

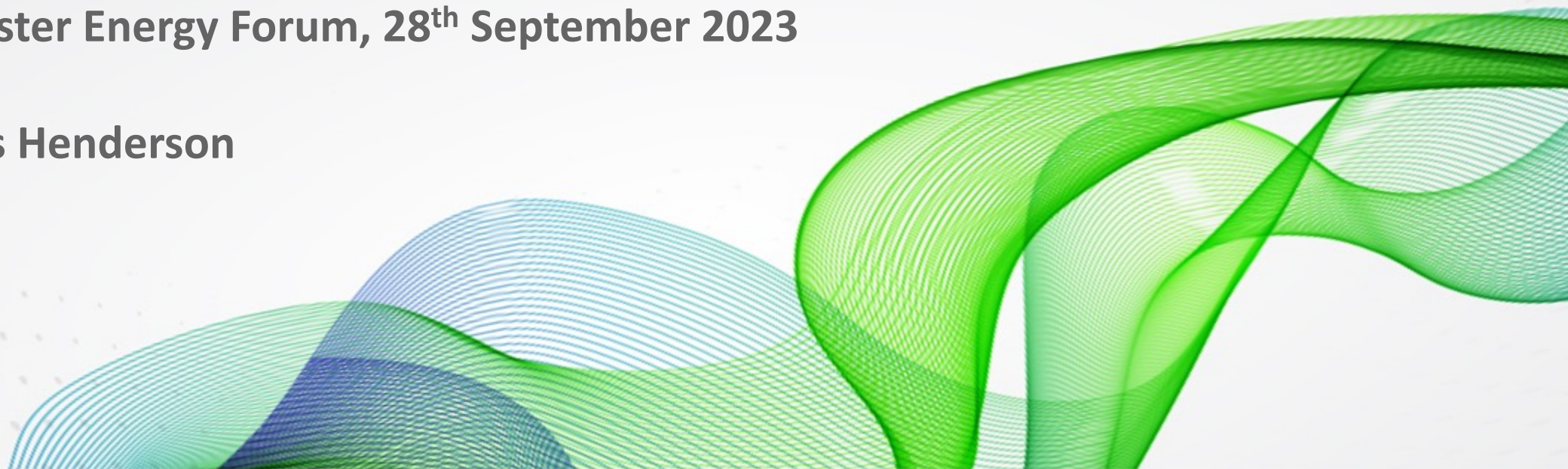


THE OXFORD
INSTITUTE
FOR ENERGY
STUDIES

Global energy challenges for the energy transition

Westminster Energy Forum, 28th September 2023

Dr. James Henderson





Volatility, risk and uncertainty for the energy transition

- **Volatility in energy markets**

- Oil and gas prices and investment
- Electricity market outlook and design
- Impact of carbon pricing

- **Risk**

- Availability and price of critical minerals
- Cost inflation
- Infrastructure development and stranded assets
- The pace of technology development and its commercialisation
- The cost and availability of finance

