

Global Outlook on Energy Markets and Transition

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- I. Context
- II. Challenges
- III. World Bank Engagement
- IV. Going Forward

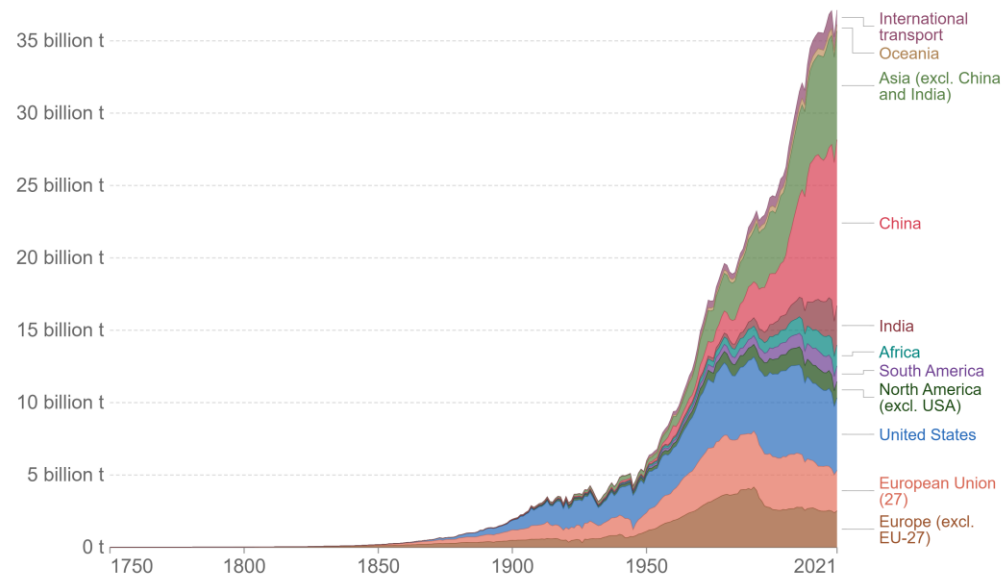


I. Context

Global GHG emissions continue to grow

Annual CO₂ emissions by world region

This measures fossil fuel and industry emissions¹. Land use change is not included.



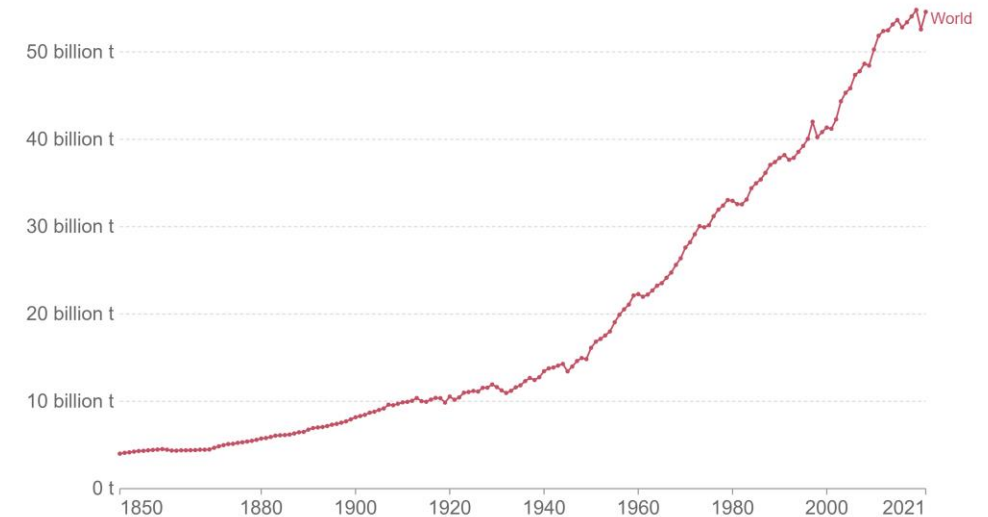
Source: Global Carbon Budget (2022)

OurWorldInData.org/co2-and-greenhouse-gas-emissions • CC BY

1. **Fossil emissions:** Fossil emissions measure the quantity of carbon dioxide (CO₂) emitted from the burning of fossil fuels, and directly from industrial processes such as cement and steel production. Fossil CO₂ includes emissions from coal, oil, gas, flaring, cement, steel, and other industrial processes. Fossil emissions do not include land use change, deforestation, soils, or vegetation.

Greenhouse gas emissions

Greenhouse gas emissions include carbon dioxide, methane and nitrous oxide from all sources, including agriculture and land use change. They are measured in carbon dioxide-equivalents¹ over a 100-year timescale.



Source: Calculated by Our World in Data based on emissions data from Jones et al. (2023)

Note: Land use change emissions can be negative.

OurWorldInData.org/co2-and-greenhouse-gas-emissions • CC BY

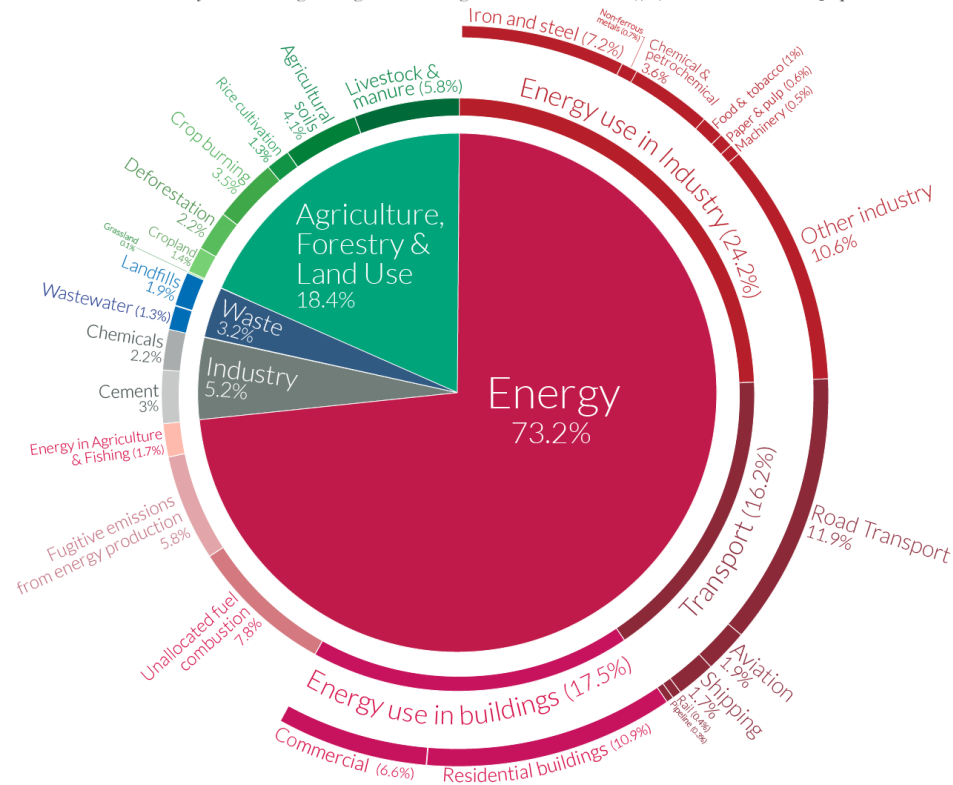
1. ****Carbon dioxide-equivalents (CO₂eq)**:** Carbon dioxide is the most important greenhouse gas, but not the only one. To capture all greenhouse gas emissions, researchers express them in 'carbon dioxide-equivalents' (CO₂eq). This takes all greenhouse gases into account, not just CO₂. To express all greenhouse gases in carbon dioxide-equivalents (CO₂eq), each one is weighted by its global warming potential (GWP) value. GWP measures the amount of warming a gas creates compared to CO₂. CO₂ is given a GWP value of one. If a gas had a GWP of 10 then one kilogram of that gas would generate ten times the warming effect as one kilogram of CO₂. Carbon dioxide-equivalents are calculated for each gas by multiplying the mass of emissions of a specific greenhouse gas by its GWP factor. This warming can be stated over different timescales. To calculate CO₂eq over 100 years, we'd multiply each gas by its GWP over a 100-year timescale (GWP100). Total greenhouse gas emissions – measured in CO₂eq – are then calculated by summing each gas' CO₂eq value.

Energy and coal use contribute significantly

Global greenhouse gas emissions by sector

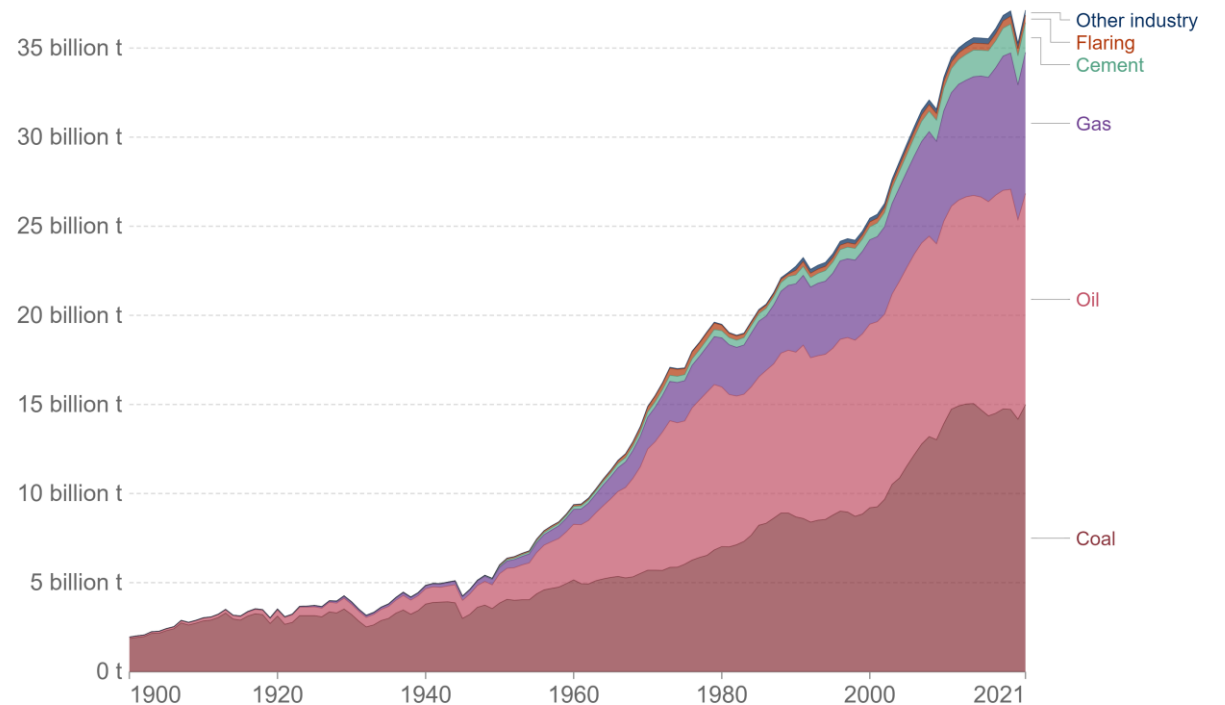
This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO₂eq.

Our World
in Data



CO₂ emissions by fuel or industry type, World

Our World
in Data



Source: Global Carbon Budget (2022)

OurWorldInData.org/co2-and-greenhouse-gas-emissions • CC BY

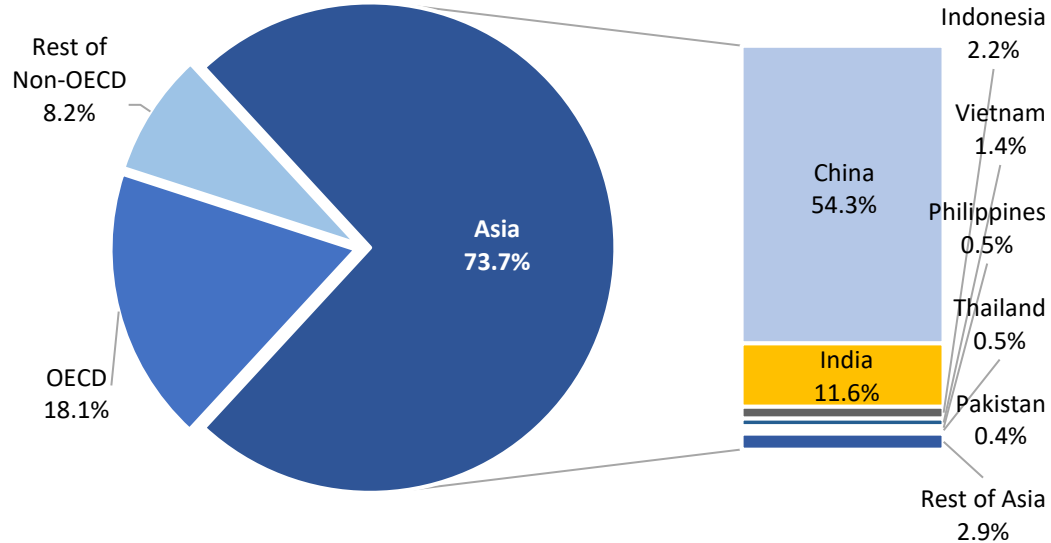
OurWorldInData.org – Research and data to make progress against the world's largest problems.

Source: Climate Watch, the World Resources Institute (2020).

Licensed under CC-BY by the author Hannah Ritchie (2020).

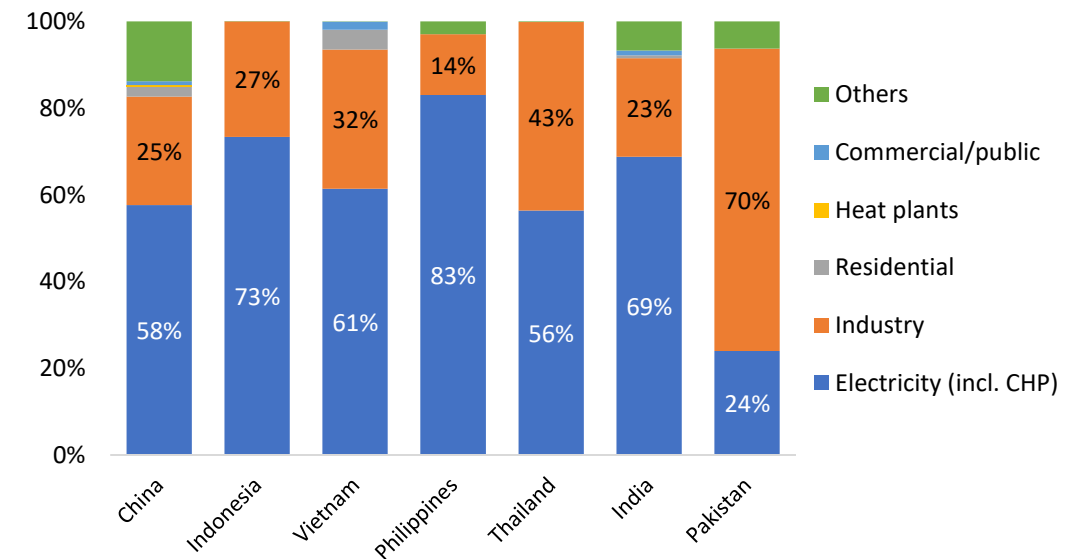
Coal use is led by Asia mainly for power generation

Coal consumption by country in 2020



Source: BP Statistical Review of Global Energy 2021

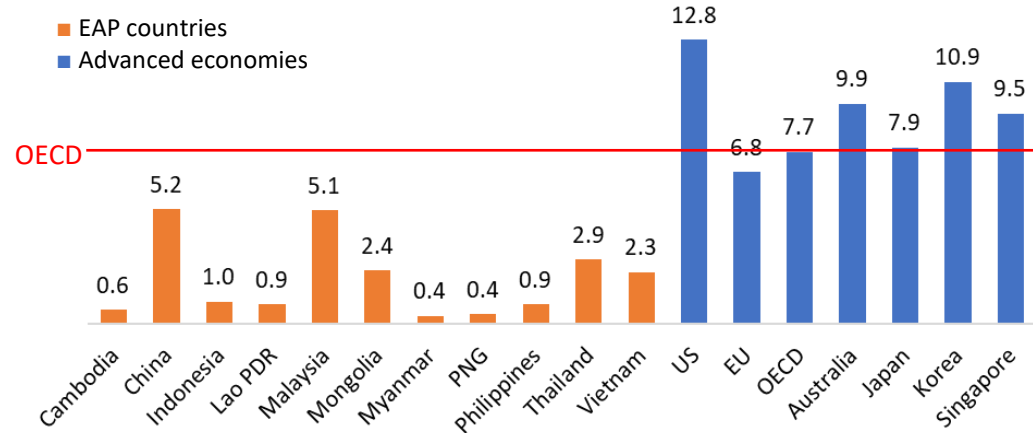
Coal consumption by sector in 2018
(selected countries)



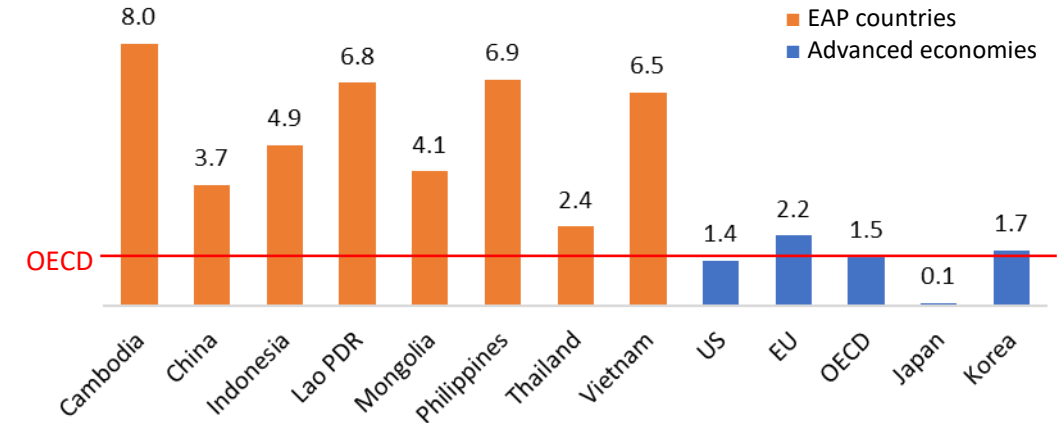
Source: IEA World Energy Balances

Developing countries expect higher demand growth

Electricity Consumption per capita (MWh per person) in 2019



Electricity demand growth forecast 2020-30 (%)

