Some discussion and review about global energy market transformation

10am
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This week at JSGEE

Going to be a busy week….

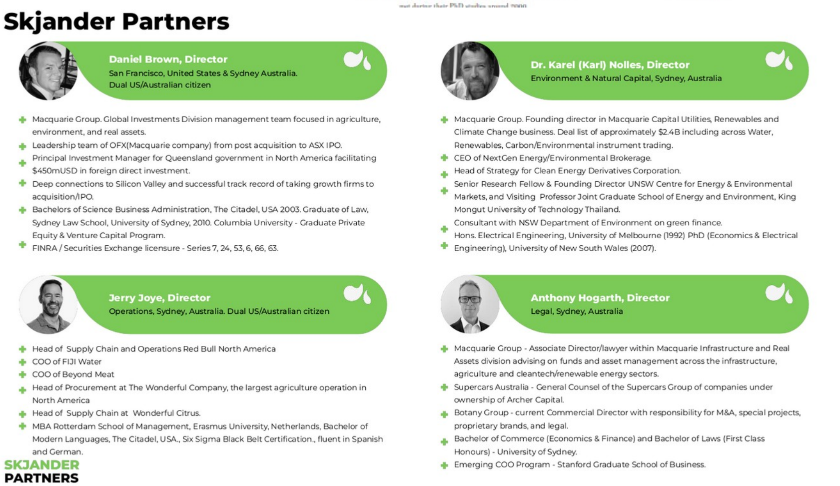
- **~~Monday 26th June~~**
  - ~~Challenges in the Australian Electricity Market~~
- **~~Tuesday 27th June~~**
  - ~~Survey of Environmental Finance~~
- **Wednesday 28th June (AM) - POSTPONED TO JULY**
  - Introduction to the Taskforce Nature related Financial Disclosures
- **Wednesday 28th June (PM) - POSTPONED TO JULY**
  - Market examples from biodiversity markets
- **Thursday 29th June (AM) ← THIS LECTURE**
  - Global energy transformation issues, and the IEA reports

Who am I to be talking about all this ?

- **Australian Financial Markets Association Electricity and Environmental Products Policy Officer**
  - Developed a lot of data services and documentation
- **Senior Lecturer / Founding Director University of New South Wales Centre for Energy and Environmental Markets**
- **Director in Macquarie Bank Climate Change team**
- **CEO of NextGen Brokerage**

AND TODAY

- **Visiting Professor JGSEE**
- **Founder and Director, Aton Consulting**
  - Currently (among other things) advising NSW Department of Environment and Australian Grains Research Development Corporation
- **Co-founder of Skjander Partners**
  - Biodiversity and carbon investment management



IEA has just released some new reports

https://www.iea.org/reports/world-energy-investment-2023

https://www.iea.org/reports/scaling-up-private-finance-for-clean-energy-in-emerging-and-developing-economies

https://www.iea.org/reports/renewable-energy-market-update-june-2023

Profound trends at cross purposes

The shock to the system from the global energy crisis has come at a time of increasingly visible impacts of a changing climate and has taken many forms. Price spikes created strong economic incentives to increase supply and to find alternative or more efficient ways to meet demand. Energy security shocks created powerful incentives for policy makers to reduce vulnerabilities and dependencies, while also – for many developing economies in particular – draining the financial resources available to address them.

P6, Energy Review

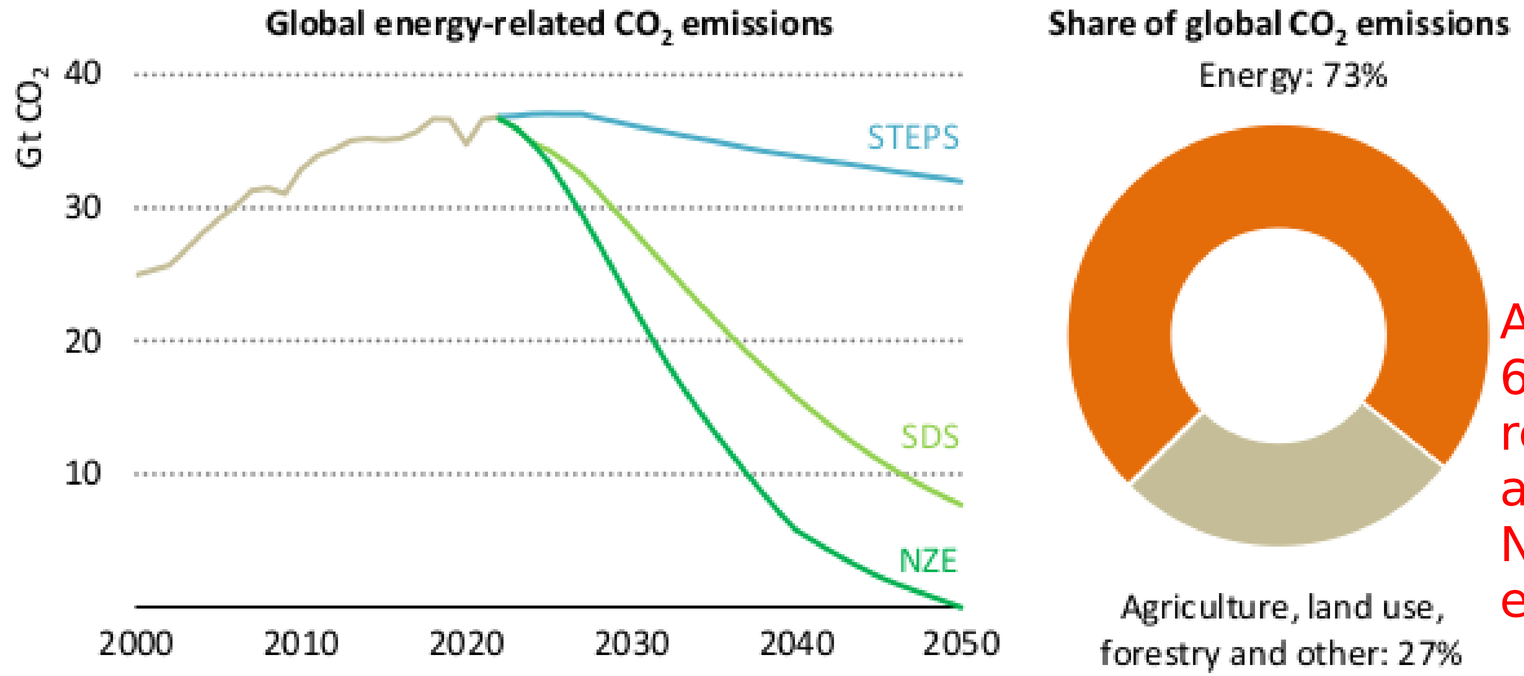
Current policies don't meet stated goals…

Three scenarios are referenced in this report:

- The **Stated Policies Scenario (STEPS)** explores the implications of today's policy settings, based on a detailed sector-by-sector assessment of what policies are actually in place or are under development by governments around the world. This scenario does not automatically assume that ambitious net zero or other climate targets are met. Emissions in the STEPS do not reach net zero and the rise in average temperatures associated with the STEPS is around 2.5°C in 2100.
- The **Sustainable Development Scenario (SDS)** achieves key energy-related UN SDGs, but reaches global net zero emissions in the 2060s (with many countries and regions reaching net zero much earlier). This scenario is aligned with the Paris Agreement objective of "holding the increase in the global average temperature to well below 2°C.
- The **Net Zero Emissions by 2050 (NZE) Scenario** sets out a pathway to the stabilisation of global average temperatures at 1.5°C above pre-industrial levels, showing what is needed for the global energy sector to achieve net zero CO_2 emissions by 2050. Like the SDS, it also meets the key UN SDGs related to universal energy access, alongside major improvements in air quality.

The SDS and the NZE Scenario are normative scenarios that show the pathways to reach specific outcomes. Between the two, the NZE Scenario represents the safer pathway to ensuring the Paris Agreement goals are met.

Figure 1.2 ▹ Global energy-related CO_2 emissions by scenario and share of energy in total emissions



Achieving net zero emissions and the stabilisation of the global average temperature will require a huge acceleration in the pace of clean energy deployment

Assumes 680GW of renewables and 20GW+ Nuclear pa every year.

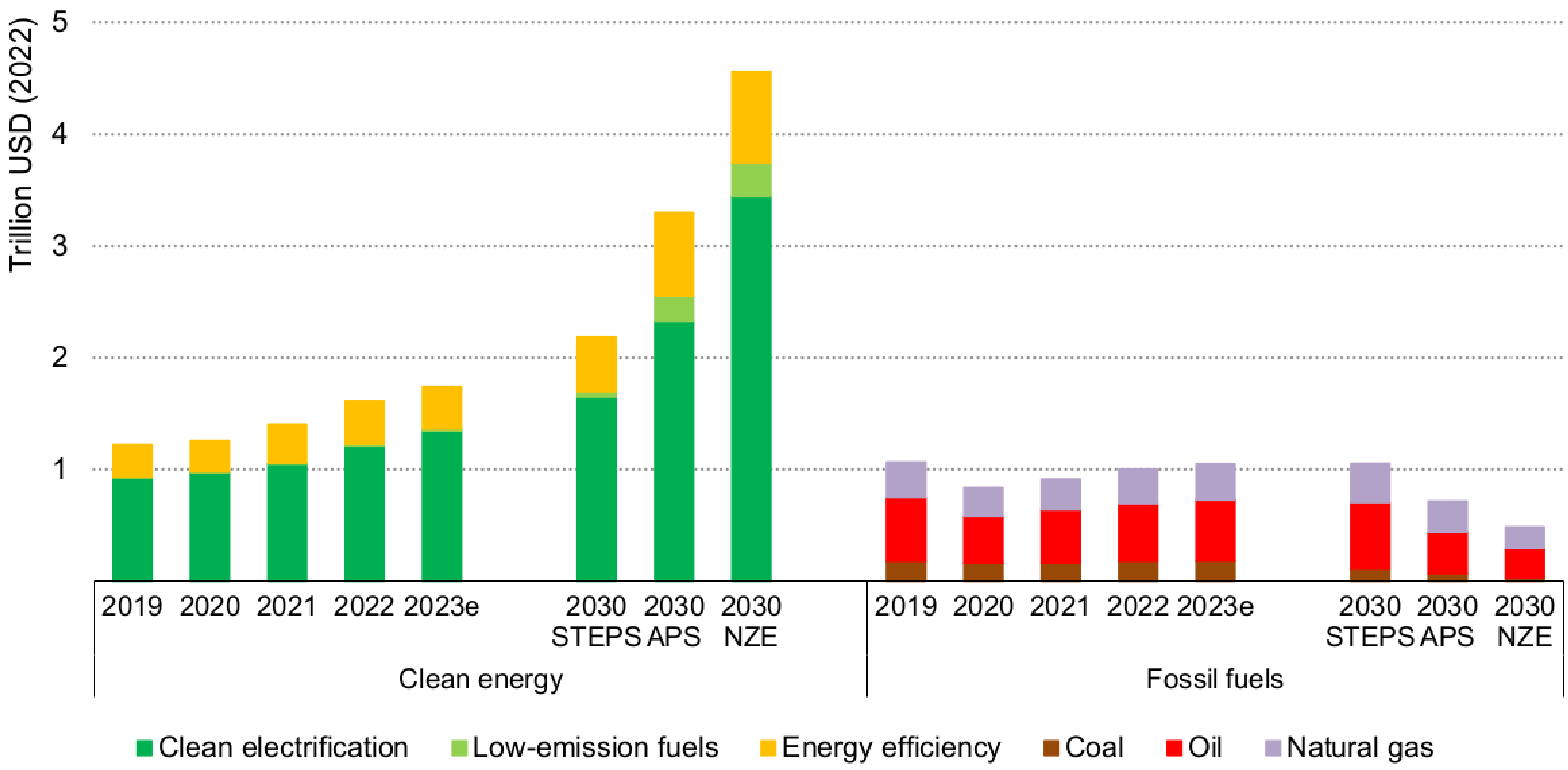
(Mostly in China, India and Middleeast)