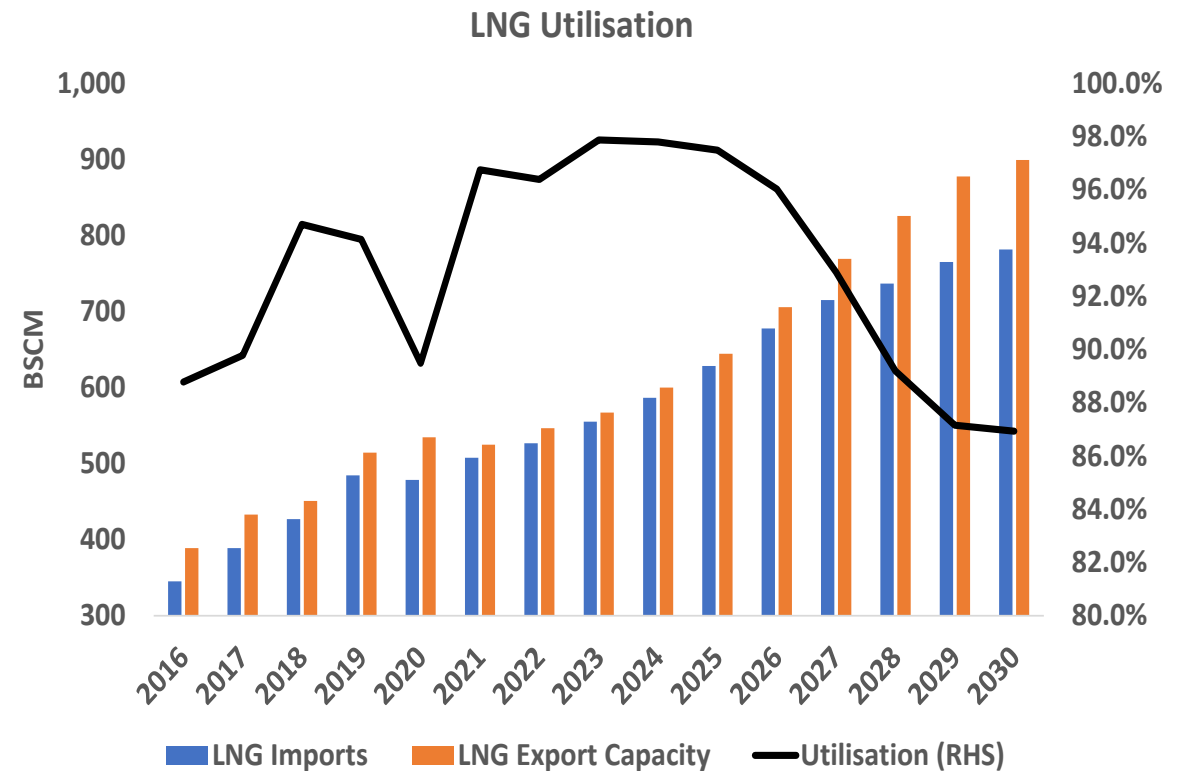
- **Uncertainty**

- Role of governments versus markets
- Policy competition between regions and countries
- Climate negotiations and disputes between developed and developing countries
- The role of hydrocarbons in a decarbonising world
- The varying pace of the energy transition in different regions



