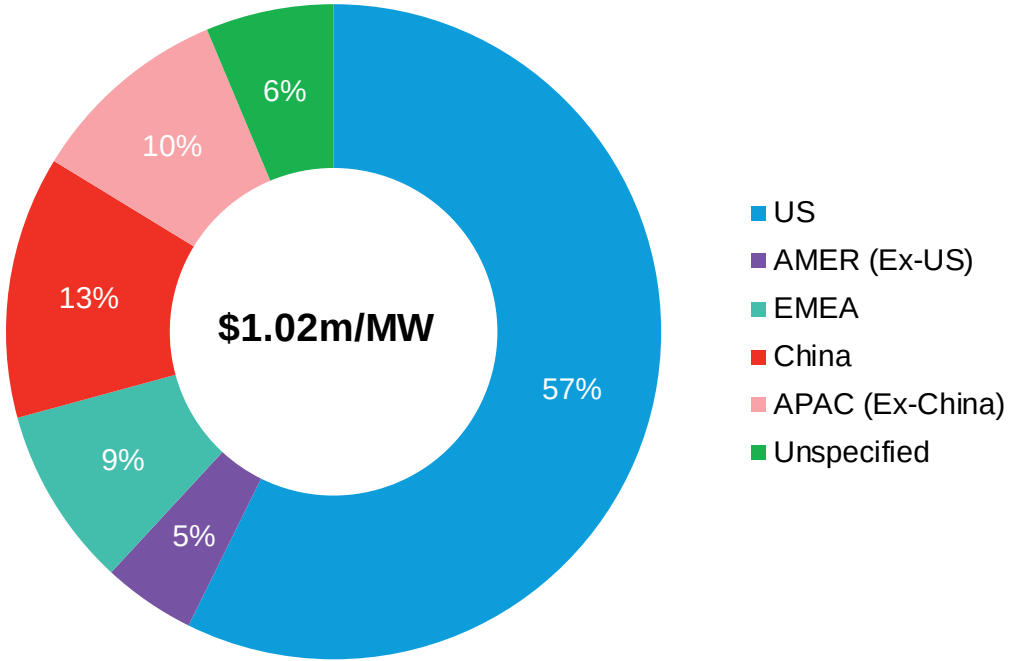
BloombergNEF

The US is a major wind supply chain hub, alongside China, Europe and India



Source: BloombergNEF. Note: Data as of September 25, 2020. Includes only operational factories.

US-manufactured components account for most of a wind turbine's value



Source: BloombergNEF, USITC, LBNL. Note: Includes blade, tower, gearbox, generator, converter, bearing, yaw and pitch, and balance of nacelle. APAC = Asia Pacific. EMEA = Europe, Middle East and Africa. AMER = Americas.

International competition is ratcheting

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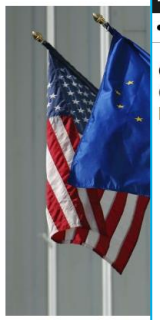
QuickTake

Why Biden's Green Subsidies Have US Allies Fuming



The USA and European Union

By Bryce Baschuk
January 18, 2023 at 4:
1:36 PM GMT

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Green
Climate
Politics

Climate Policy Has Become Central in the Fight for Global Power

- Major economies are creating incentives for green investment
- Russia's war in Ukraine has made Europe's shift more urgent

Margrethe Vestager, competition commissioner of the European Commission, speaks at a ne
conference with US Secretary of State Antony Blinken, right, and EU Trade Commissioner
Valdis Dombrovskis, left, during the US-EU Trade and Technology Council meeting in College
Park, Maryland, on Dec. 5. *Photographer: Ting Shen/Bloomberg*

By Ewa Krukowska, Jennifer A Dlouhy and Laura Millan Lombrana
December 20, 2022 at 11:00 AM GMT

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Politics

France Demands Tougher EU Response to US Climate Law

- Le Maire says Inflation Reduction Act endangers EU industry
- No option excluded in EU response to US, Le Maire says

Bruno Le Maire *Photographer: Valeria Mongelli/Bloomberg*

By Alan Katz and William Horobin
November 7, 2022 at 6:46 AM GMT *Updated on November 7, 2022 at 8:45 AM GMT*

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Green

China Mulls Protecting Solar Tech Dominance With Export Ban

- Export ban considered for technology used to make solar wafers
- China accounts for 97% of global output for the wafers