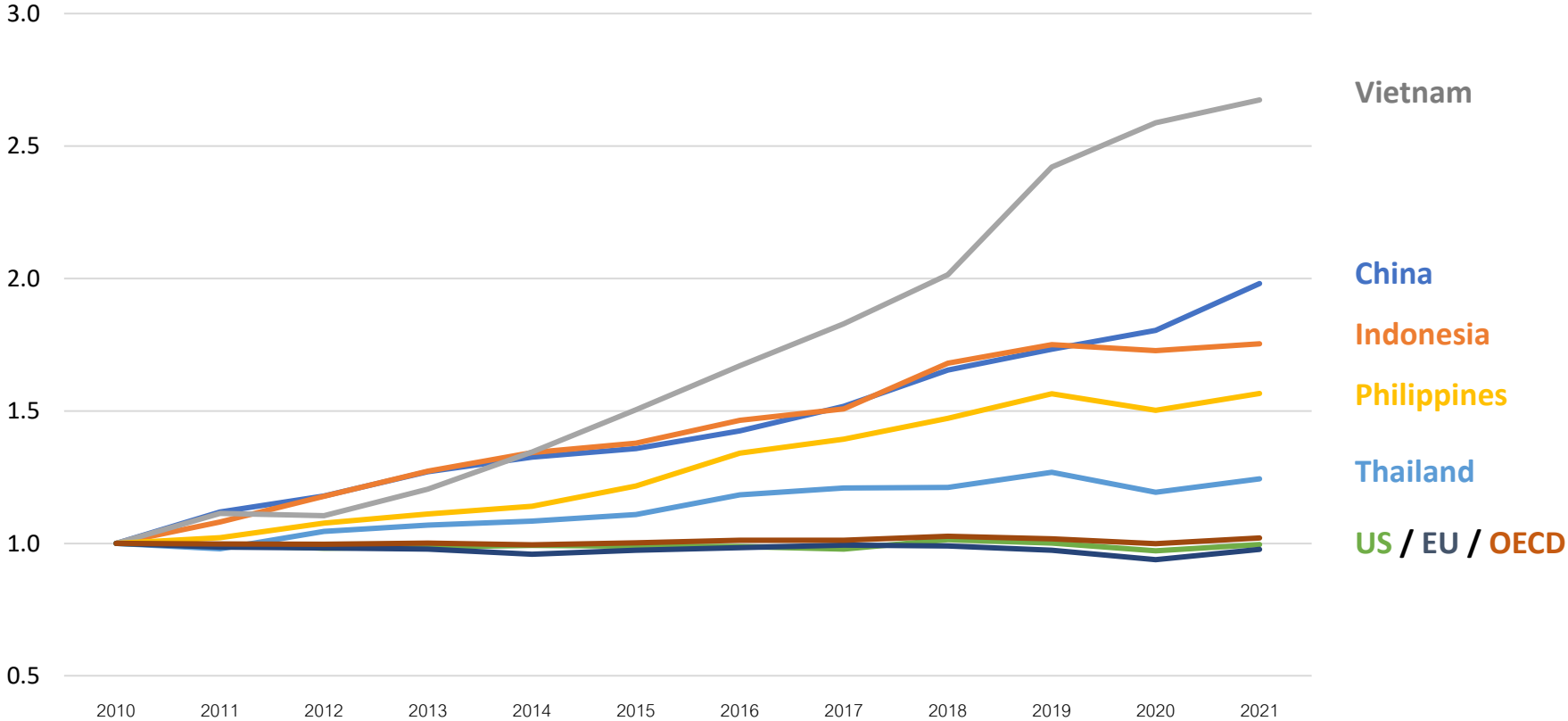




Electricity demand grows fast in developing countries

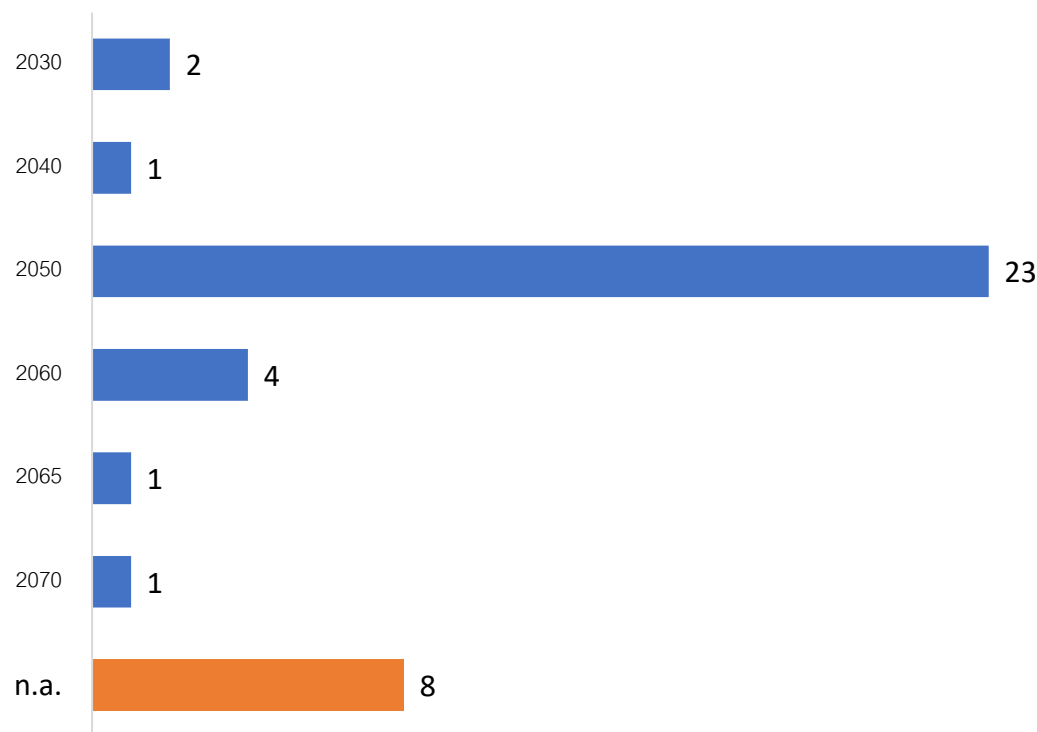


Annual electricity generation growth for selected countries/economies 2010-2021
(2010 level = 1)



Many Asian countries are committed to net zero

Number of developing Asian countries by net zero target year



Source: ADB, Asia in the Global Transition to Net Zero (2023)

Party	Most Recent NDC Submission	Long-Term Strategy Submission	Net Zero	Status
Afghanistan	2016 First NDC	NS	2050	Declaration/Pledge
Armenia	2021 Updated first NDC	NS	2050	Declaration/Pledge
Azerbaijan	2017 First NDC	NS	NS	
Bangladesh	2021 Updated first NDC	NS	NS	
Bhutan	2021 Second NDC	NS	2030	Achieved
Cambodia	2020 Updated first NDC	2021	2050	In policy document
People's Republic of China	2021 Updated first NDC	2021	2060	In policy document
Cook Islands	2016 First NDC	NS	2040	In policy document
Fiji	2020 Updated first NDC	2019	2050	In law
Georgia	2021 Updated first NDC	NS	NS	
India	2022 Updated first NDC	2022	2070	Declaration/Pledge
Indonesia	2022 Updated first NDC	2021	2060	In policy document
Kazakhstan	2016 First NDC	NS	2060	In policy document
Kiribati	2016 First NDC	NS	2050	Declaration/Pledge
Kyrgyz Republic	2021 Updated first NDC	NS	2050	Declaration/Pledge
Lao PDR	2021 Updated first NDC	NS	2050	In policy document
Malaysia	2021 Updated first NDC	NS	2050	In policy document
Maldives	2020 Updated first NDC	NS	2030	In law
Marshall Islands	2020 Second NDC	2018	2050	In policy document
Micronesia, Federated States of	2022 Updated first NDC	NS	2050	Declaration/Pledge
Mongolia	2020 Updated first NDC	NS	NS	
Myanmar	2021 Updated first NDC	NS	2050	Declaration/Pledge
Nauru	2021 Updated first NDC	NS	2050	In policy document
Nepal	2020 Second NDC	2021	2050	In policy document
Niue	2016 First NDC	NS	...	
Pakistan	2021 Updated first NDC	NS	2050	Declaration/Pledge
Palau	2016 First NDC	NS	2050	Declaration/Pledge
Papua New Guinea	2020 Second NDC	NS	2050	Declaration/Pledge
Philippines	2021 Updated first NDC	NS	NS	
Samoa	2021 Second NDC	NS	2050	Declaration/Pledge
Solomon Islands	2021 Updated first NDC	NS	2050	In policy document
Sri Lanka	2021 Updated first NDC	NS	2060	In policy document
Tajikistan	2021 Updated first NDC	NS	NS	
Thailand	2022 Second NDC	2022	2065	In policy document
Timor-Leste	2022 Updated first NDC	NS	NS	
Tonga	2020 Updated first NDC	NS	2050	Declaration/Pledge
Turkmenistan	2016 First NDC	NS	NS	
Tuvalu	2016 First NDC	NS	2050	Declaration/Pledge
Uzbekistan	2021 Updated first NDC	NS	2050	In policy document
Vanuatu	2022 Updated first NDC	NS	2050	Declaration/Pledge
Viet Nam	2022 Updated first NDC	NS	2050	In policy document

Lao PDR = Lao People's Democratic Republic, NDC = nationally determined contribution, NS = not submitted/declared/pledged.
 Notes: Color corresponds to NDC submission and net zero pledge status. Status as of end 2022. Excludes Brunei Darussalam and the newly industrialized economies of Hong Kong, China; the Republic of Korea; and Taipei, China.
 Sources: UNFCCC, 2023. NDC Registry; Net Zero Tracker; Climate Action Tracker; CAT Net Zero Tracker (all accessed 20 February 2023); UNEP, 2022. Emissions Gap Report 2022.



Governments take initiatives for energy transition



President Xi says China will start cutting coal consumption from 2026

April 22, 2021 9:01 PM GMT+8

Indonesia to stop building new coal plants after 2023

June 4th 2021

U.S., Japan and partners mobilise \$20 billion to move Indonesia away from coal

November 15, 2022 7:07 PM GMT+8

Philippines shuts door on new coal power proposals

NOVEMBER 4, 2020 / 3:29 PM

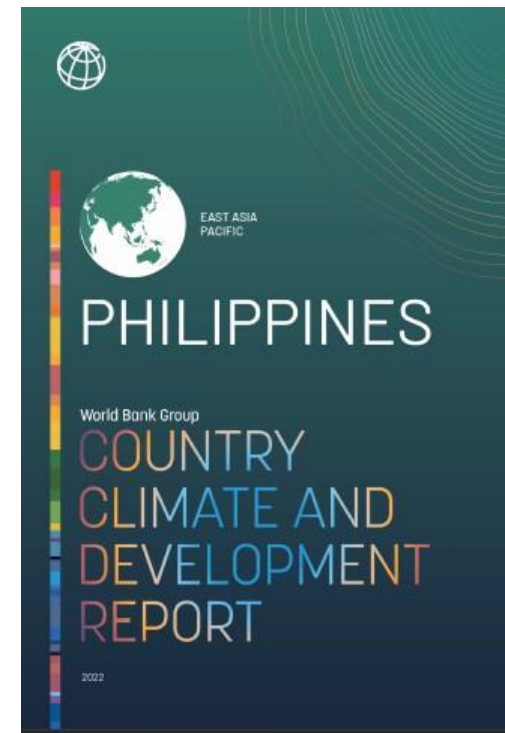
Exclusive: India amends power policy draft to halt new coal-fired capacity

May 5, 2023 7:29 AM GMT+8

Just Energy Transition Partnership to mobilise \$15.5 billion to support Việt Nam's green transition

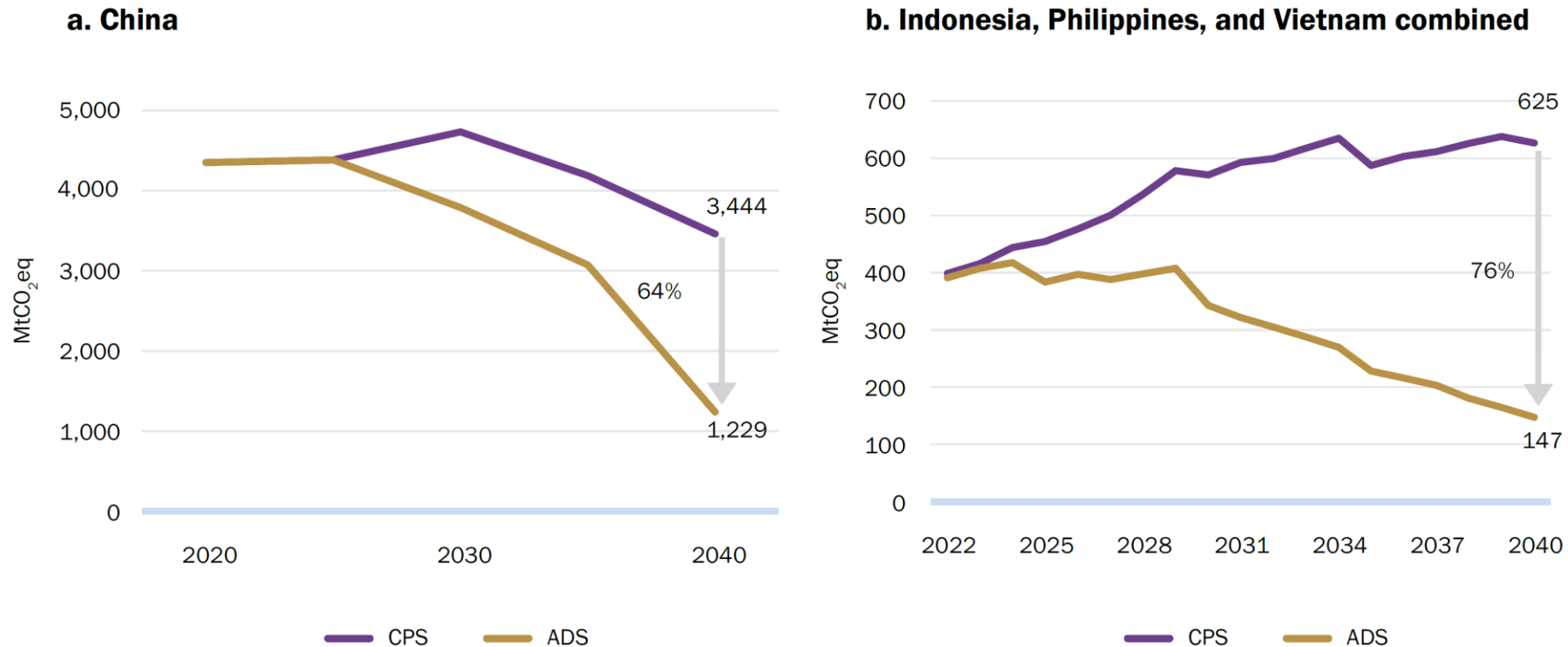
🕒 December 15, 2022 - 17:52

WBG's Country Climate and Development Reports (CCDRs) provide diagnosis on intertwined challenges



Feasible pathways for transition in the power sector

Projected annual carbon emissions from the power sector



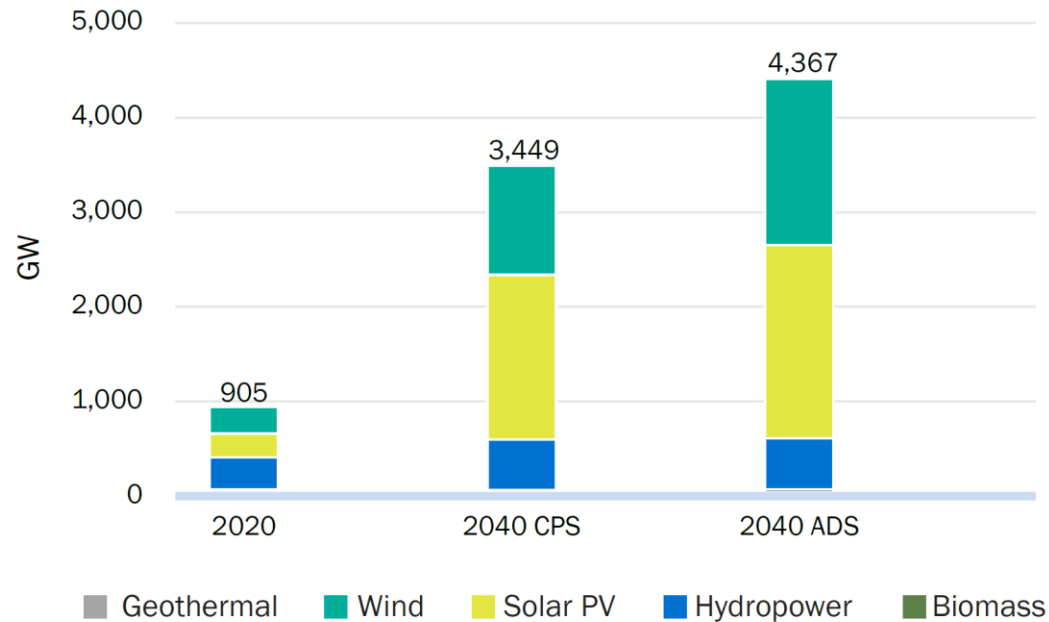
Note: ADS = accelerated decarbonization scenario; CPS = current policy scenario; MtCO₂eq = million tons CO₂ equivalent.

