Energy Transitions Commission

Making Clean Electrification Possible: 30 Years to Electrify the Global Economy

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Energy Transitions Commission

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Knowledge partners

BloombergNEF, SYSTEMIQ

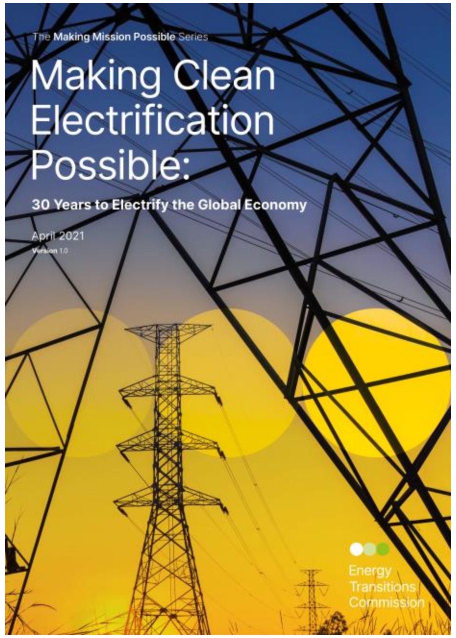
A net-zero global economy is technically and economically possible by mid-century, but we need to act in the 2020s to put mid-century targets within reach.

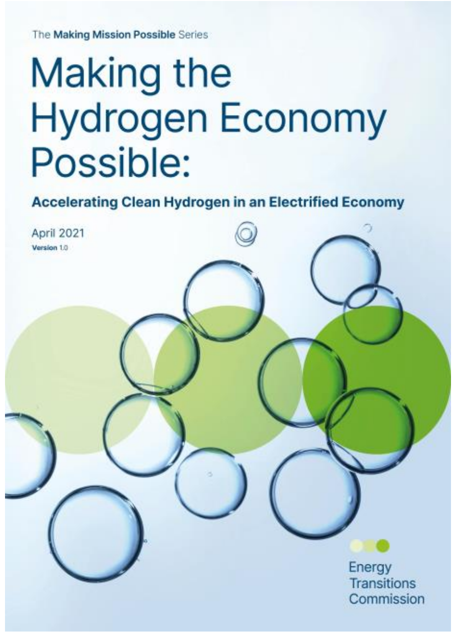
Making Mission Possible series sets out how to achieve a Net Zero economy by mid-century

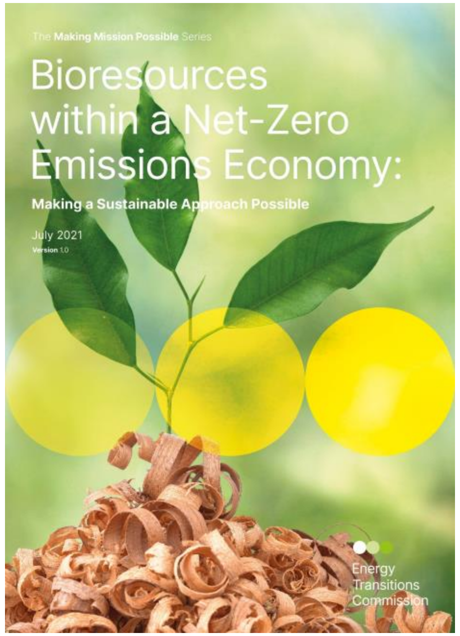
The Making Mission Possible Series

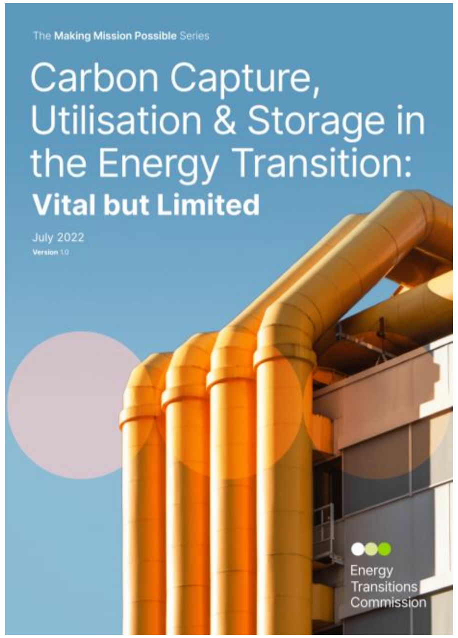
Decarbonisation

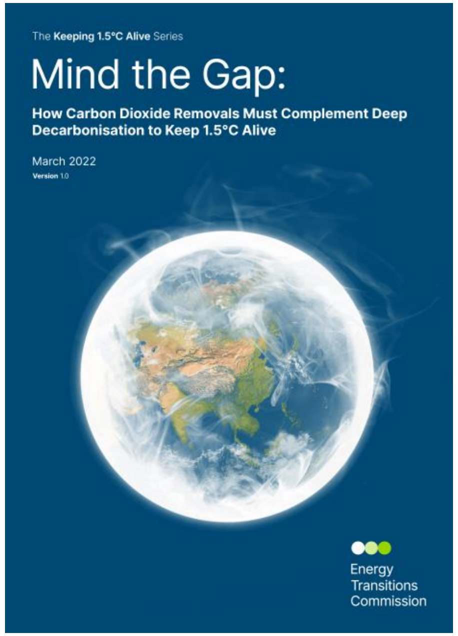
Negative Emissions



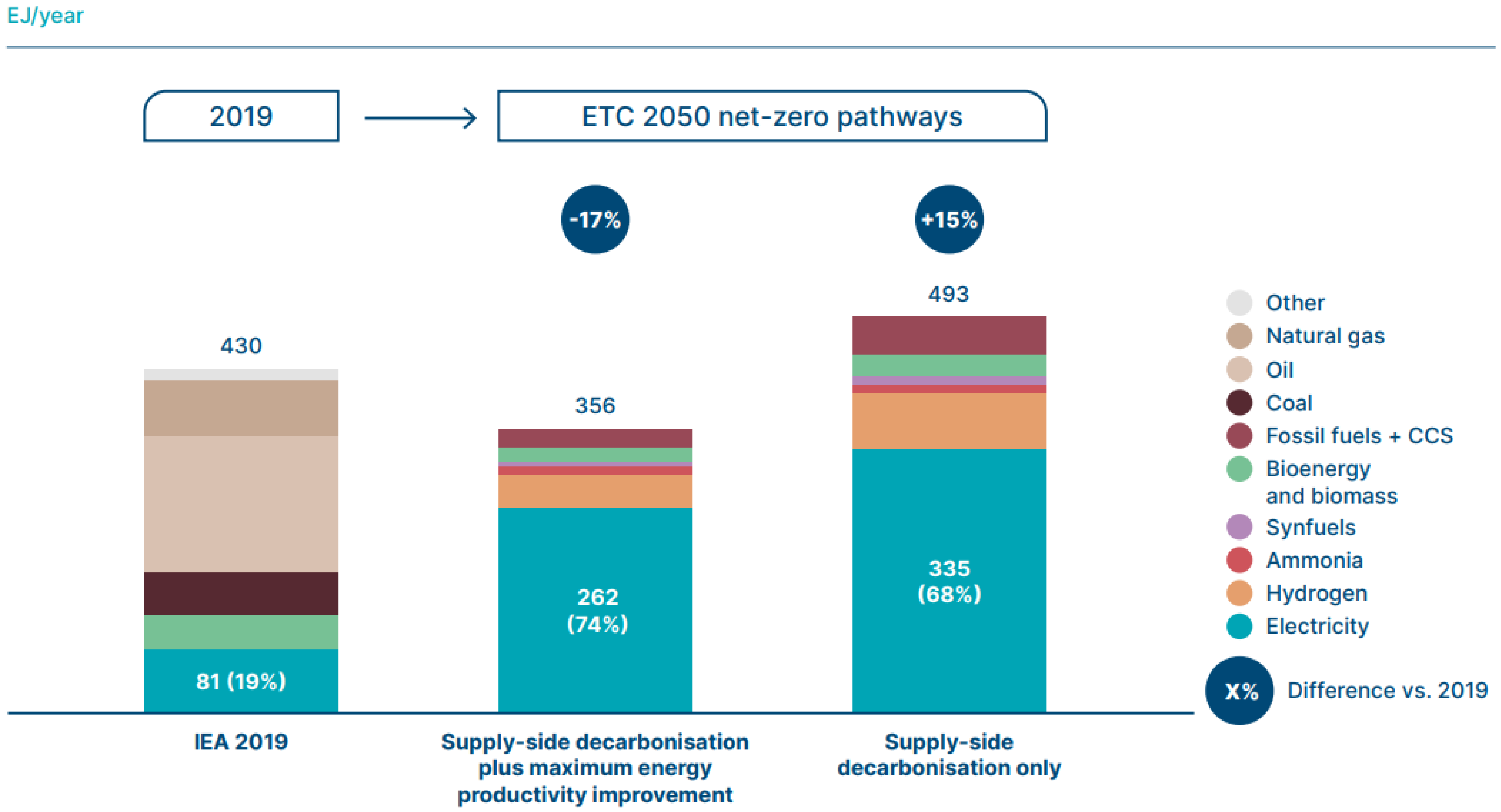








Final energy mix in a zero-carbon economy: electricity will become the dominant energy vector, complemented by hydrogen and fuels derived from it



Source: SYSTEMIQ analysis for the Energy Transitions Commission (2021); IEA (2020), *World Energy Outlook*

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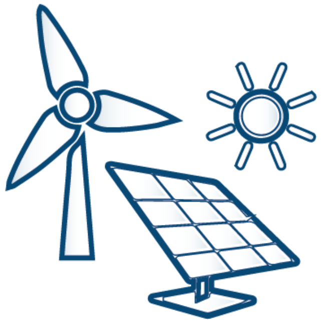
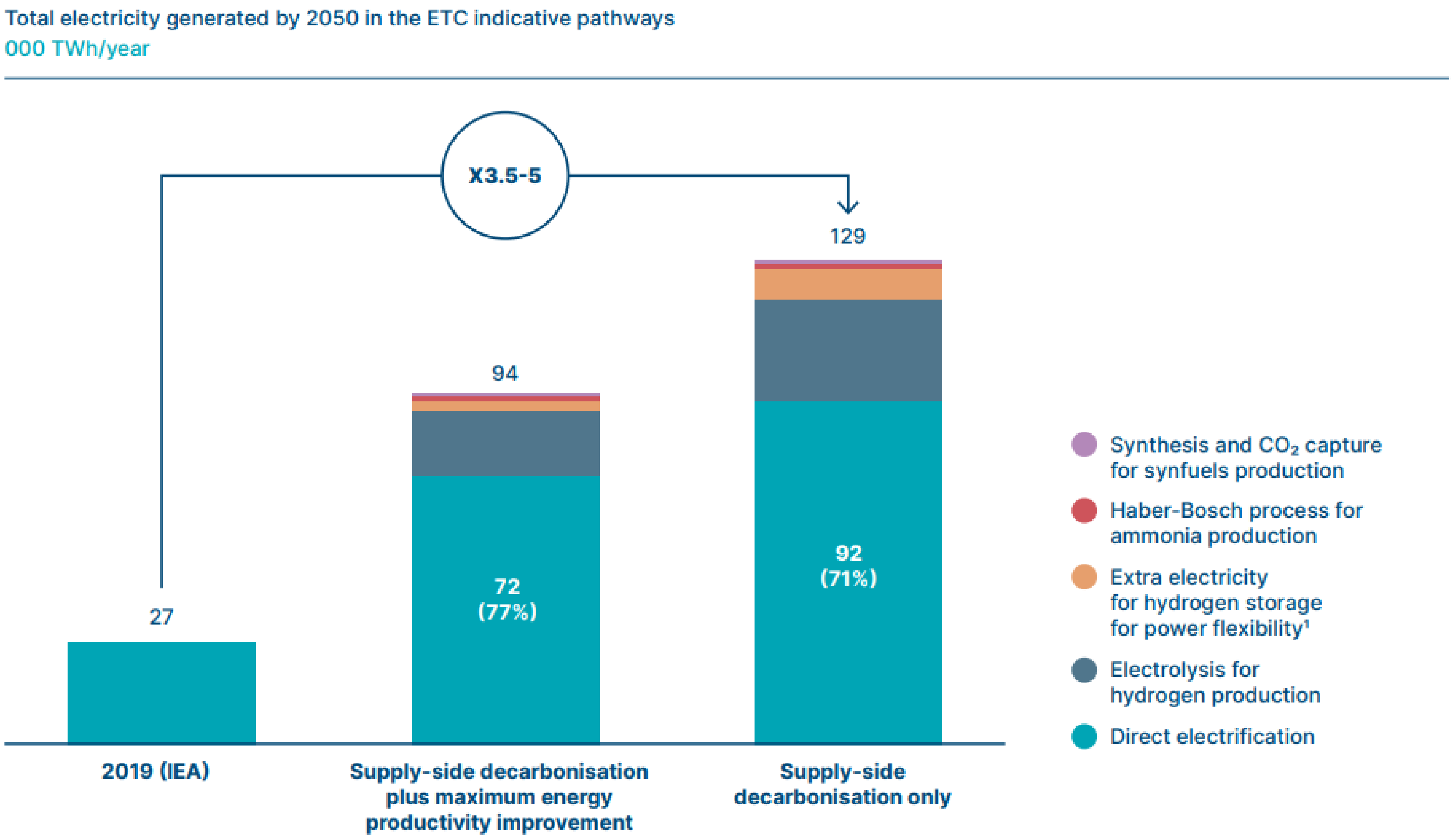


Clean electrification

Massive clean electrification at the heart of a net zero emissions economy: global power system growing 3.5-5x and simultaneously decarbonising

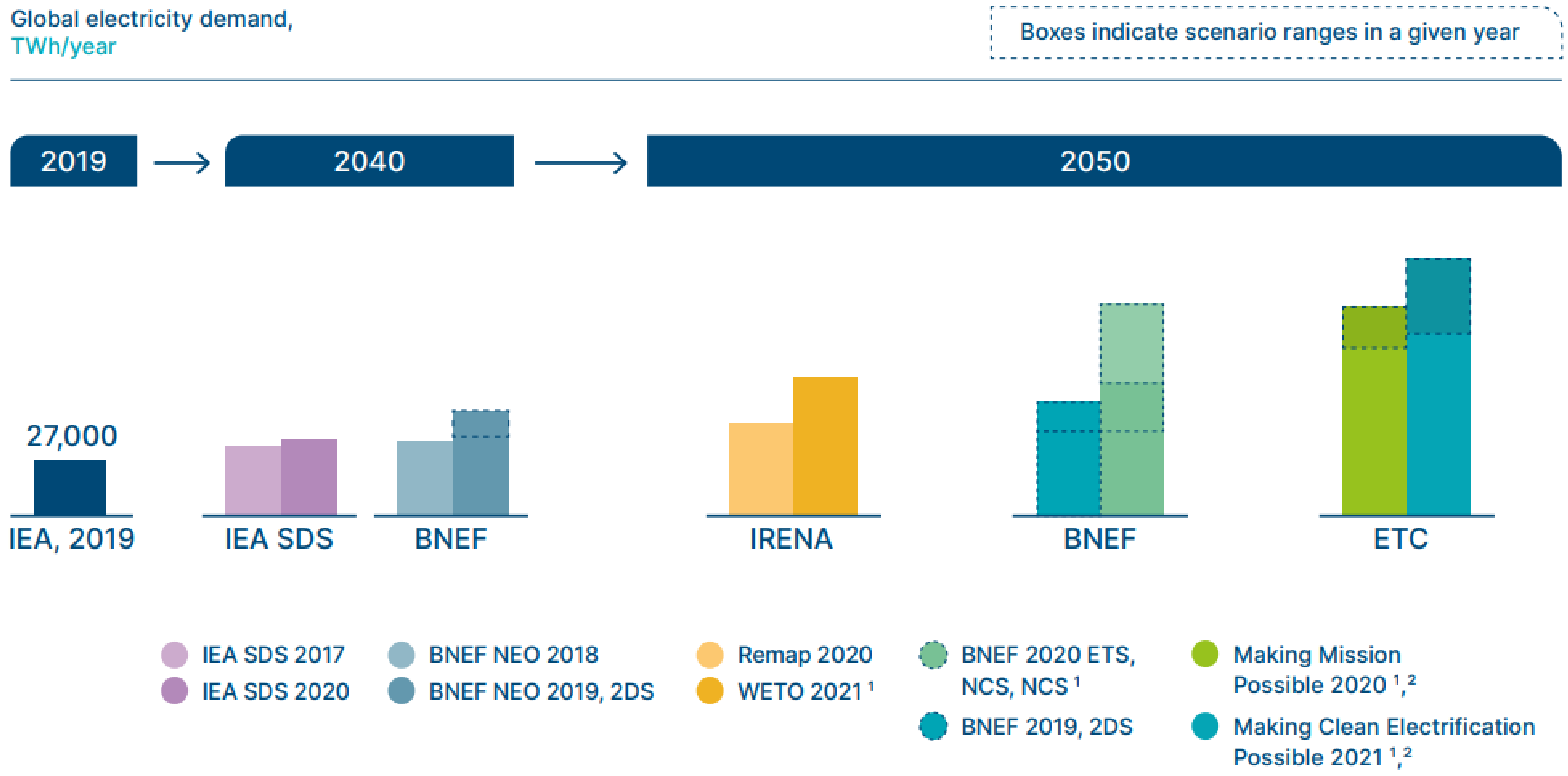
1. **Massive electrification to deliver a zero-carbon economy**
2. **Generating low-cost, zero-carbon power**
3. **Building and financing zero-carbon power systems**
4. **Critical priorities for the 2020s**