By Dan Murtaugh
January 26, 2023 at 7:57 PM GMT

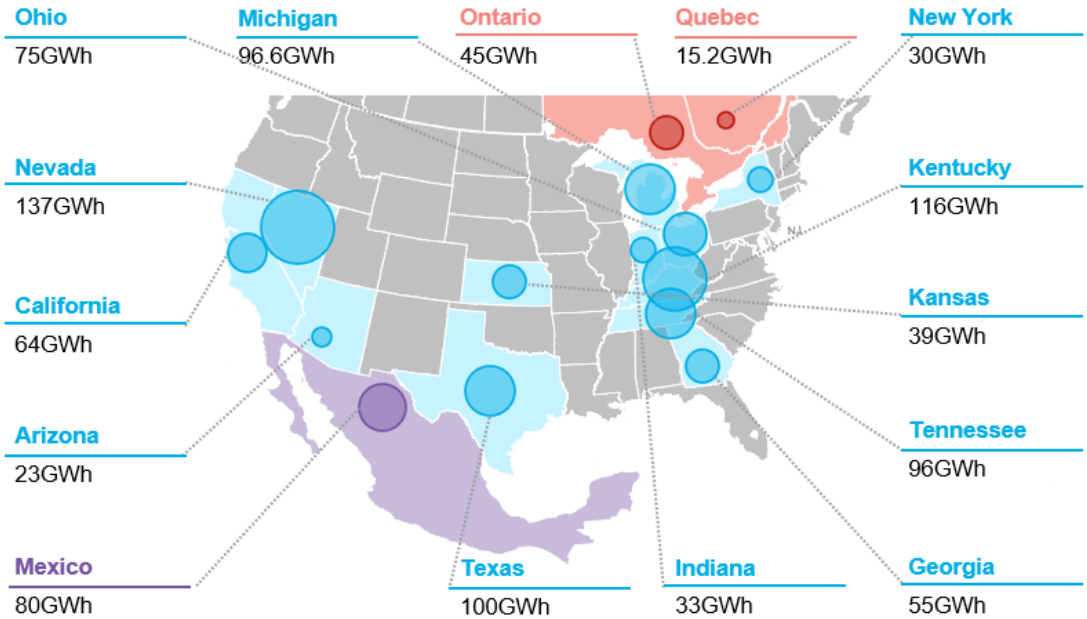
Source: Bloomberg LP

US passes landmark climate legislation

Source: Bloomberg LP

Battery manufacturing capacity are on the rise

Battery manufacturing projects announced since IRA passage

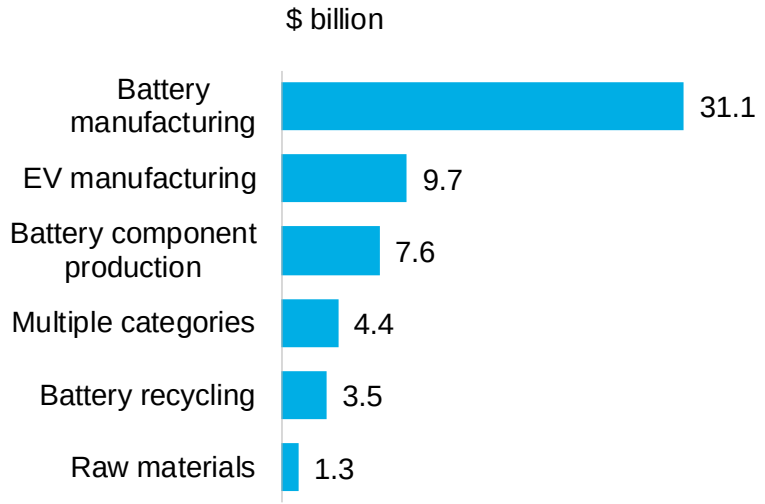


Source: BloombergNEF. Note: Dates for fully commissioned plants correspond to the data when the last phase was commissioned. Bubble size corresponds total capacity commissioned, under construction and announced.