Source: World Bank

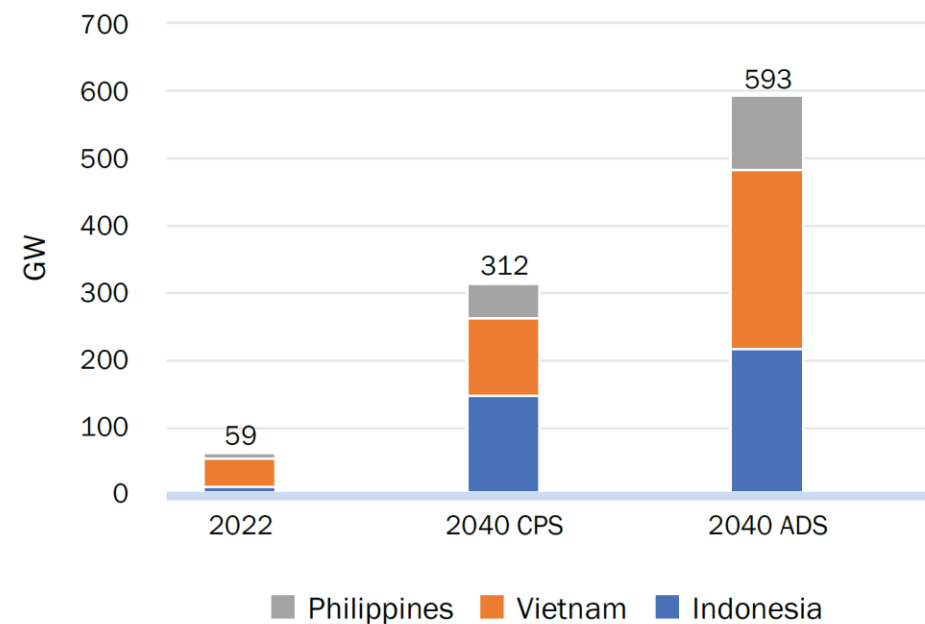
RE capacity will need to increase fivefold by 2040

Projected renewable energy installed capacity

a. China



b. Indonesia, Philippines, and Vietnam combined

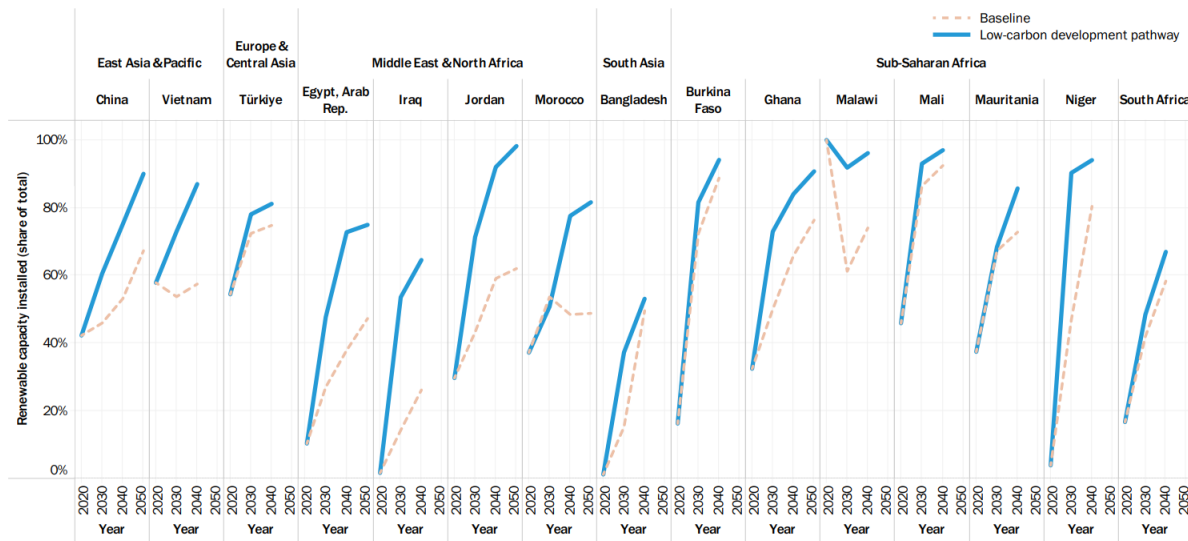


Source: World Bank

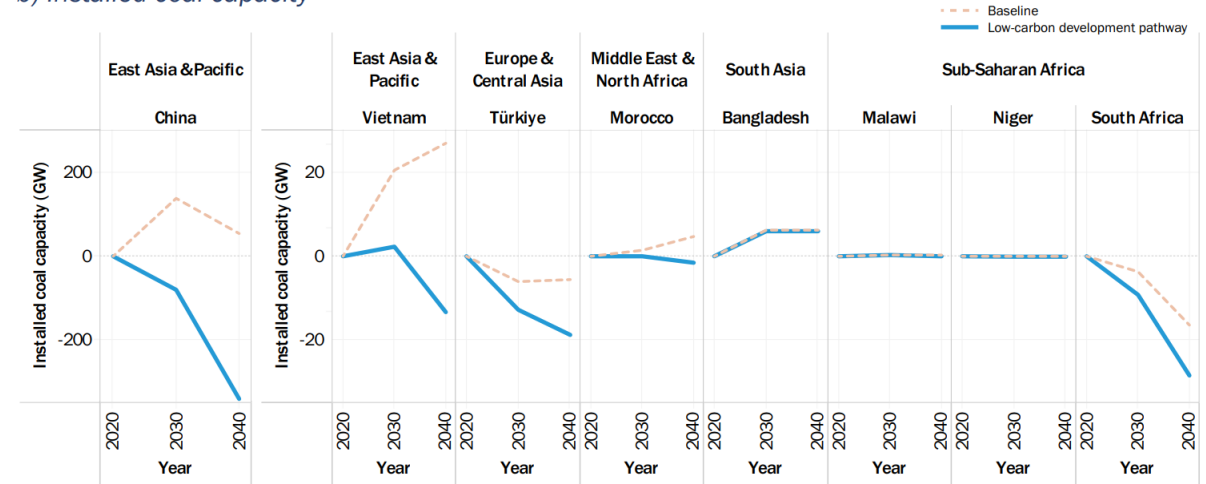
CCDRs shows that scaling up RE and phasing down coal are necessary across many countries

Evolution of the share of renewable energy and coal capacity in selected countries

a) Share of renewable energy capacity



b) Installed coal capacity

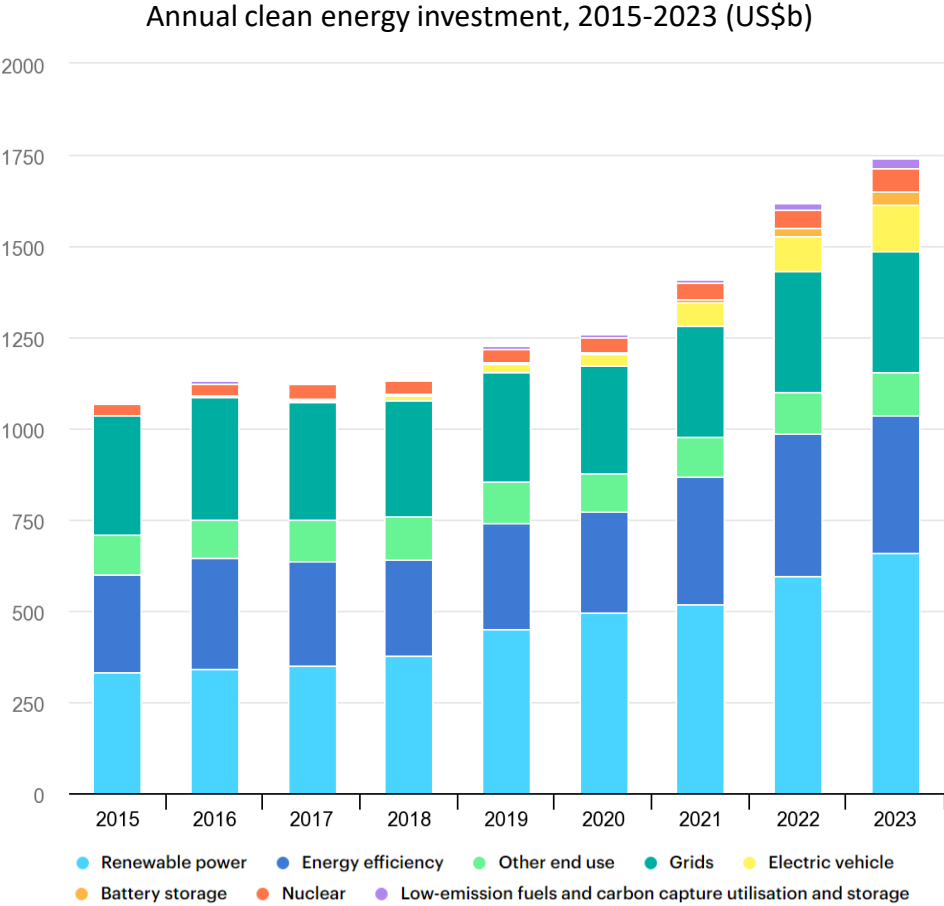


Notes: In panel a, year 2020 data are set to equal modeled results for 2021 for Iraq and Jordan. Renewables = solar, on- and offshore wind, and hydropower. In panel b, the vertical scale for installed capacity is different for China.

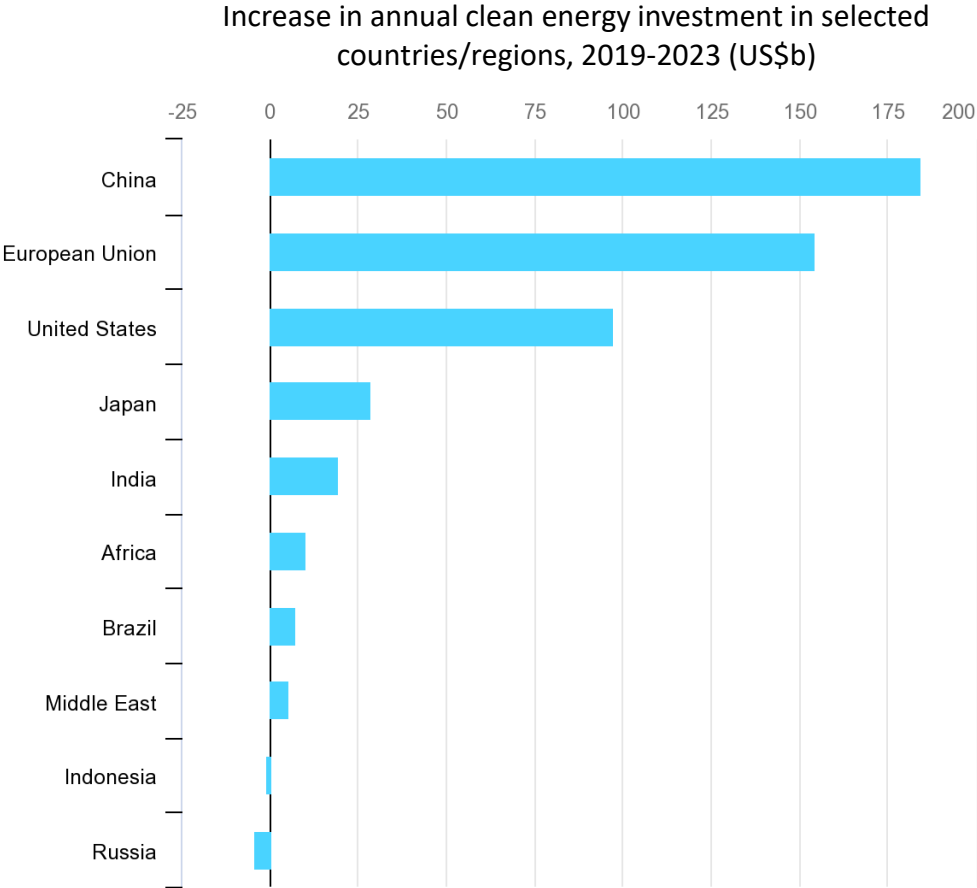
Source: World Bank



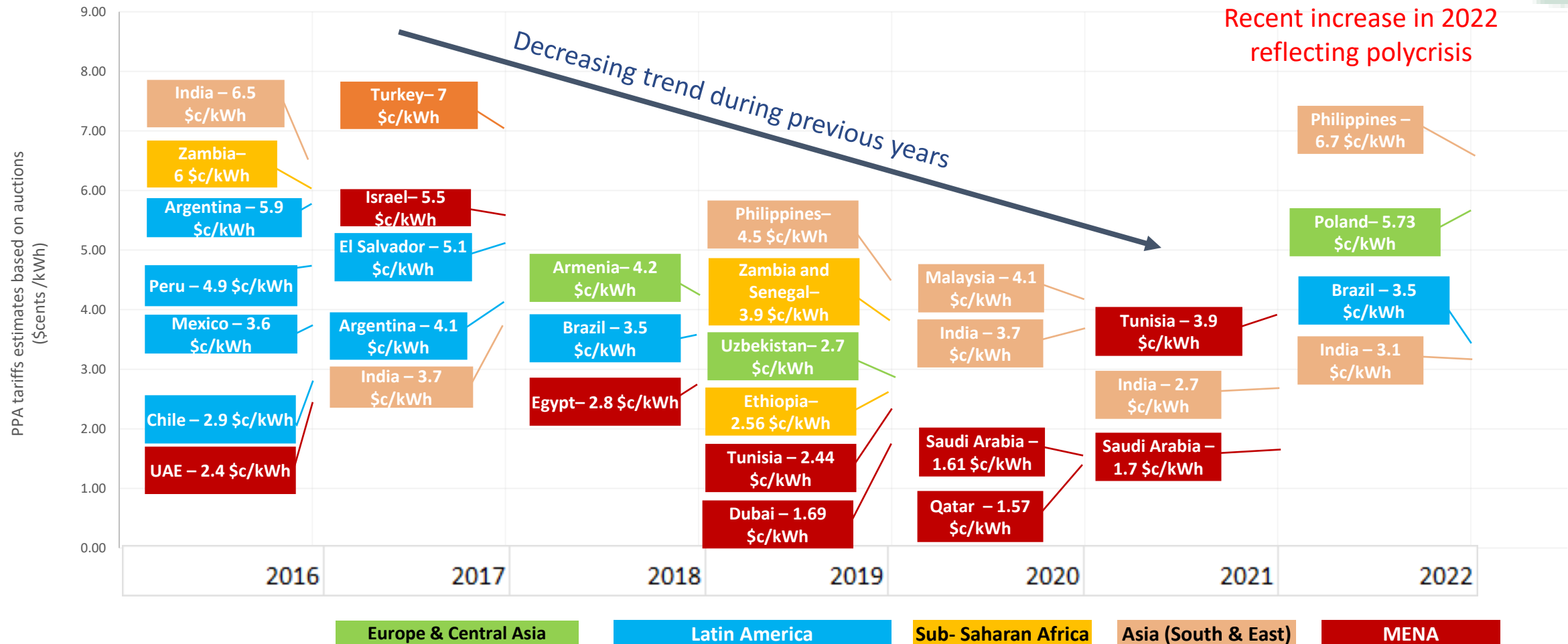
Investment in clean energy continues to increase