Investment trends are not all positive…

Annual investment in low-emission dispatchable generation, with the exception of nuclear power, has fallen back, while spending on grid infrastructure in recent years has also been below the average seen prior to the Covid-19 pandemic. These are worrying trends not just

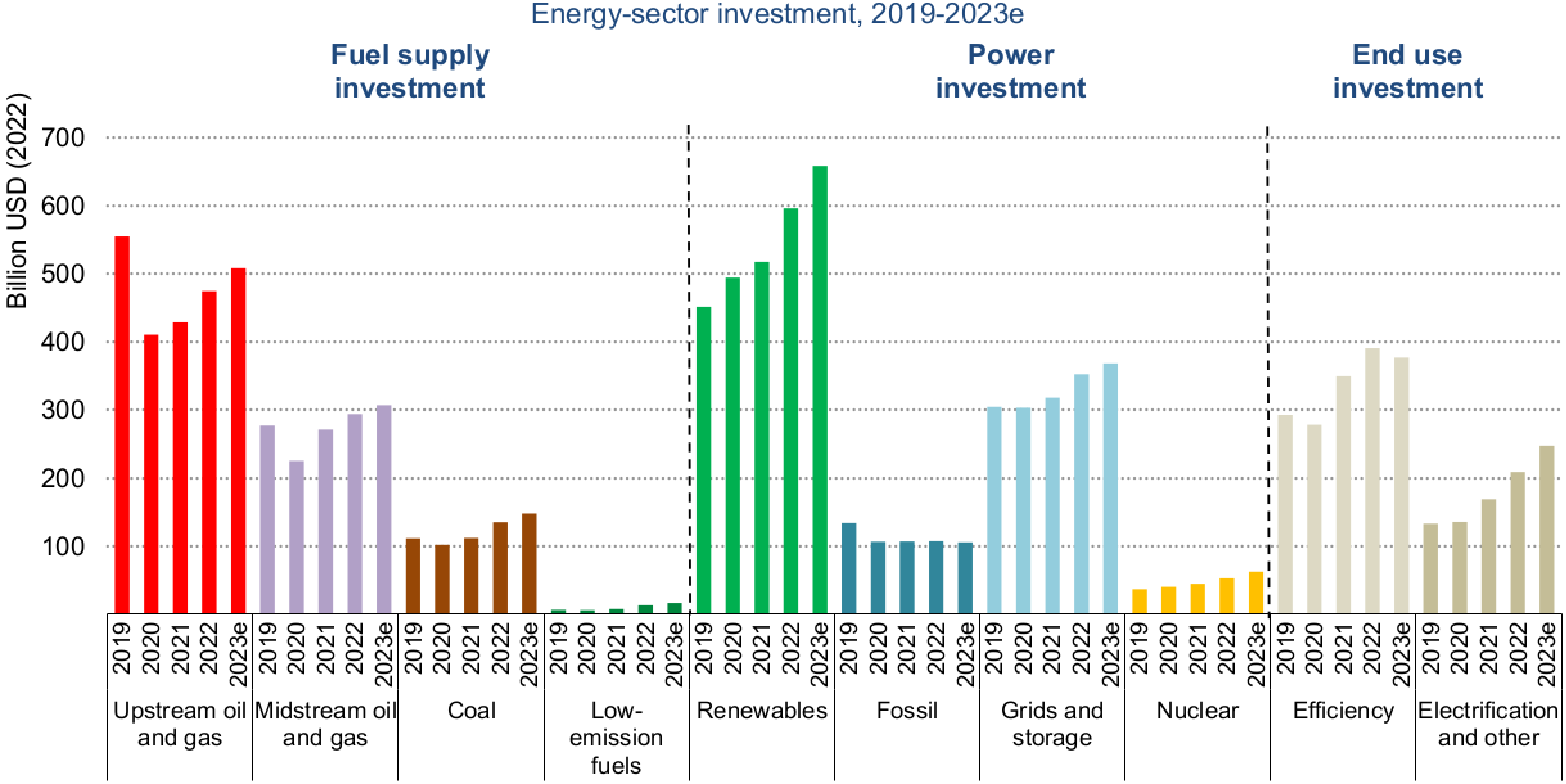
Scaling up clean investment is the key task for the sustainable and secure transformation of the energy sector

Historical investment in energy benchmarked against needs in IEA scenarios in 2030



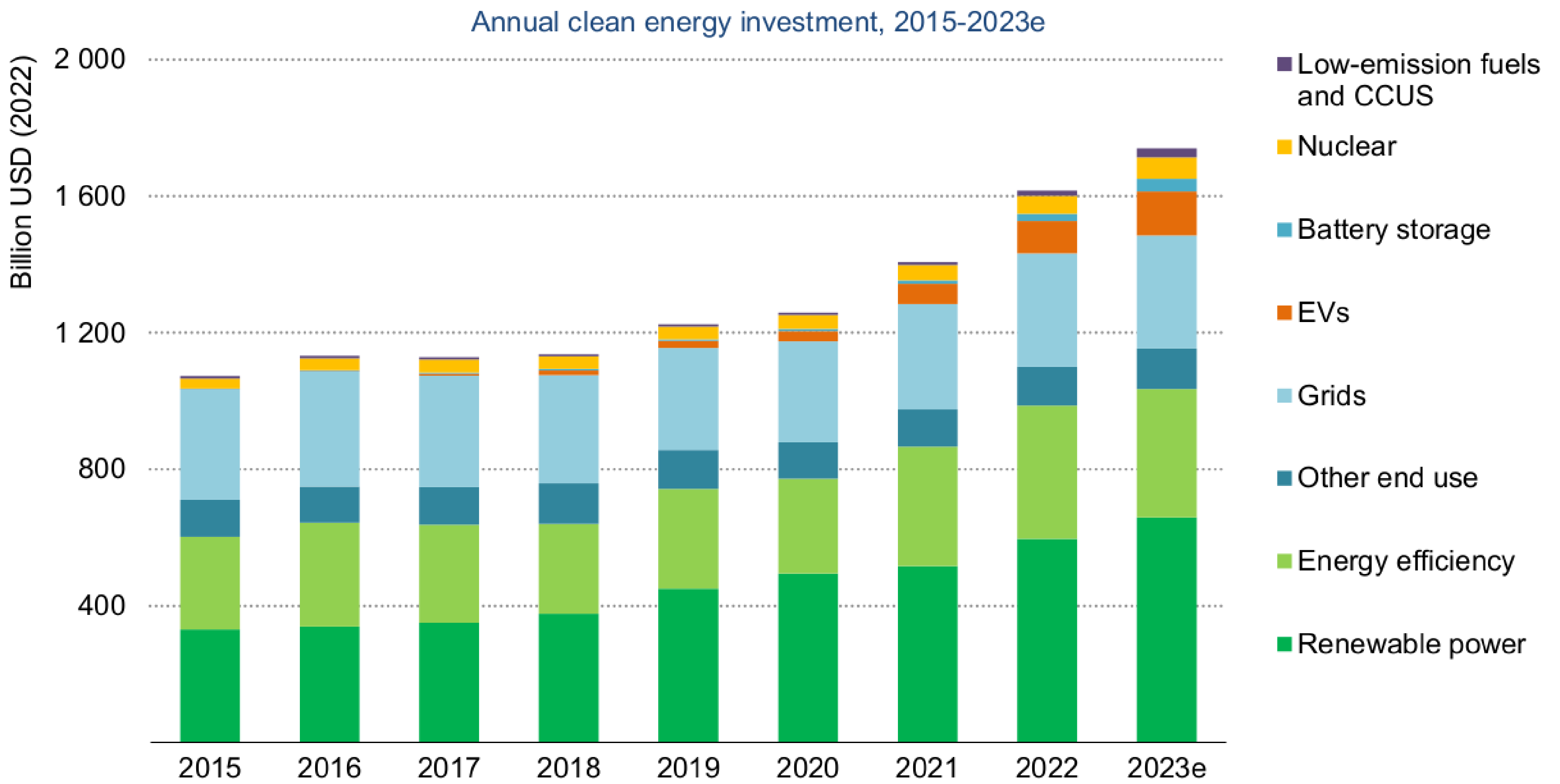
Notes: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; NZE = Net Zero Emissions by 2050 Scenario. 2023e = estimated values for 2023.

Increases across almost all categories push anticipated spending in 2023 up to a record USD 2.8 trillion



Notes: "Low-emission fuels" include modern liquid and gaseous bioenergy, low-emission hydrogen and low-emission hydrogen-based fuels; "Other end use" refers to renewables for end use and electrification in the buildings, transport and industrial sectors. The terms grids and networks are used interchangeably in this report and do not distinguish between transmission and distribution; 2023e = estimated values for 2023..

Renewables, led by solar, and EVs are leading the expected increase in clean energy investment in 2023



Notes: "Low-emission fuels" include modern liquid and gaseous bioenergy, low-emission hydrogen and hydrogen-based fuels that do not emit any CO_2 from fossil fuels directly when used and emit very little when being produced; "Other end use" refers to renewables for end use and electrification in the buildings, transport and industrial sectors. 2023e = estimated values for 2023; CCUS = carbon capture, utilisation and storage; EV = electric vehicle.

Figure 1.3 ▷ Select development indicators for EMDEs, 1990-2022, and global population projections, 1990-2035