BloombergNEF

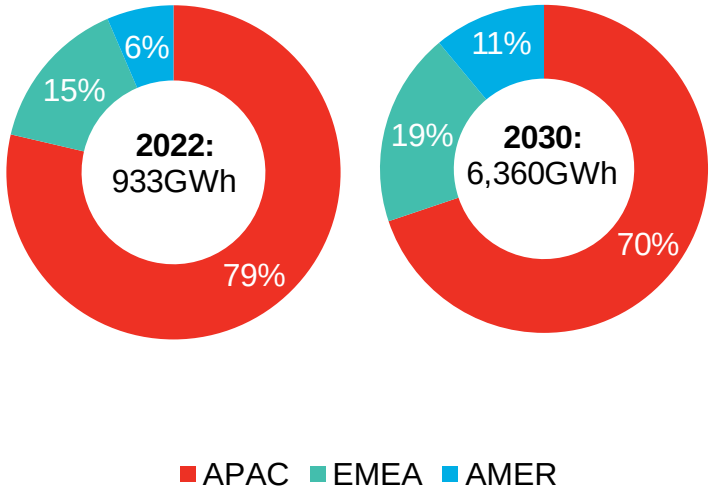
Battery investments and manufacturing capacity are on the rise

North America EV and battery investments planned post-IRA



Source: BloombergNEF, company press releases. Note: Includes investments in the North America region through April 3, 2023. 'Multiple categories' investments do not disclose how much is dedicated to each category.

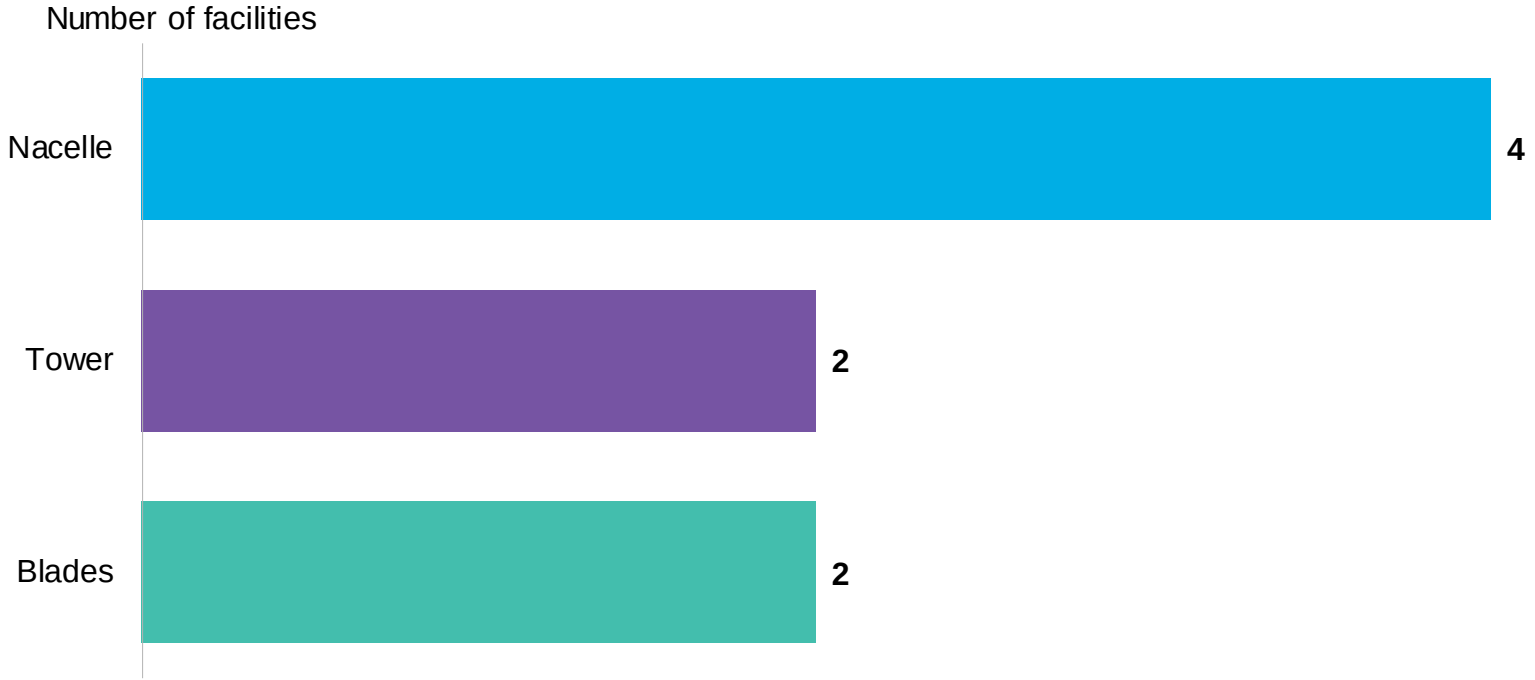
Global Li-ion cell manufacturing capacity