Source: IEA, World Energy Investment 2023

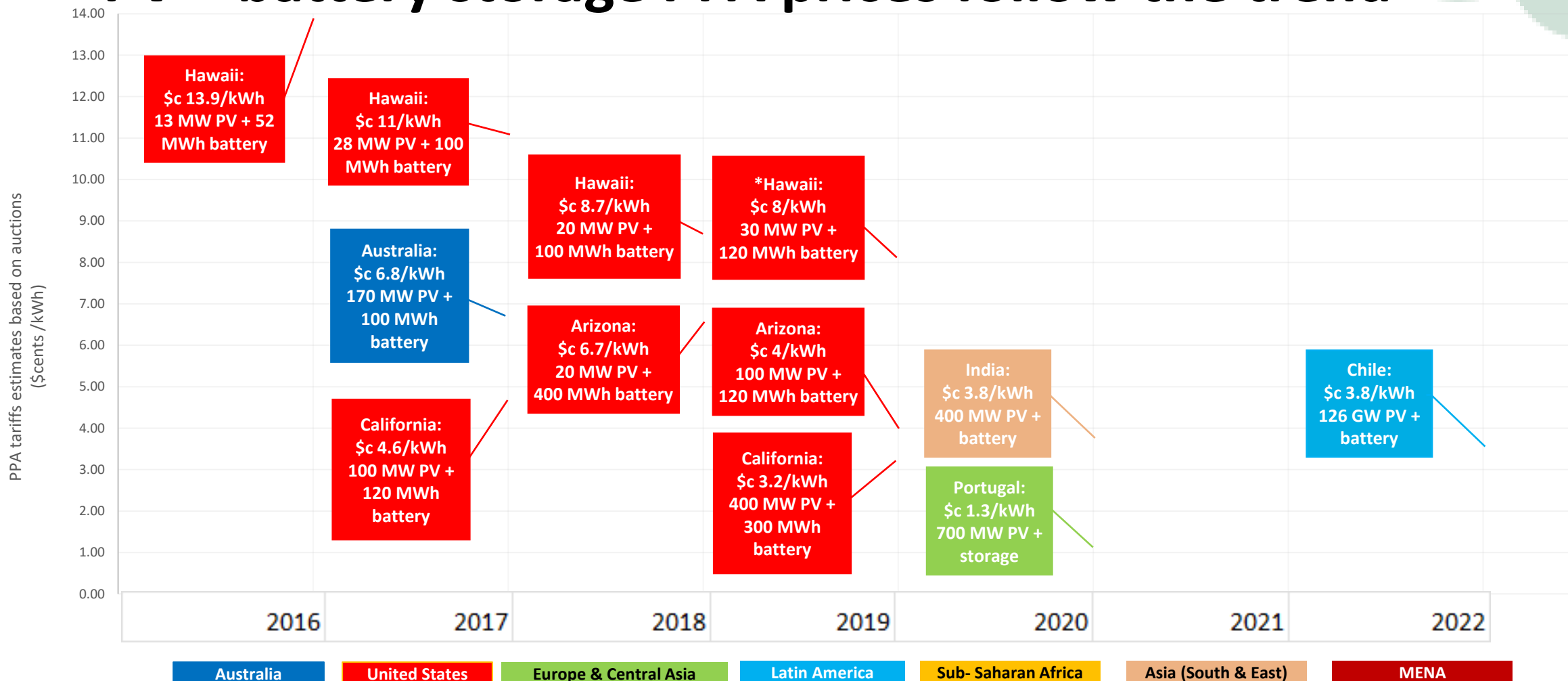


Solar PV energy auction prices continue to decline



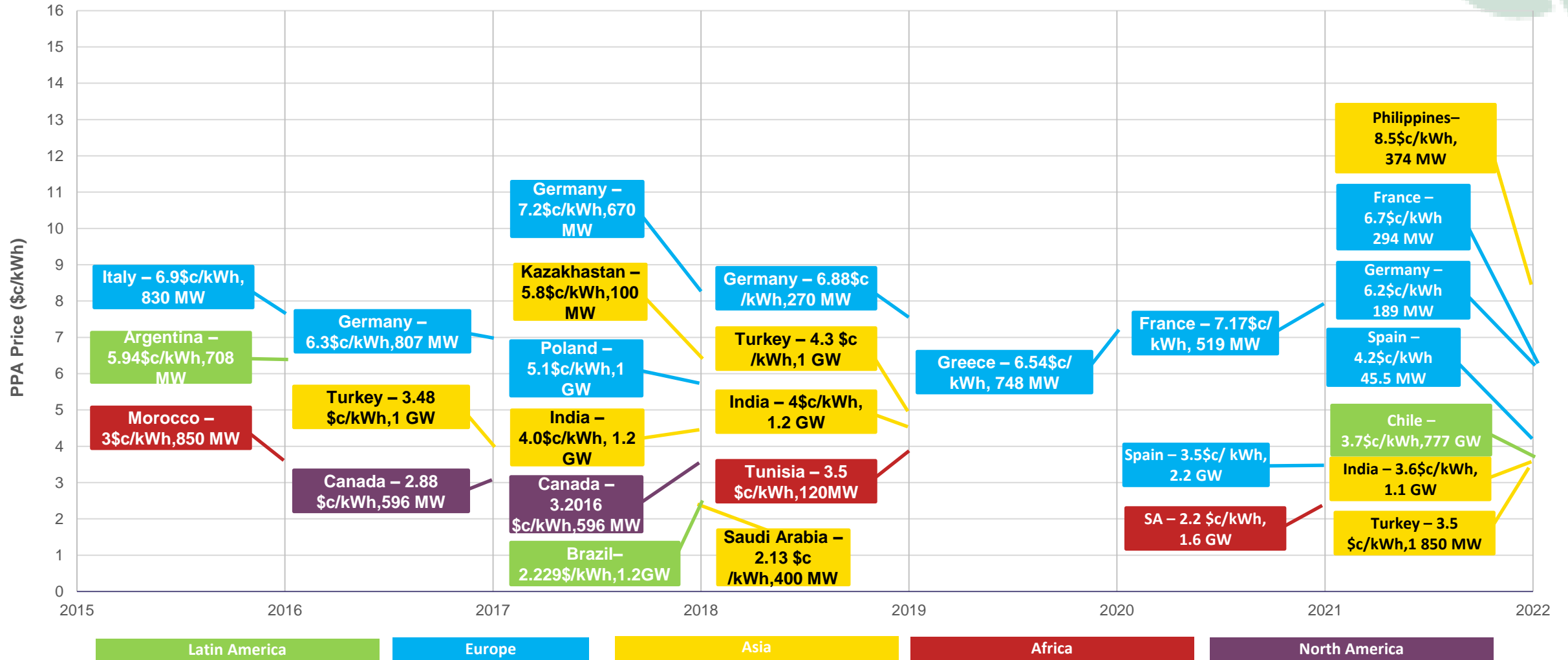
Source: PV magazine, GTM, IEA, Scaling Solar, EPE, WB own data, computed data from internet by the WB team

PV + battery storage PPA prices follow the trend



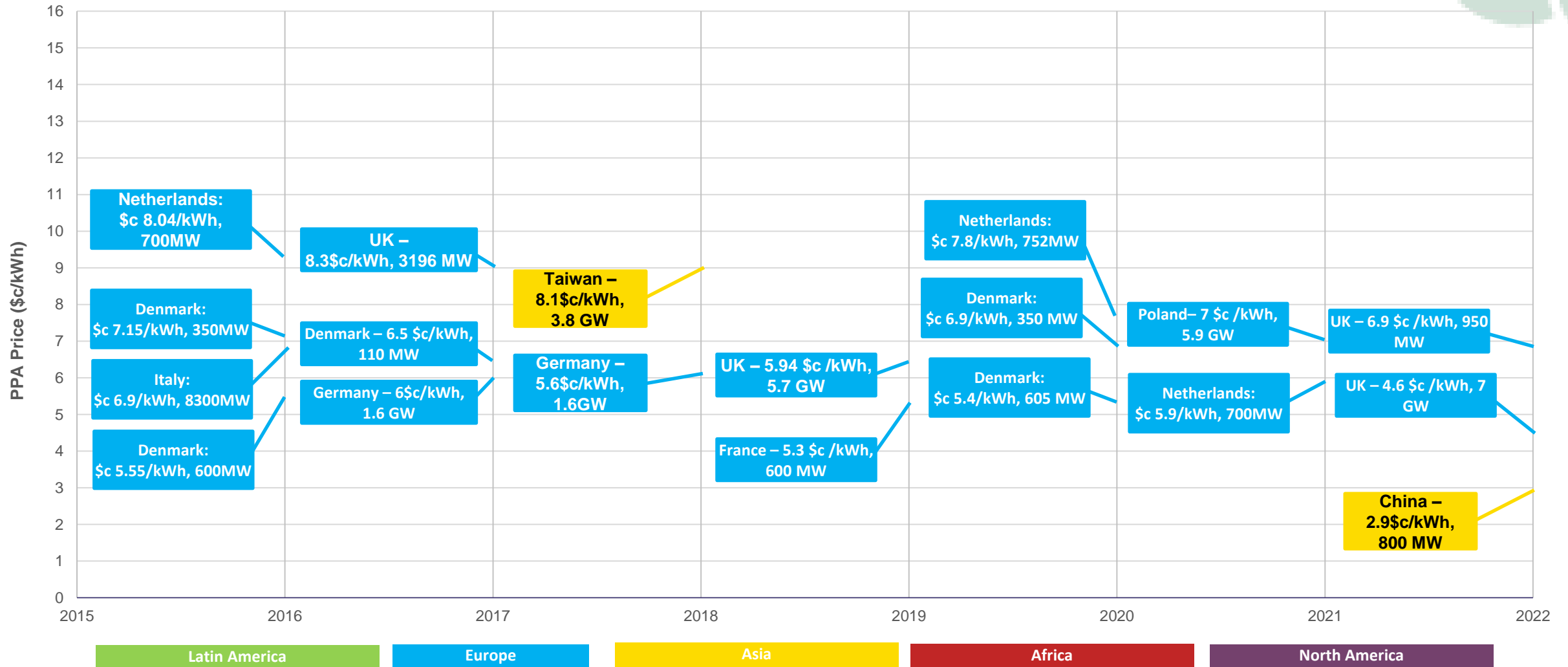
Source: PV magazine, GTM, IEA, Scaling Solar, WB own data, computed data from internet by the WB team

Onshore wind auction prices keep going down



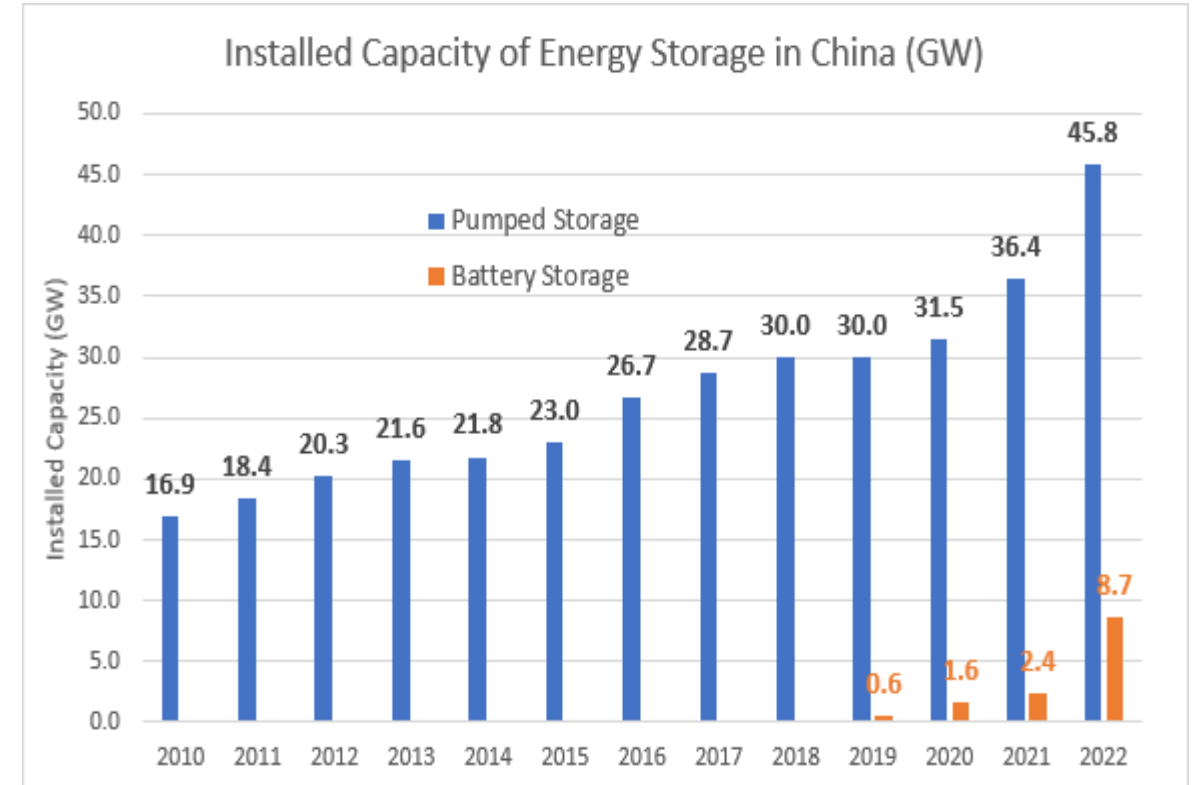
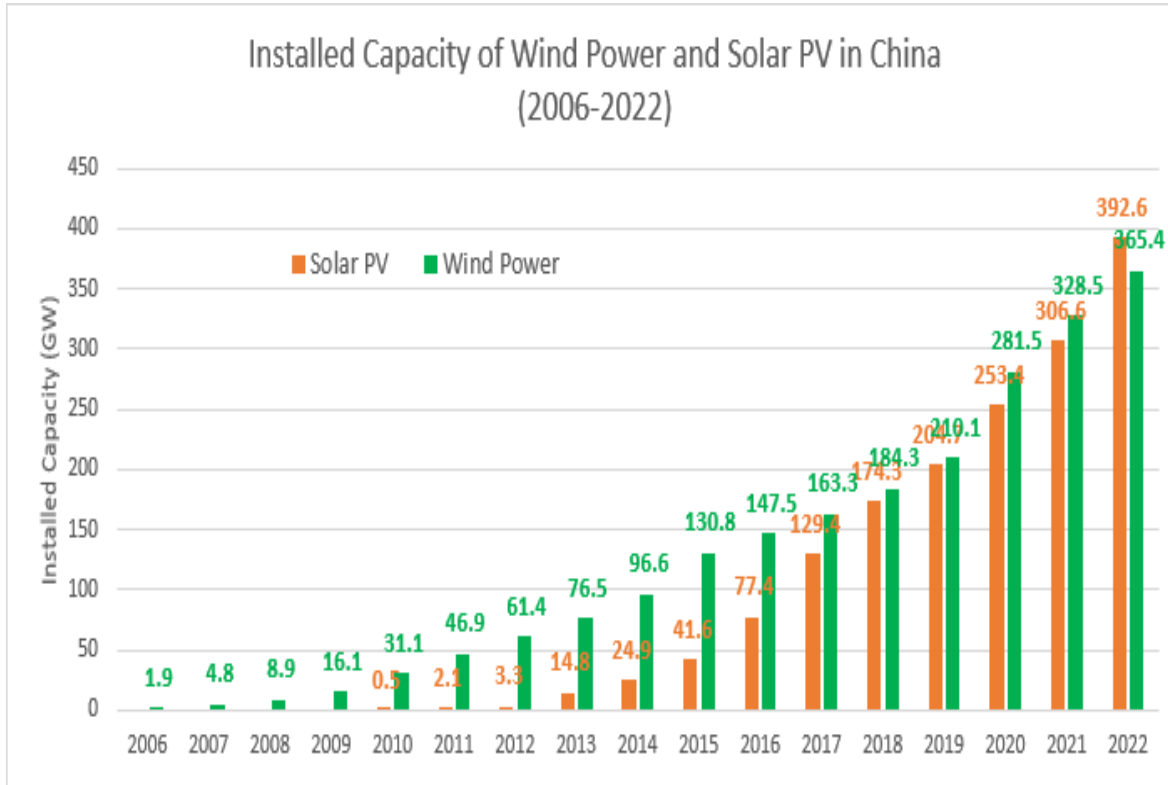
Source: wind magazine, tender watch, IEA, WB own data, computed data from internet by the WB team

Offshore wind auction prices are plummeting



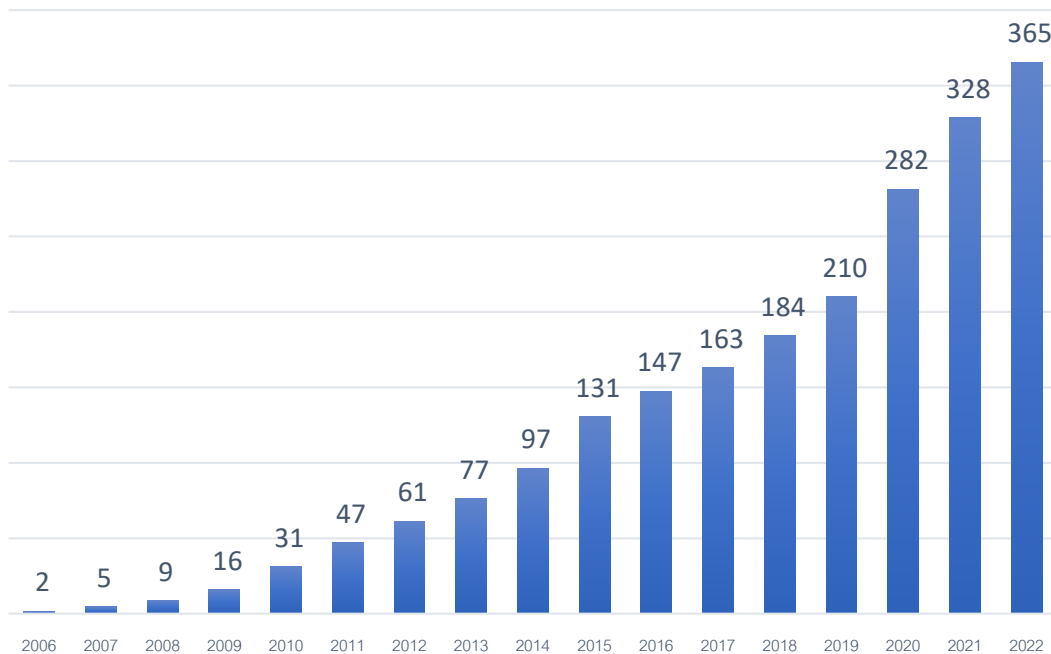
Source: wind magazine, tender watch, IEA, WB own data, computed data from internet by the WB team

China becomes the largest investor in clean energy

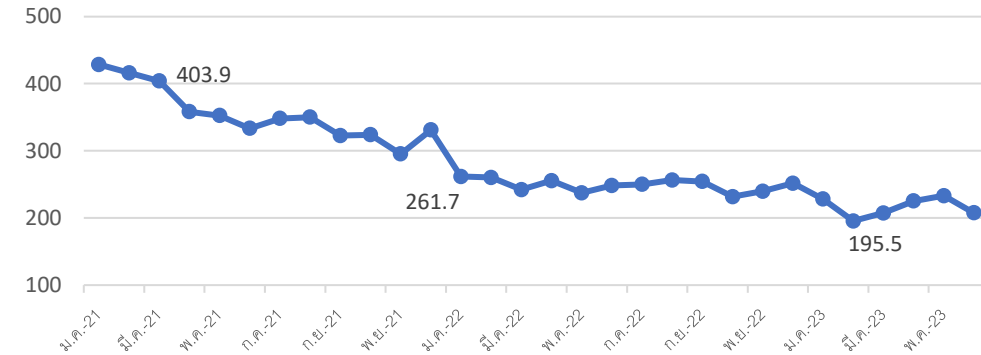


China's growing investment leads to cost reduction

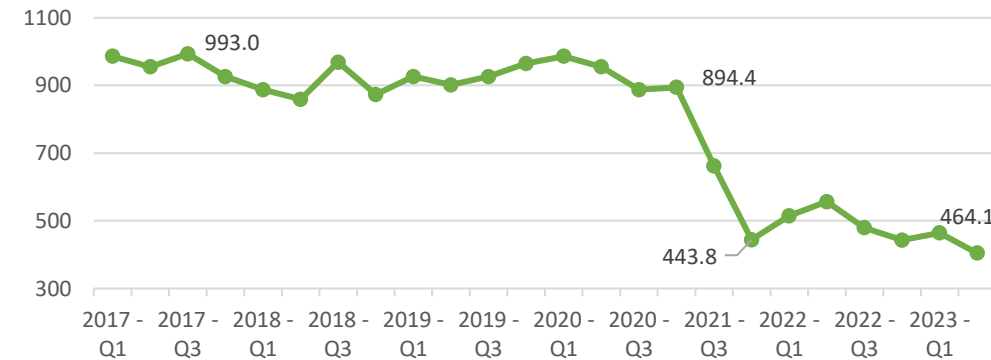
Wind power installed capacity in China (GW)



Onshore wind turbine bid price in China (US\$/kW)

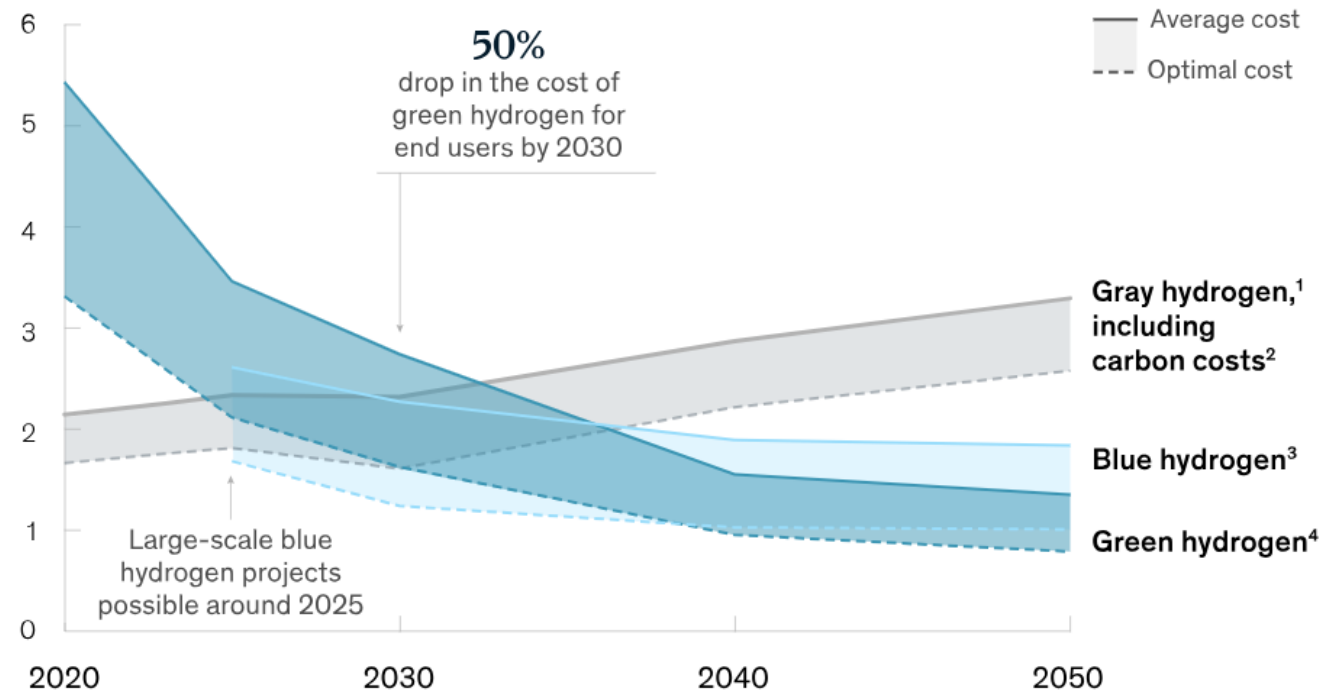


Offshore wind turbine bid price in China (US\$/kW)



Falling green hydrogen cost will facilitate clean energy transition

Projected global production cost of hydrogen, \$/kilogram



¹Steam methane reforming (SMR) without carbon capture, utilization, and storage (CCUS).