By 2050, global electricity demand expected to grow 3.5-5x to 90-130,000 TWh



Note: Assumes 85% green hydrogen production in 2050. 1: Extra electricity for hydrogen storage for power flexibility only covers the electricity loss due to the transformation into hydrogen and back to electricity. Source: SYSTEMIQ analysis for the Energy Transitions Commission (2021), IEA (2020), *World Energy Outlook*

All major outlooks now see major role for electrification



Key 2022 outlooks (**BNEF NZS, BP, NGFS, IEA NZE, Shell Sky**) all see 2050 electricity generation **at or above 50,000** TWh in 2050, with **BNEF and IEA above 70,000 TWh**

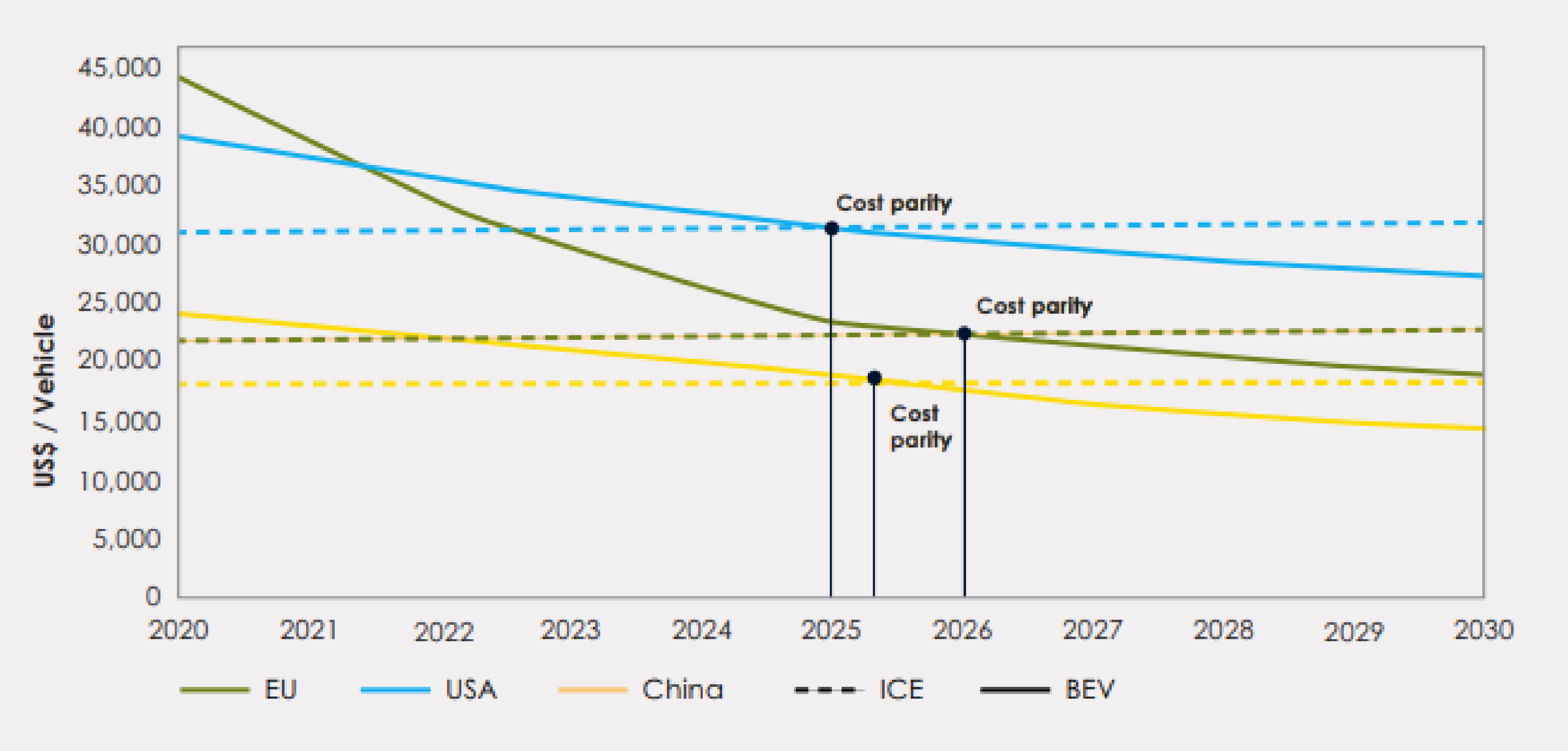
[1] Includes electricity demand from green hydrogen production. [2] Denotes range across supply-side decarbonization plus maximum energy productivity improvement and supply-side decarbonization only scenarios. Notes: IEA SDS is IEA Sustainable Development Scenario; BloombergNEF's NEO is *New Energy Outlook*, with the 2020 base case as the Economic Transitions Scenario (ETS) and the alternative, deep decarbonization scenario as the NEO-Climate Scenario (NCS). IRENA Remap is the Energy Transformation outlook to 2050, WETO is the 1.5DS in the World Energy Transitions Outlook. Source: IEA, IRENA, BloombergNEF, ETC.

Electrification will be driven by growth in existing and new applications

	Primarily existing or new applications?
Road Transport • Light duty battery electric vehicles (BEVs) costs to fall below internal combustion engine (ICE) • In medium and heavy duty trucking, role for BEVs alongside hydrogen fuel cell vehicles (FCEVs)	New
Shipping and Aviation • In short-haul segments, direct electrification to play significant role • In long-haul, primarily indirect electrification via hydrogen-based fuels (ammonia, synfuels)	New
Buildings • Building heating to be increasingly electrified, including via heat pumps • Air conditioning and other already electrified uses growth driven by rise in living standards	New and existing
Industry • Light industry which is already electrified to grow driven by rise in living standards • Harder-to-abate industry to be decarbonised via mix of CCU/S and direct/indirect electrification	New and existing

Passenger cars will be one of the first sectors to electrify - “tipping point” of upfront price parity across BEVs and ICEs expected in the mid-2020s

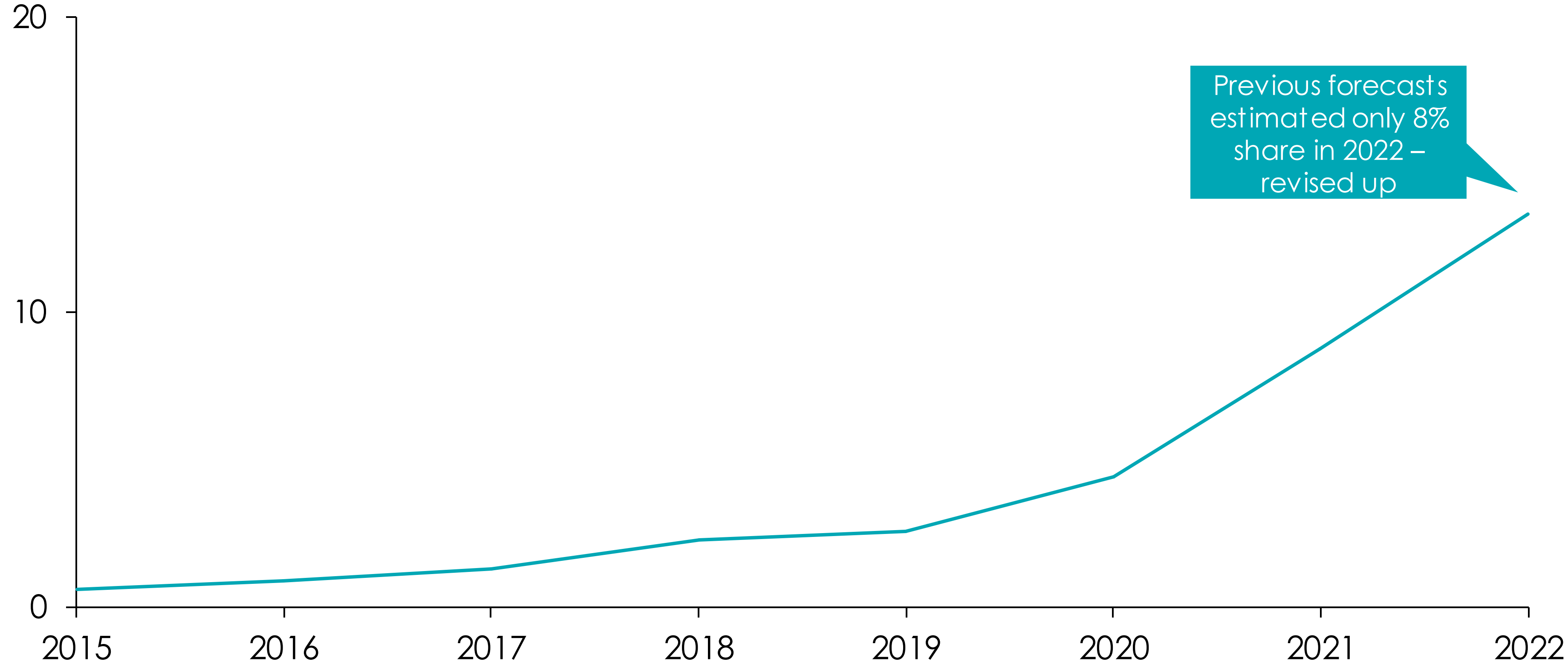
Forecast pre-tax retail prices for passenger vehicles by region



Note: Average car lifetime expectancy between 10-15 years depending on segment type and region.
Sources: [1] ICCT (2021), A Global Comparison of the Life-cycle Greenhouse Gas Emissions of Combustion Engine and Electric Passenger Cars; [2] Bloomberg NEF (2022), Electric Vehicle Outlook; [3] Bloomberg NEF (May 2021), Hitting the EV Inflection Point; [4] ICCT (2019), Update on Electric Vehicle Costs in the United States through 2030; [5] ICCT (2021), Evaluating Electric Vehicle Costs and Benefits In China in the 2020–2035 Time Frame.

Buoyed by policy support, BEV sales have taken off in key markets

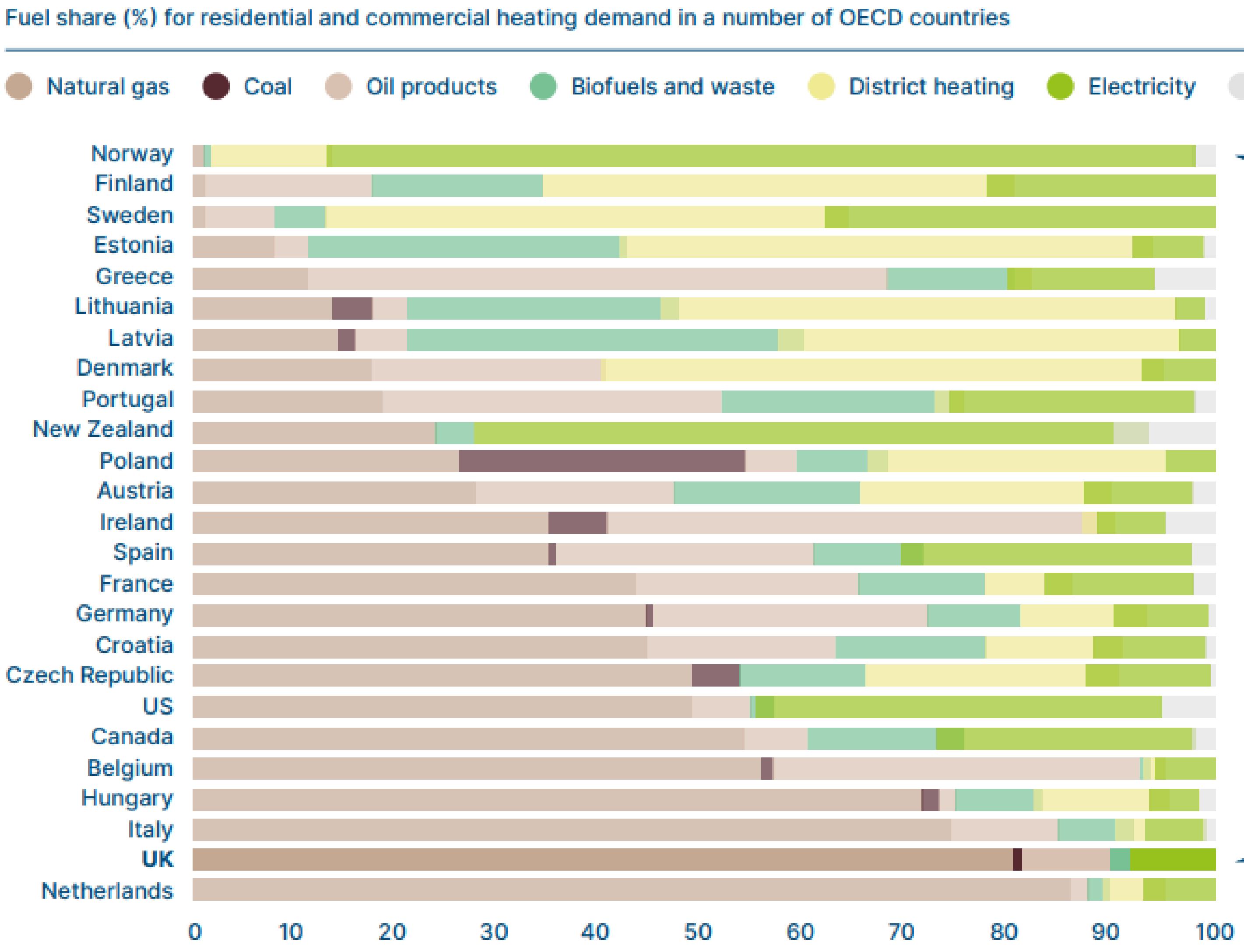
Global EV passenger vehicles
Electric vehicle sales share, %



China and **Europe** are major drivers of momentum, with EV sales reaching **above 20% of total sales in Q2 2022** in both markets

Source: BNEF (2022) *Long Term Electric Vehicle Outlook*

Building heating is another area primed for the switch to electrification, some geographies already employ electric building heating



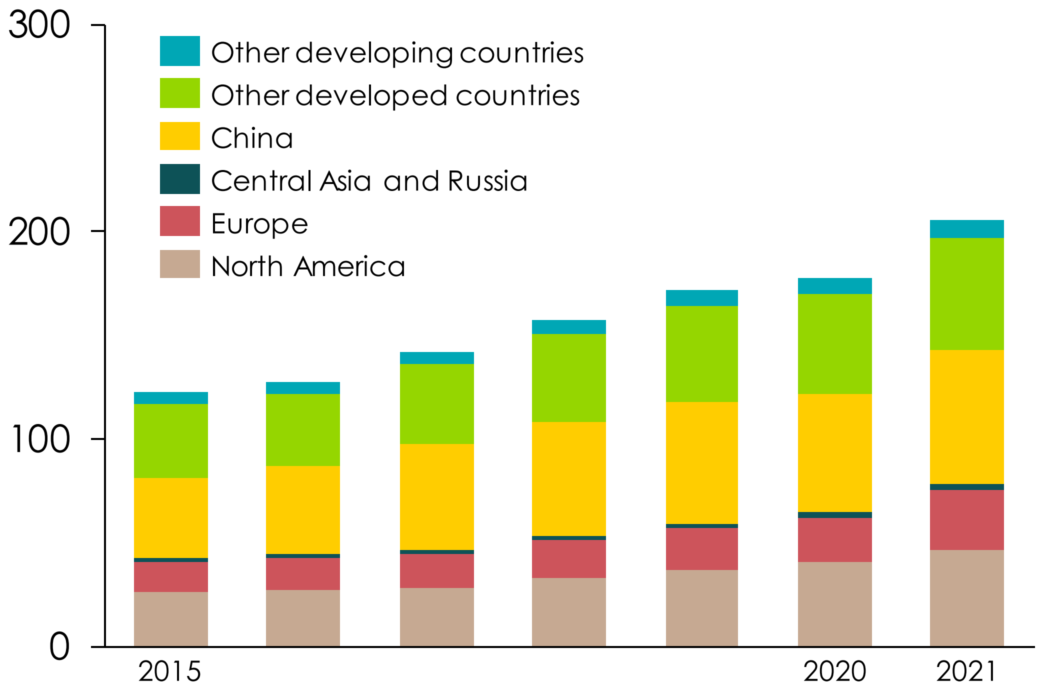
Norway has access to large volumes of cheap **hydro power**, hence electricity serves the majority of heating