Source: BloombergNEF

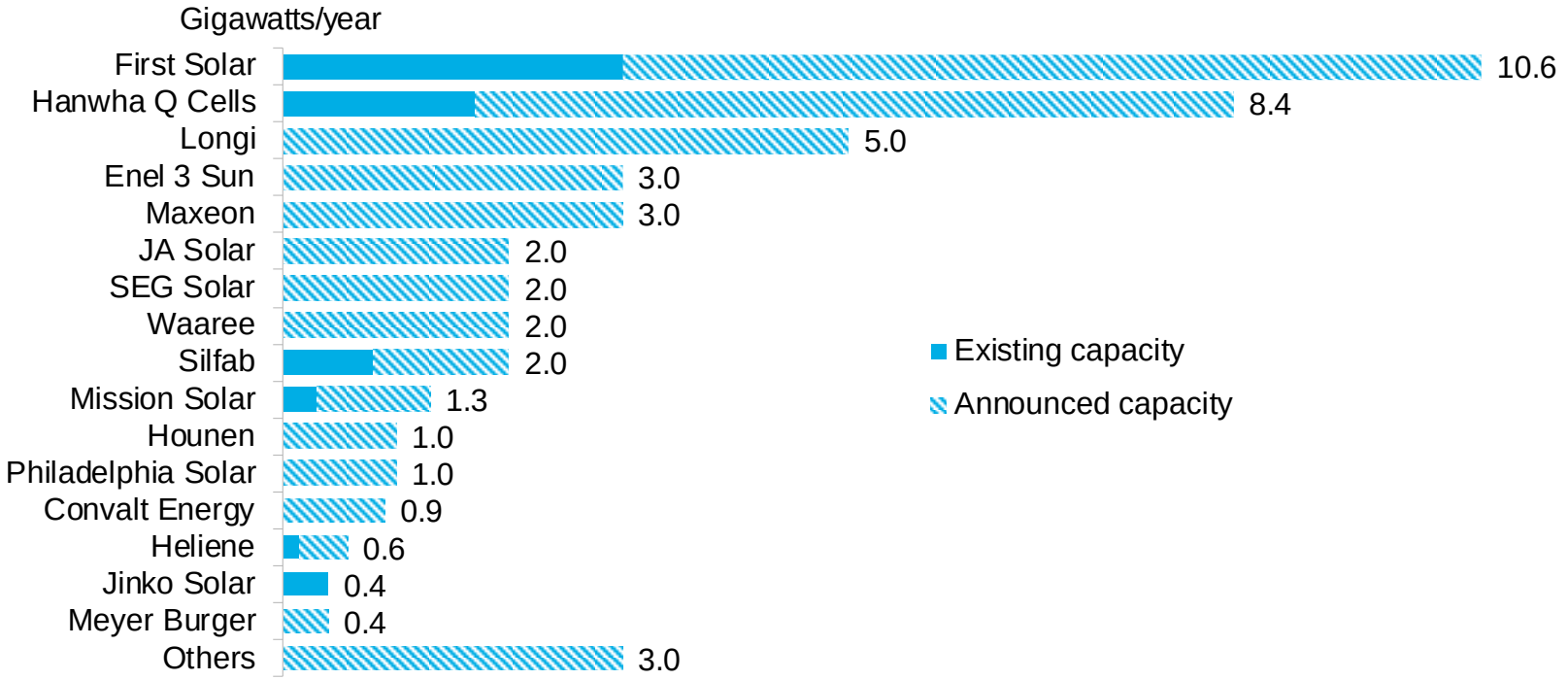
BloombergNEF

IRA has also driven wind plants to expand and reopen



Source: American Clean Power Association, BloombergNEF. Note: Only includes onshore wind facilities. Nacelle includes assembly and component manufacturing.