Developments in hydrocarbon markets - gas

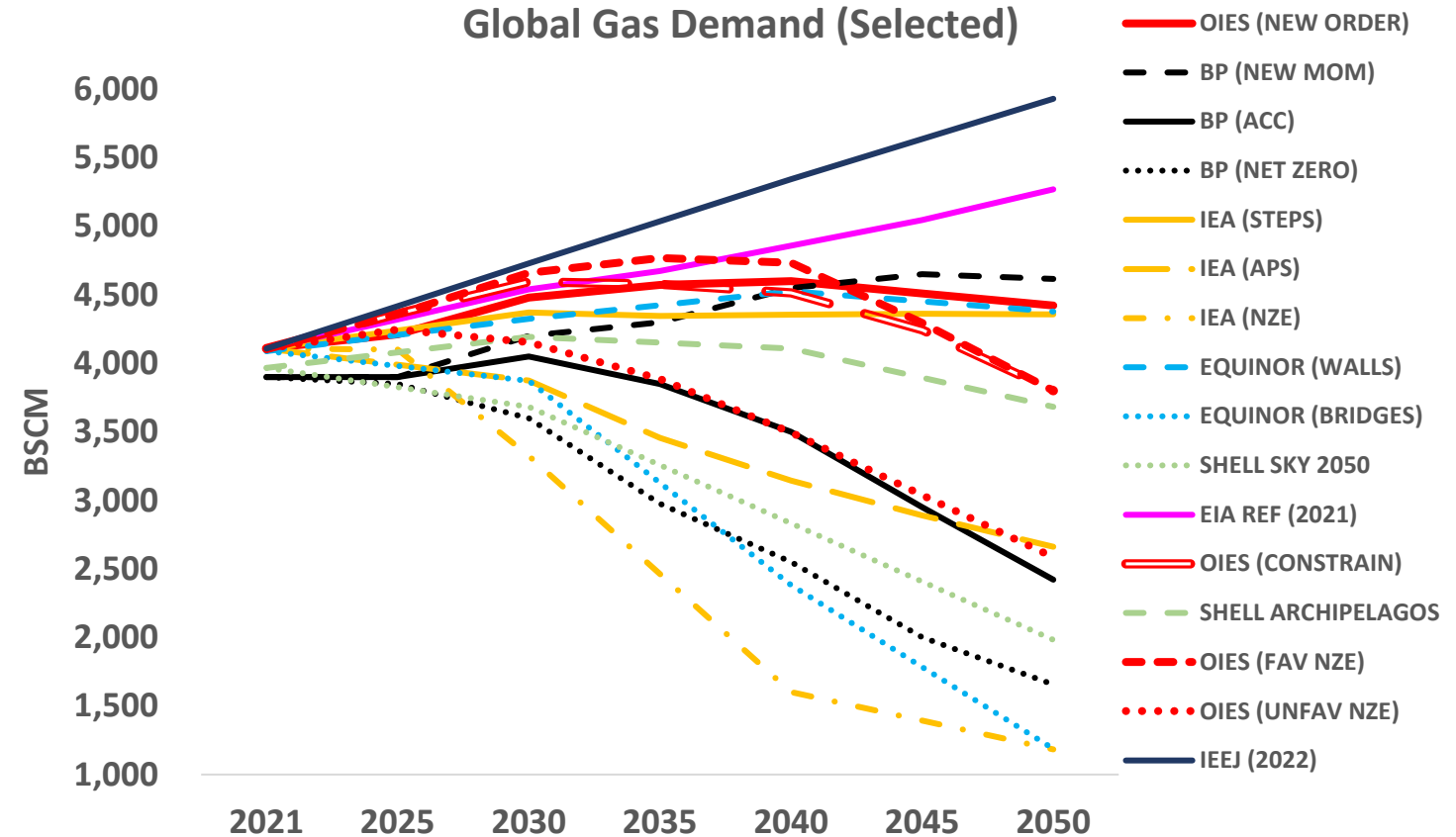
- Gas prices reached historic highs in 2022 as Europe struggled to fill storage and replace Russian gas
- Prices have fallen, but remain above the 5-year average in a market which remains tight
 - A cold winter could change the current sense of calm
- The outlook is for a wave of new LNG projects to arrive by 2025/26
 - This could easily push gas prices back into single digits (\$/mmbtu)
- A key question is whether these low prices will be sustained or will be the next part of another boom-bust cycle
- Low prices could undermine incentives to shift away from gas





Developments in hydrocarbon markets - gas

- Long-term uncertainty about the future role of gas is creating investment hesitancy
- Different regions of the world have very different views about the importance of gas in the 2030s and beyond
- Reluctance to sign long-term contracts could delay future projects
- The potential for a sharp price rise is supply fails to match demand is clear
- Price volatility is encouraging aggregators, traders and larger players to dominate the market





Developments in hydrocarbon markets - oil

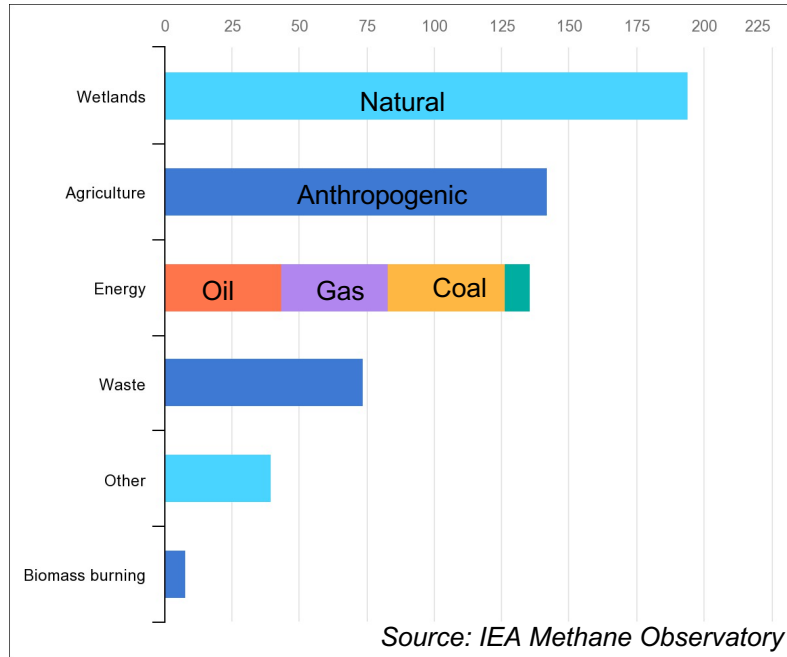


- Volatility has been less marked than in the gas market
- Nevertheless, the oil price has swung by +/- 40% since the start of the war in Ukraine
- Politics is the key variable, as OPEC and Russia aim to manage the price level by controlling supply
- Long-term uncertainty over when demand may peak is also causing investment hesitancy, leading to the potential for increased volatility in prices