When **North Sea gas** was discovered, the **UK** installed an extensive natural gas network

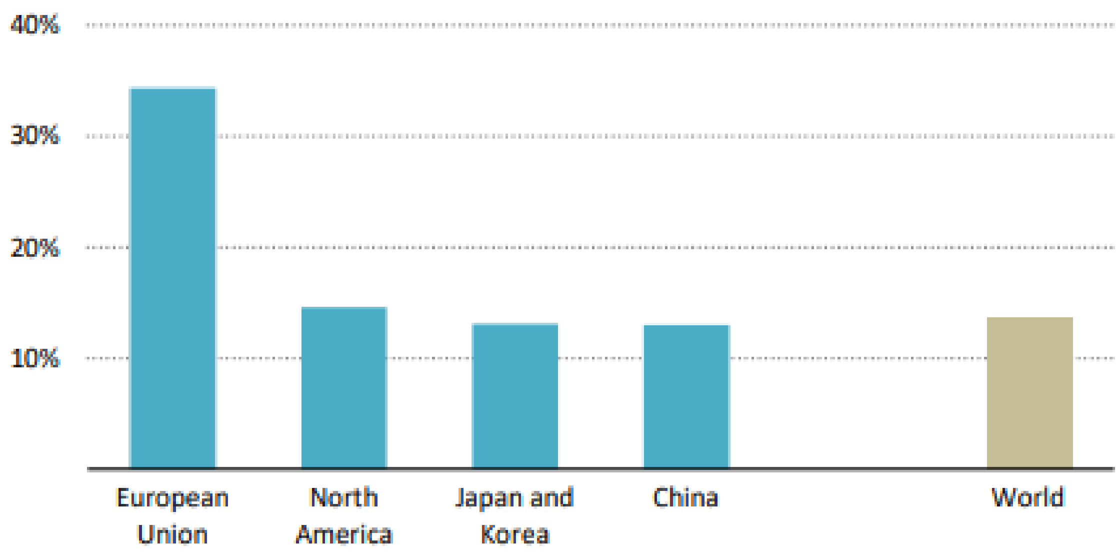
Source: Vivid Economics for the Department for Business Energy and Industrial Strategy (2018)

Heat pump sales have been growing since the energy crisis, particularly in Europe

Global heat pump capacity
Millions of units installed, cumulative



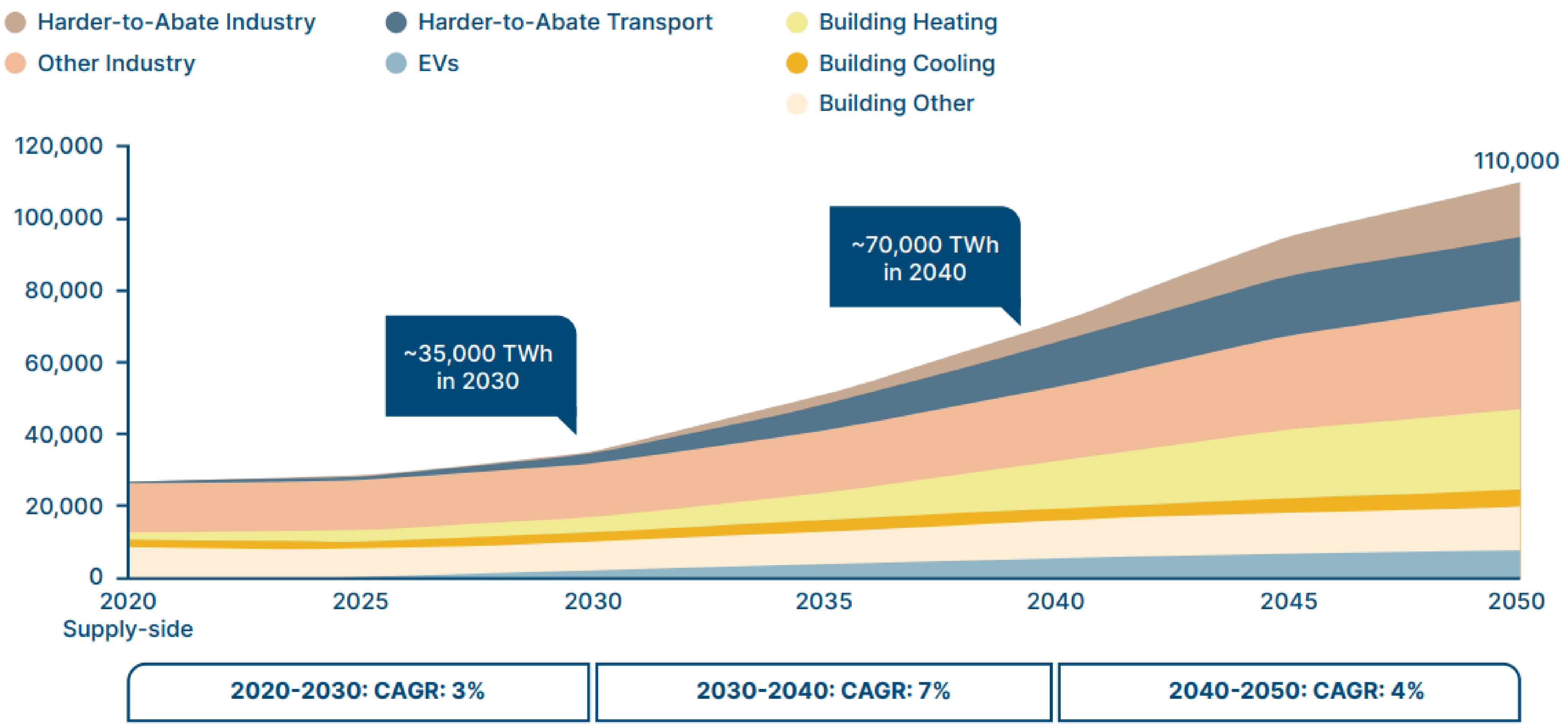
Annual growth in sales of heat pumps in buildings in selected regions, 2021, *%*



Source: IEA (2022) *The future of heat pumps, IEA analysis based on AHRI (2022), Chinabaogao (2022), EHPA (2021) JRAIA (2022)*

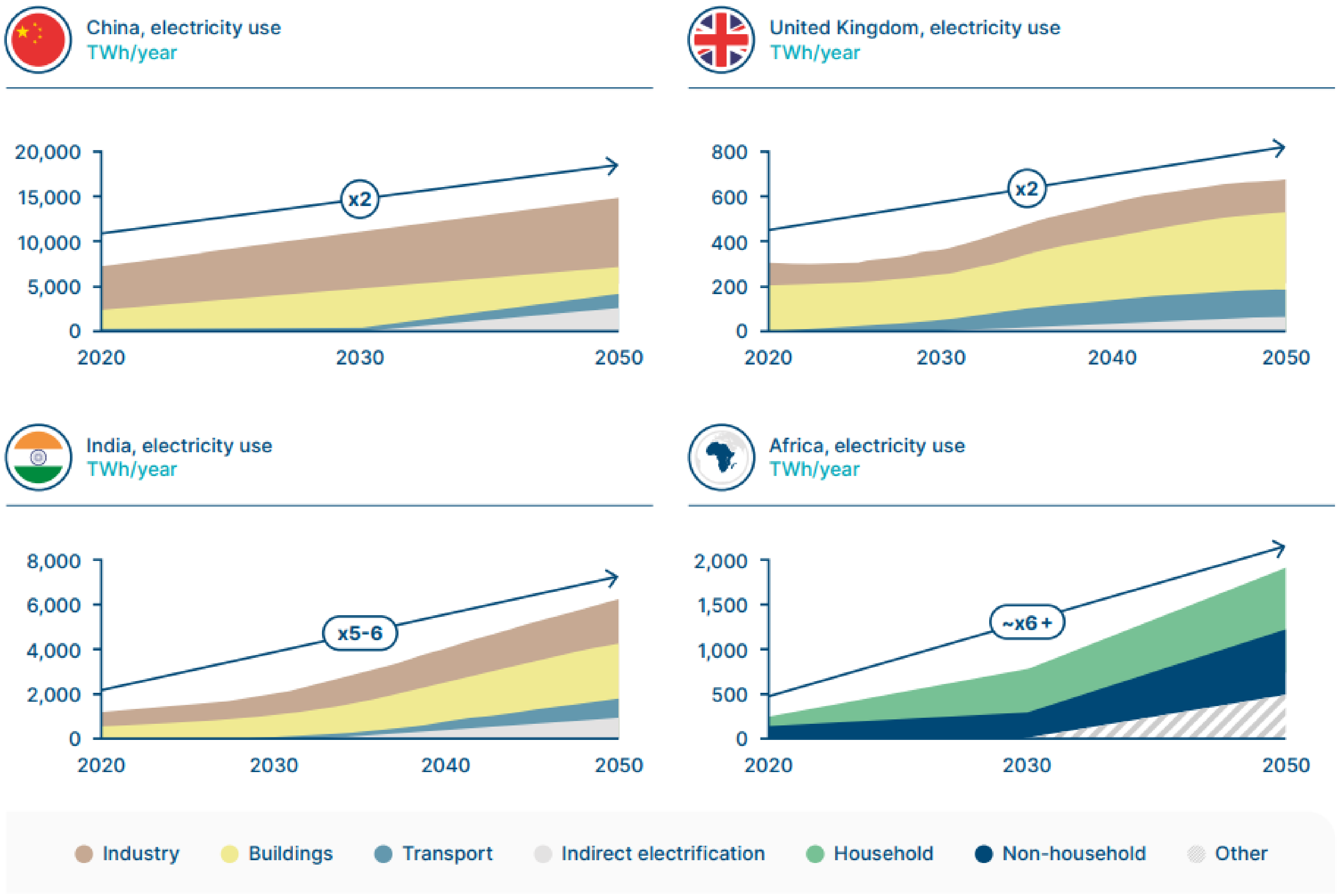
Global ramp-up of electricity use could see fastest growth in 2030s, highest absolute additions in 2040s as green hydrogen production rises

Illustrative global scenario for electricity use, TWh



Note: Other industry includes Aluminium, Pulp& Paper, Other (incl. Mining, FMCG, Textiles, Metals, Electronics, Equipment, Construction).
Source: SYSTEMIQ analysis for the Energy Transitions Commission (2021).

The pace and scale of electricity use growth will vary by region



Electricity demand growth primarily driv en by end-use switching to electrification

Electricity demand growth primarily driv en by economic growth, as well as end-use switching to electrification

Source: RMI/ETC China, TERI/ETC India, UK Climate Change Committee, IEA (2019) *World Energy Outlook* Africa case

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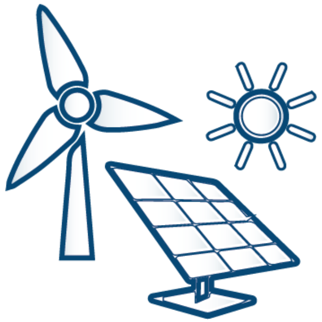

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Massive clean electrification at the heart of a net zero emissions economy: global power system growing 3.5-5x and simultaneously decarbonising

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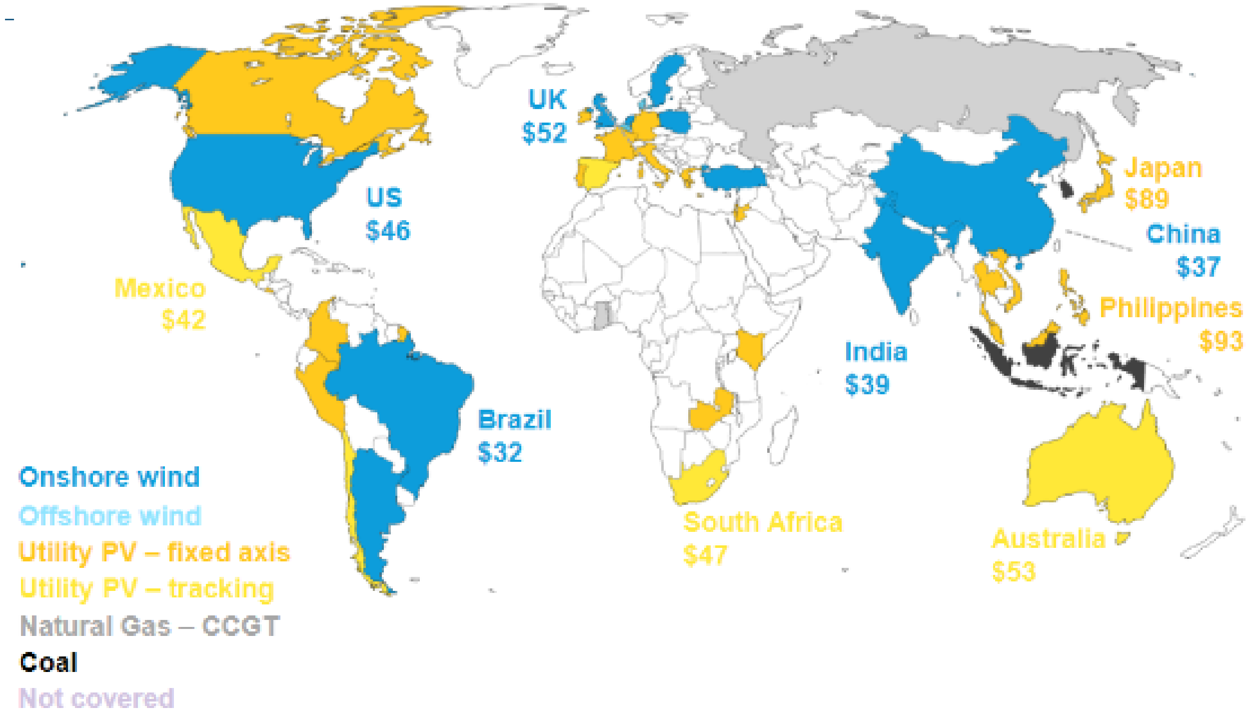
Zero-carbon power systems are low-cost and feasible

1. Wind and solar are or will soon be lowest-cost generation
2. Variety of options to solve the balancing challenge in high variable renewable systems
3. Total system generation costs in zero-carbon power systems likely to be the same as or below those of fossil-based power systems
4. Power network expansion and digitalisation can support zero-carbon systems
5. Sufficient VRE resources available globally, though some regions will face higher constraints
6. Steady phase out of unabated fossil generation can be achieved

Falling costs means wind and solar are increasingly cost-competitive against both new and existing fossil generation

New build wind and solar vs new build fossil

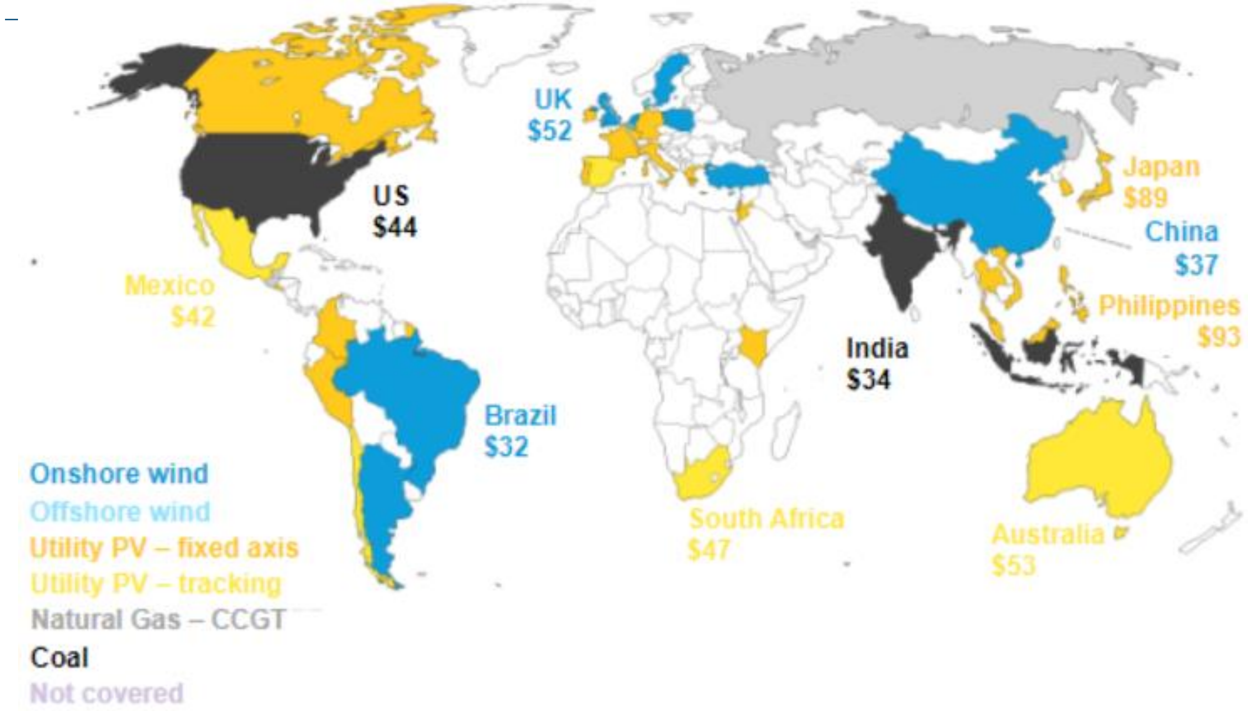
Cheapest source of bulk generation globally, 2H 2022



Solar or onshore wind is cheaper than new fossil in countries representing 96% of electricity generation.