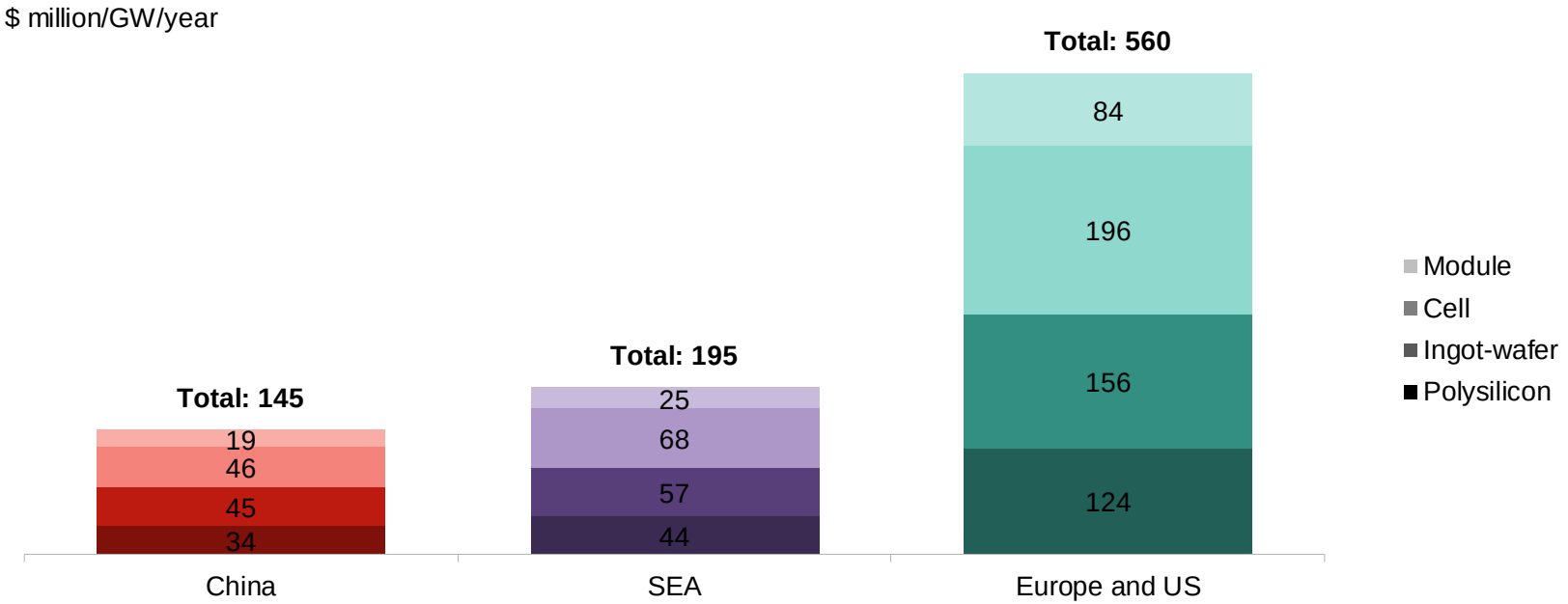
IRA has inspired a huge influx of solar module factory announcements