²Based on projected average global CO₂ costs of \$57/ton (2030), \$94/ton (2040), and \$131/ton (2050). For Saudi Arabia, CO₂ costs are assumed to be \$33/ton in 2030, \$69/ton in 2040, and \$105/ton in 2050.

³Gas prices of \$2.60 to \$6.80/MMBtu (approximately \$3/MMBtu in Saudi Arabia).

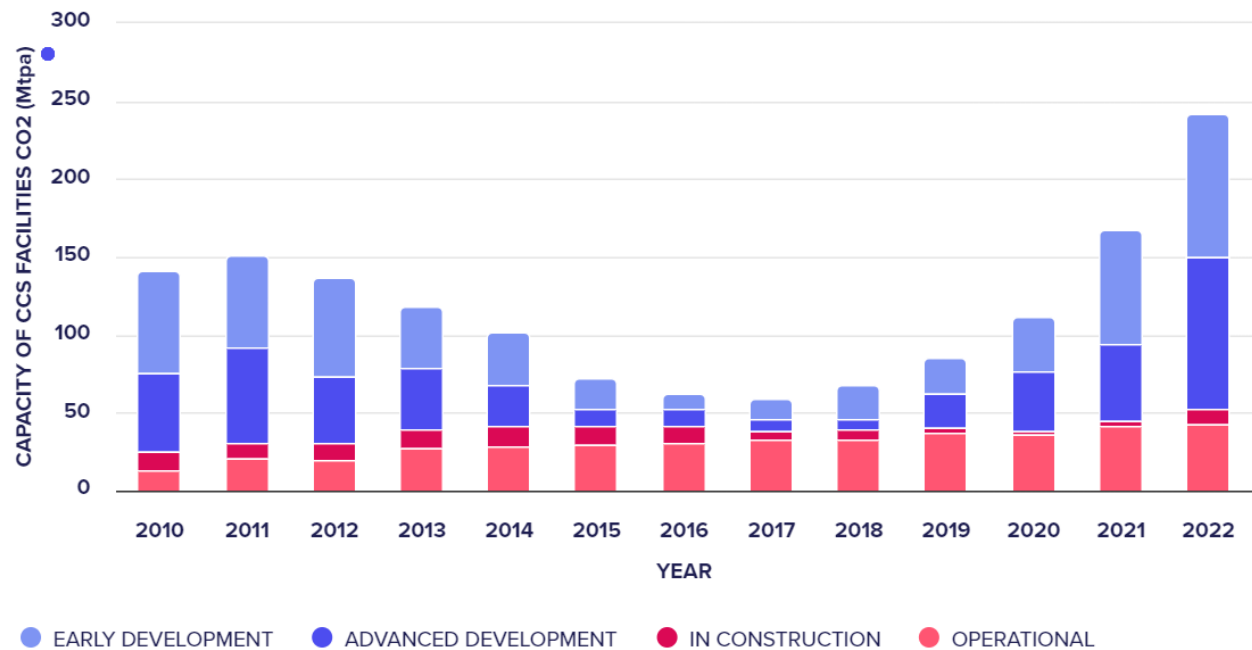
⁴Refers to the cheapest green hydrogen, which is provided by solar energy.

Source: McKinsey Hydrogen & Derivatives Flows Model, October 2022



CCUS applications are growing on commercial basis

Pipeline of commercial CCUS facilities since 2010



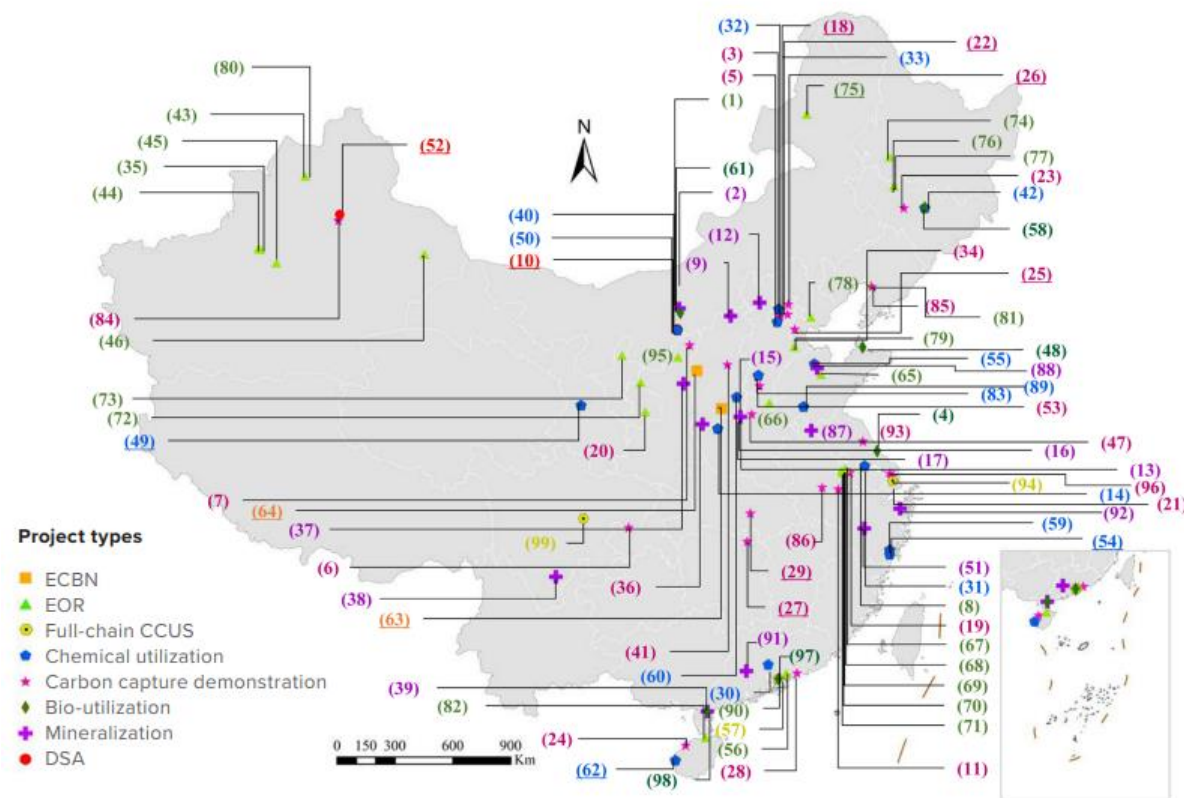
Commercial CCUS Facilities by number and total CO₂ capture capacity (Mtpa) (as of mid-September 2022)

	OPERATIONAL	IN CONSTRUCTION	ADVANCED DEVELOPMENT	EARLY DEVELOPMENT	OPERATIONAL SUSPENDED	TOTAL
NUMBER OF FACILITIES	30	11	78	75	2	196
CAPTURE CAPACITY	42.58	9.63	97.6	91.86	2.3	243.97

Source: Global Status of CCS (2022)

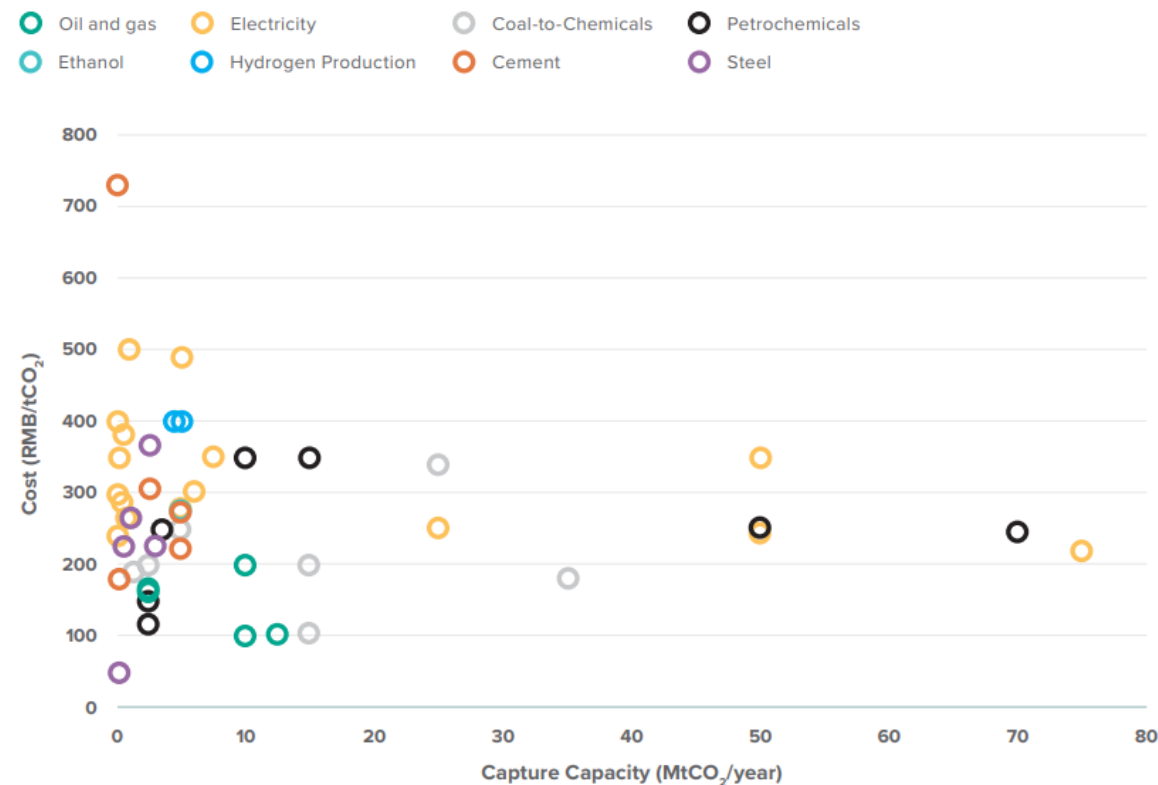
In China, SOEs lead CCUS demonstration at scale

CCUS demonstration projects in China



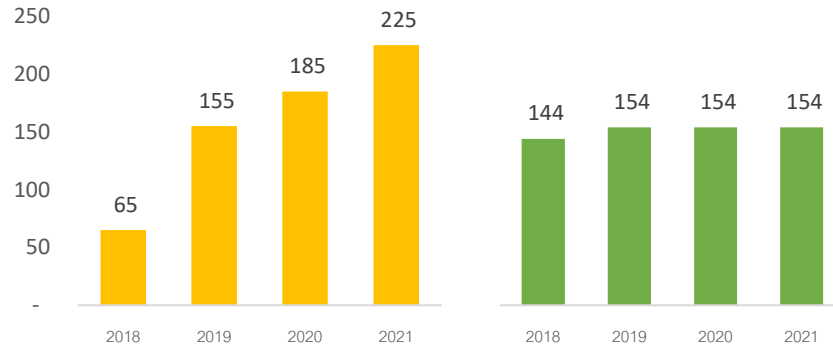
Source: CCUS Progress in China – Status Report (2023)

Cost of CCUS demonstration projects in operation in China

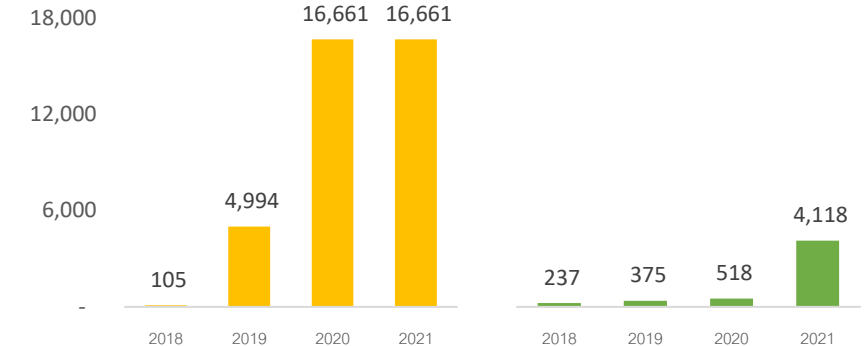


However, clean energy growth remains slow in many developing countries

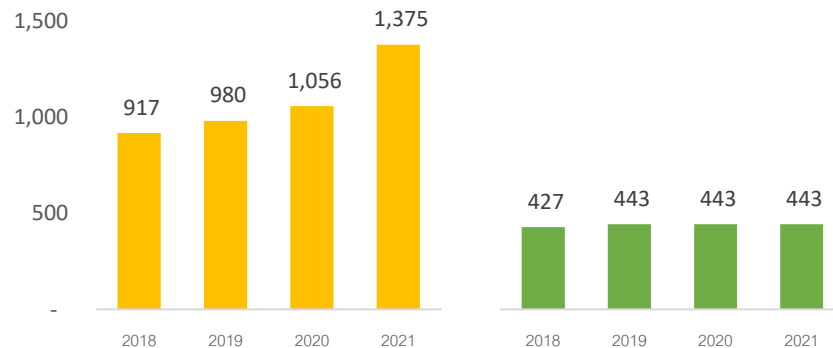
Indonesia



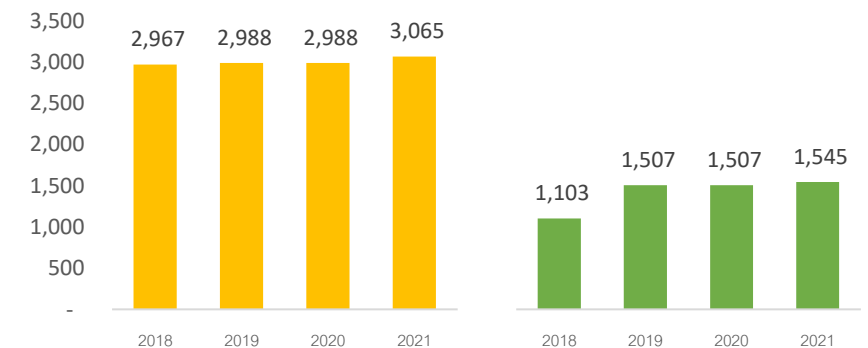
Vietnam



Philippines



Thailand



Note: Solar PV and wind power installed capacity; ■ solar, ■ wind; units in MW



II. Challenges



Four key challenges to clean energy transition



Energy Security

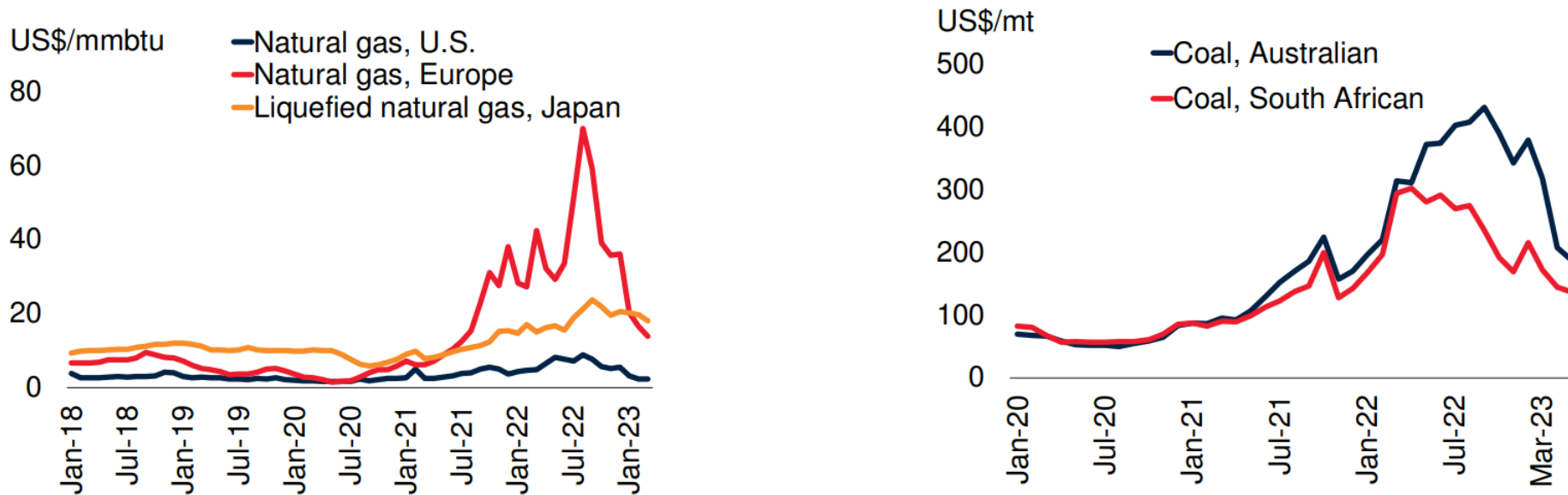
Financing

Affordability

Just Transition

Meeting fast growing electricity demand is becoming a priority amid volatile market conditions