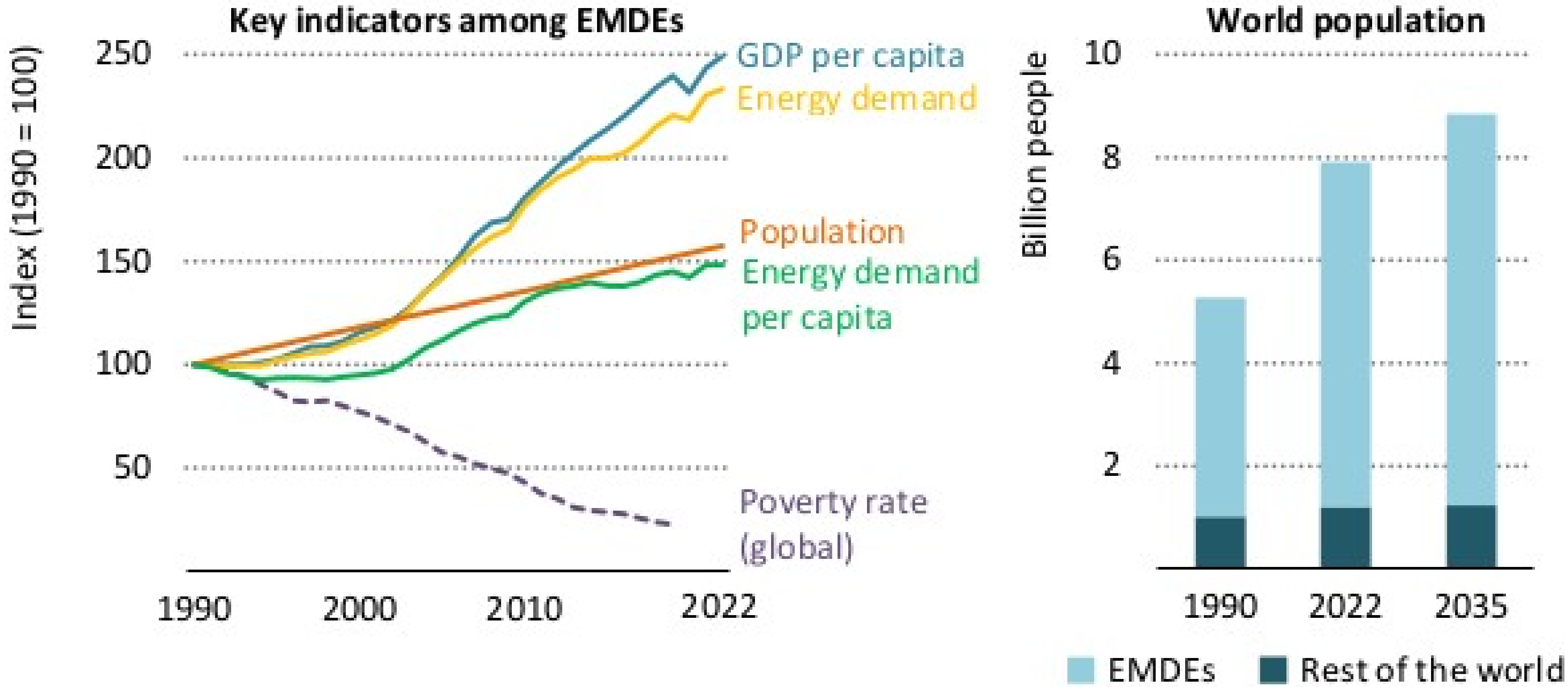
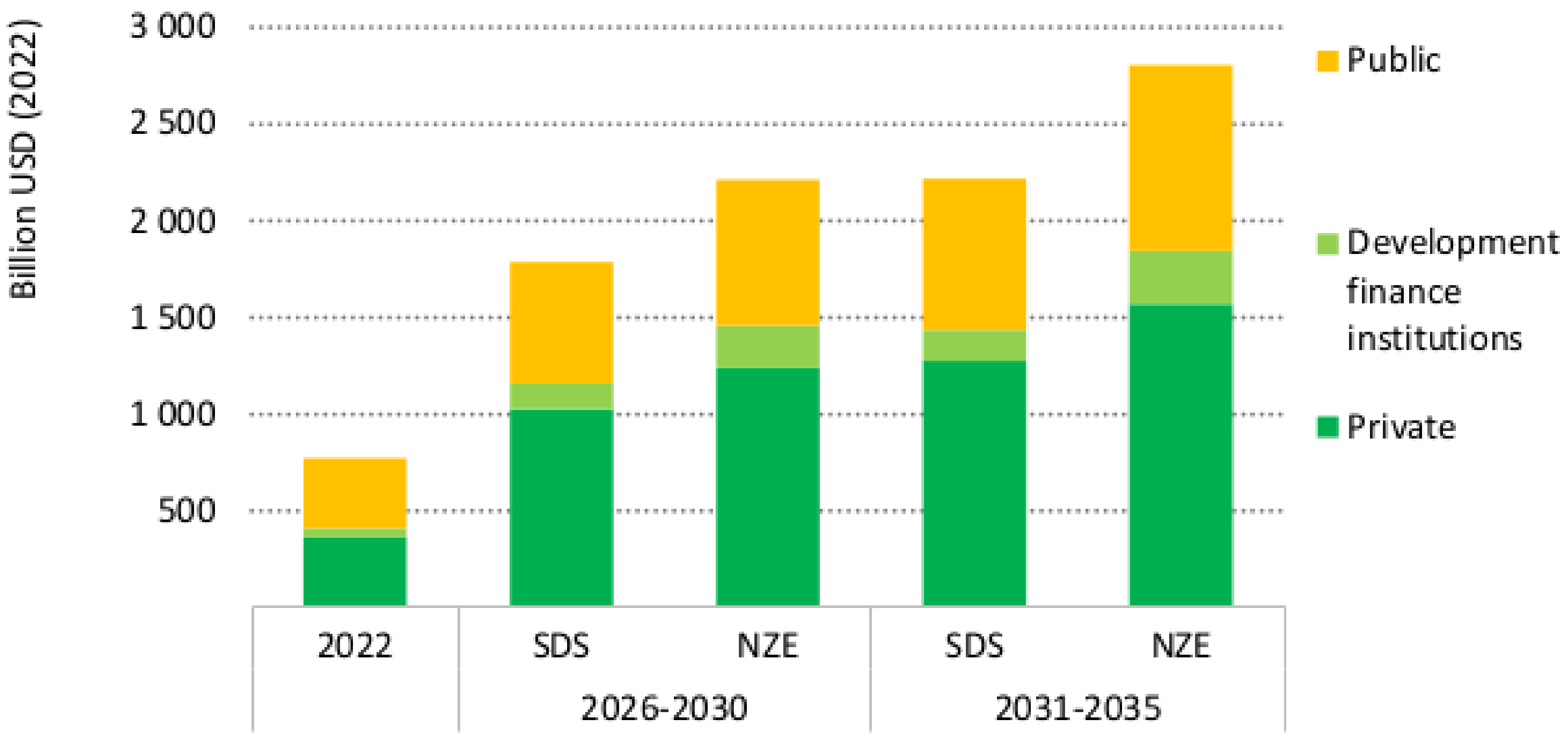


Figure 2.14 ▷ Estimated sources of finance for clean energy investment in EMDEs in the NZE Scenario and SDS



Some fascinating comparison stats....

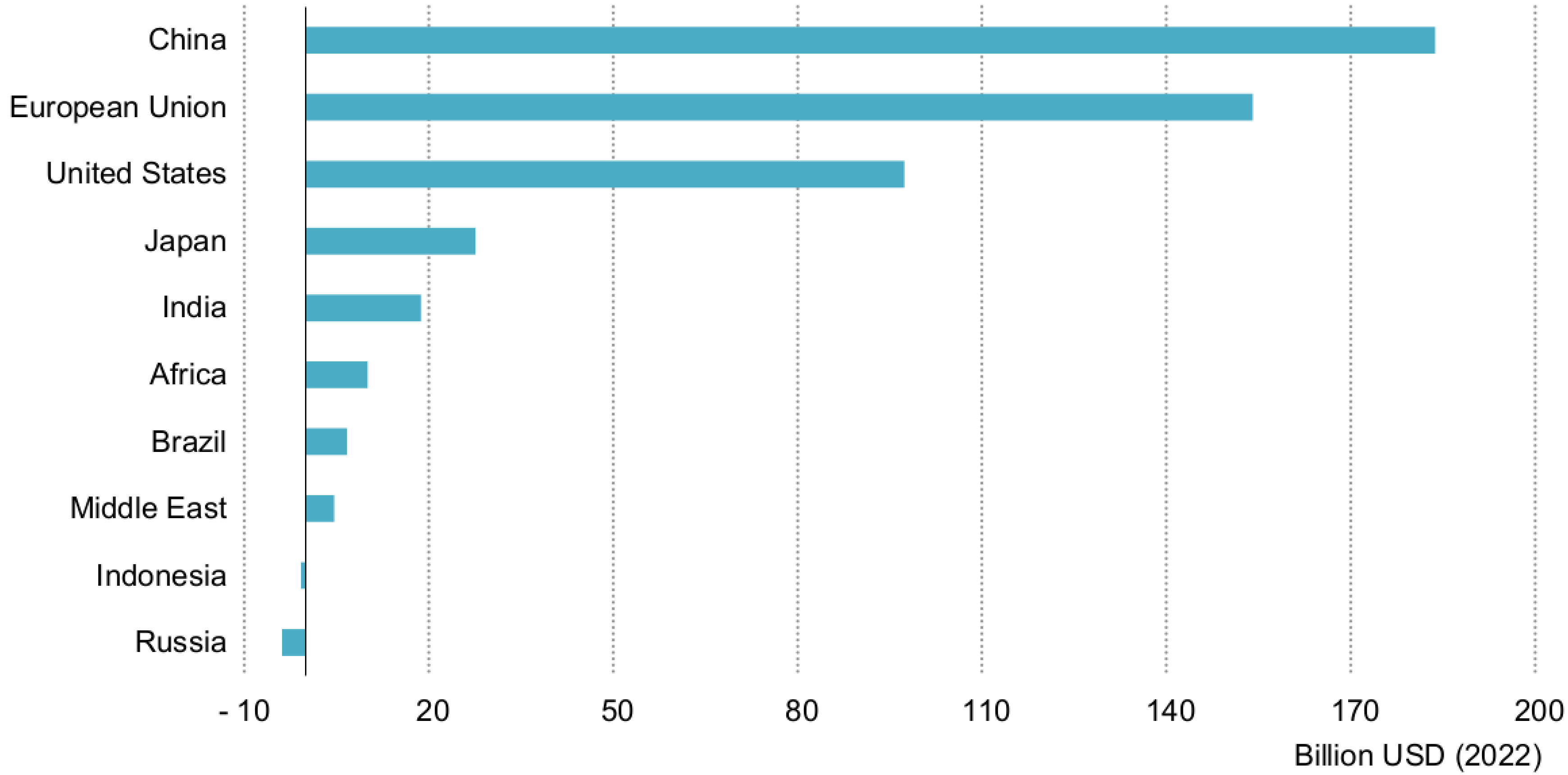
Table 1.1 ▷ Key economic and energy indicators for selected EMDEs

	Population	Urban population	Access to clean cooking	GDP per capita	CO_2 emissions	Energy demand per capita	Electricity consumption per capita	Share of renewables in power mix	Energy Investment	Clean energy investment
	2021 *million*	2021 *%*	2021 *%*	2021 *USD/capita, PPP*	2020 *Million tonnes*	2020 *GJ/capita*	2020 *kWh/capita*	2020 *%*	2021 *% of GDP*	2021 *% of total energy*
Argentina	46	92	100	23 650	149	68	2 814	26	1.8	26
Bangladesh	167	39	23	6 494	84	11	498	2	3.1	68
Brazil	214	87	96	16 031	389	56	2 541	84	3.5	65
Chile	20	88	100	28 685	84	82	4 151	49	1.9	67
China	1 412	63	81	19 338	10 081	104	5 262	28	3.6	67
Colombia	50	82	92	16 819	73	34	1 506	66	1.9	67
Egypt	104	43	100	12 706	188	36	1 544	12	2.8	34
India	1 391	35	64	7 242	2 075	26	928	21	2.6	57
Indonesia	275	57	82	13 027	532	36	980	19	1.8	38
Kazakhstan	19	58	92	28 685	204	147	5 513	11	6.1	25
Kenya	55	28	18	5 211	16	22	166	94	2.4	48
Mexico	128	81	85	20 277	351	58	2 218	20	1.5	42
Morocco	37	64	98	8 853	62	24	908	18	2.8	34
Mozambique	32	38	5	1 348	6	15	392	84	2.4	48
Nigeria	211	53	14	5 408	88	32	134	24	2.4	48
Russia	144	75	86	32 863	1 552	220	6 838	20	4.4	22
Saudi Arabia	35	85	100	48 711	484	276	10 311	0.2	5.7	15
Senegal	17	49	24	3 840	8	12	322	12	2.4	48
South Africa	60	68	87	14 624	388	88	3 538	5	1.7	63
Thailand	70	52	84	18 761	243	80	2 770	17	2.5	45
Viet Nam	98	38	65	11 676	294	42	2 321	35	2.5	45

Note: PPP = purchasing power parity. Source: IEA calculations; World Bank (2022).