New build wind and solar vs existing fossil

Cheapest source of bulk generation globally, 2H 2022



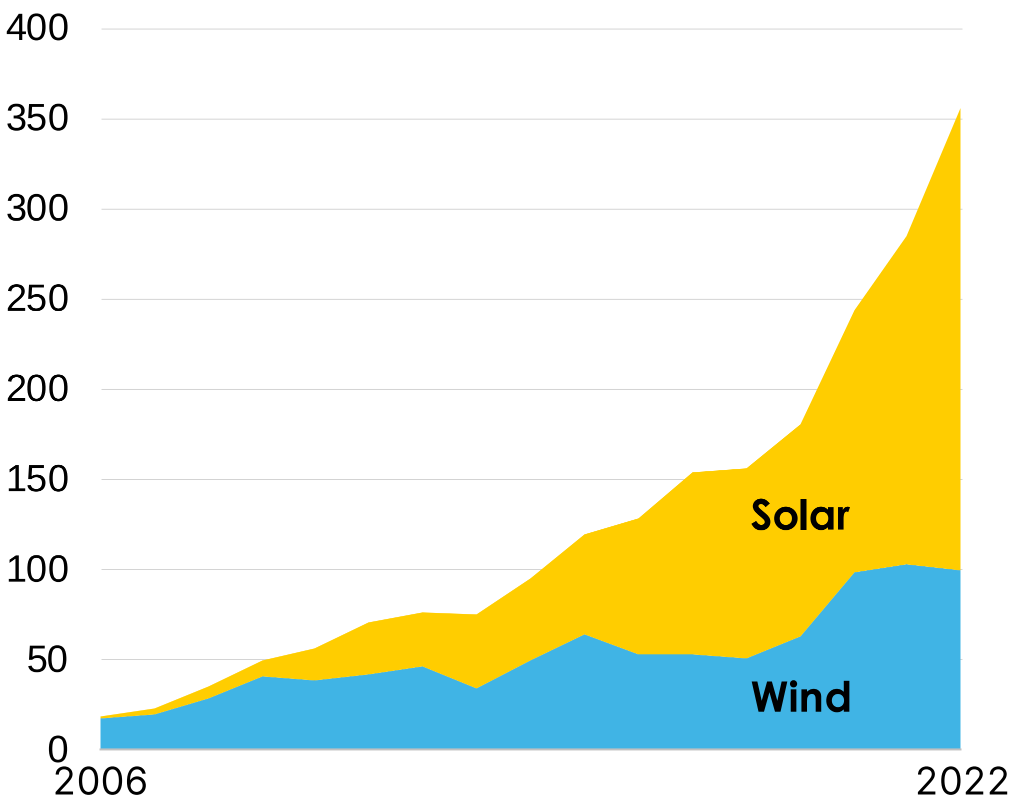
Renewables outcompete existing fossil in countries accounting for 60% of electricity generation.

Note: The maps indicates for each country the technology with the lowest LCOE (levelised cost of electricity) for new-build solar and wind plants or short-run marginal costs for coal and gas-fired power plants. Marginal costs include a carbon price where applicable. The dollar numbers below the country name denote the per-MWh levelized cost of that technology. All LCOEs are in nominal terms. Calculations exclude subsidies, tax-credit or grid connection costs. CCGT is combined-cycle gas turbine
Source: BNEF (2022), *2H 2022 LCOE Update*.

Wind and solar now account for over 75% of net new capacity additions

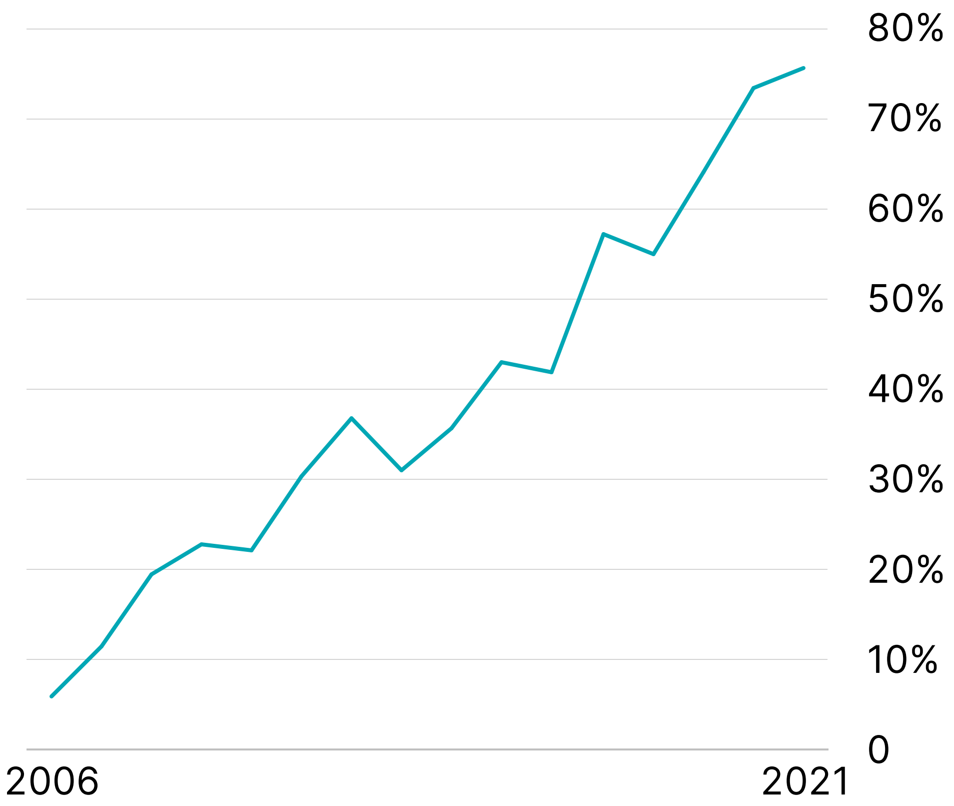
Wind and solar capacity additions

GW capacity installed



Wind and solar percentage of net installations

% of net total installations



Source: BNEF (2023), *Global Installed Capacity*

The key power system issue is how to balance supply and demand across hours, days, weeks and seasons

Balancing needs are dependent on the shape of VRE supply and of demand, and vary by market:

Within day balancing

- **Hour-by-hour balancing:** forecastable hour-by-hour supply variations (e.g. cloud cover), and very short-term fluctuations in precise supply (e.g. change in wind levels)
- **Day-to-night balancing:** Predictable diurnal cycle (e.g. solar generation during the day, but demand to run AC at night)

Seasonal energy differential

- **Balance across seasons**: Predictable seasonal month by month cycle in demand or supply (e.g. winter demand peak for building heating in Northern latitude economies; wind generation peak in India during the monsoon season)

Security of supply

- **Week-by-week variations:** Unpredictable months in advance, and varying in importance each year (e.g. extended weeks of 'wind droughts'/anticyclones)

Daily, seasonal and weekly balancing challenge for zero-carbon power systems can be met with different options

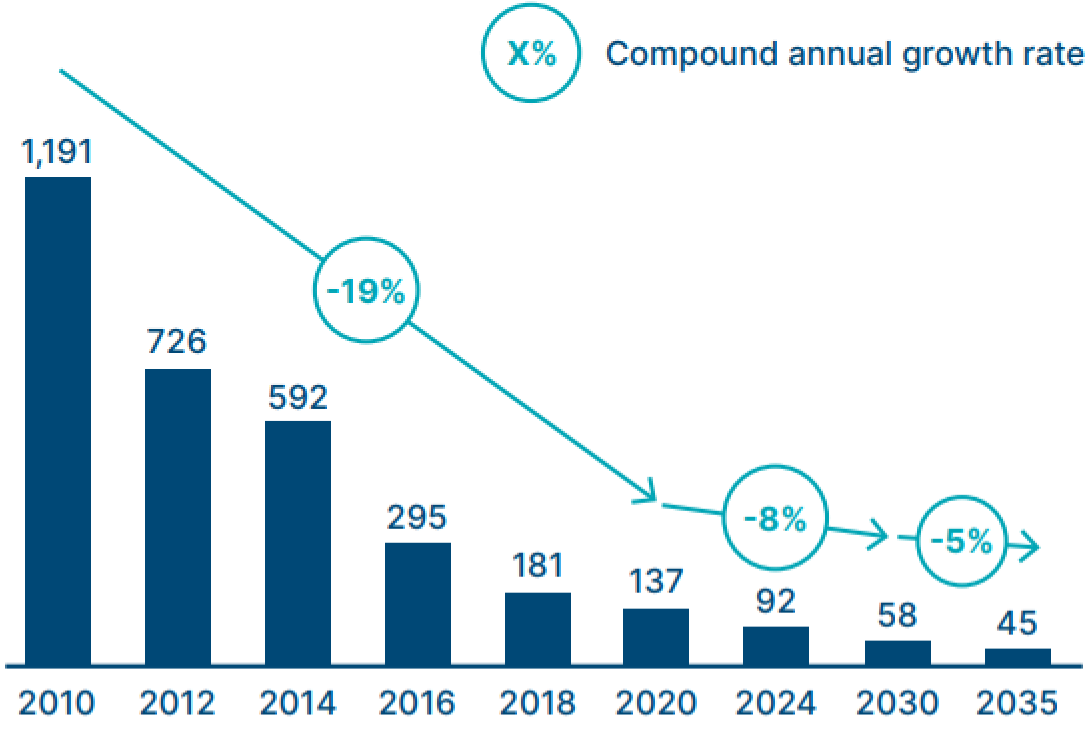
Range of dispatchable generation, energy storage, demand-side flexibility options

			Daily	Seasonal (predictable)	Week-by-week (unpredictable)
Dispatchable generation	Other zero carbon	Hydro, nuclear[1]	✓	✓	✓
	Fossil	Fossil (or bioenergy) + CCS	✓	✓	✓
		Fossil – very low utilisation	✓	✓	✓
Energy storage		Pumped hydro	✓	✓	✓
		Lithium ion battery[2]	✓		
		Emerging technologies	✓		
		Power-to-X-Power[3]	✓	✓	✓
Demand side flexibility		EV (smart charging, V2G)	✓		
		Heating load	✓		
		Industrial load[4]	✓	✓	

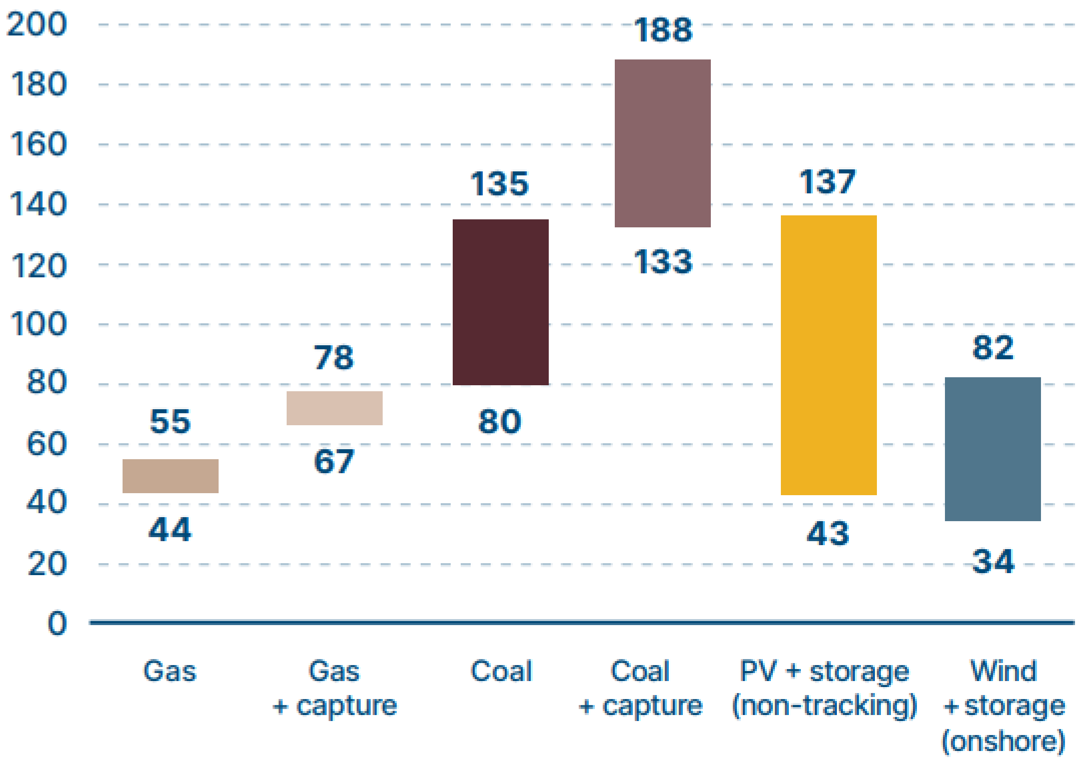
Notes: [1] Limited nuclear capacity for flexible ramping. [2] Li-ion storage is utility scale and behind-the-meter. [3] Examples of Power-to-X-Power include hydrogen from electrolysis and hydrogen re-conversion into power via gas turbines or fuel cells. This also has elements of demand-side flexibility as production (e.g. hydrogen via electrolysis) can be aligned to optimal times for the system.[4] Including hydrogen electrolysis. Source: Adapted from Climate Policy Initiative for the Energy Transitions Commission (2017), *Low-cost, low-carbon power systems*

For daily balancing, lithium-ion batteries will be an increasingly cost-effective solution

Battery prices – Observed and Outlook
Real 2020 $/kWh (historical, predicted)



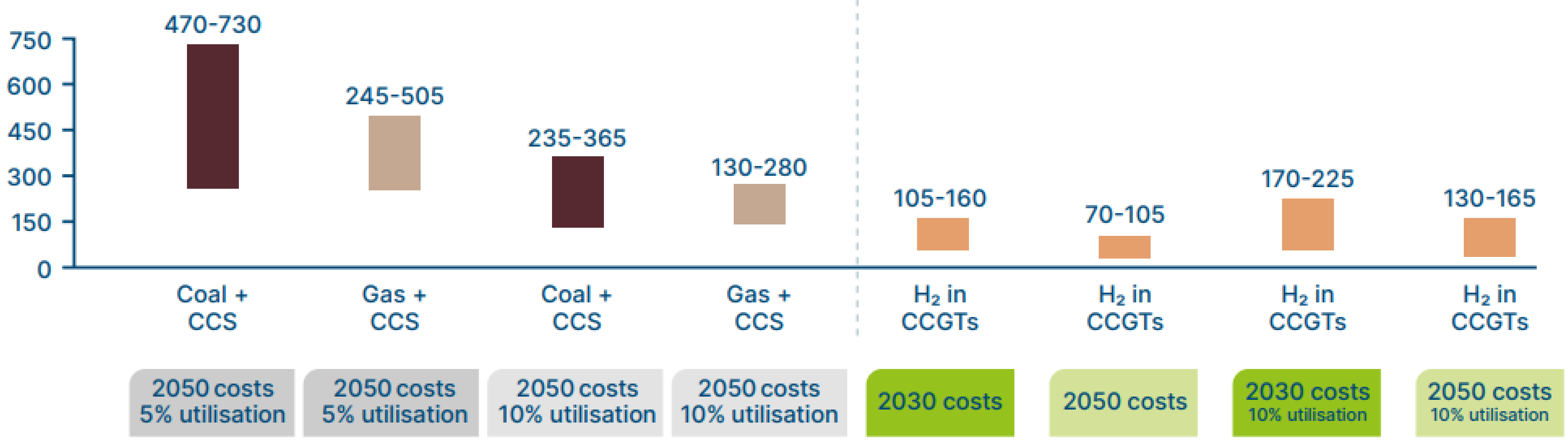
Comparison of US LCOEs in 2023
$/MWh, (2018 real)



Note: on RHS, capture refers to post-combustion, liquid absorption of CO_2. LCOE forecasts use 4hr battery storage. LCOEs exclude subsidies, tax credits, and CO_2 transport and storage costs. Source: BloombergNEF (2020)

H2 in CCGTs could be most cost effective zero-carbon way to meet unpredictable week-by-week variations