Natural gas and coal market price trend



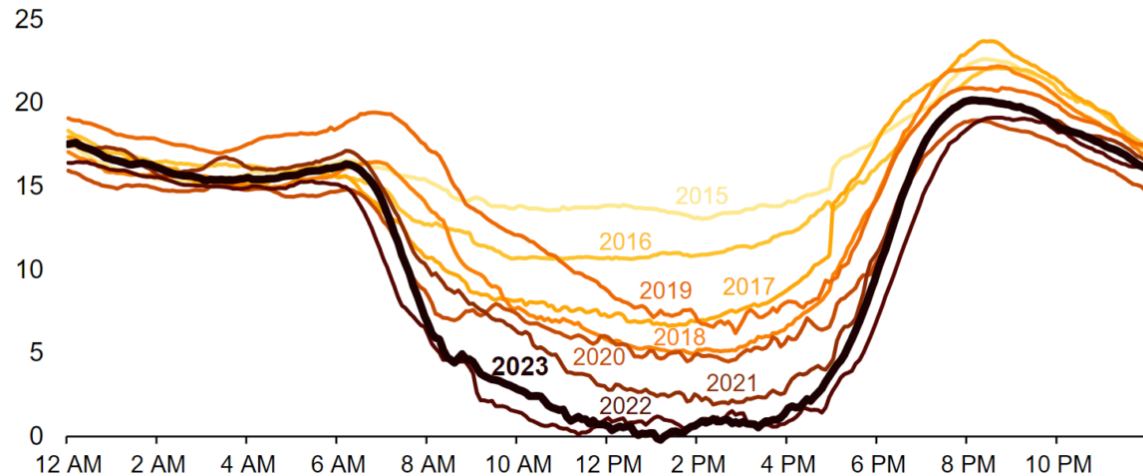
Source: World Bank, Commodity Markets Outlook, April 2023

High RE share poses threat to reliable power supply

California's hourly load net of solar/wind in Spring (GW)

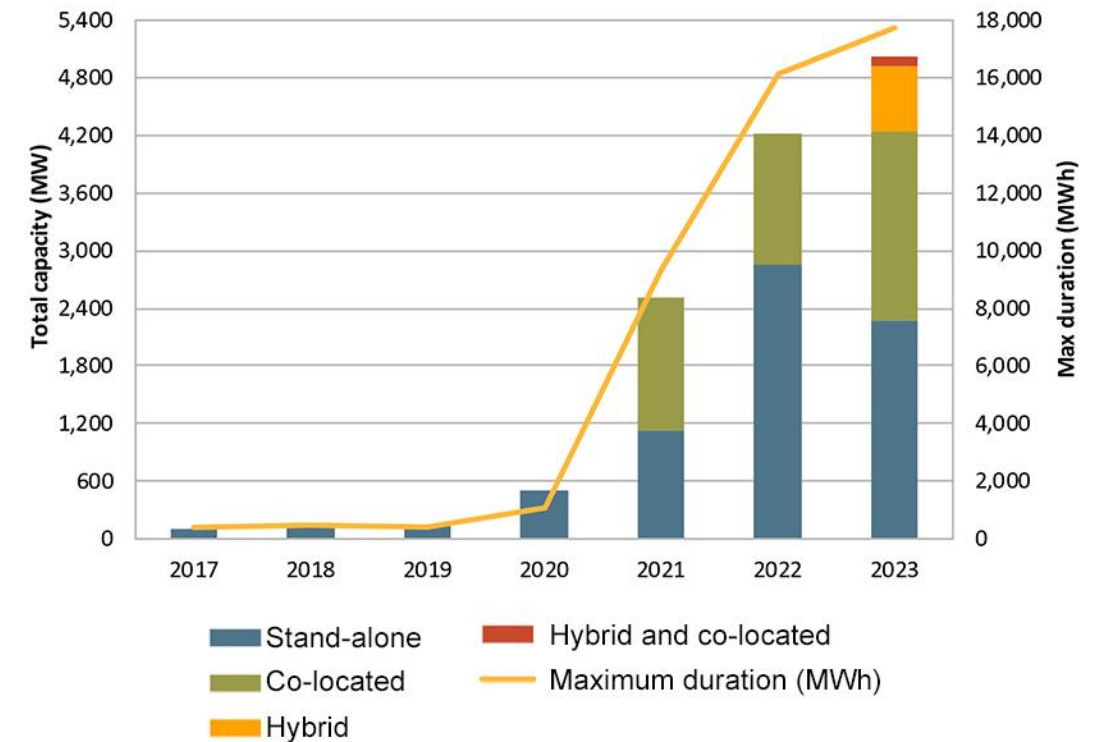
California's duck curve is getting deeper

CAISO lowest net load day each spring (March–May, 2015–2023), gigawatts



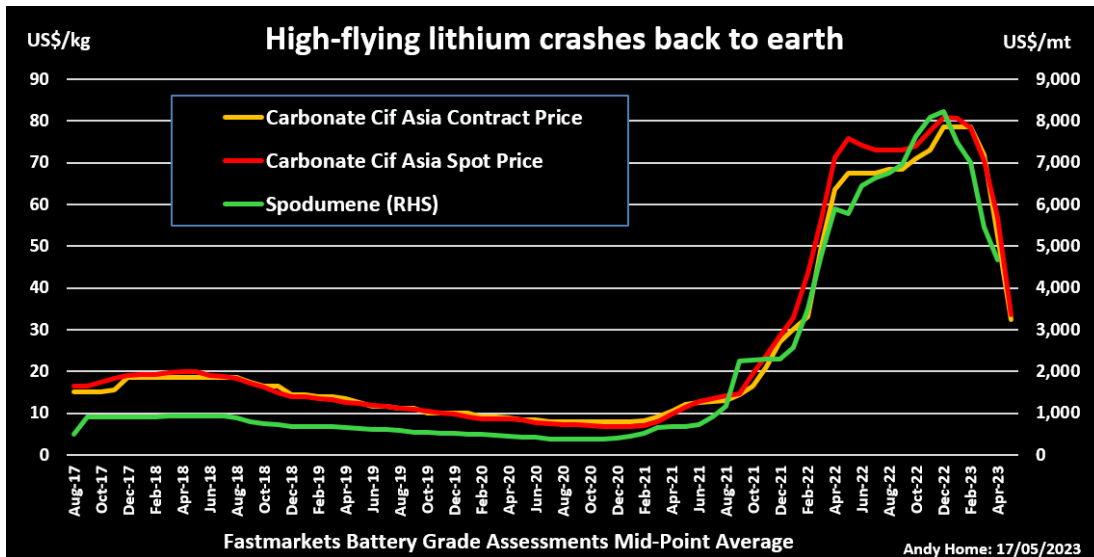
Source: US Energy Information Administration

California's battery storage capacity



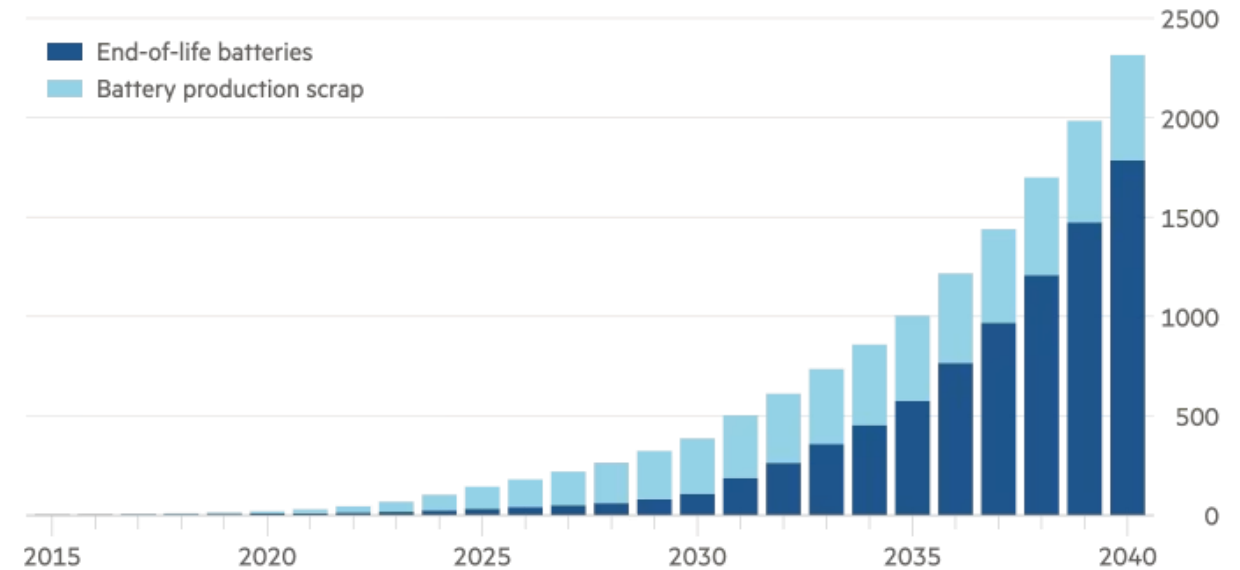
Source: CAISO

Growing battery storage demand brings risks and opportunities



Battery factories to generate biggest source of critical mineral scrap over next decade

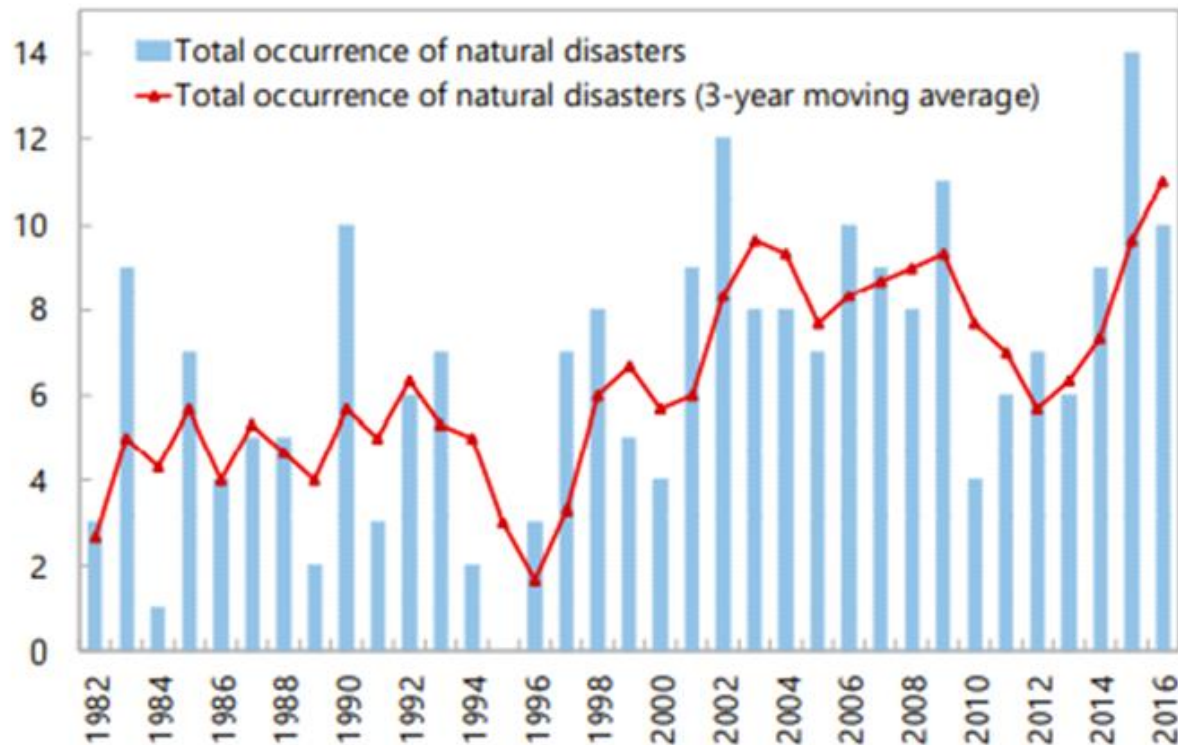
Available scrap material (GWh)



Source: Benchmark Mineral Intelligence
© FT

Power sector resilience constitutes an important part of energy security due to climate risks on the rise

Occurrence of Natural Disasters in PICs



MAJOR U.S. POWER OUTAGES

— Weather-Related — Non Weather-Related



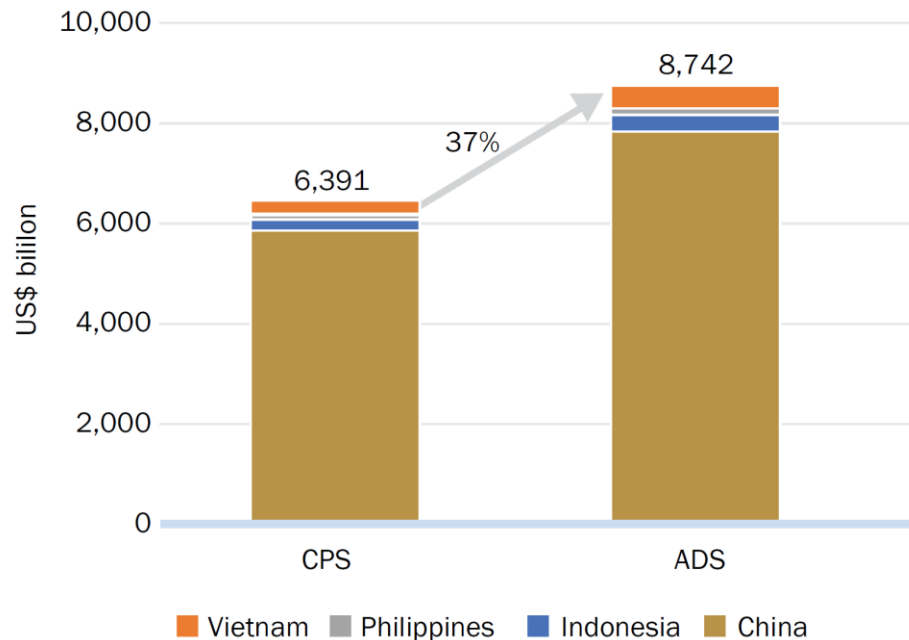
Number of outages affecting more than 50k customers.
Source: U.S. Department of Energy Form OE-417

CLIMATE CENTRAL

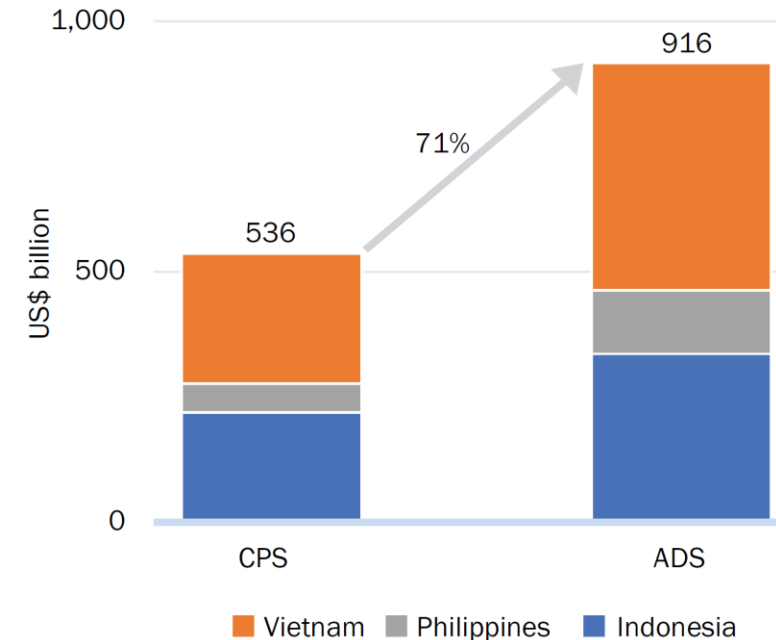
Clean energy transition requires higher upfront capital investment

Capital investment needed in the power sector between 2020 and 2040 (undiscounted terms)

a. Four countries combined



b. Indonesia, Philippines, and Vietnam combined



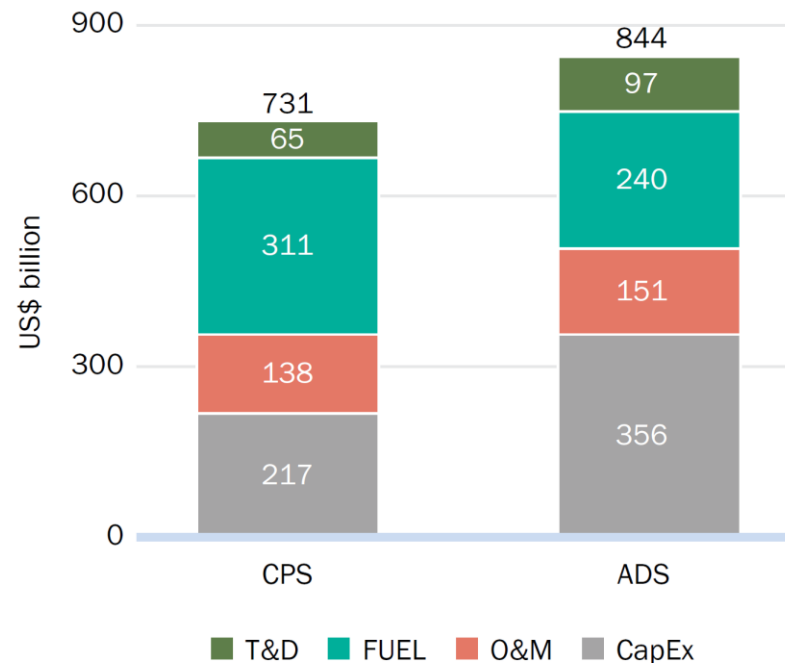
Note: ADS = accelerated decarbonization scenario; CPS = current policy scenario; MtCO₂eq = million tons CO₂ equivalent.