Source: BloombergNEF

Shifting to local manufacturing often comes at added cost

Estimated per unit capex for solar factories, by geography

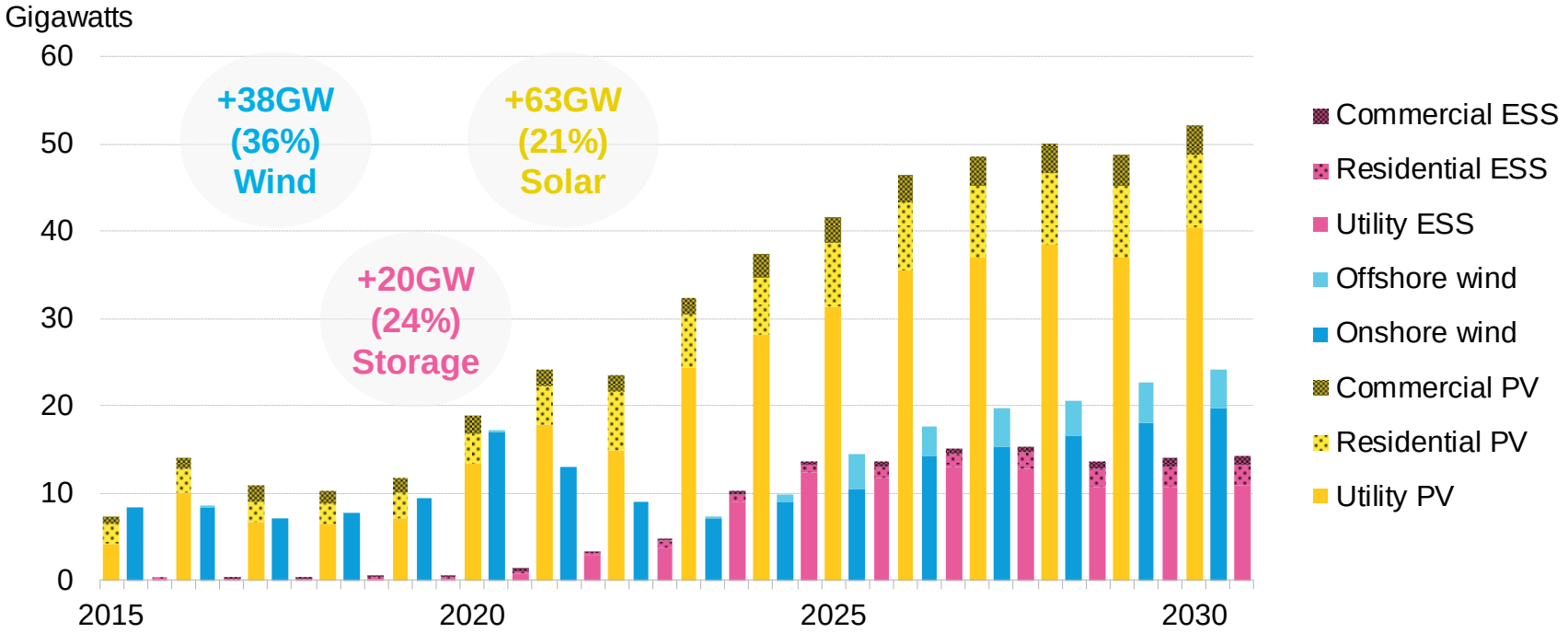


Source: BloombergNEF, company filings, interviews

There are many positive signs that clean power will overcome these challenges

Source: Bloomberg LP

IRA drove an increase of over 100GW in our clean energy forecast to 2030

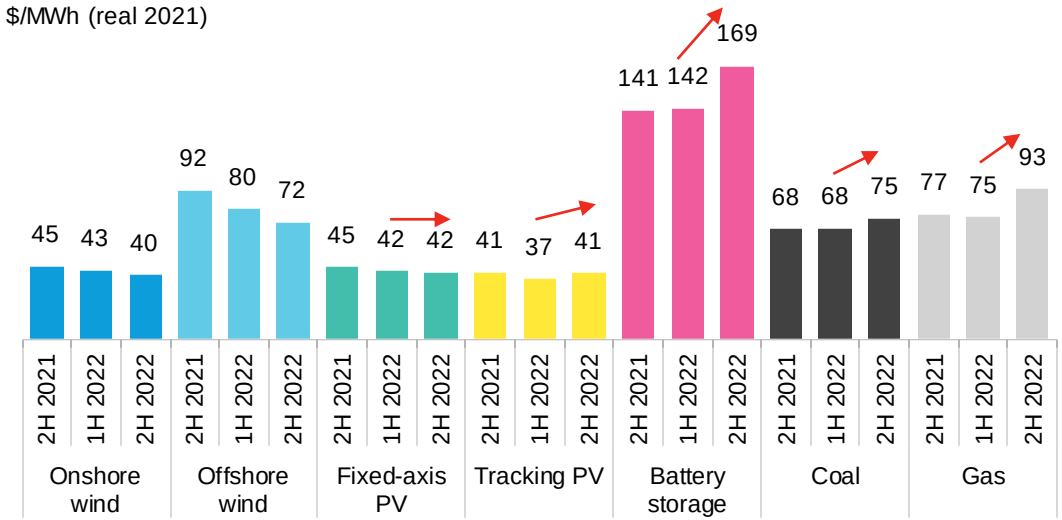


Source: BloombergNEF. Note: ESS = energy storage system.