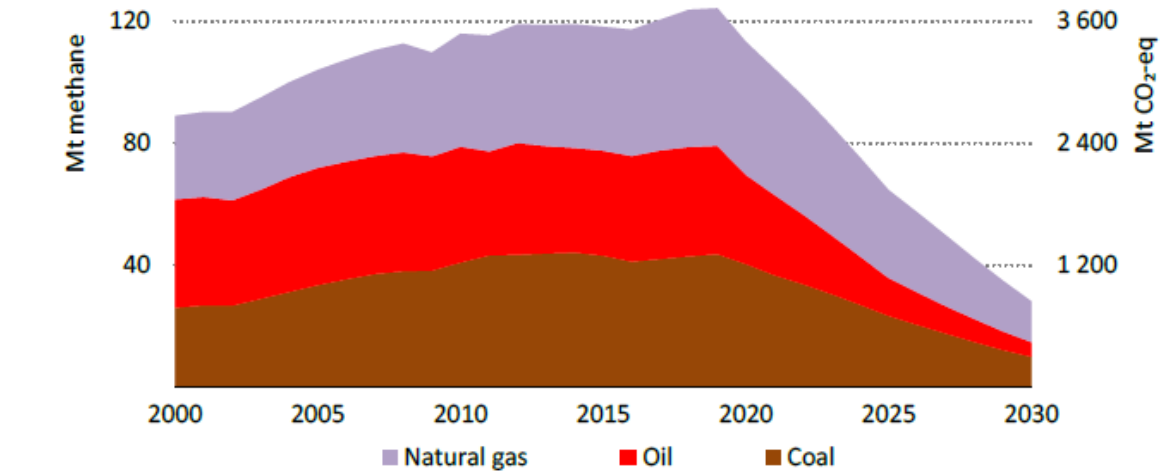


The question of methane emissions is becoming more urgent and relevant for hydrocarbon producers

Sources of methane emissions (2021)



Decline required in Net Zero scenario



- Pricing of oil and gas could become more complex as and when emissions impact is included
- Methane emissions from hydrocarbons value chains are becoming a critical short-term global warming issue and need to decline by 75% by 2030
- Producers may start to compete on the basis of emissions intensity, with preferential pricing for better performers
- Import taxes on emissions, similar to the CBAM proposal, could create new trade routes and differential pricing



The future of carbon markets

Carbon price choices

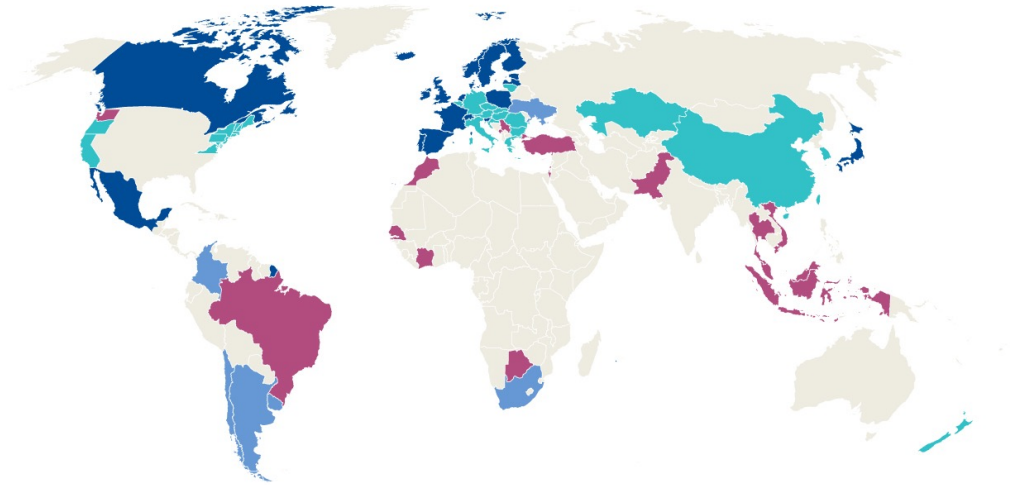
Countries and states are choosing different approaches to carbon pricing based on their own circumstances and objectives.