Source: World Bank

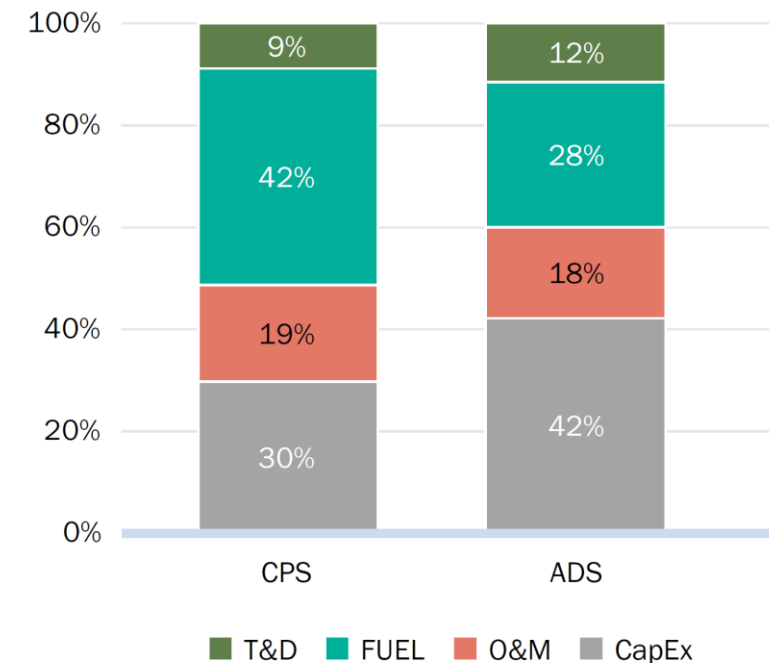
Electricity cost is projected to increase by 16 percent

Total system cost composition in Indonesia, the Philippines, and Vietnam combined

a. Present value of total system cost 2022–40



b. Share of total system cost 2022–40



Note: ADS = accelerated decarbonization scenario; CapEx = capital expenditure; CPS = current policy scenario; O&M = operation and maintenance; T&D = transmission and distribution.

Source: World Bank

Concessional climate finance catalyzes large financing



US\$12.8 billion
committed to
226 projects



US\$7.5 billion
committed to
398 projects

Accelerating Coal Transition (ACT) Investment Program

Indonesia

- Investment plan approved
- US\$500 million mobilizing US\$5 billion

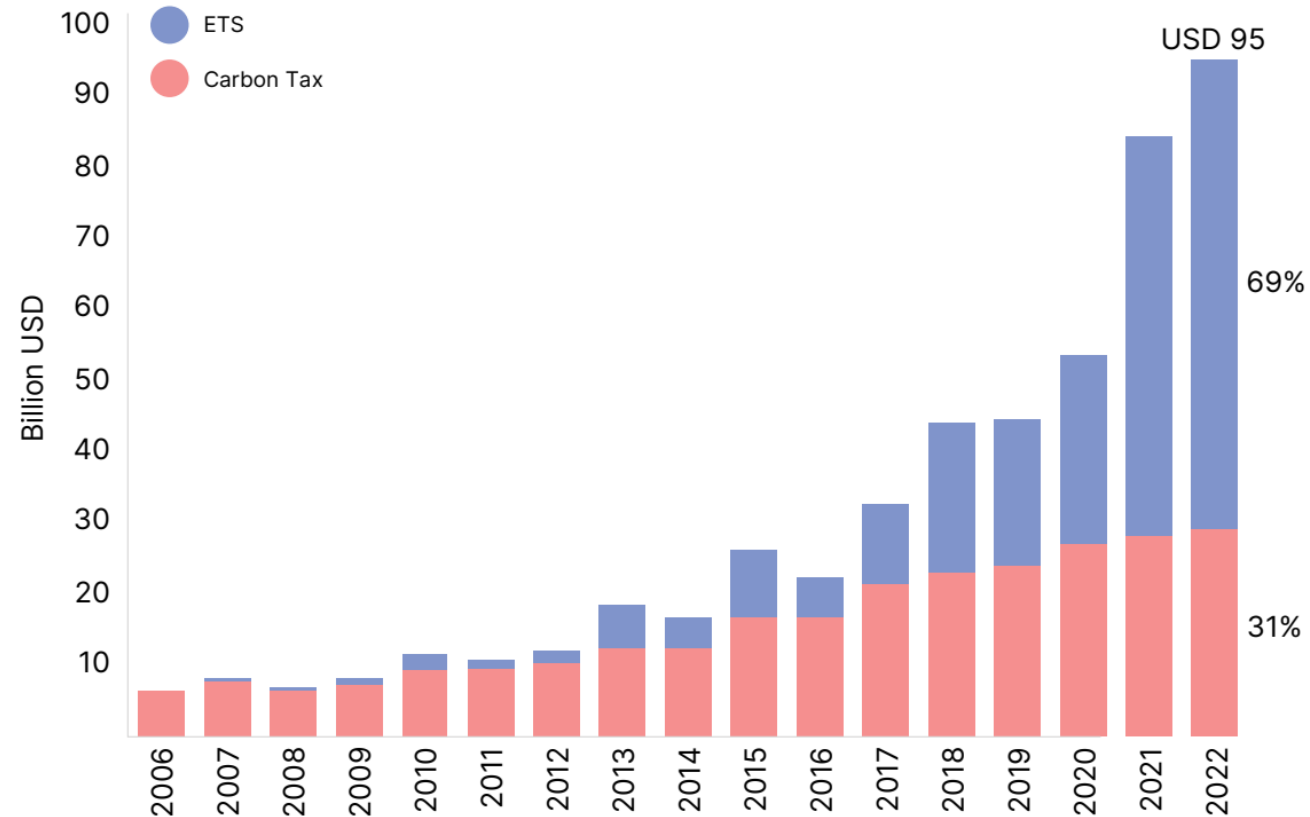
Philippines

- Investment plan in development
- Up to US\$500 million concessional fund

Source: World Bank

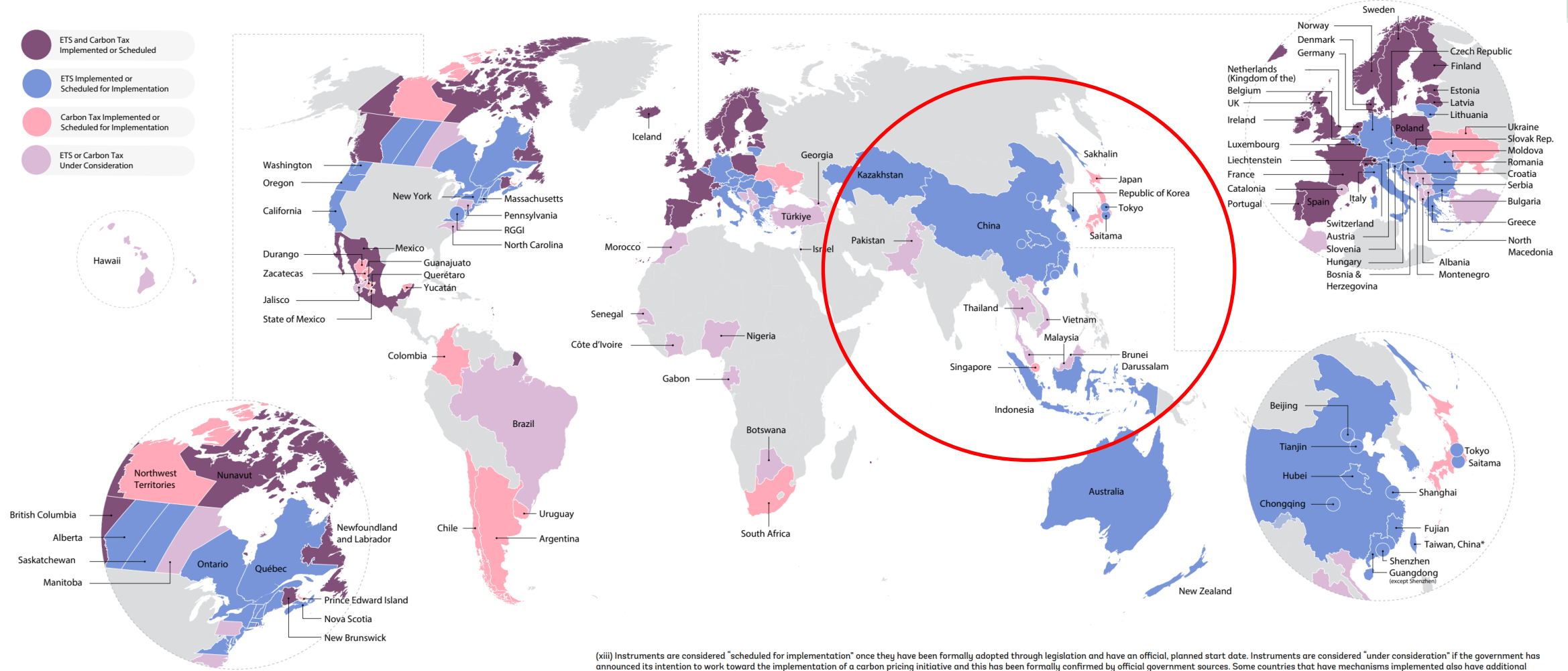
Carbon revenue has a potential to fill financing gap

Evolution of global revenues from carbon taxes and ETSs over time (nominal)



Source: World Bank

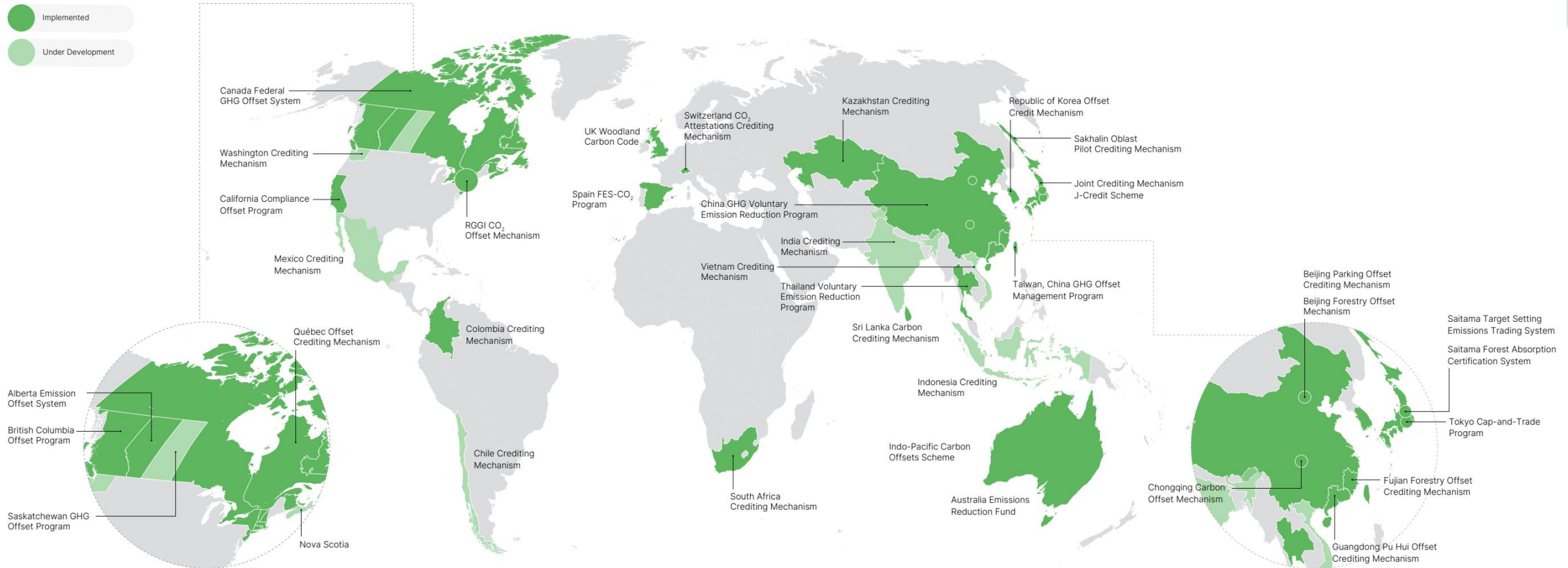
ETS/carbon tax is at the early stage in Asia



(xiii) Instruments are considered "scheduled for implementation" once they have been formally adopted through legislation and have an official, planned start date. Instruments are considered "under consideration" if the government has announced its intention to work toward the implementation of a carbon pricing initiative and this has been formally confirmed by official government sources. Some countries that have mechanisms implemented also have additional instruments under consideration. For subnational jurisdictions only the subnational instrument is reflected.

Source: World Bank

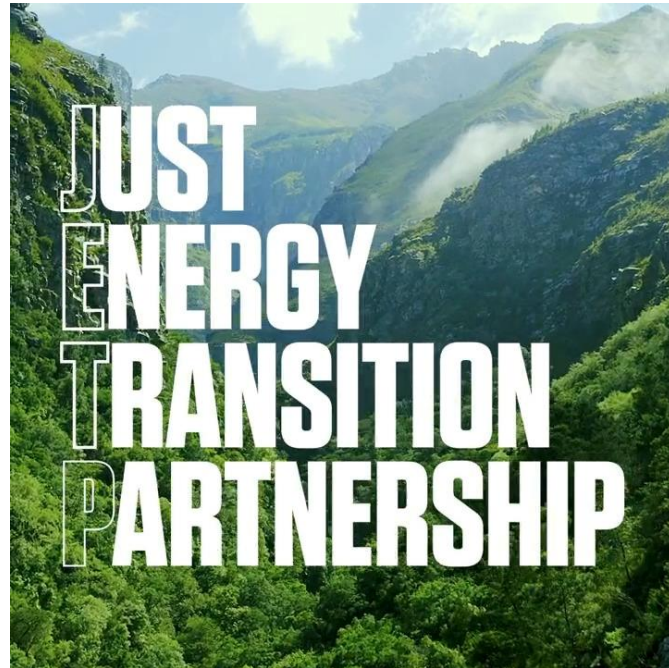
Carbon crediting mechanism is emerging in Asia



Source: World Bank

Circles represent crediting mechanisms in subnational jurisdictions and cities. "Implemented" crediting mechanisms have the required framework (e.g., legislative mandate) as well as the supporting procedures, emission reduction protocols and registry systems in place to allow for crediting to take place. For subnational jurisdictions, the color reflects the status of subnational instruments.

International supports formed for energy transition



South Africa

November 2021 US\$8.5 billion

Indonesia

November 2022 US\$20 billion

- Peak power sector emissions by 2030
- Reach net zero power sector emissions by 2050
- Increase the share of renewable energy in electricity generation to 34% by 2030

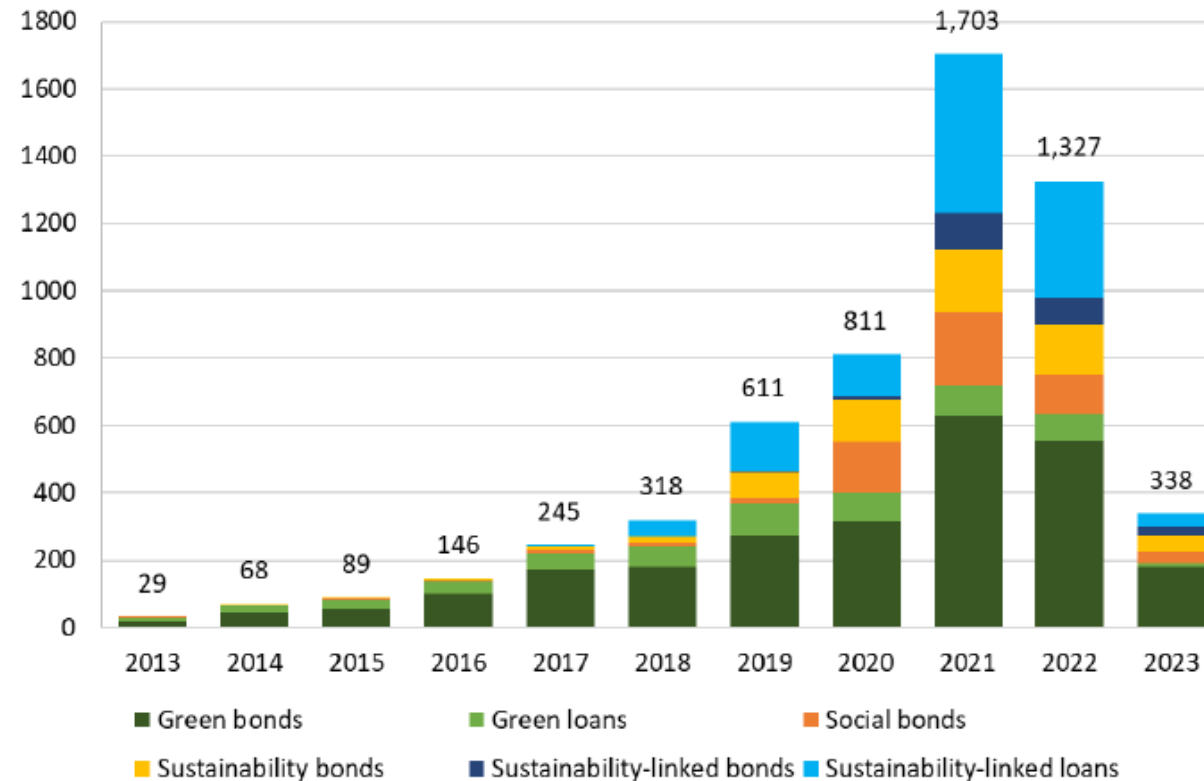
Vietnam

December 2022 US\$15.5 billion

- Peak power sector emissions by 2030
- Limit CFPP capacity to 30.2 GW
- Increase the share of renewable energy in electricity generation to 47% by 2030

New sustainability-linked instruments are growing

Global sustainable debt annual issuance, 2013 - Q1 2023



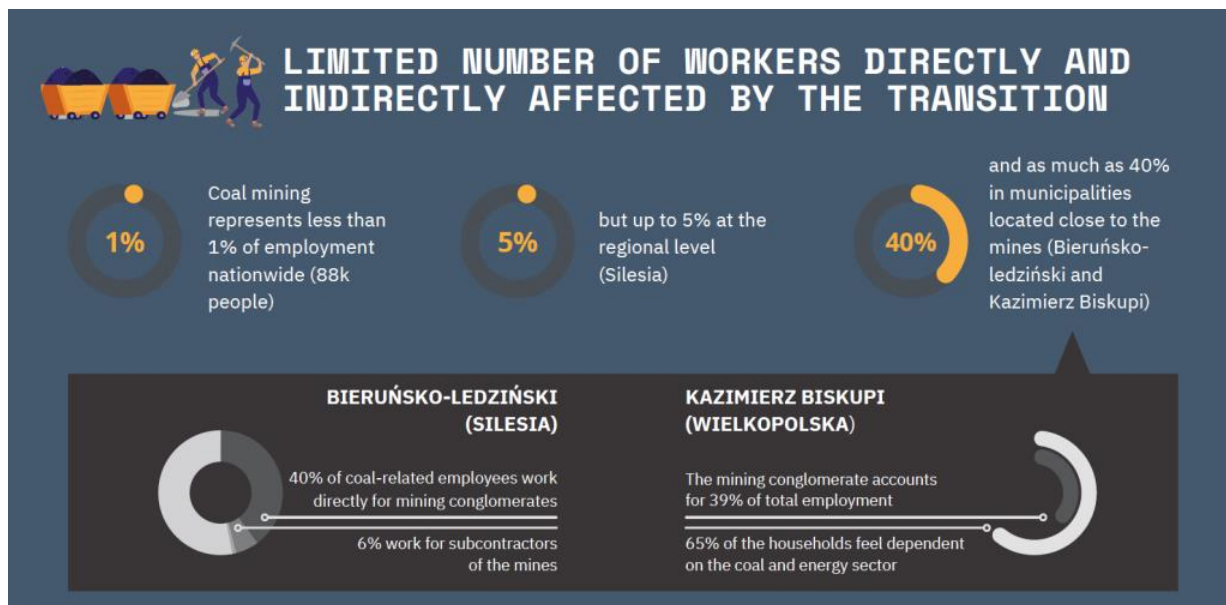
Source: World Bank, IFC based on BloombergNEF, Bloomberg L.P.