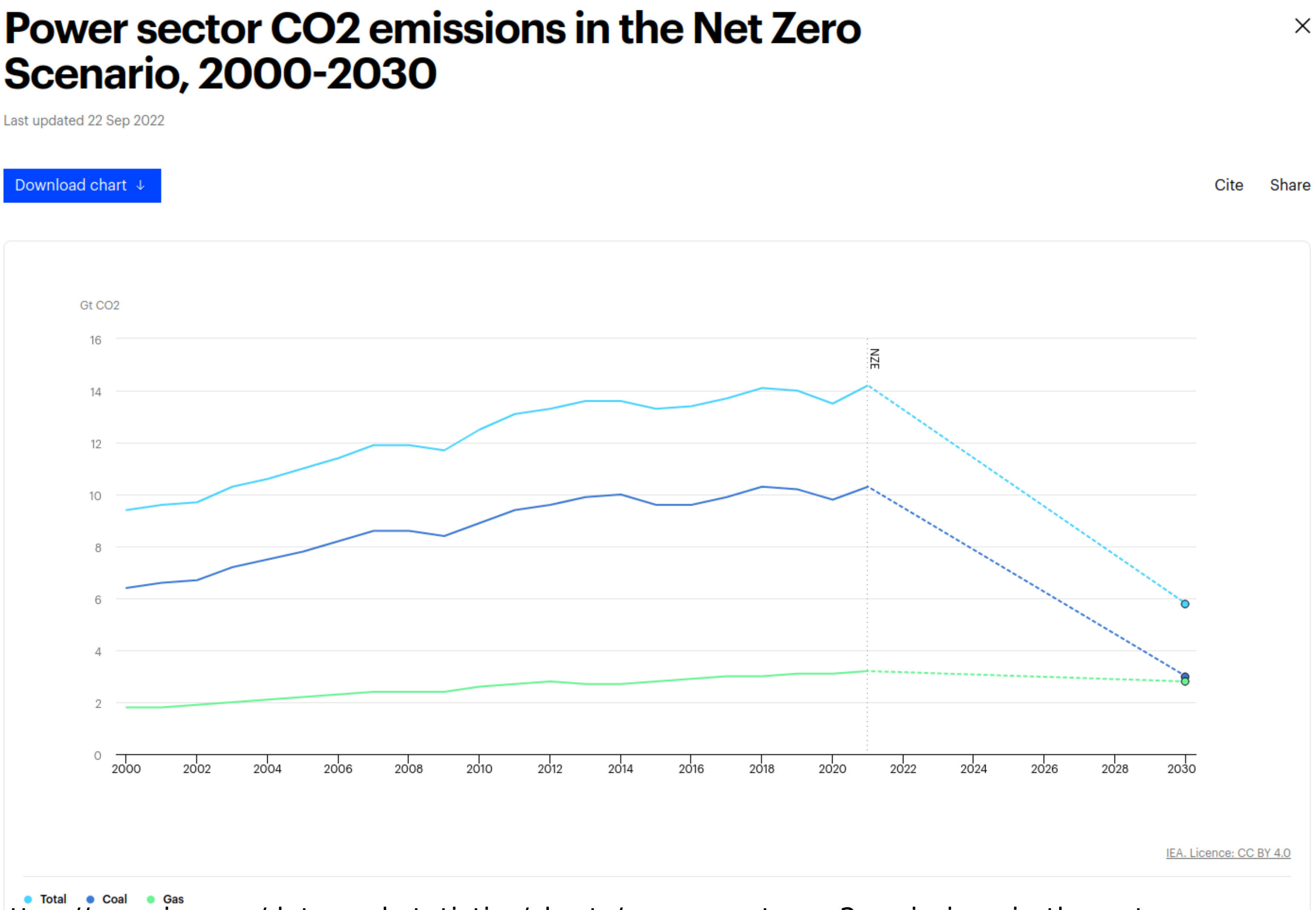
The increase in clean energy spending in recent years is impressive but heavily concentrated in a handful of countries

Increase in annual clean energy investment in selected countries and regions, 2019-2023e



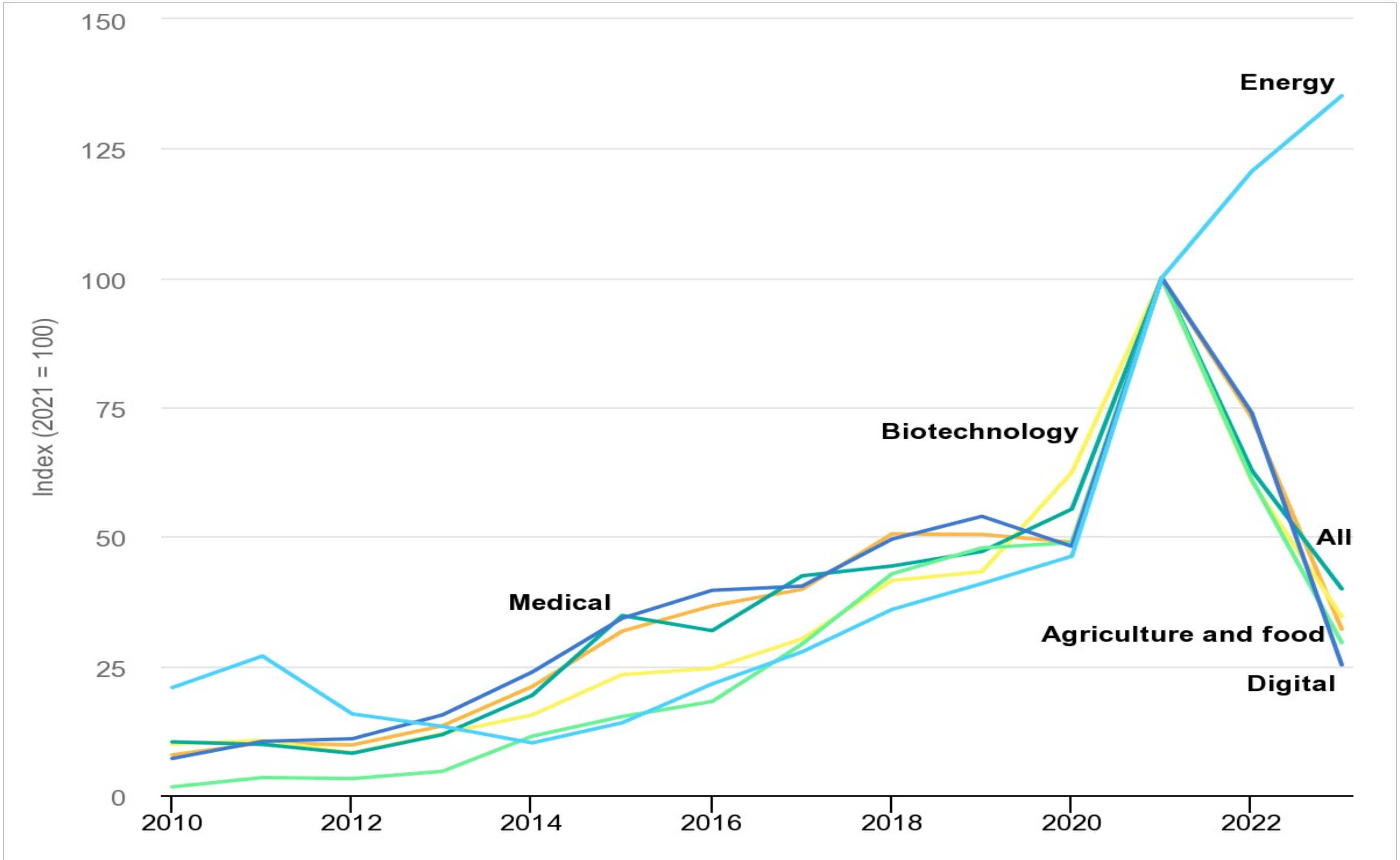
Note: 2023e = estimated values for 2023.

The global trajectory on power sector CO2 emissions is not consistent with announced targets



https://www.iea.org/data-and-statistics/charts/power-sector-co2-emissions-in-the-net-zero-scenario-2000-2030-2

Early-stage start-up global venture capital investment by sector, 2010-2023

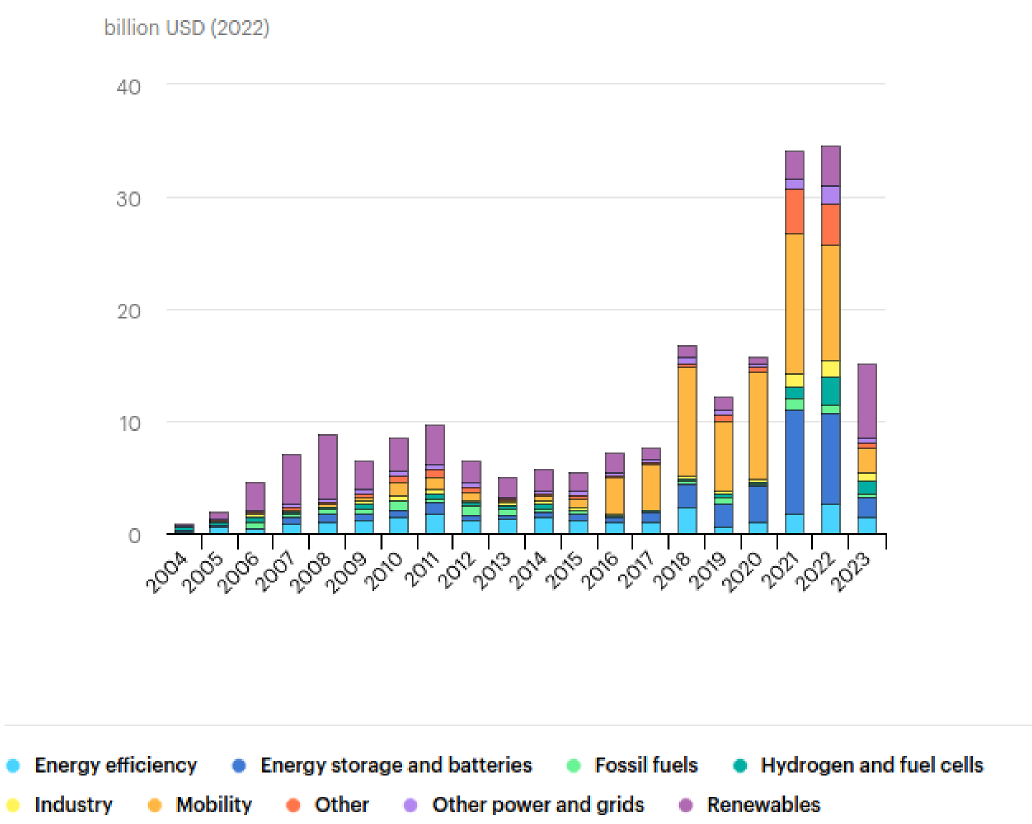


https://www.iea.org/data-and-statistics/charts/early-stage-start-up-global-venture-capital-investment-by-sector-2010-2023

However a lot is going into early stage transformation efforts

Venture capital investment in energy start-ups, by technology area, for growth-stage deals, 2004-2023

Open



Venture capital investment in energy start-ups, by technology area, for early-stage deals, 2004-2023