Under consideration
or planned

Carbon tax

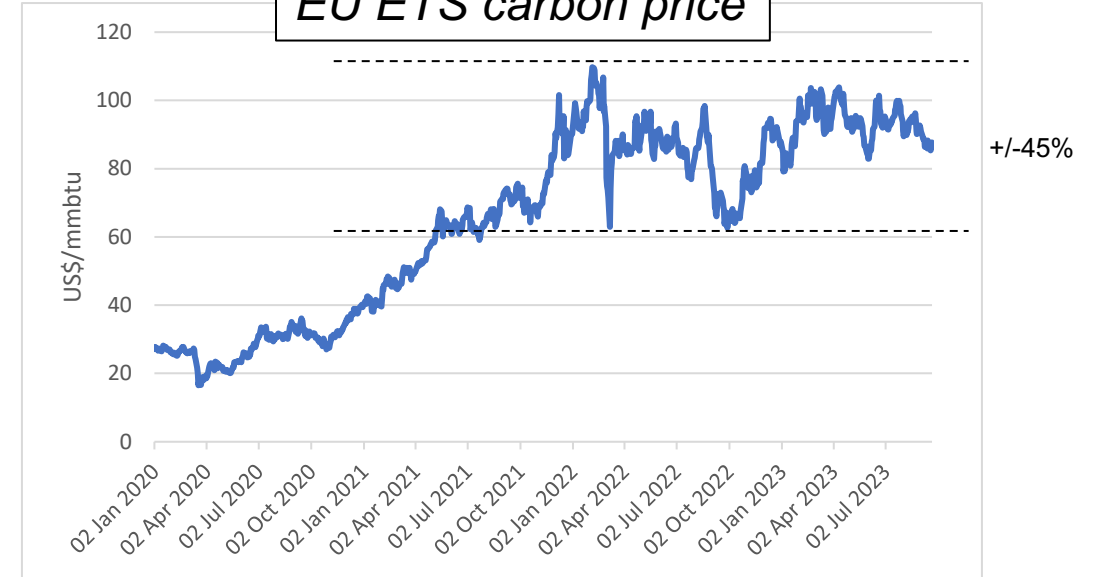
Emissions trading
scheme (ETS)

Carbon tax
and ETS



Source: WBG, IMF staff calculations, and national sources. Note: The boundaries and other information shown on any maps do not imply on the part of the IMF any judgment on the legal status of any territory or any endorsement or acceptance of such boundaries.