Energy transition may bring adverse economic, social, and environmental impacts



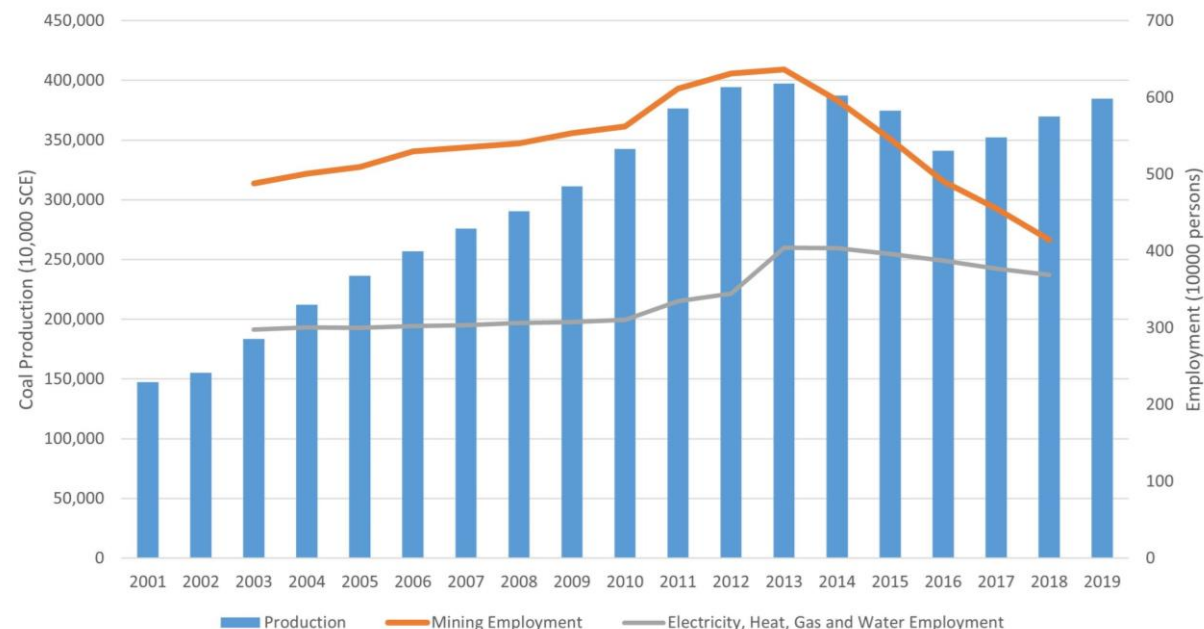
Impacts on employment and economy across coal value chain should be carefully managed

Coal mining employment in Poland



Source: World Bank

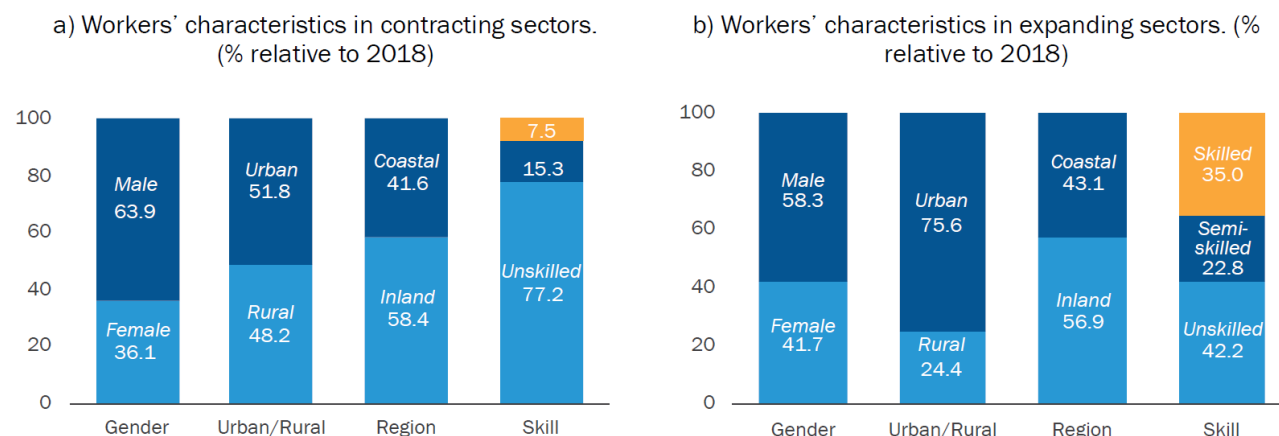
Coal mining employment in China



Source: Columbia Political Review using data from Chinese Statistical Yearbook

Impacts of the transition can be disproportionate

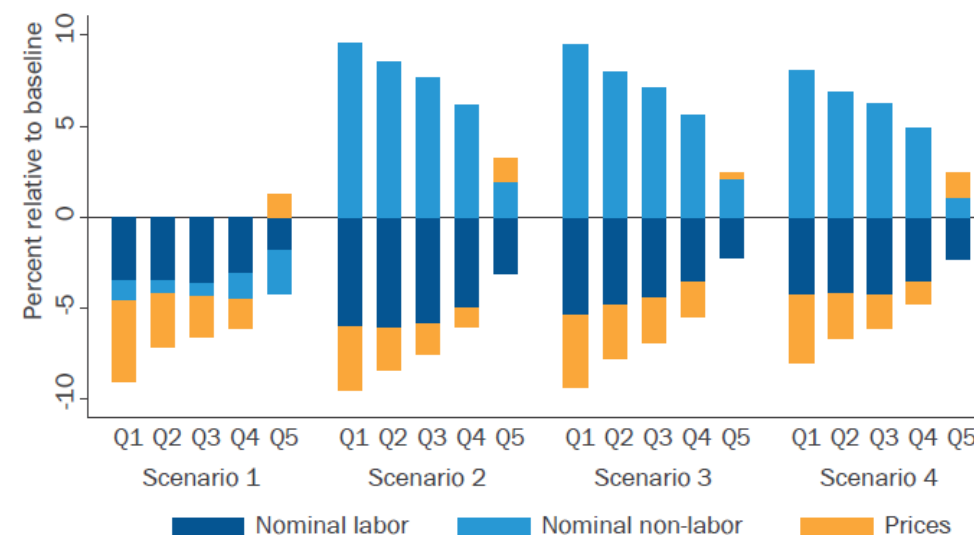
Distribution of jobs lost and gained, holding job characteristics fixed in China



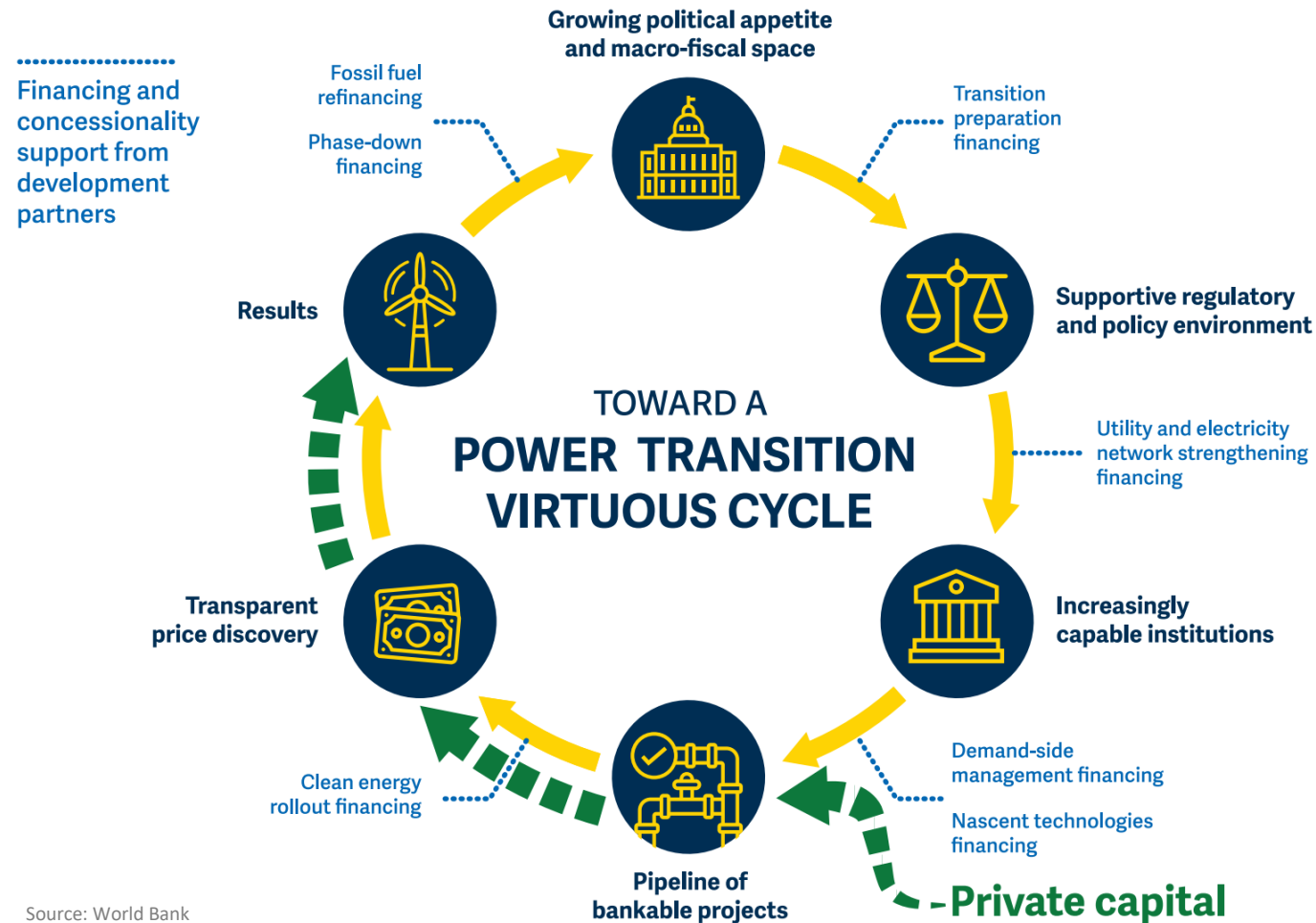
Source and Notes: World Bank calculations based upon CGE modeling results in 2030 relative to 2018, combined with average sector characteristics based on 2018 China Family Panel Survey household survey data. Sector characteristics are held fixed at their 2018 levels.

Source: World Bank

Welfare impacts by income groups in 2060 in China (% relative to baseline)



Gov't has a critical role in mobilizing private capital



Source: World Bank



III. World Bank Engagement



WBG engagement under a comprehensive framework



Pillar 1: Reduce coal dependency

- Power/energy sector planning
- Pricing and incentive policies
- Coal power plant repurposing
- Coal mine closure

Pillar 2: Scale up clean energy

- Renewable energy
- Natural Gas
- Energy efficiency
- Grid enhancement
- Energy storage
- Industry/transport decarbonization
- Frontier solutions (hydrogen, CCUS, etc)

Pillar 3: Ensure a just transition

- Social service and assistance
- Workforce transition
- Active labor market policies
- Environmental remediation
- Land reclamation

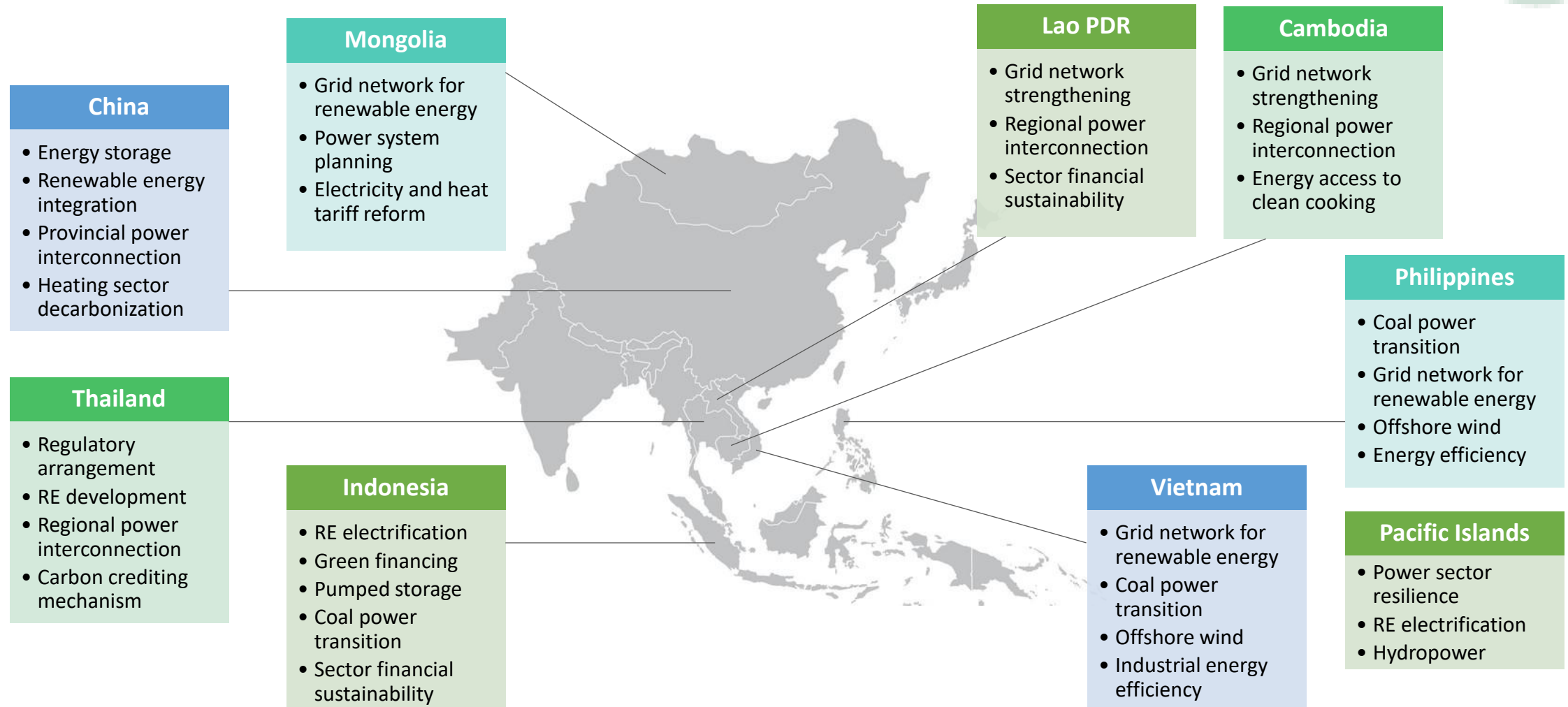
Pillar 4: Improve sector governance

- Sector financial viability
- Electricity tariff reform
- Utility financial/operational reform
- Subsidy reform and fiscal management
- Market mechanisms

Cross-Pillar: Mobilize grant resource for technical assistance

Cross-Pillar: Mobilize concessional finance to de-risk and reduce cost

Active work programs in East Asia and Pacific region





IV. Going Forward



Some takeaway messages...



- ✓ Energy transition becomes a core part of sustainable energy sector development across Asian countries
- ✓ Aligning climate actions and energy transition plans with domestic development objectives is important, as highlighted in CCDRs
- ✓ Technology innovation is driving down cost of clean energy, but it remains a challenge for developing countries to manage the cost and financing for accelerating the transition
- ✓ About US\$12 trillion will be needed by 2040 for energy transition in the power sector in the six major Asia coal-consumption countries



Some takeaway messages...



- ✓ Governments have a critical role to create an enabling environment for private sector participation and de-risking transition process
- ✓ Governments can lead the effort to tap concessional climate finance and unlock potential of carbon pricing to fill the financing gap
- ✓ Governments also need to consider strategically positioning themselves to benefit from global energy transition



THANK YOU