Indicative levelised cost of electricity (LCOE), $/MWh

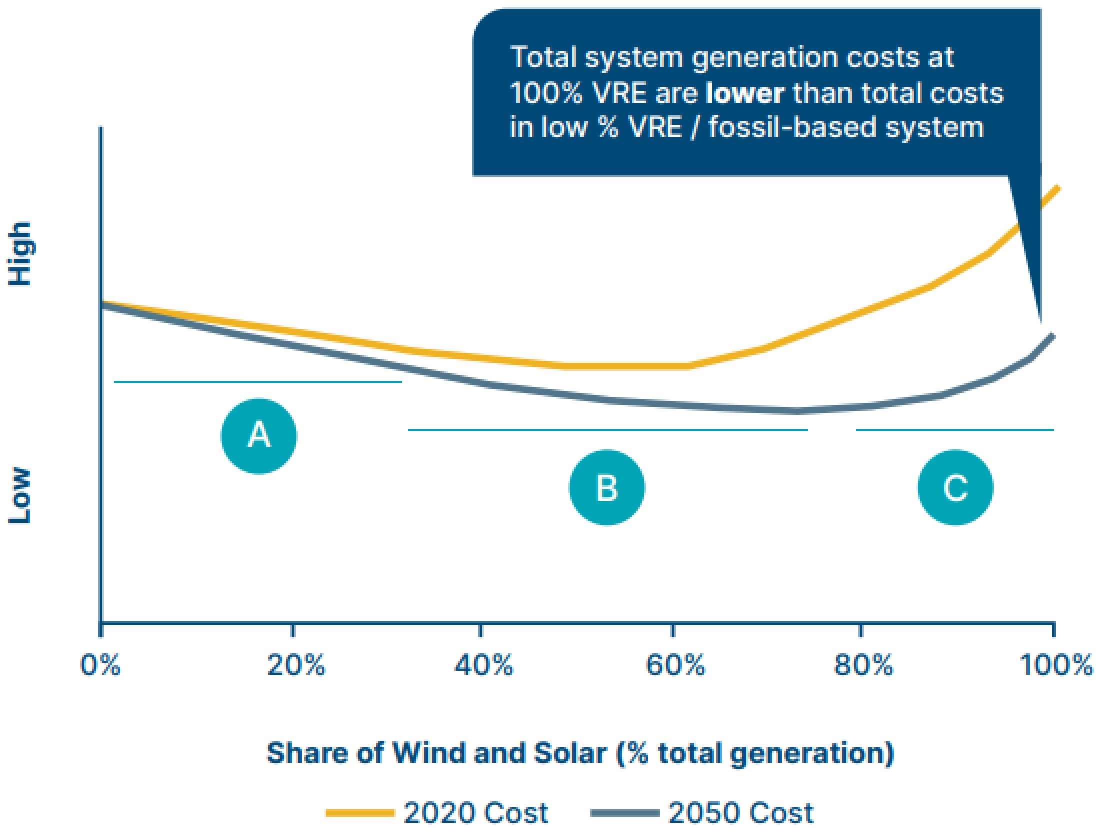


CCS Capex	Yes (new asset)	n/a	
Generation Plant Capex	No (existing asset)	No (existing asset with no retrofit cost, assumes H_2-compatible gas turbine)	Yes (new asset, H_2-compatible gas turbine)

Notes: High/Low ranges determined by CCS capex cost ($2490-4770/KW for coal CCS and $1620-3560/KW for gas), fuel costs ($2-7/MMBtu for gas, coal fuel costs assumed to be negligible in 2050), and costs of hydrogen production ($1.5-2.5/kg in 2030, and $0.9-1.5/kg in 2050). Hydrogen T&S cost assumed to be $0.2/kg. Assuming 50% conversion efficiency in CCGTs for hydrogen. Hydrogen-ready CCGT capex is assumed to be $1000/KW in 2050 and $1080/KW in 2030. Assumed 20-year asset lifetimes. Source: S. Budinis, S. Krevor et al, (2018), *Energy Strategy Reviews*, "An assessment of CCS costs, barriers and potential." BloombergNEF(2020), *Hydrogen: The Economics of Power Generation*, SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Total system generation costs in zero-carbon power systems likely to be the same as or below those of fossil-based power systems

Total system generation costs as function of VRE penetration, $/MWh, 2020 and 2050 cost scenarios



A

0-30% VRE penetration

Declining system generation costs as cheaper renewables replace fossil in baseload generation; no balancing needs

B

30-80% VRE penetration

Further cost declines as renewables + storage increasingly cheaper than fossil for dispatchable generation

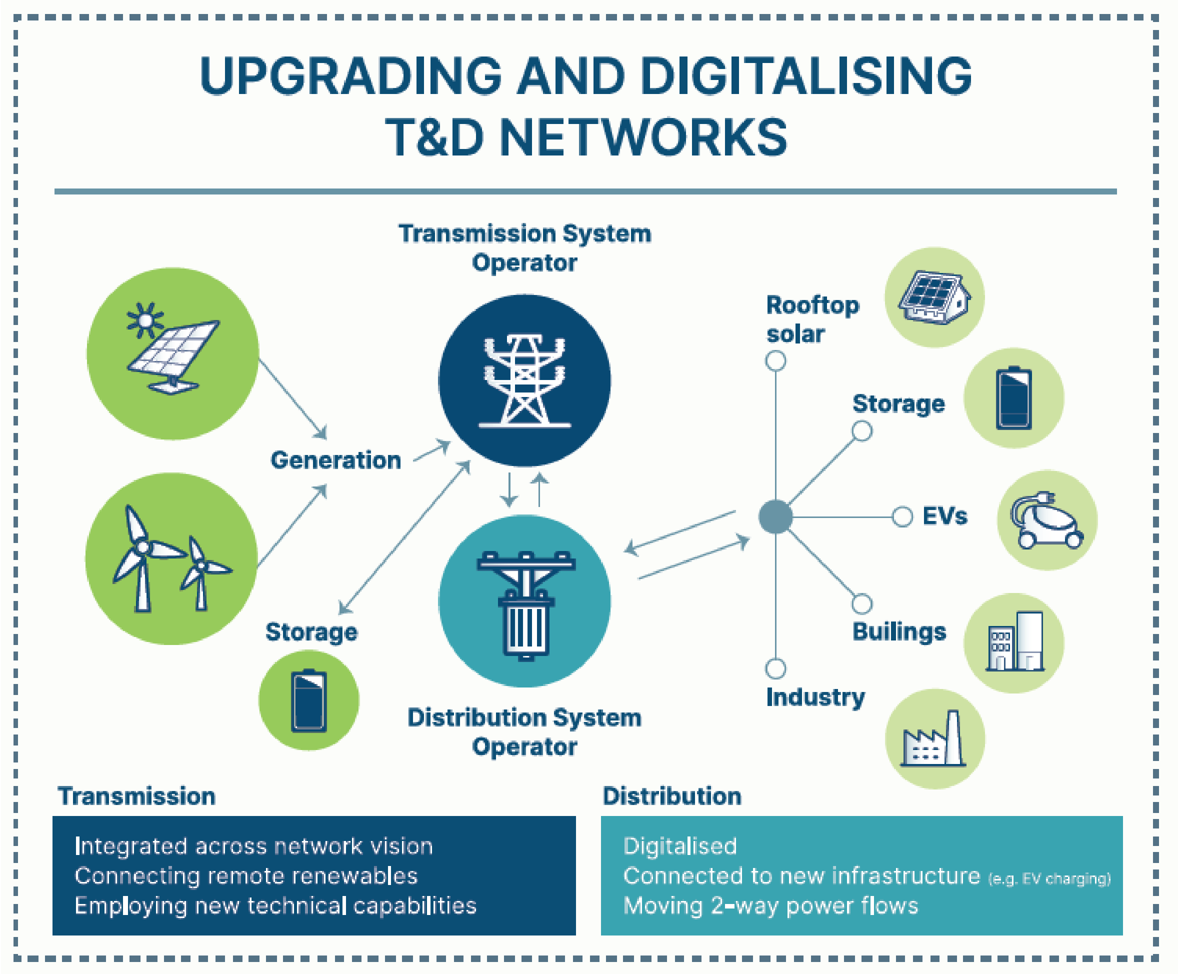
C

80-100% VRE penetration

Increase in total system generation costs as significant costs required to provide zero carbon answers to the "last 10%-20%" of generation

Source: Adapted from TERI/ETC India (2020) *The Potential Role of Hydrogen in India*

Power network expansion, digitalisation needed to support zero-carbon systems



Factors that <u>increase</u> T&D spending needs relative to power system size (2020-2050)

- Expansion, digitalisation
- Increase in peak demand load and capacity needs, infrastructure upgrades for mass electrification *(can be offset by enabling network optimisation in the future)*
- Interconnectors
- Higher undergrounding

Factors that <u>decrease</u> T&D spending needs relative to power system size (2020-2050)

- Optimised line capacity *(enabled by digitalisation)*
- Load shifting *(enabled by digitalisation and infrastructure upgrades)*
- Increase in distributed energy resources

Sufficient VRE resources available globally, though some regions will face higher constraints

Solar

- Global solar resources **massively exceed** needs; 100,000 TWh electricity production would require only **1-1.2% of total land area**
- Important **national constraints** in high population density countries

Wind

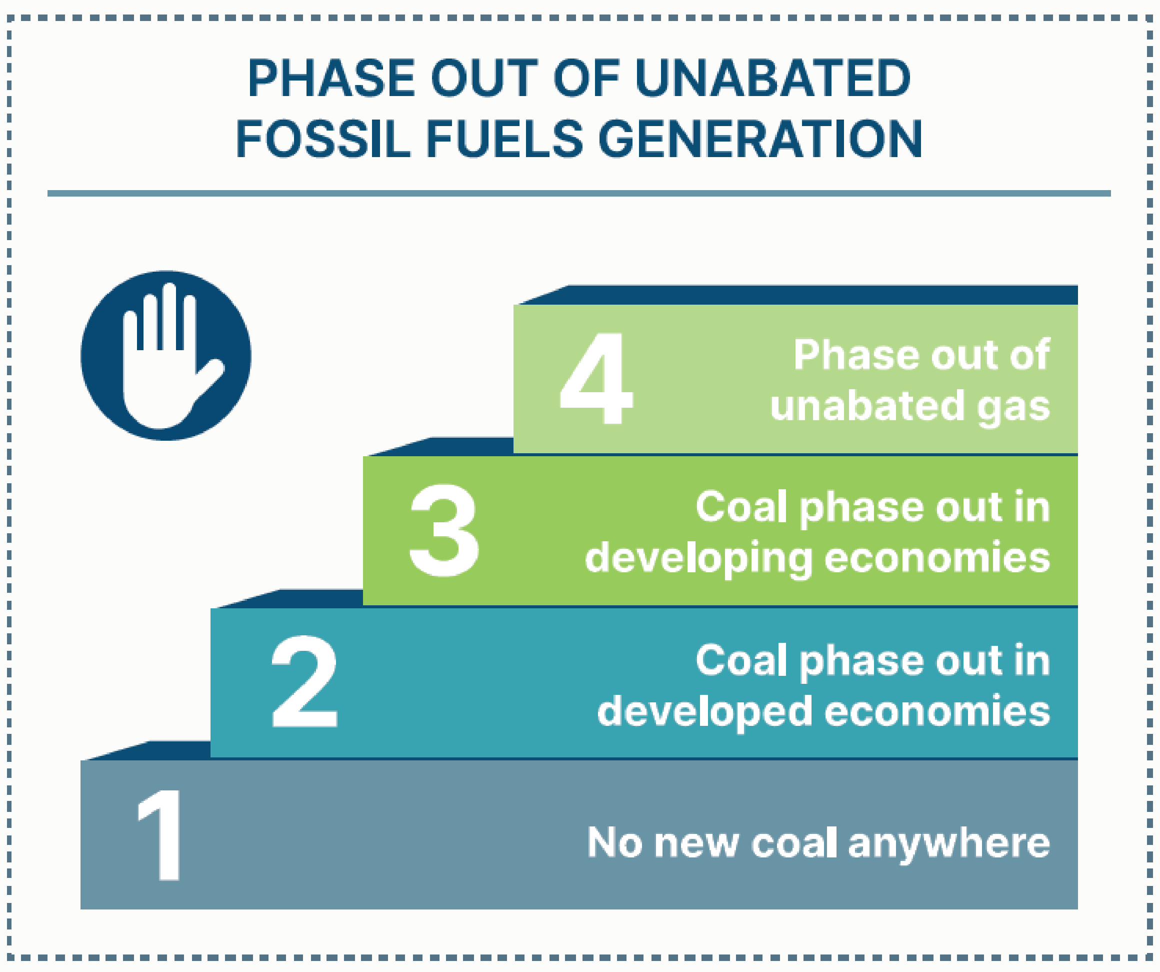
- Global wind resources show **massive potential**
- IEA estimates technical potential to generate more than **420,000 TWh/year** from offshore wind alone – 4x ETC high case of future demand

Minerals

- **Sufficient resources of lithium, nickel, cobalt** to meet demand from EV and grid batteries
- Opportunity to push **circularity in value chain,** including via materials recycling
- Concerns about cobalt supplies have unleashed **technological progress** which makes possible zero-cobalt batteries

Source: IEA (2019), *World Energy Outlook*, US Geological Survey (2020).

Steady phase out of unabated fossil generation can be achieved



- All countries should commit to **near totality of new growth of electricity as zero-carbon. No new coal** capacity should be added, and the **role of new gas should be limited** to very specific circumstances.
- New **VRE generation is now fully competitive** with new fossil power generation in many locations, and this cost advantage will spread wider and grow larger over time.
- While **existing thermal plants** will need to play a flexible **role in balancing systems** in many geographies, almost all countries have **sufficient capacity in place** to play this role even in hugely expanded electricity systems.

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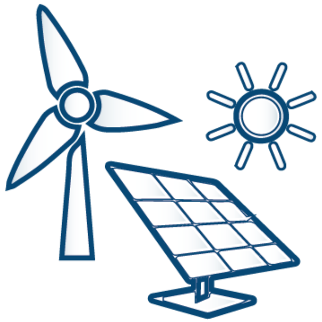