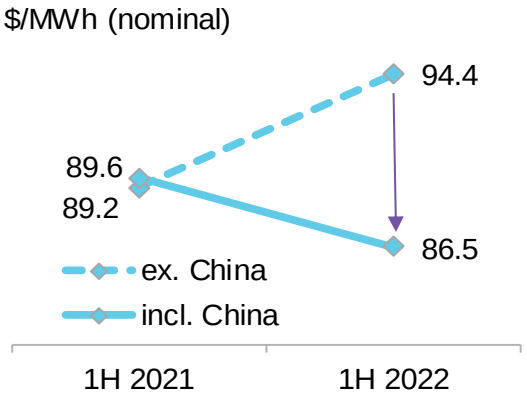
BloombergNEF

LCOEs are rising for the first time in history, driven by supply chains, inflation and pricier debt

Change in global LCOEs, 2H 2021 through 1H 2022



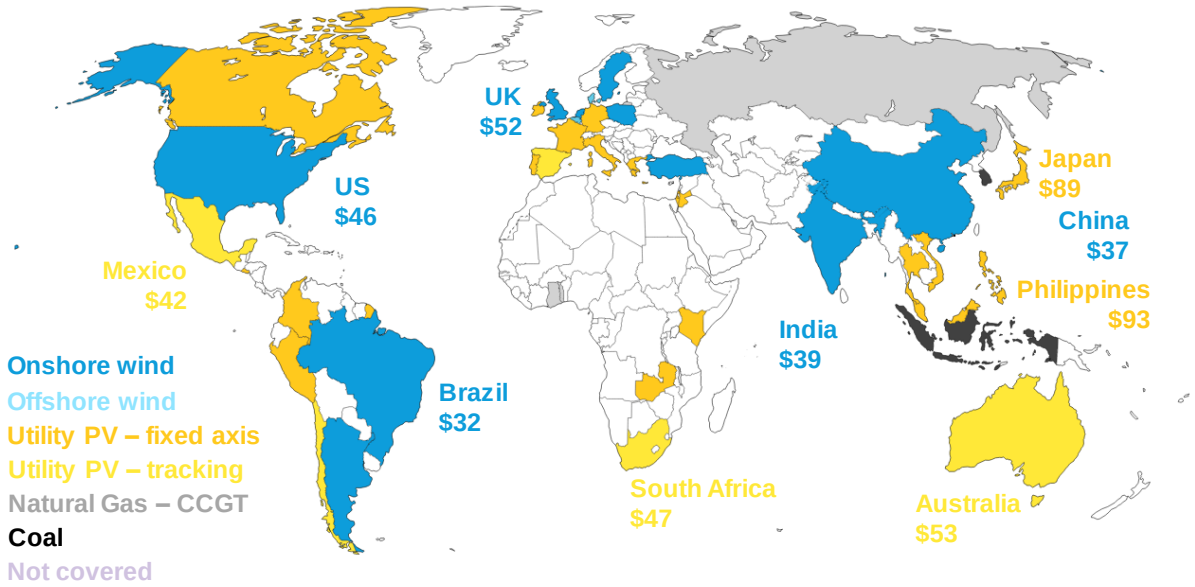
Impact of China on offshore wind LCOE benchmark



Source: BloombergNEF. Note: The global benchmarks are country-weighted levelized cost of electricity (LCOE) averages using the latest annual capacity additions. Offshore wind includes offshore transmission costs. LCOEs do not include subsidies or tax credits.

Solar or onshore wind is the cheapest source of electricity in countries representing 96% of global electricity generation