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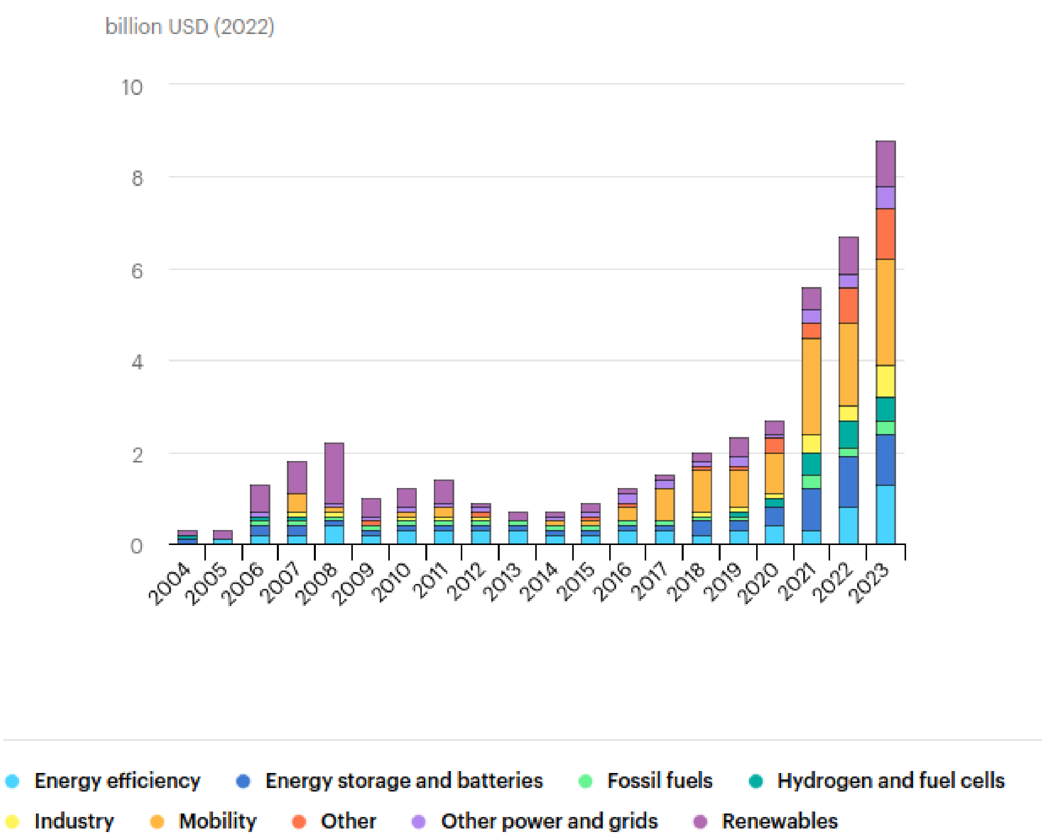
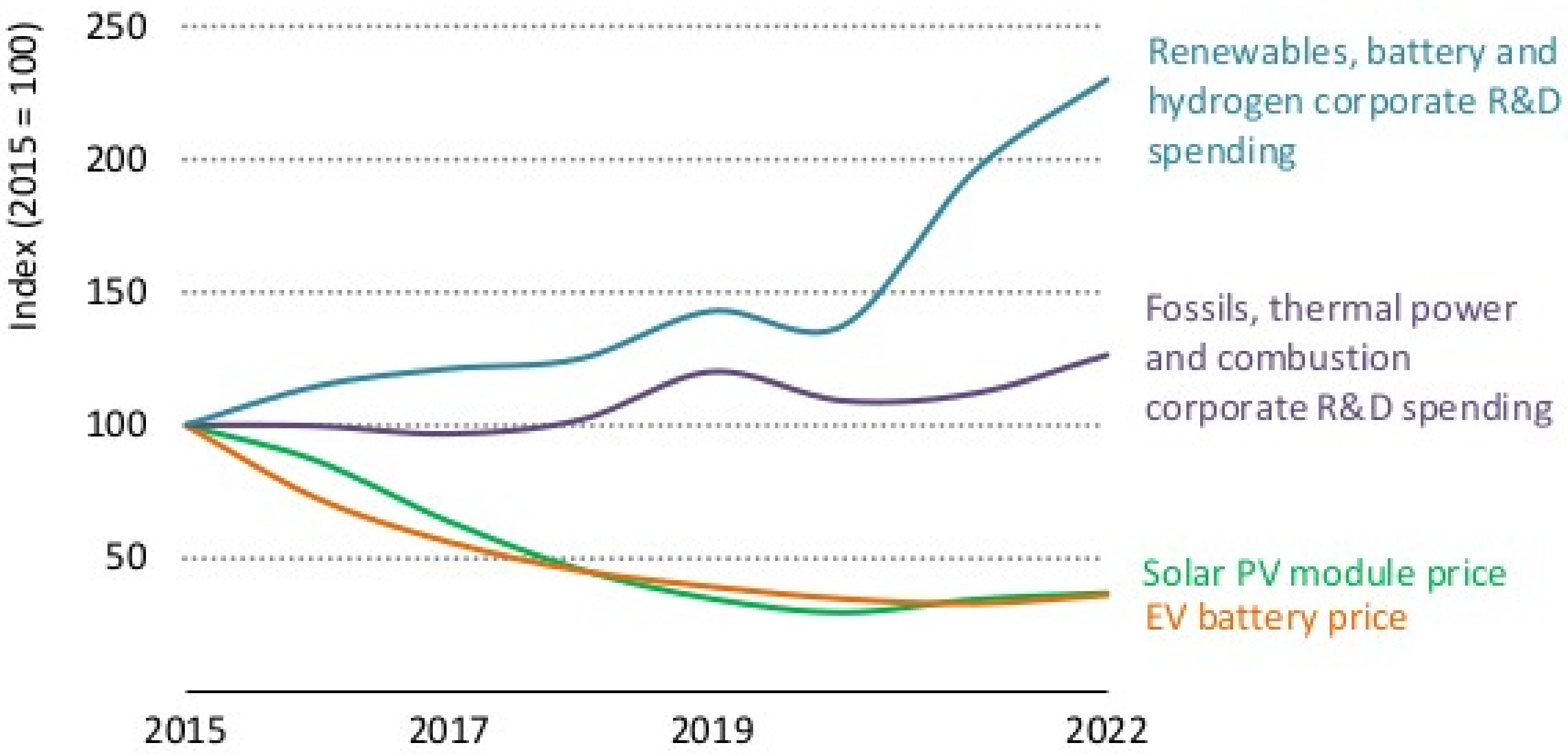
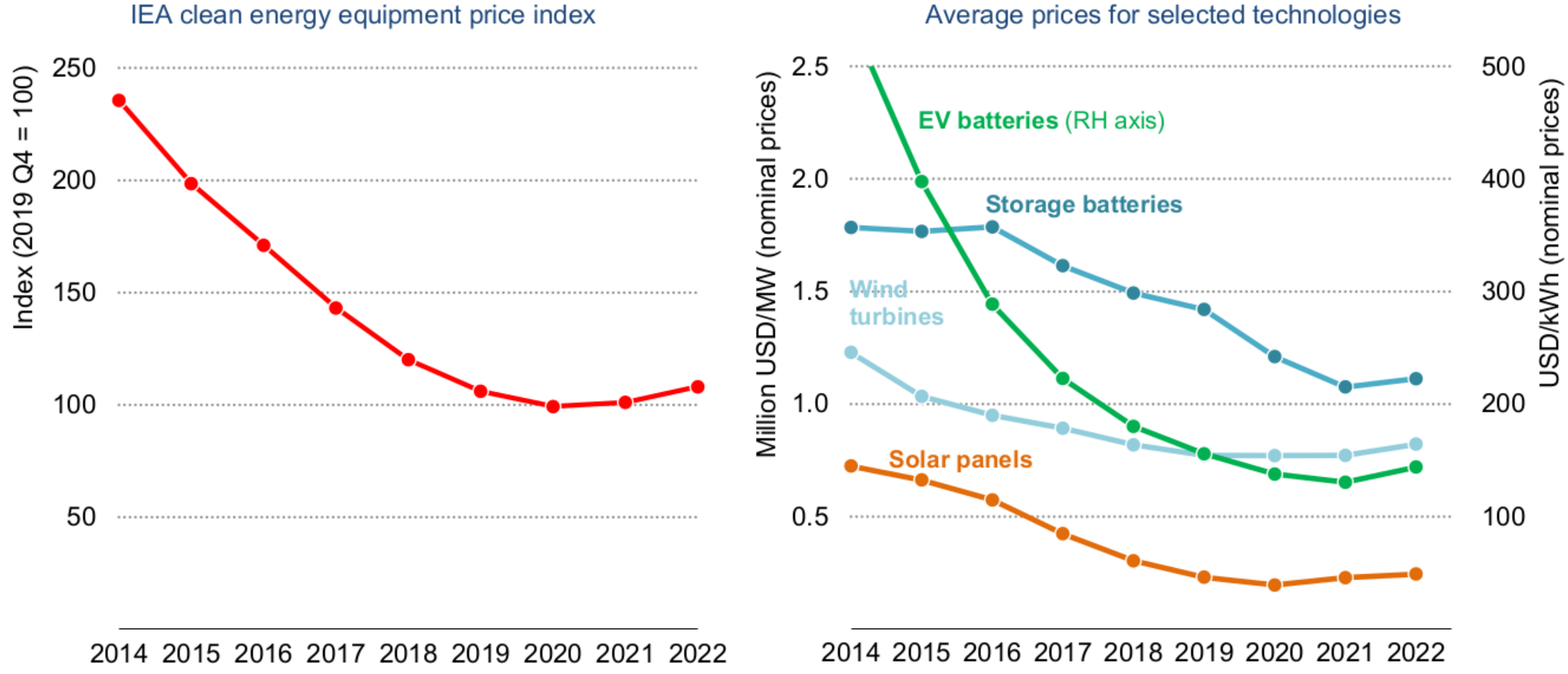


Figure 1.5 ⊳ Global corporate R&D spending and clean energy technology prices



Prices are no longer declining…

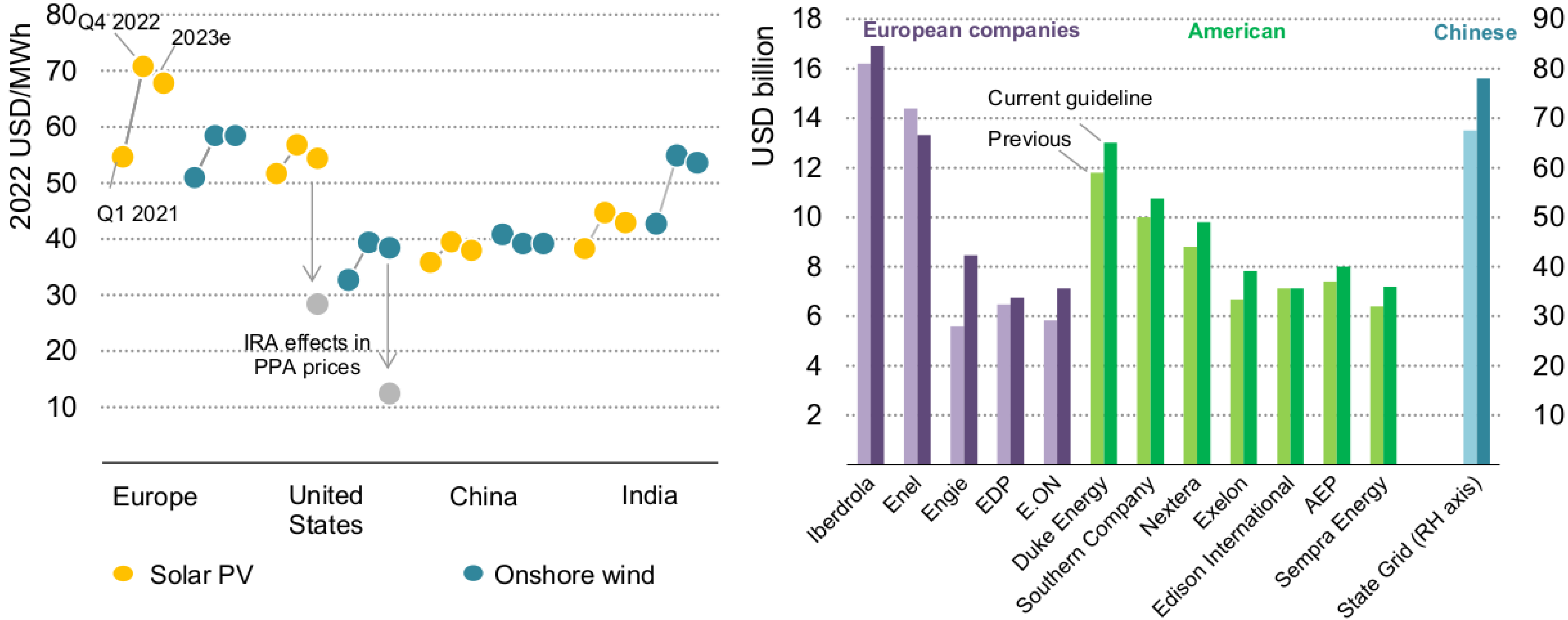
Clean energy costs edged higher in 2022, but pressures are easing in 2023 and mature clean technologies remain very cost-competitive in today's fuel-price environment