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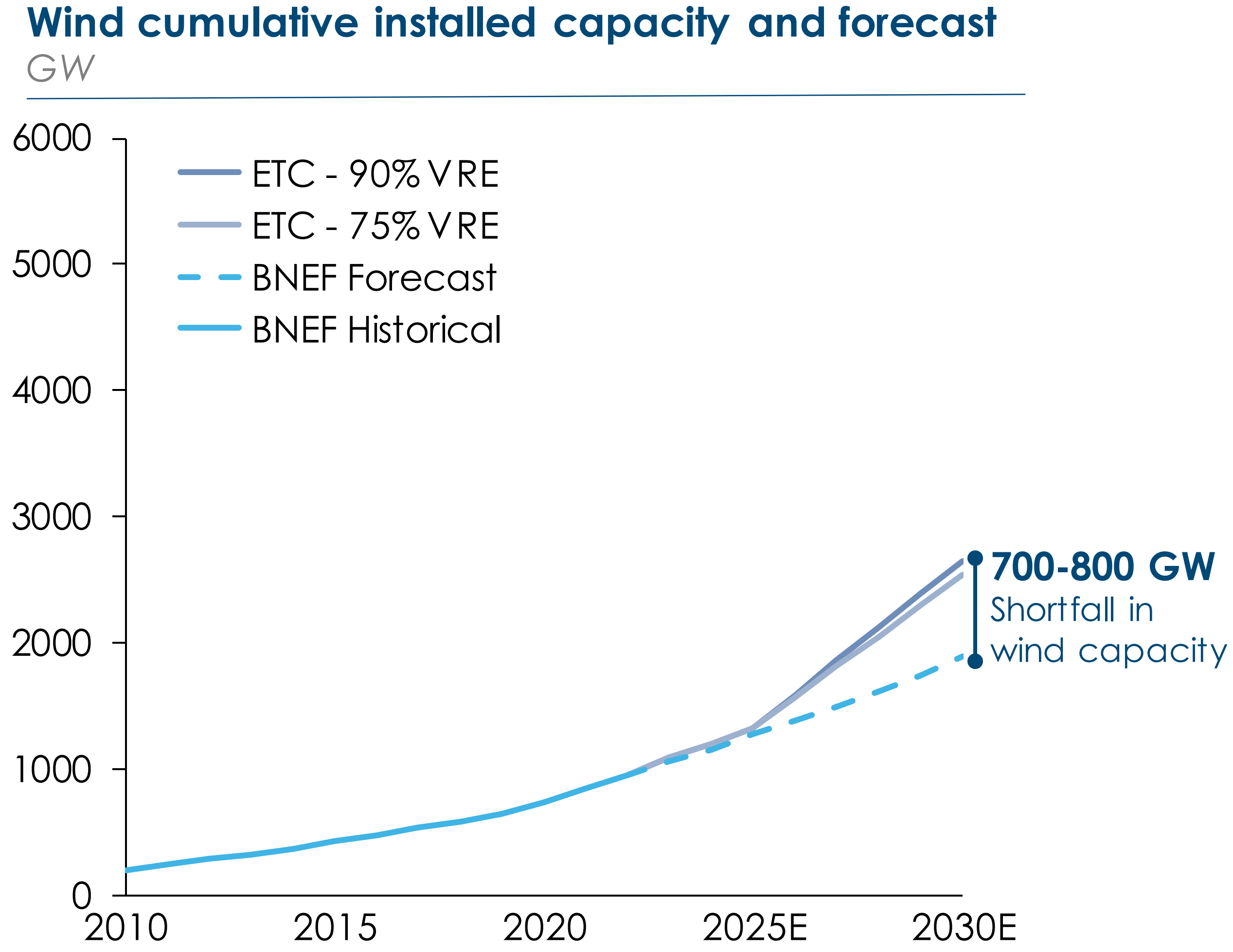
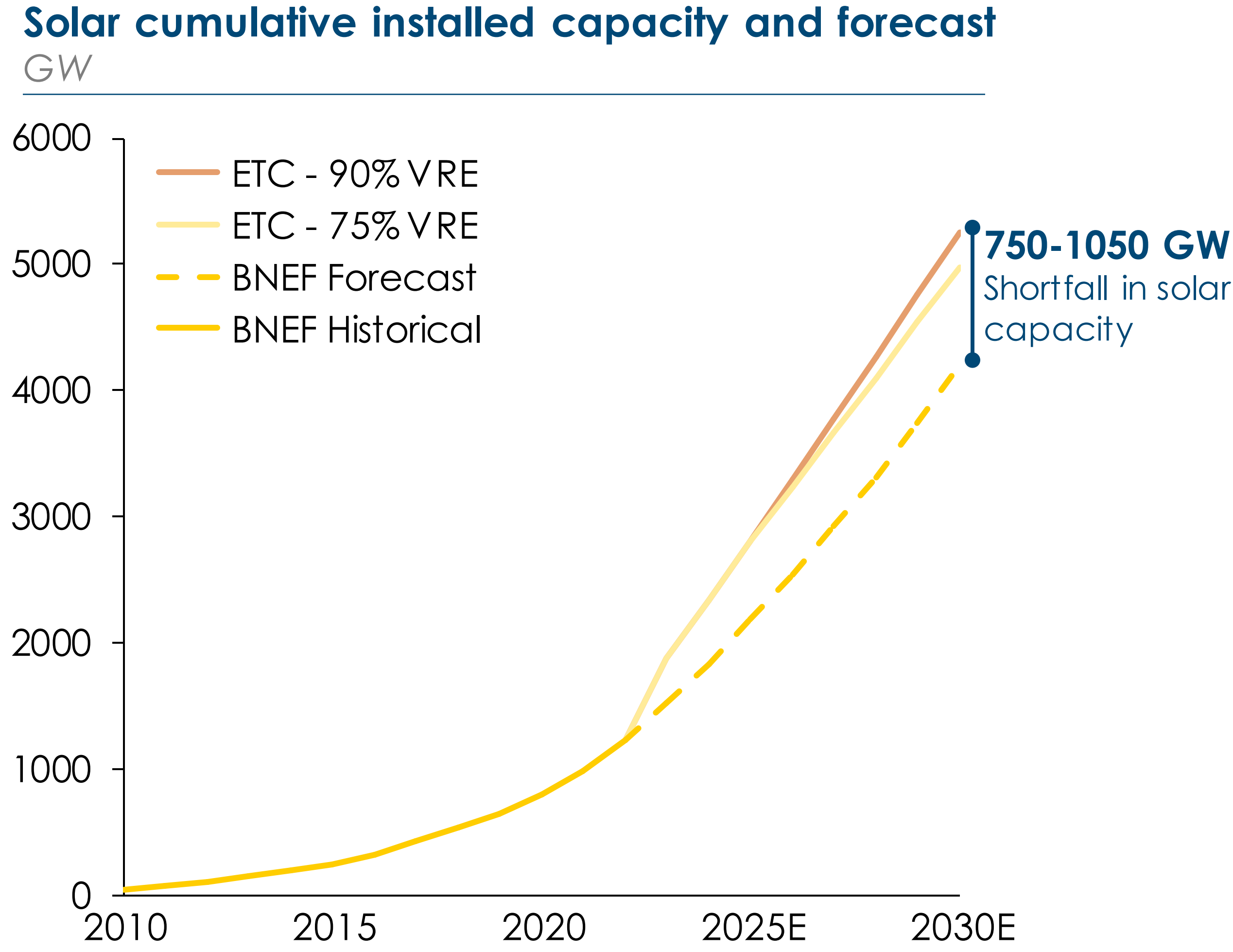
Despite good progress current forecasts see wind and solar capacity and generation lagging behind ETC's vision for 2030

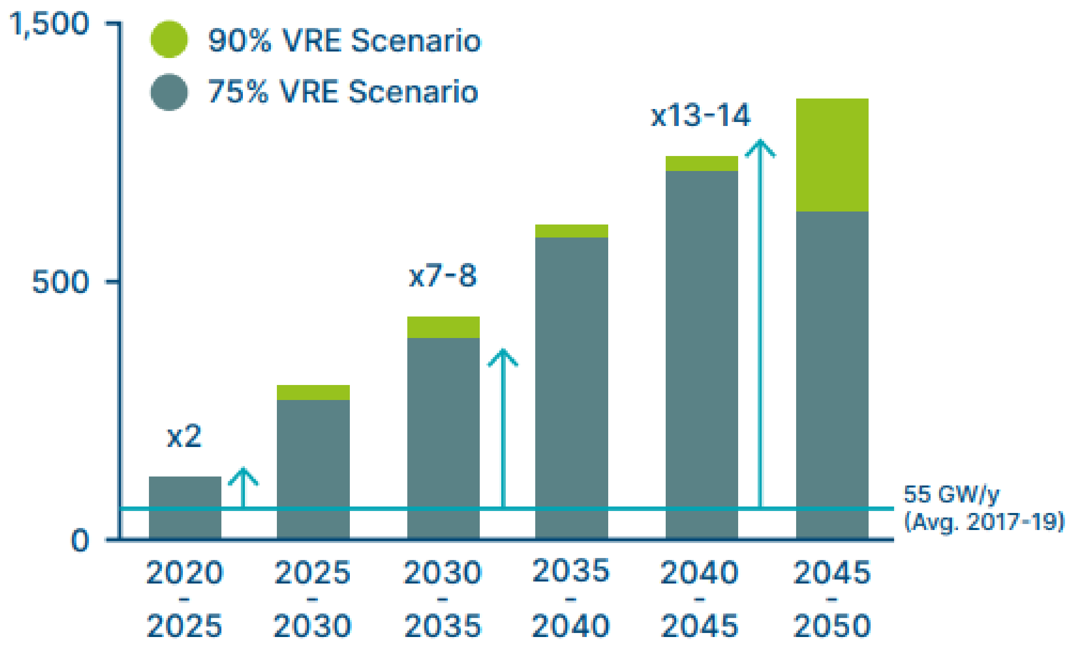




Source: BNEF (2022) *Global installed capacity*

To meet ETC targets, annual wind and solar installations must grow dramatically

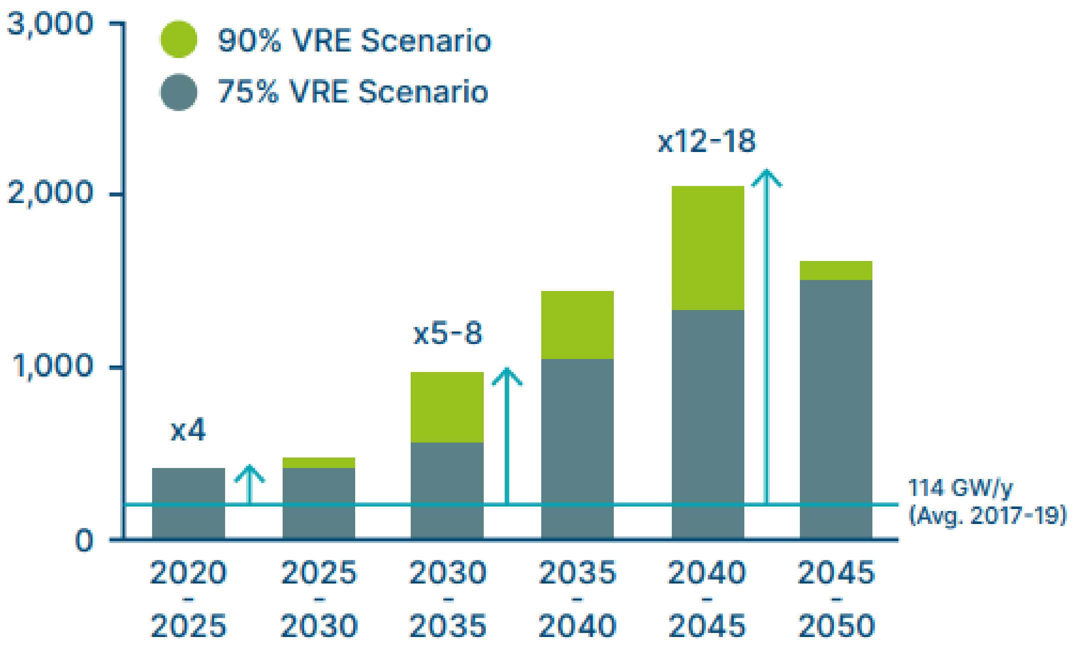
Wind - annual installed capacity additions
GW / year (annual average over 5-year period)



Average annual additions over total period (2020-50)

~3460 GW / year	~510 GW / year

Solar - annual installed capacity additions
GW / year (annual average over 5-year period)

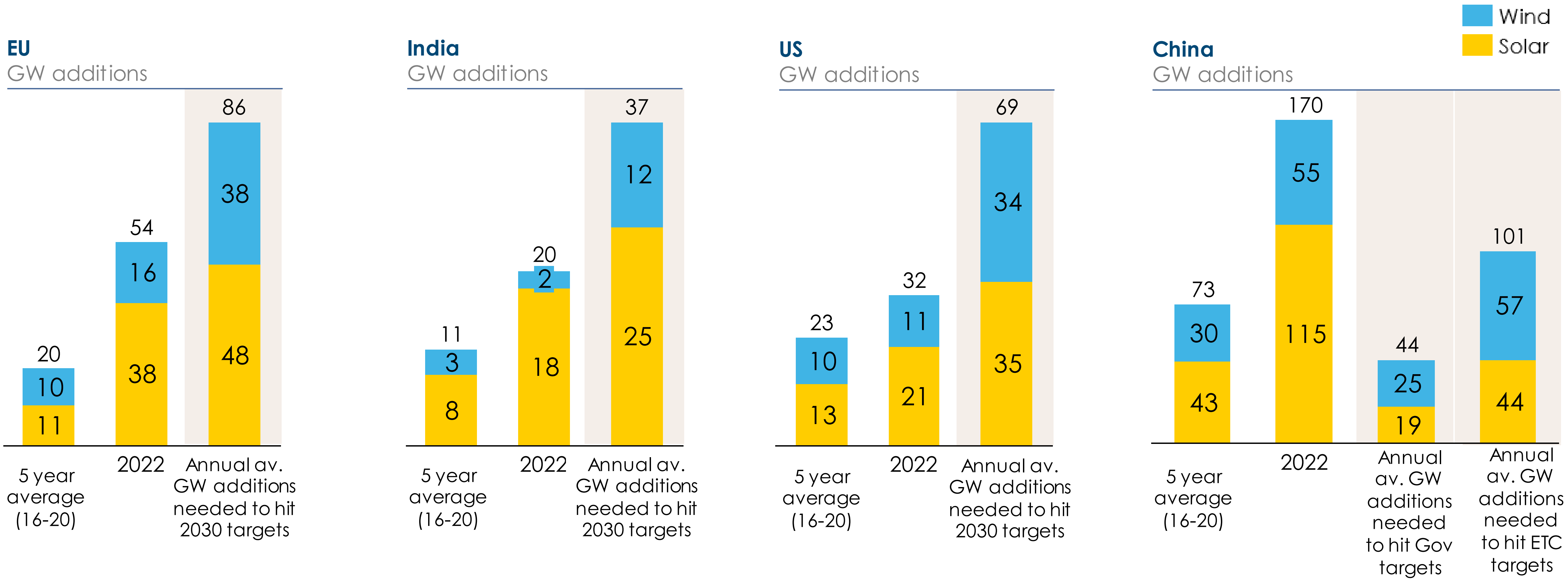


Average annual additions over total period (2020-50)

~870 GW / year	~1,110 GW / year

Note: 75% VRE scenario assumes 32% solar and 43% wind generation in 2050. 90% VRE scenario assumes 42% solar generation and 48% wind generation in 2050.
Source: BloombergNEF (2020) *New Energy Outlook*, SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Build rates of renewables has been increasing, but countries must go faster to hit 2030 targets – with the exception of China



2030 targets derived from:

***REPowerEU** – Commission working document targets from May 2022*

Indian Government's 2030 renewable targets

***Princeton Net Zero America Report** – E+ high electrification scenario (in line with clean electricity by 2035*

Chinese Government's 2030 renewable targets & ETC RMI China Zero-Carbon Electricity

Notes: 5-year averages are capacity additions from 2016-2020; annual average GW additions needed to hit 2030 targets across 2022-2030
Source: BNEF (2022), Global installed capacity; European Commission (May 2022) Commission staff working document, Implementing the REPowerEU Action Plan; MONGABAY (2022) What does India need to meet its 2030 renewable energy targets?; ETC/RMI (January 2021) China Zero Carbon Electricity Growth in the 2020s: A Vital Step Toward Carbon Neutrality

By far the largest investment will be required in the power system, which accounts for ~70% of the global total, followed by ~15% for buildings

Annual capital expenditure in the energy system

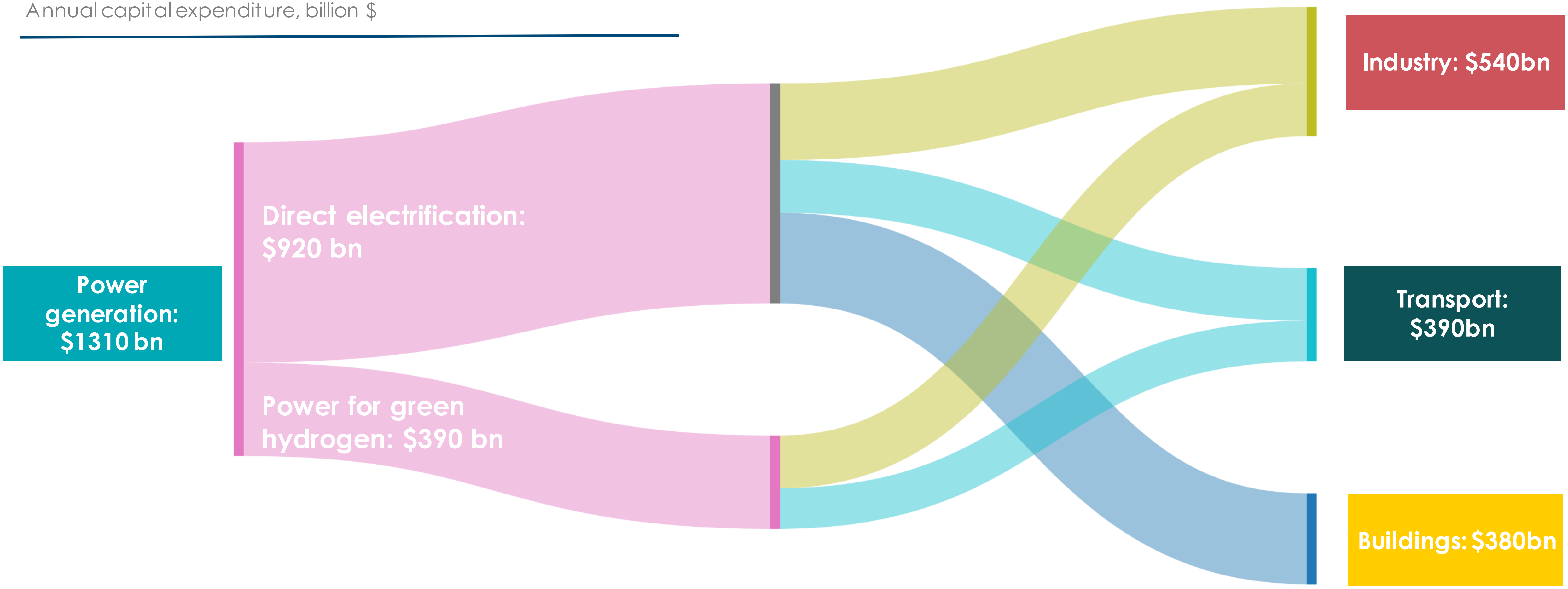
Billion $ p.a. 2021-2050

Source: Systemiq analysis for ETC (2022).