EU ETS carbon price

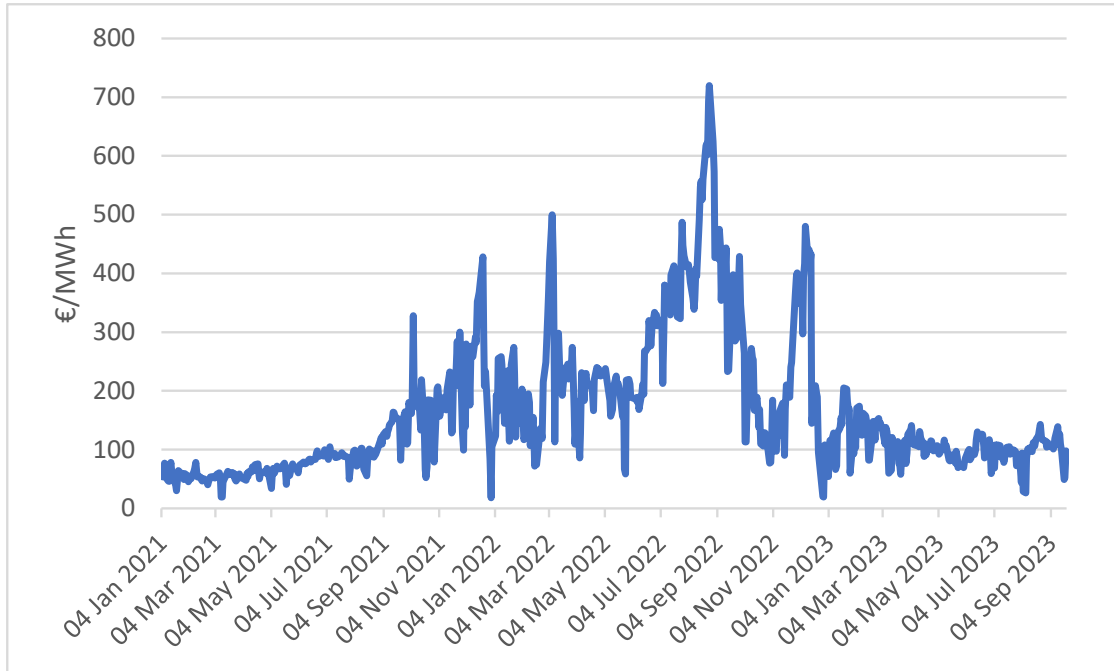


- Carbon tax implementation is progressing at very different rates globally
- Price levels in countries with taxes vary markedly
- Prices within individual regions and countries are volatile and can be manipulated by governments
- The incorporation of carbon offset markets will add a further layer of complexity and volatility



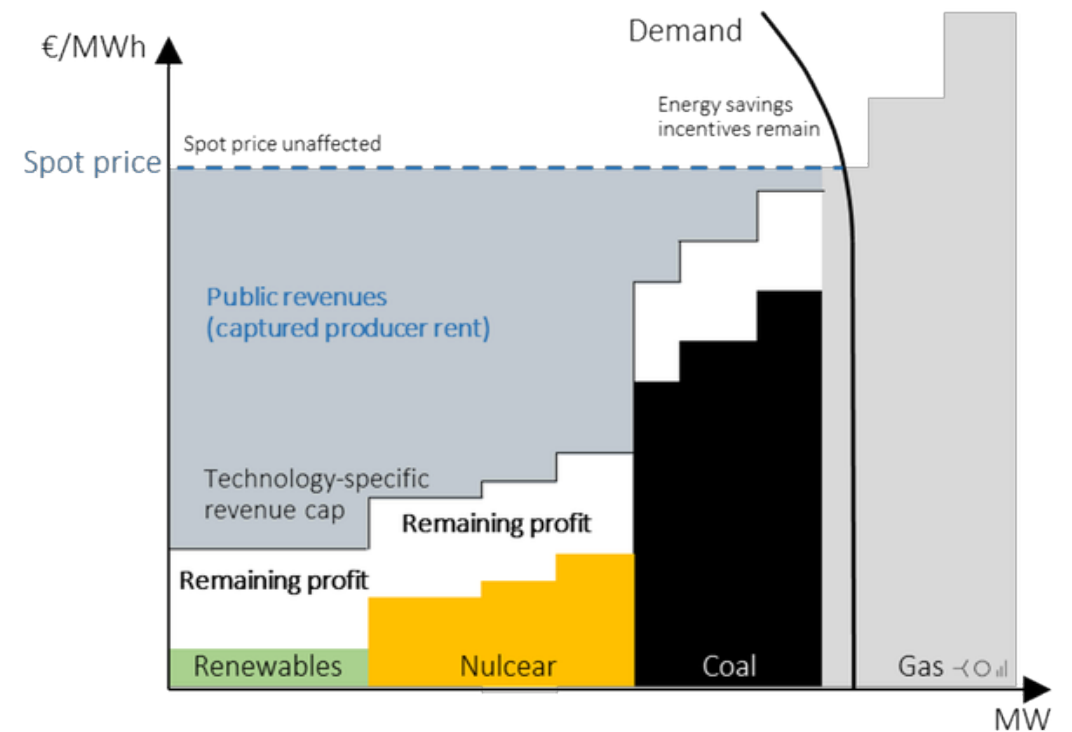
The need for a re-design of electricity markets

Wholesale electricity price in Germany



- Electricity price volatility is increasing and was exaggerated dramatically by the events of 2022
- Issues around nuclear maintenance, hydro and temporal shortages of wind, left the power market dependent on high-cost gas as the marginal source of electricity