Notes: The IEA clean energy equipment price index tracks price movements of a fixed basket of equipment products that are central to the clean energy transition, weighted according to their share of global average annual investment in 2020-2022: solar PV modules (48%), wind turbines (36%), EV batteries (13%) and utility-scale batteries (3%). Prices are tracked on a quarterly basis with Q4 2019 defined as 100.

Power company investment plans remain robust, even as levelised costs for renewables moved higher

LCOE estimates of utility-scale solar PV and wind; and average annual short-term investment guidelines of selected power companies

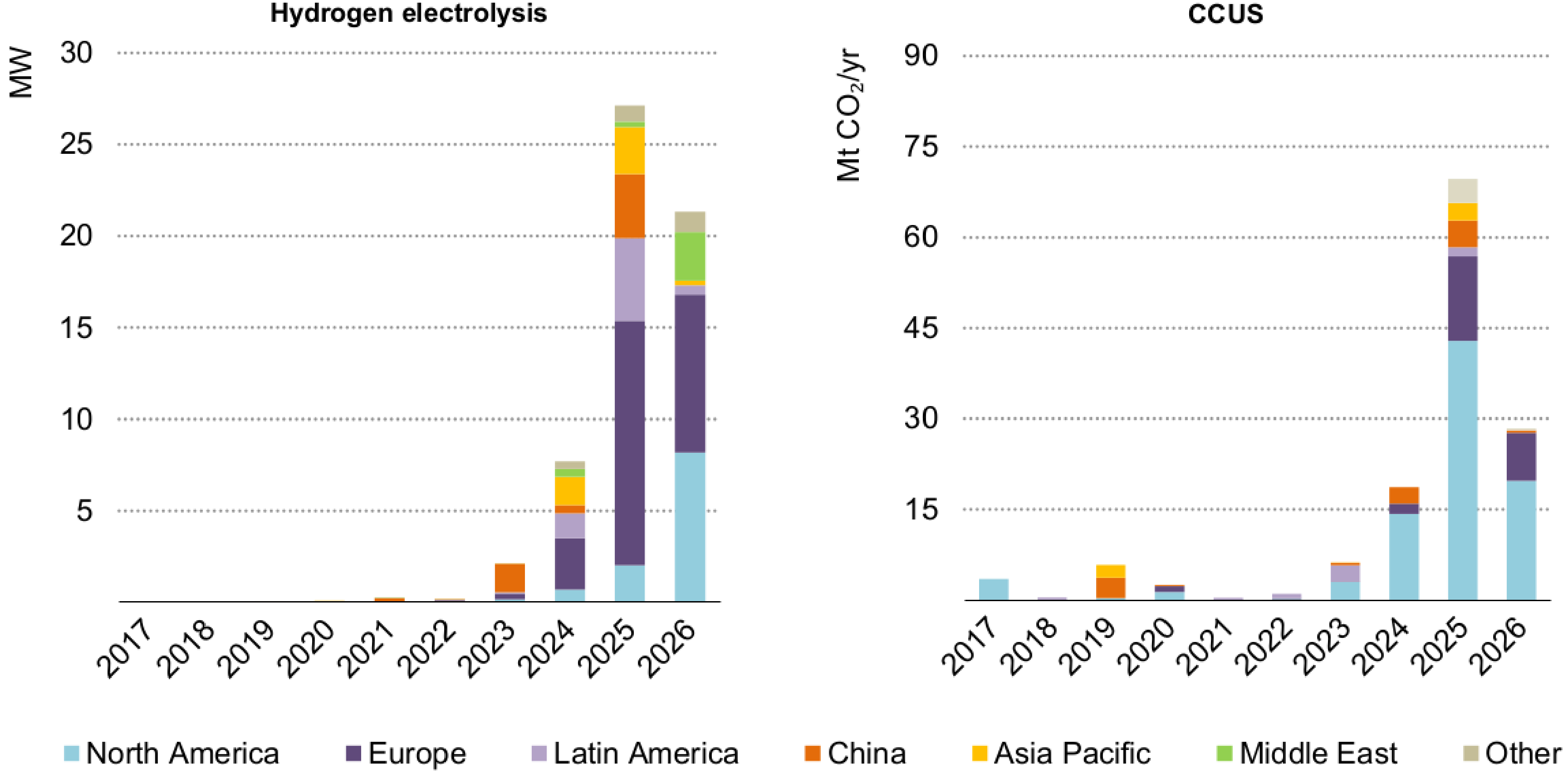


Notes: LCOEs calculations assume increases in the cost of capital in Europe, United States and India between Q1 2021 and Q4 2022 for both solar PV and wind, while remaining constant in 2023e. Capital costs are assumed to increase in Q4 2022 across the four regions (except wind in China) and reduce or remain flat in 2023, though not totally compensating for the 2022 increase. Capacity factors are consistent with WEO 2022. IRA effects assume a 26 USD/MWh of production tax credit. Annual company investment reflects nominal capital spending guidelines (for all group-level related activities) published in annual reports or strategic plans; for example, if a company announced an investment of USD 15 billion over 2020-2023 and USD 18 billion over 2023-2025 (most recent announcement) this is reflected as USD 5 billion (previous) and USD 6 billion (current); figures for Indian companies were not included as data were unavailable; the drop in Enel's figures is due to Enel streamlining its business (e.g. exiting Argentina, Peru and Romania), but its investment in other geographies remains as planned. 2023e = estimated values for 2023; IRA = US Inflation Reduction Act; LCOE = levelised cost of electricity

Sources: Companies' annual reports.

Strong policy signals and new support schemes have triggered a rapid expansion in the project pipelines for low-emissions hydrogen and CCUS

Capacity additions for hydrogen electrolysis and CO_2 capture projects by announced start date, 2017-2026



Notes: GW = GW of electricity input; for years before 2023, actual start dates are shown; for 2023 onwards, scheduled start dates as announced by developers are shown; CCUS covers all sources of CO_2, including low-emission hydrogen projects using CCUS; data include projects at the "feasibility" stage and beyond.

Sources: IEA analysis based on IEA hydrogen project database, CCUS projects database and recent announcements.

Some interesting headline takeways

Despite the higher utilisation factors of Wind, over 2/3rds of new renewable capacity to be installed in 2023 will be solar (both distributed and in utility scale systems)

Onshore wind installation rate is expected to decline in2023 compared to 2022.

War in Ukraine has considerably accelerated renewables deployment across the EU, with the IEA's analysis showing a projected 40% increase in renewables deployment in 2023 (75% of which being solar).

"European countries introduced more policy and regulatory changes to ease permitting in the last 18 months than over the entire previous decade. "

To meet rising energy needs in ways that align with the Paris Agreement, annual investment, public and private, in clean energy in EMDEs will need to more than triple from USD 770 billion in 2022 to USD 2.2-2.8 trillion per year by the early 2030s, remaining around these levels to 2050. If China is excluded, the increase is even steeper, amounting to as much as a seven-fold rise in annual investment from USD 260 billion to between USD 1.4-1.9 trillion. This surge in investment provides a powerful opportunity to underpin sustainable economic growth, create jobs and provide full energy access.

Both public and private investment need to increase to deliver clean energy at the scale required, but public resources alone will not suffice. In 2022 finance by public entities accounted for about half of EMDE clean energy spending, compared with less than 20% in advanced economies. We estimate that around 60% of the finance for EMDE clean energy investment (outside China) will need to come from the private sector: this requirement for private sector financing amounts to USD 0.9-1.1 trillion annually by the early 2030s, up from only USD 135 billion today.

Bringing in private capital at the scale and pace needed will require developing a much larger flow of clean energy projects that match investors' risk and return expectations. For the moment, the cost of capital for a typical utility-scale solar project can be two or three times higher in key emerging economies than in advanced economies or China, reflecting real and perceived risks at the country, sectoral and project levels. Tackling these risks and bringing down the cost of capital will require new and better ways of working between the public and private sectors.

The financing requirements are enormous
Real focus needs to be on how to attract, and deploy, private sector investment.

The key role of concessional finance

Concessional finance must be significantly scaled up and used strategically to mobilise the largest possible amounts of private capital in support of EMDE development and climate goals. Concessional funds (guarantees, senior or subordinated debt or equity, performance-based incentives, interest rate or swap cost buydowns, viability gap funding or other investment grants) are not a substitute for needed policy action or institutional reforms, but when used judiciously can mobilise private capital for clean energy projects that otherwise would not be financed. This includes projects: that involve newer technologies that have yet to scale and are not yet cost-competitive in many markets, such as battery storage, offshore wind, renewable-powered desalination, or low-emission hydrogen; that are in frontier

- In 2022 around USD 770 billion was invested in clean energy across EMDEs. Although this amount is set to rise in 2023, the geographical distribution of this spending is very uneven: China accounts for two-thirds of clean energy investment in EMDEs, and the top three countries (China, India and Brazil) for more than three-quarters. Outside China, spending on clean energy in EMDEs in recent years has been essentially flat at around USD 260 billion per year, a worrying trend.