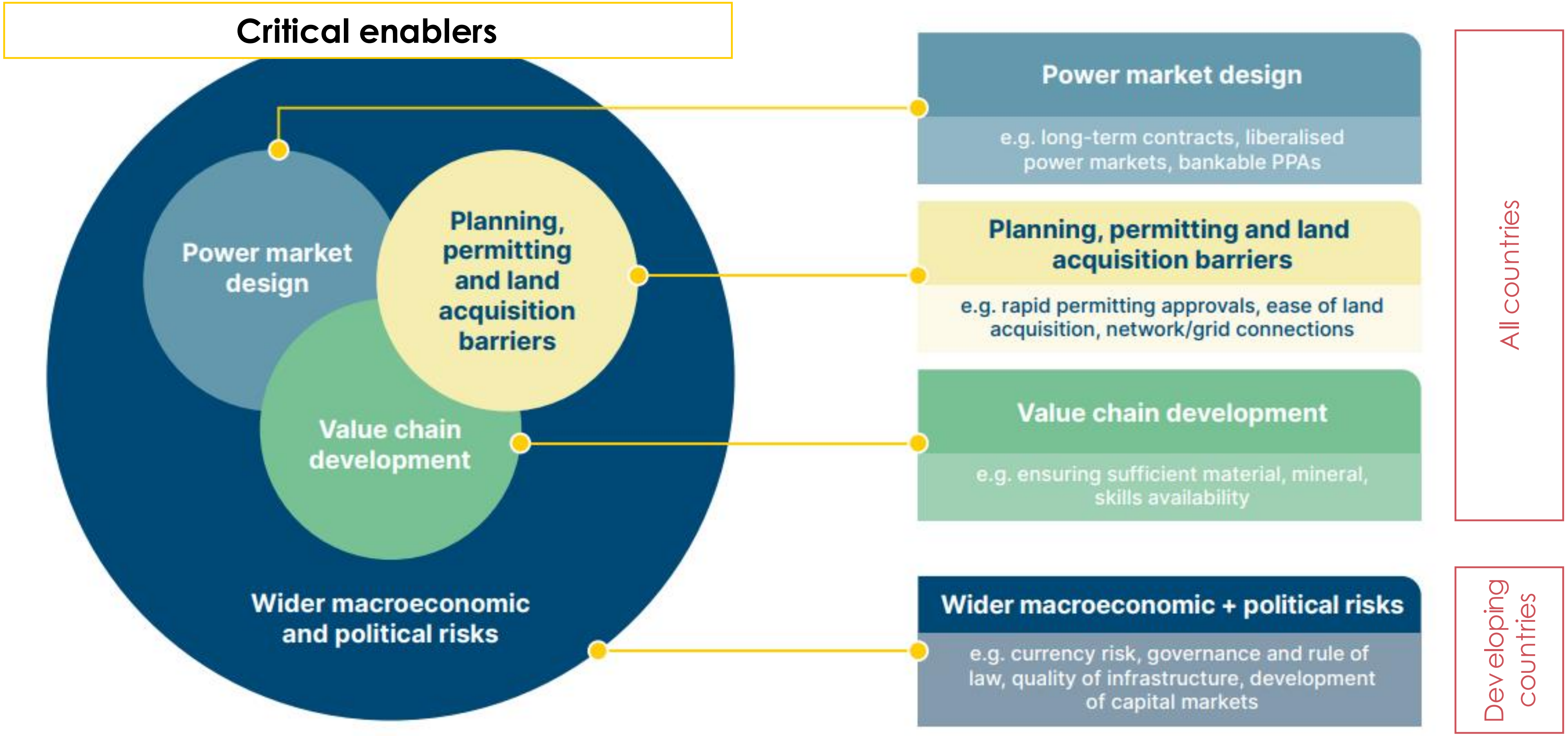
Clean power underpins the decarbonisation of other sectors - industry accounts for the biggest share of power investments

Electricity production investments between 2021-2050, allocated to end-sector based on relative consumption

Annual capital expenditure, billion $

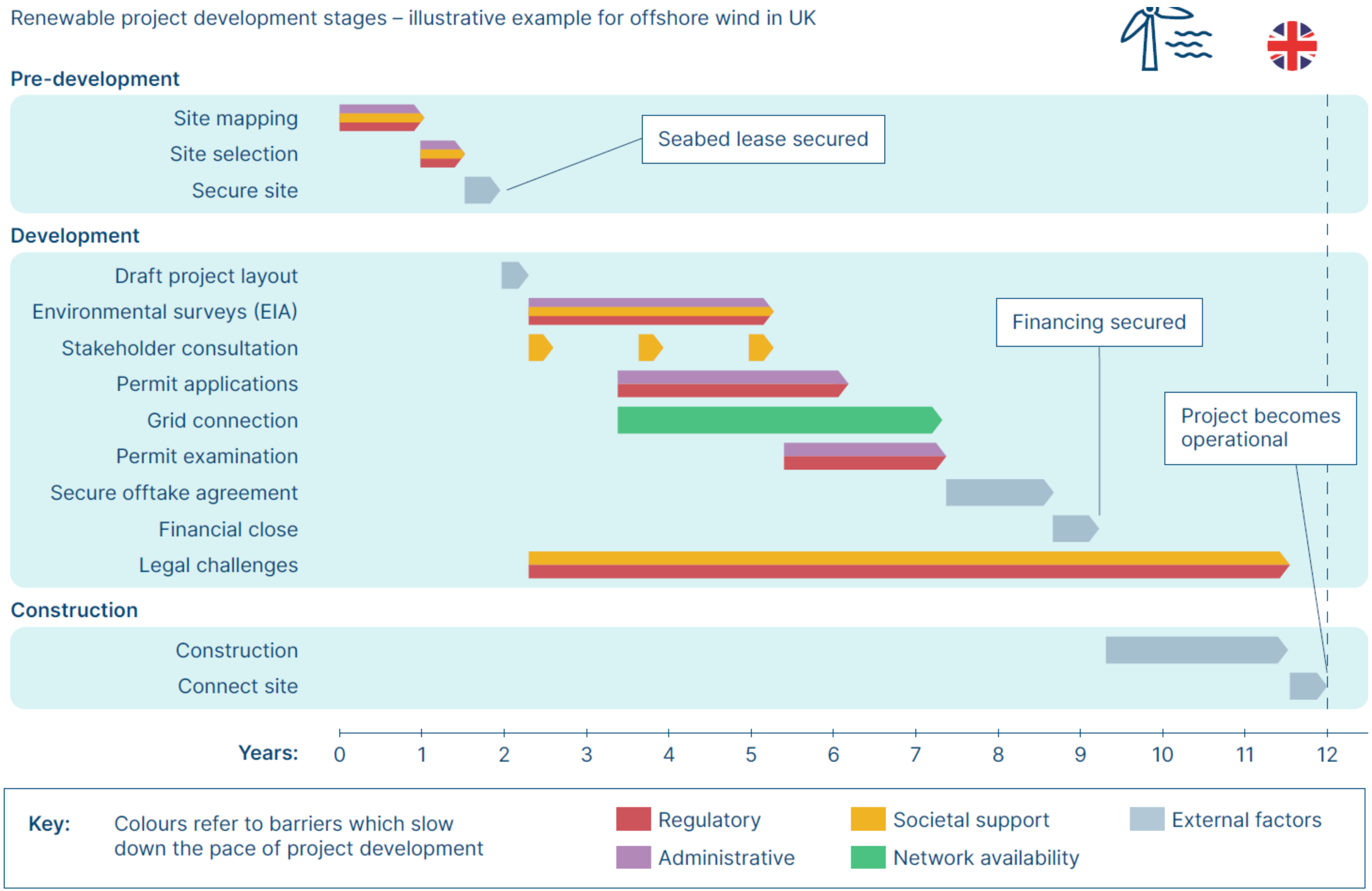


Achieving the build and investment at the pace and scale required will necessitate critical enablers



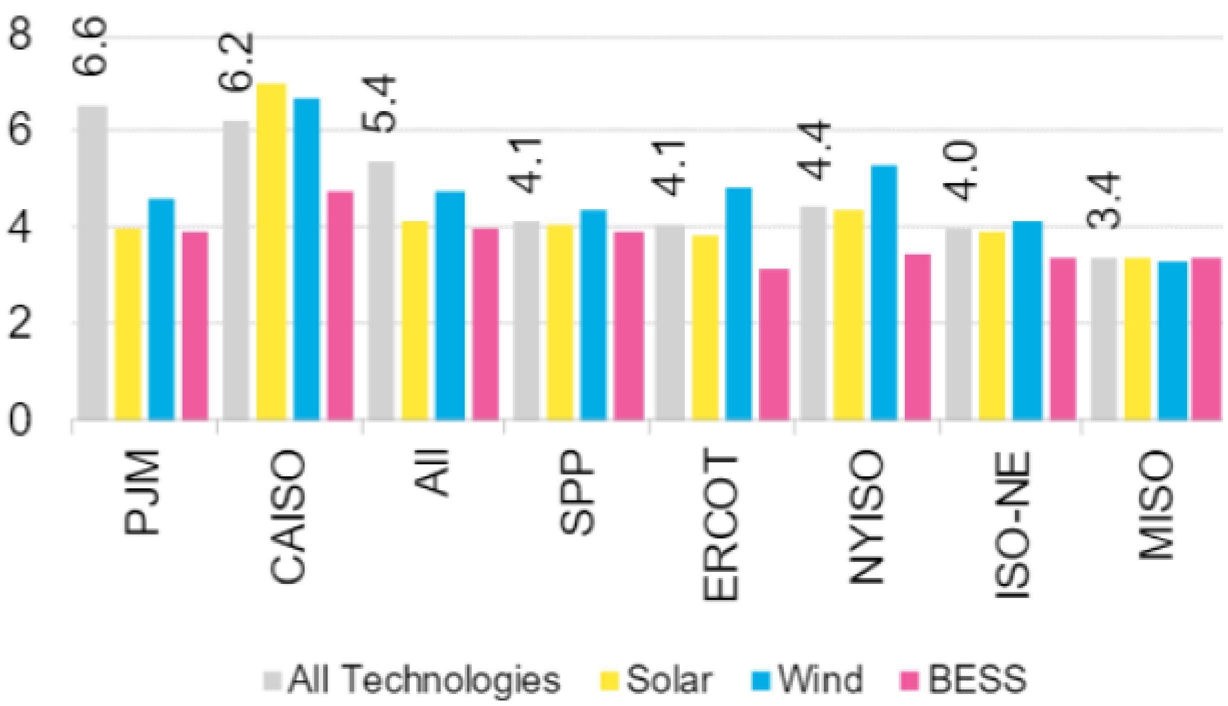
Source: Industry interviews, SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Recent trends: planning & permitting delays means it can take longer to permit an offshore wind farm than to build it



Recent trends: grid interconnection queues are reaching record levels in some geographies

Average time active projects in US grid interconnection queues have been waiting for approval
Years

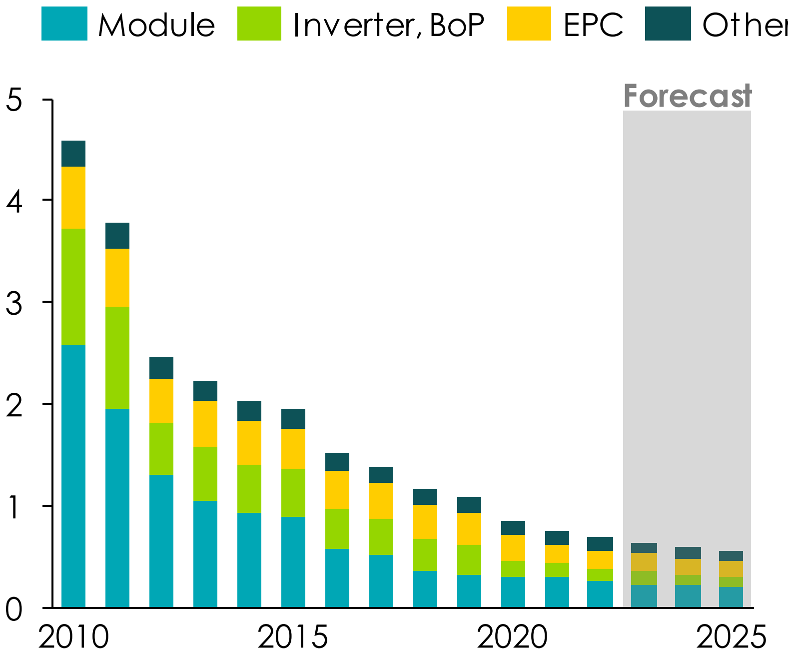


- The United States currently have **1.4 TW** of wind, solar and battery projects waiting for a connection to the power grid.
- The amount of time projects spend in the queue has been increasing, from **2.1 years** on average in 2010, to **3.7 years** in 2021.
- Transmission infrastructure needs to be built to **three times total 2022 capacity** to decarbonise the power system by 2035.
- Environmental review of long-distance electric transmission lines and related permitting severely restricts grid buildout, as this normally takes **between 5 and 10 years**, sometimes even longer.

Notes: Chart represents projects which have been in the queue since 2020 to minimise distortion from recent projects.
Sources: BNEF (2022), *US electricity regulator hopes to ease grid access bottleneck to renewables;* Berkeley Lab (2022), Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection as of the End of 2021.

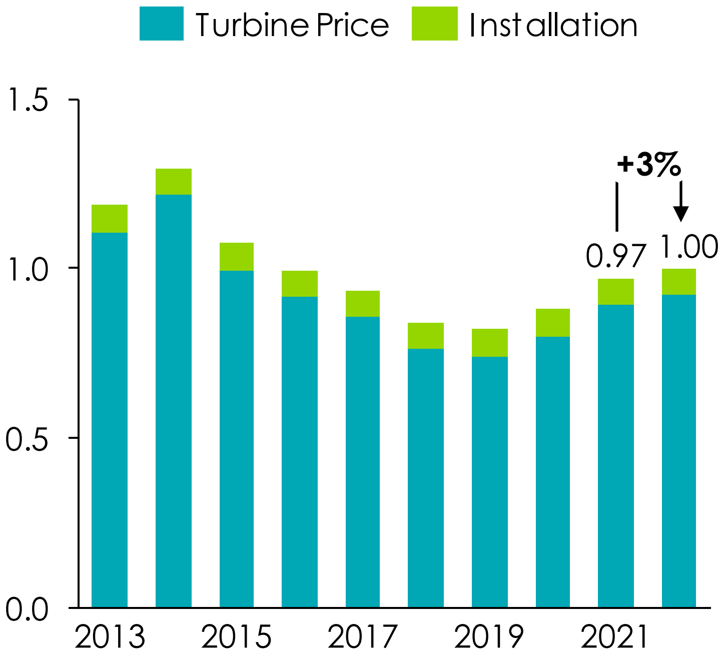
Recent trends: the past few years have exposed supply chain risks for clean energy technologies, leading to price rises for wind and batteries

Solar PV capex benchmark
2022 $/W(DC)



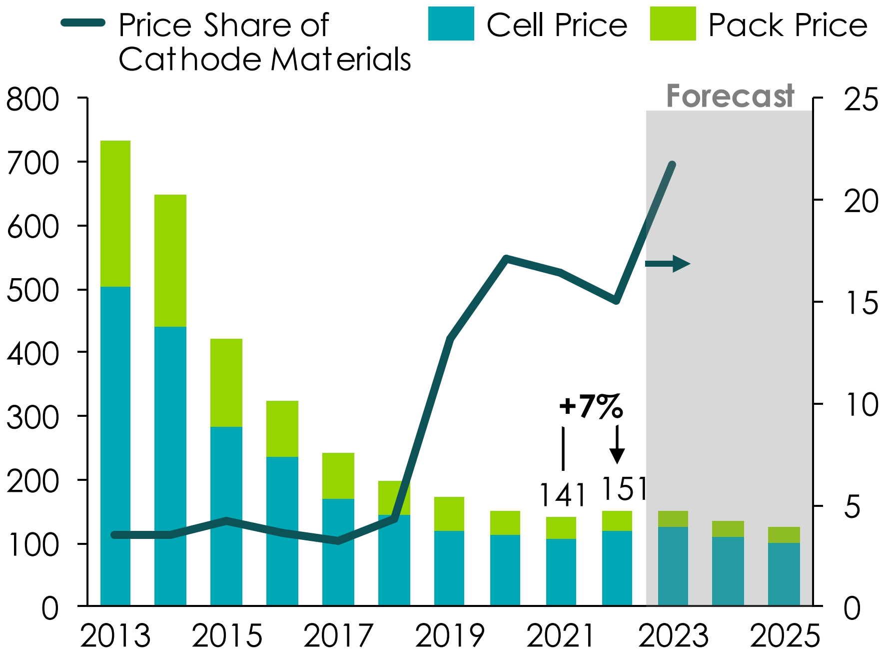
Solar: slowing of price reductions in 2022 due to tight supply for polysilicon and increased freight costs, alongside higher commodity prices, but expected to keep falling from 2023.

Wind turbine price by signing date
2022 $m/MW



Wind: cost increases driven by increasing prices of copper, aluminium and steel from 2020 onwards, alongside higher freight and shipping costs; however, **prices have been falling in China**.

Li-ion battery survey price
2022 $/kWh (LHS); % of total price (RHS)



Batteries: first-ever price rises in 2022 as prices of cathode materials (Li, Ni, Co) have risen sharply in past year; will take several years to recover to previous trend.