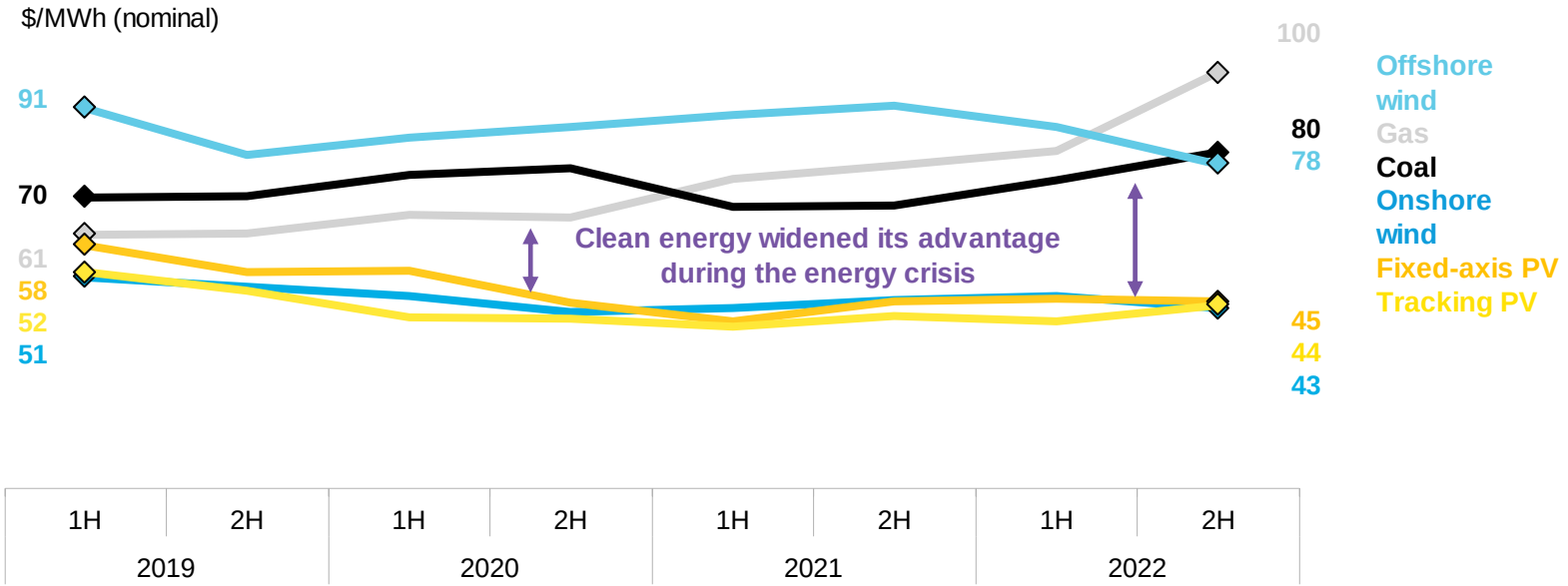
Cheapest source of bulk generation, 2H 2022



Source: BloombergNEF.

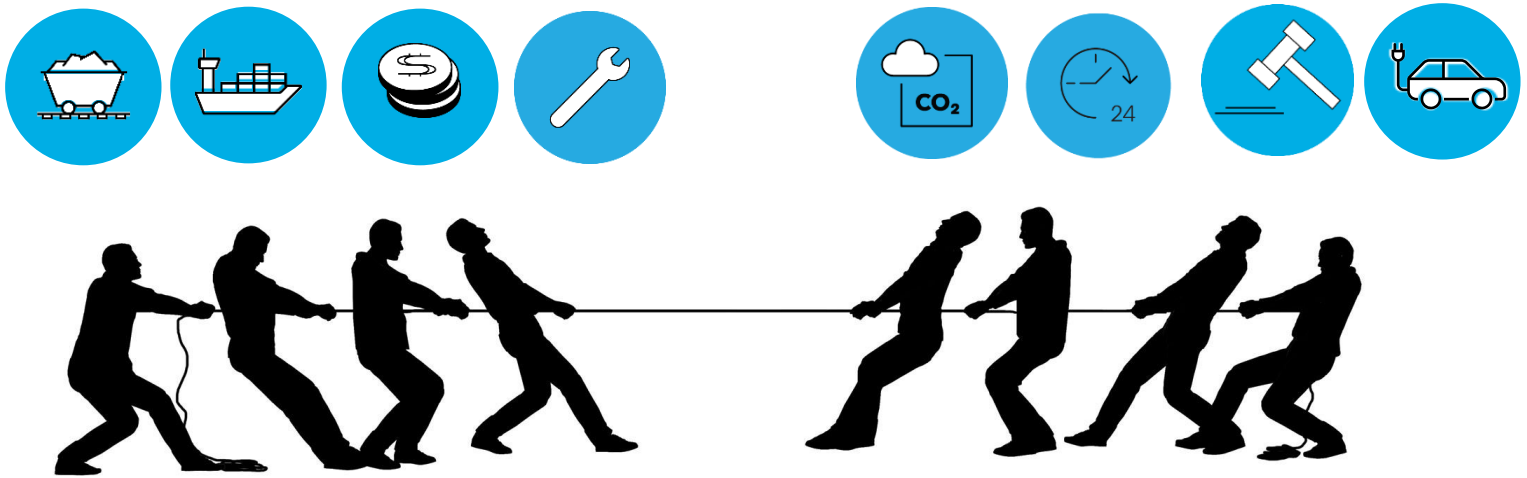
Clean energy still has the enduring advantage

Global levelized cost of electricity benchmarks



Source: BloombergNEF

Buffeted by competing forces, where does the momentum lie?



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