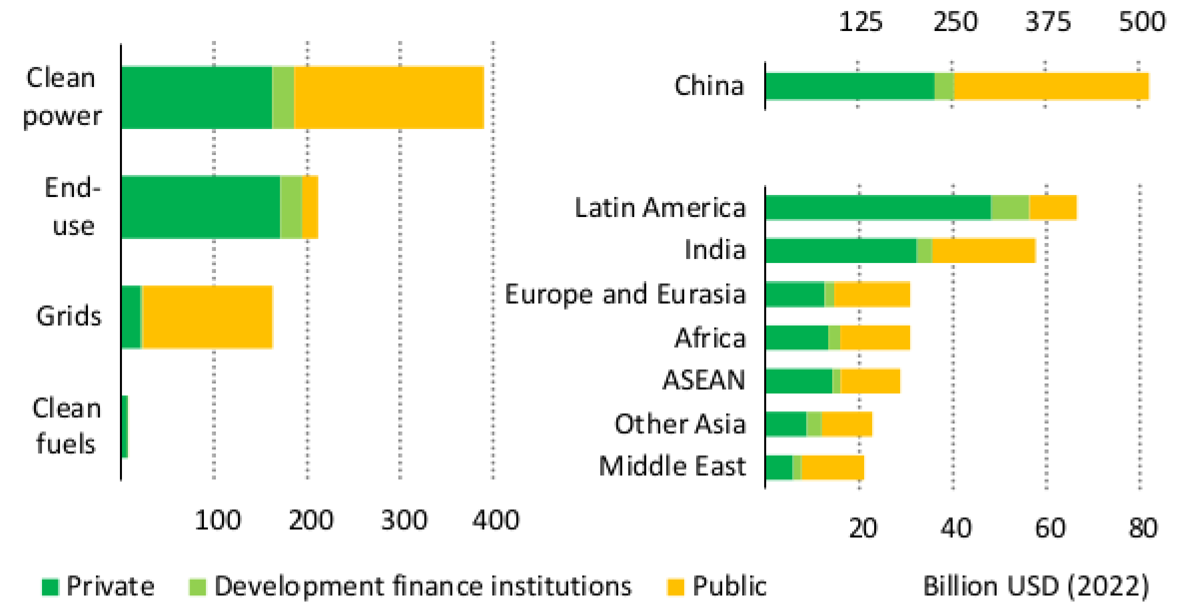
Achieving stated goals involves at least a 3x increase in investment. (ie: towards $2.5T pa)

This is not occurring across EMDEs (ex-China, India and Brazil)

IEA estimates 60%+ of this needs to be private finance.

The investment is not just in generation....

Figure 1.1 ▹ Clean energy finance in EMDEs by public and private sources in 2022

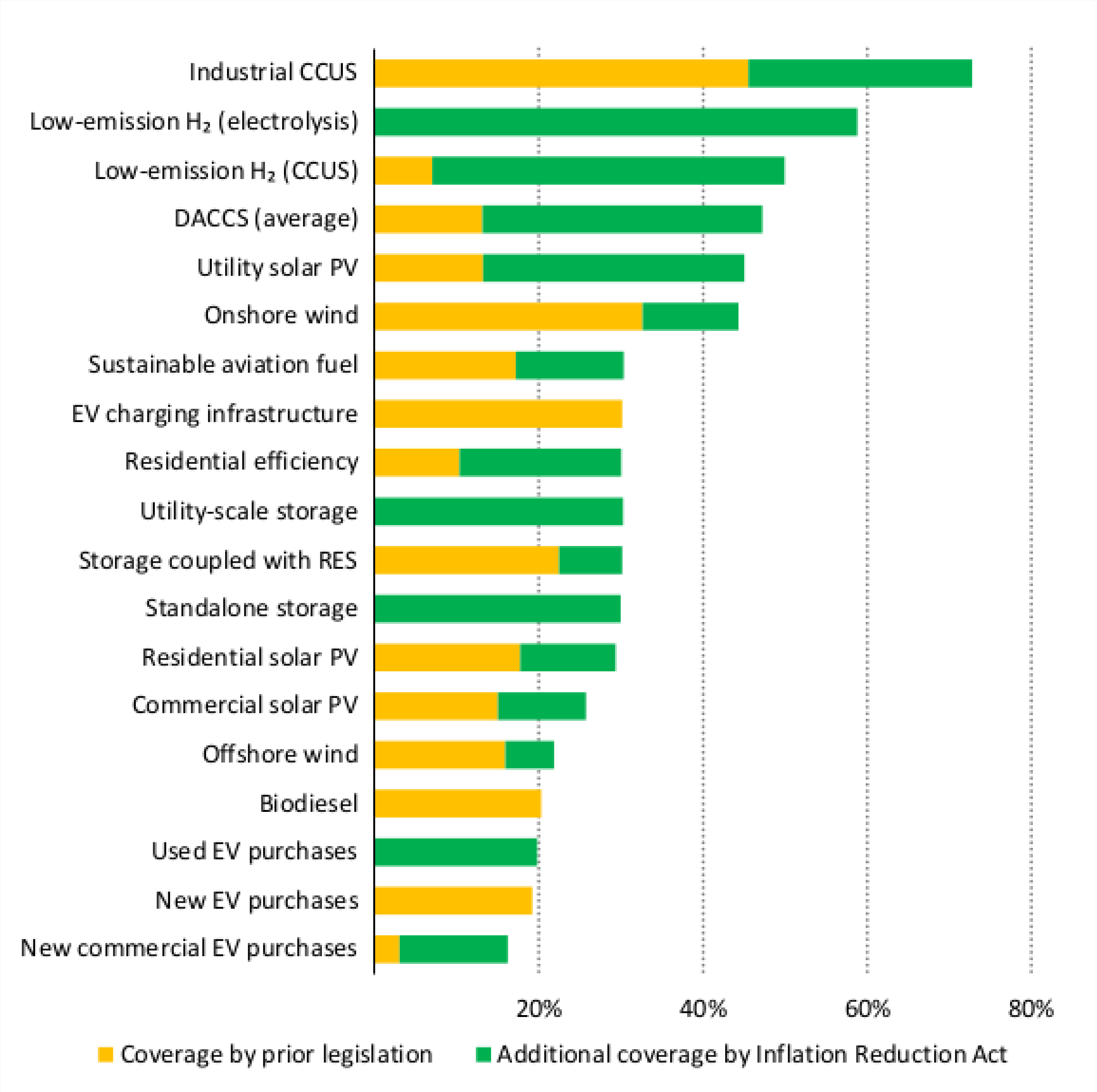


Over the next ten years, more than one-third of the clean energy investment required by the early 2030s goes into low-emission generation; another one-third is needed for improvement in efficiency and other end-use spending, including electric mobility; just under a quarter is needed for electricity grids and storage; and around 8% for clean fuels. In climate-driven scenarios, we estimate that the private sector will need to finance about 60% of the clean energy spend in EMDEs.

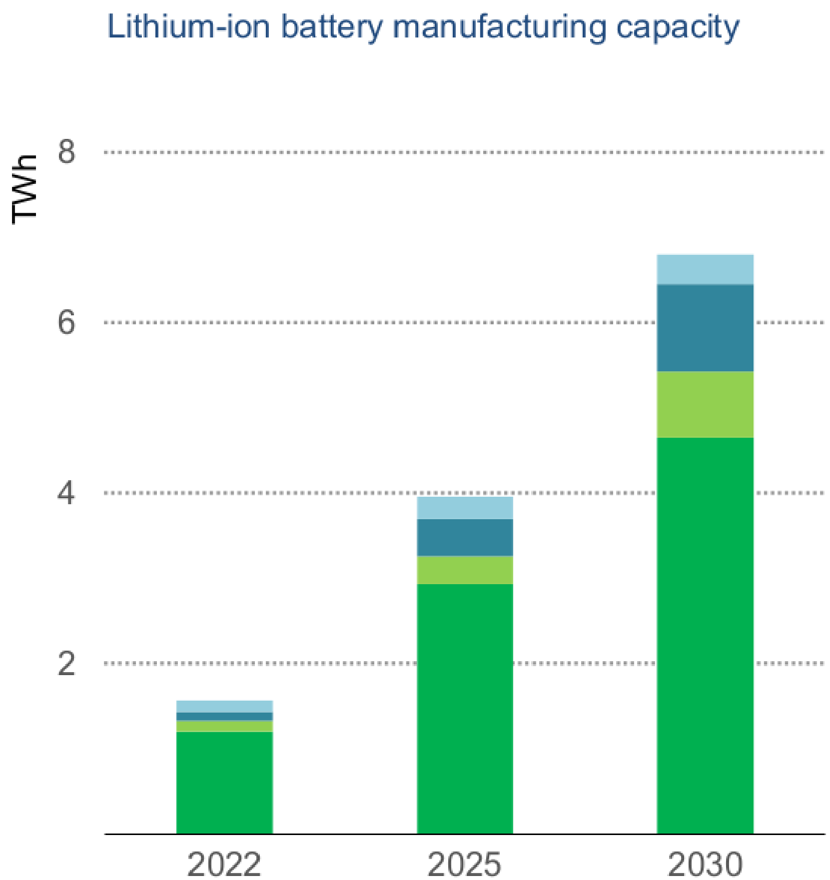
in a sustainable way. Clean energy investment has been increasing in China and advanced economies; in practice, the increase seen in spending on clean energy investment in these economies since 2019 is bigger than the total spending in all EMDEs without China. Early signs from 2023 underscore these diverging trends between regions, creating a clear risk of new dividing lines in global energy and climate affairs.

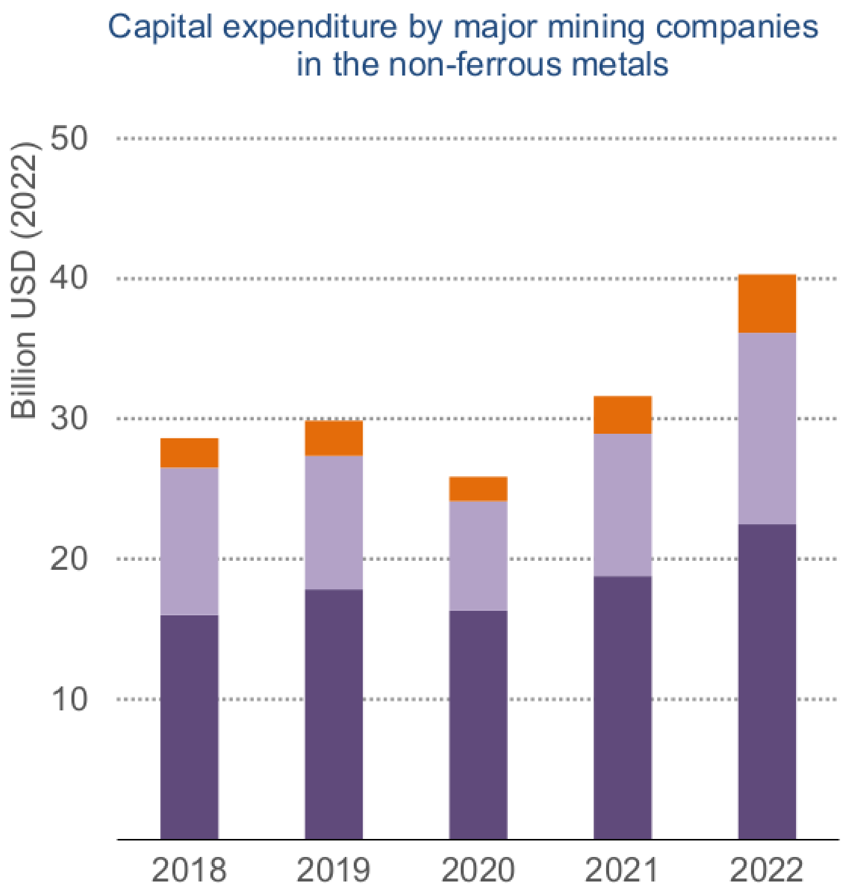
Figure 3.1 ▹ US Inflation Reduction Act tax credits and other incentives as a percentage of the average total cost of each technology

An aggressive move !!