Source: BNEF (2022), *4Q Global PV Market Outlook*; BNEF (2022) *Lithium-Ion Battery Price Survey*, BNEF, *1H Global Wind Market Outlook*, 2022; BNEF, *1H Wind Turbine Price Index*, 2022

Several types of planning and permitting barriers contribute to slowing deployment rates

Regulatory	Administrative	Societal support	Network availability
Lack of strategic vision	Multiple authorities in charge of permitting	Understanding scale up challenge	Network system capacity
Lack of dedicated land	Lack of capability and resources	Protecting biodiversity	Queues to connect to grid
Complex regulation	Lack of digital permitting infrastructure	Local socio-economic concerns	Lack of strategic infrastructure planning
Inflexible permits	Lack of data aggregation		(Network availability will be the focus of a forthcoming briefing)
Adverse legal system			
Land ownership issues			

Key solutions must be acted upon to overcome challenges, with a critical role for governments and policymakers

Planning & Permitting

Regulatory

1. Strategic vision
2. Ensure renewables are appropriately prioritised in law and land use
3. Reduce the time taken in permitting stages
4. Increase the flexibility of permits
5. Streamline and clarify the legal process
6. Establish legal ownership

Administrative

1. Speed permitting applications and examination
2. Create better environmental mapping tools

Societal Support

1. Stakeholder engagement
2. Responding to local concerns and benefits-sharing
3. Biodiversity conscious development
4. Community awareness
5. Tender processes which recognise non-price factors

Streamlining planning and permitting can reduce project development times by more than half for wind and solar projects

Planning & Permitting

Offshore wind

÷2

From a 12 year indicative timeline to a 5.5 year expedited timeline.

Onshore wind

÷2

From a 10 year indicative timeline to a 4.5 year expedited timeline.

Solar

÷4

From a 4 year indicative timeline to a 1 year expedited timeline.

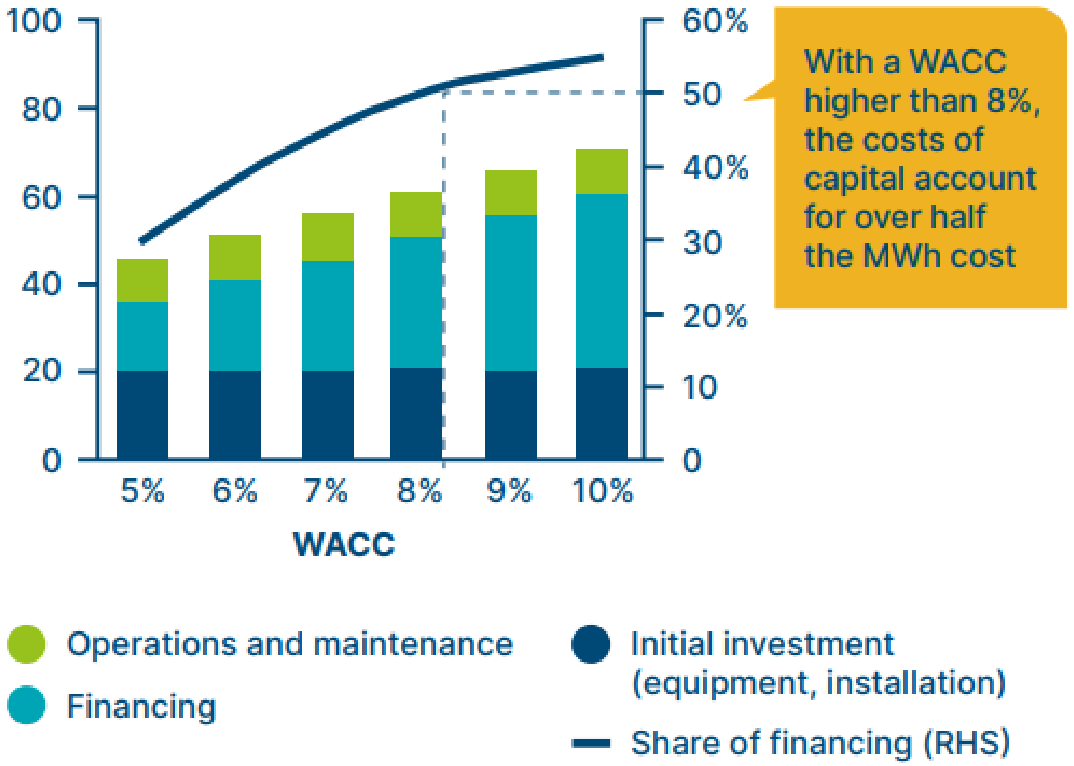
- Expedited timelines assume that **social and environmental standards** for projects are **either maintained or strengthened.**
- To achieve maximum project time savings, it is likely that the **entire set of proposed solutions** would need to be implemented where these are not currently utilised in respective countries, and **more stages of project development** would need to be **conducted in parallel**.

Note: Project development time savings are illustrative examples for countries with strong democratic processes. Illustrative examples of good practice project development timelines have been indexed against: UK for offshore wind, Spain for onshore wind, France for utility-scale solar.

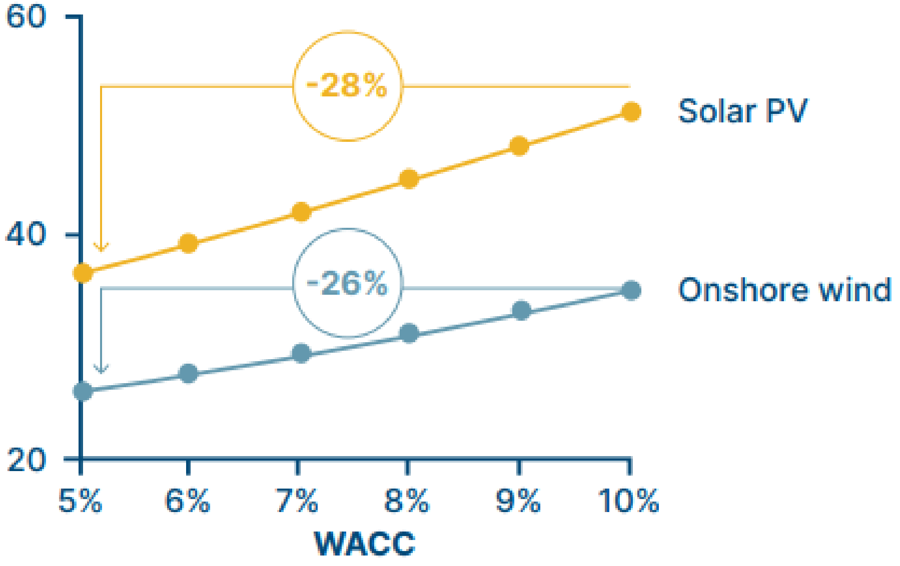
A low cost of capital (WACC) will significantly reduce the cost of VREs build out, given VRE's high CAPEX, low OPEX cost profile

Financing & market design

LCOE and share of financing costs, Solar PV, $/MWh, %



Illustrative LCOE, WACC for US wind and solar [1], $/MWh, %



Note: [1] illustrative example assuming project lifetimes of 20 years.
Source: IEA (2019) *Solar Energy: Mapping the Road Ahead*, SYSTEMIQ analysis for the Energy Transitions Commission (2021),

Optimal long-term energy contract structures can ensure sufficient revenue certainty and keep WACC low

Financing & market design

When organised at the market level, long-term energy contracts must balance

- Attracting **low-cost capital/WACC** by ensuring sufficient **revenue certainty** for investors
- Incentivising **supply aligned to market needs, minimising distortion of short-term markets**

Production-based energy long-term contracts should include the following features

1 Competitive price-setting mechanisms	• Strike price set competitively via **auction, pay-as-bid** • **2- way contracts**. sharing risk across counterparties (i.e. generators reimburse any positive difference between strike price and wholesale reference price), or **1-way contracts** to optimise locational signals and drive lower auction bids
2 Ensure sufficient revenue certainty	• **Long term** contract (e.g. 15 years) • **Reference price based on technology-specific price** to minimise exposure to specifically low prices during times of VRE generation
3 Expose generators to wholesale market signals	• **Sliding premium with 'medium' settlement time**, e.g. daily, weekly or monthly, to incentivise producers to align generation with system needs based on wholesale pricing, and encourage the deployment of storage • Clause **against producing during negative wholesale prices**
4 Time of day / year / locational components	• **Multiple auctions with different time components (time of day, year) and / or locational components** - based on 4-6 year forecasts to reflect where / when energy shortages occur
5 Incentivise long-term use of existing assets	• **Market-wide contracts**, with existing and repowered generation able to bid into long-term production-based auctions once initial long-term energy contracts expires (e.g. after 15 years) for next auction period (esp. important for offshore wind)

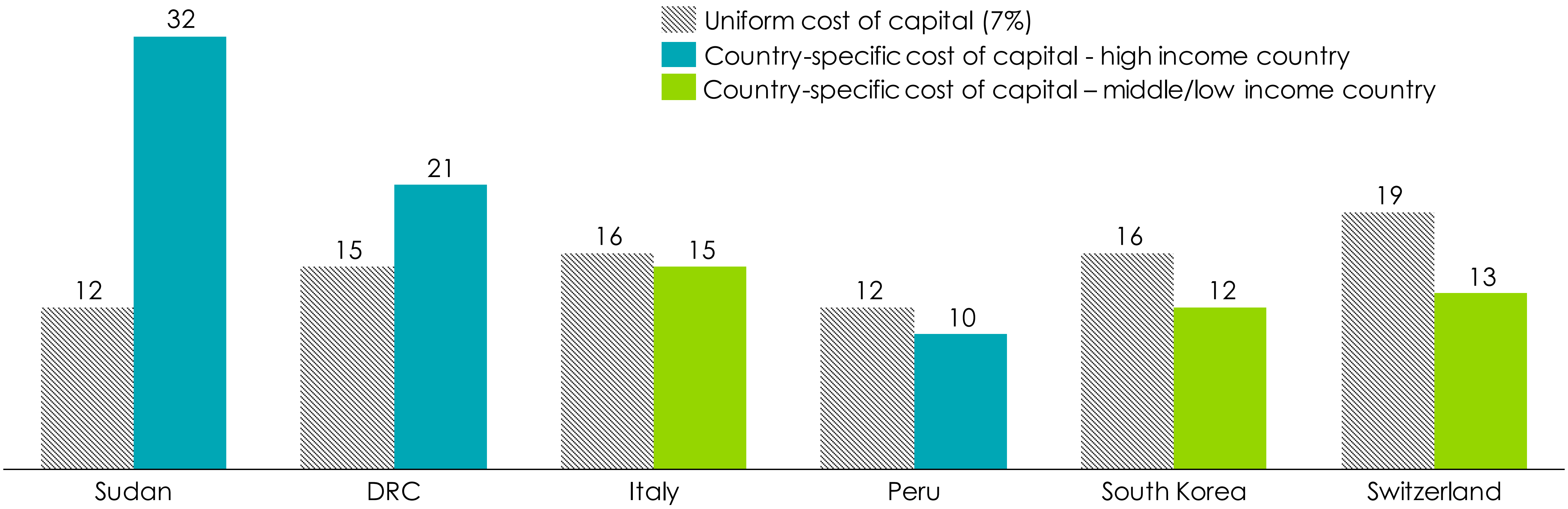
Source: Industry interviews, IRENA, BNEF, SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Costs in some African countries could be significantly higher than those in higher income countries due to cost of capital

Financing & market design

LCOE of solar PV based on country WACC

€/MWh



WACC:	25.5%	12.1%	6.1%	4.7%	3.8%	3.1%

Sources: Egli et al. (2019) *Bias in energy system models with uniform cost of capital assumption.*

There are 4 critical priorities for the 2020s to scale up capital investment in middle- and low-income countries

Financing & market design

1

Increased mobilisation of domestic savings and private financial flows

- Improved tax collection + carbon pricing
- MDBs support growth of local currency markets

2

Significant scale up in MDB and other external finance

- Explore levers to expand financial capacity
- Targeted use of concessional instruments (e.g., grants and guarantees)
- Utilise Special Drawing Rights

3

Expanded role for MDBs and national governments in creating the conditions for profitable investments

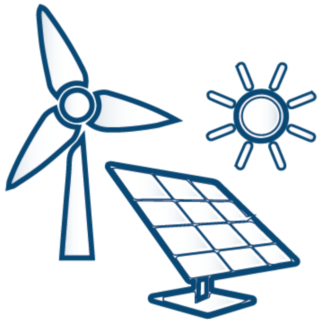
- Support countries to develop transition strategies
- Proactively develop bankable projects
- Catalyse more private finance

4

Private sector commitments and enhanced capability to invest in lower income countries

- Understand scale and nature of the opportunity
- Actively develop project pipelines
- Build relationships with MDBs where necessary

Making Clean Electrification Possible:
30 Years to Electrify the Global Economy



Clean electrification

Massive clean electrification at the heart of a net zero emissions economy: global power system growing 3.5-5x and simultaneously decarbonising

1. **Massive electrification to deliver a zero-carbon economy**
2. **Generating low-cost, zero-carbon power**
3. **Building and financing zero-carbon power systems**
4. **Critical priorities for the 2020s**

Clean electrification

2030 TARGETS:

ELECTRIFICATION

Global electricity use up 1.5 times

- EVs near 100% of new car sales in developed countries, 50%+ in developing countries
- Heating increasingly electrified, building retrofits under way

WIND AND SOLAR DEPLOYMENT

Wind and solar ~40% global generation

- 5-7x increase in annual wind + solar installations
- Scaling storage and flexibility deployment

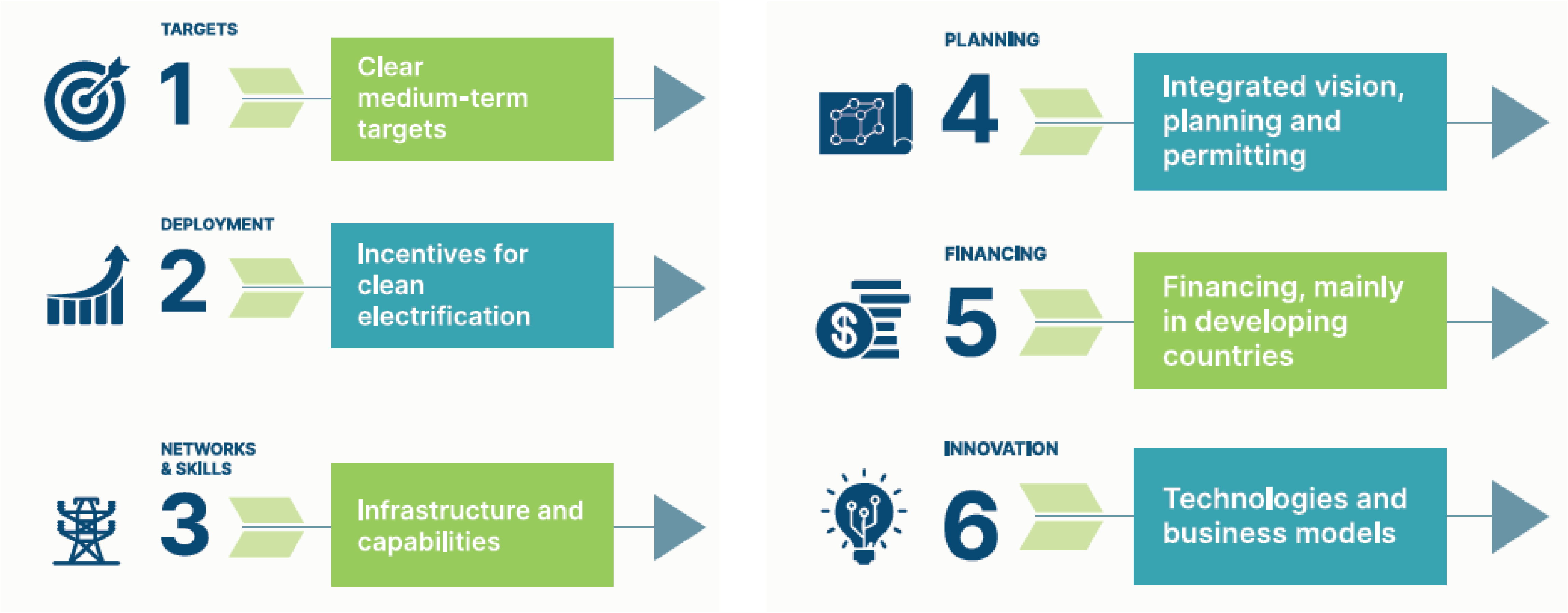
FOSSIL PHASE OUT

Grid emissions intensity

Developed countries	Developing countries
<80 gCO_2/kWh	<180 gCO2/kWh

- Immediate stop to new coal
- Meet all new electricity growth with wind and solar

Six critical actions for the 2020s to put mid-century targets in reach



Energy Transitions Commission

The Energy Transitions Commission is hosted by SYSTEMIQ Ltd.