Investment is flowing to clean energy manufacturing and critical minerals, but ensuring well-sequenced growth of new supply chains will be a major task



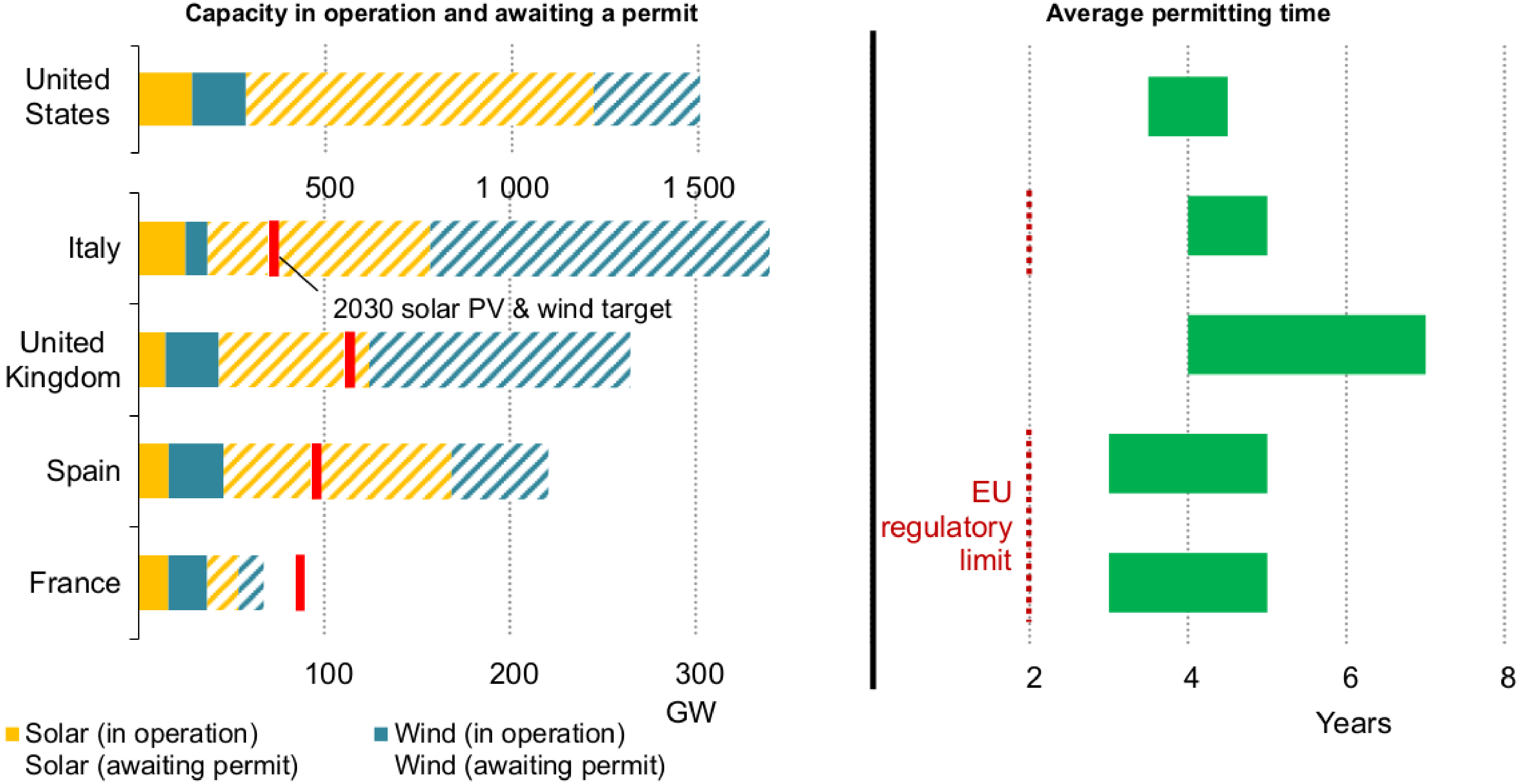


China Europe United States Rest of world Diversified major Cu,Ni,Co specialist Lithium specialist

Notes: Cu = copper; Ni = nickel; Co = cobalt; the illustrative expansion of manufacturing capacity assumes that all announced projects proceed as planned.

But getting projects up and running has often been slow, putting the focus on permitting and other practical obstacles facing investors

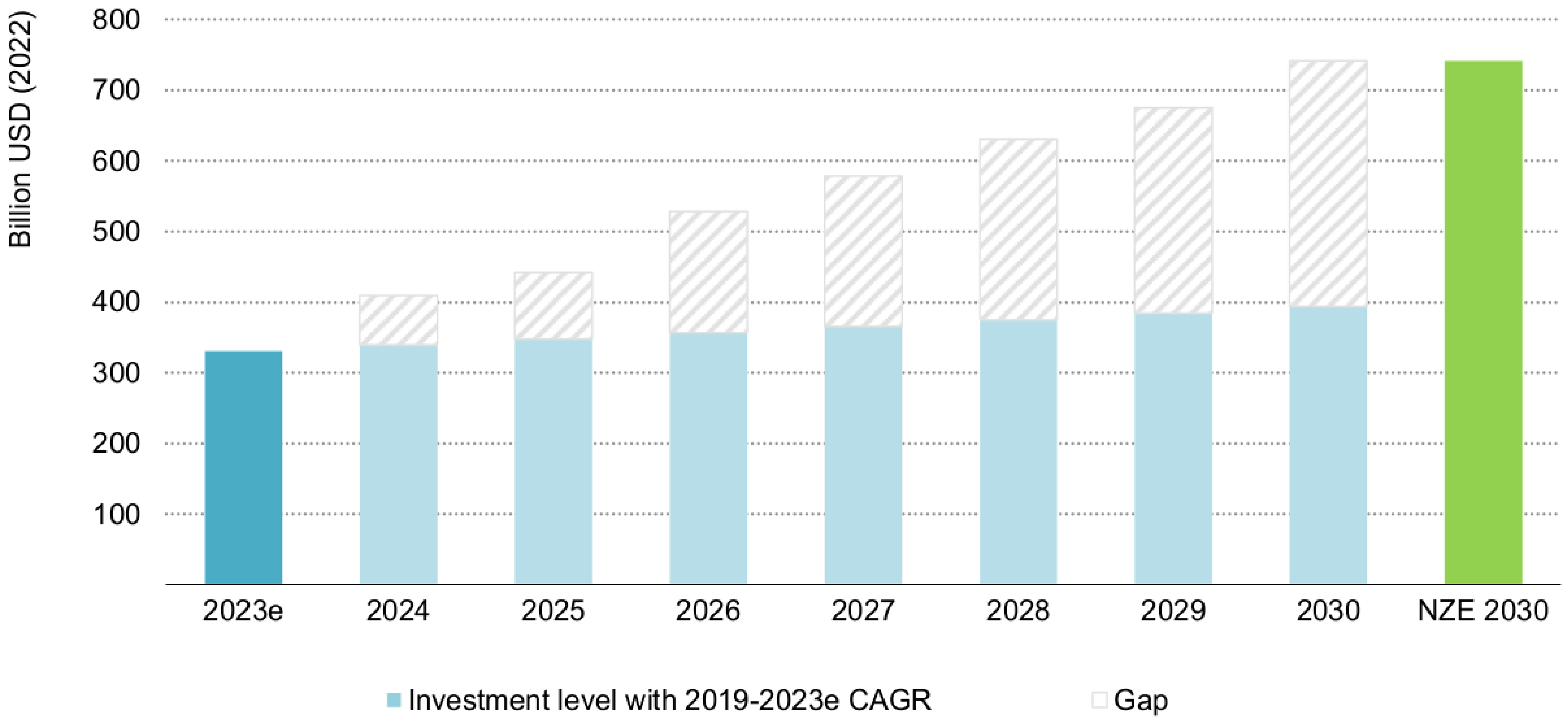
Capacity awaiting permits and under construction and average permitting times in the United States and major European renewable markets



Notes: United States, United Kingdom and France show capacity in December 2023; Italy shows capacity in January 2023 and Spain in March 2023; wind includes onshore and offshore.
Sources: Red Eléctrica, Terna, Ministère de la Transition Energétique, National Grid and Lawrence Berkeley National Laboratory; BNEF (average waiting times).

If policymakers and regulators do not provide the necessary incentives for investment in grid spending, it could pose a significant obstacle to the clean energy transitions

Grid investment level with current growth trend and gap to reach NZE Scenario trajectory



Notes: IEA estimation applying the compound annual growth rate (CAGR) of 2019 to 2023e to grid investment between 2024 and 2030; NZE = IEA Net Zero Emissions by 2050 Scenario; 2023e = estimated values for 2023.

An example of driving down LCOE

Box 3.5 ▹ **RenovAr Auctions Programme, Argentina**

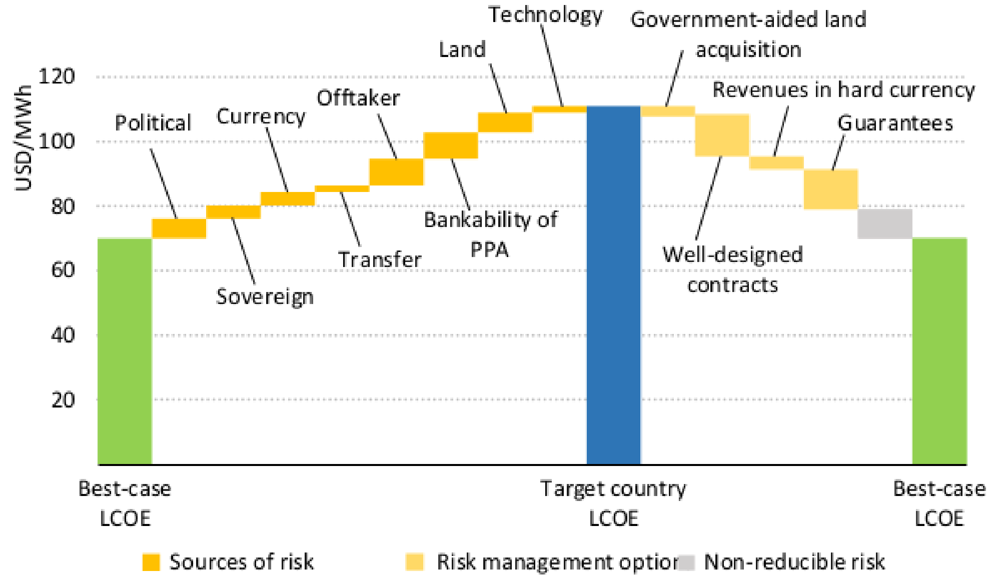
In early 2016 the government of Argentina called on both the World Bank and IFC to provide advice on the structuring and implementation of a new tender process for its large-scale RenovAr programme. The IFC team provided advice on the overall attractiveness of the programme to private investors and developing bankable project documentation. The World Bank team prepared a guarantee programme to support the financing of RenovAr projects.

RenovAr improved project bankability through the following key features:

- Electricity generated by RenovAr projects given priority on the grid ahead of other sources.
- PPA tariffs in USD, but payable in ARS.
- Provisions to ensure that the lender has to give prior agreement to any amendment or renegotiation of the PPA.
- A pre-funded liquidity and guarantee fund (FODER) to provide payment in case offtaker is not able to pay.
- A dispute resolution mechanism based on international arbitration.
- Compensation triggered by payment default or convertibility/transferability restrictions, in the form of a put option granted by the government and payable out of FODER and with additional backstops from the Ministry of Energy and Mines, the Ministry of Finance and earmarked government securities.
- Optional World Bank guarantees in the event that the abovementioned compensation is not paid or in the event of inconvertibility or non-transferability.

Since its inception, the RenovAr programme has awarded 154 projects representing almost 5 GW of renewables at highly competitive prices. The programme is also providing important lessons to other markets interested in scaling up renewables investment.

Figure 3.3 ▹ **Risks affecting variations in the LCOE and the role of risk management options in improving the LCOE**



Increased oil prices cause increased subsidies .....

Figure 3.4 ▹ Fossil fuel subsidies by fuel and country