Adjusting the marginal cost pricing model

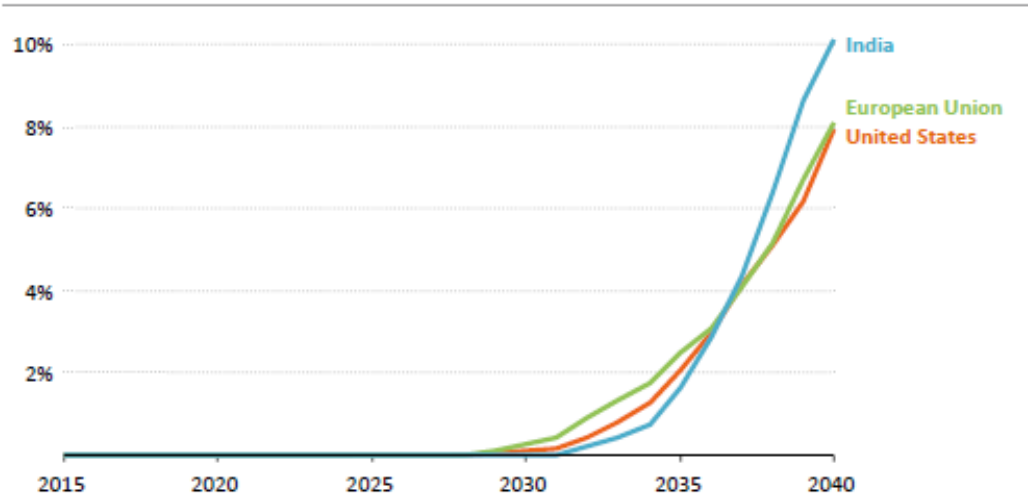


- Governments sought to intervene to resolve a “market failure”
- The marginal cost pricing methodology has been called into question
- More low-cost renewables is an obvious answer



The need for a re-design of electricity markets

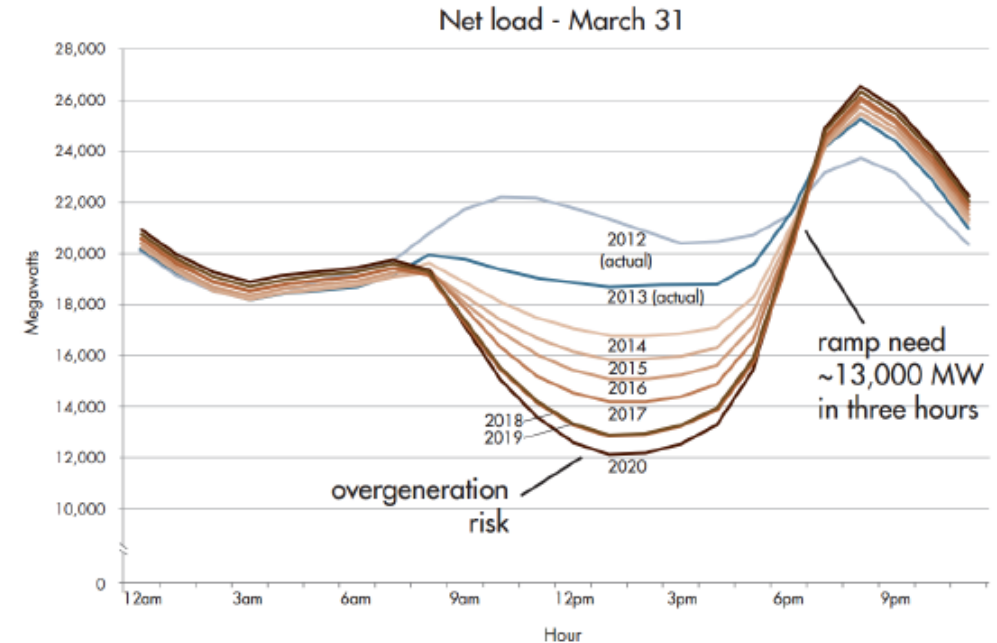
IEA estimate of share of zero price power



Hourly market prices near zero become increasingly common in the 450 Scenario, but would occur much more often without demand response and energy storage

- In future there will be longer periods of time when power prices approach or reach zero
- This can be great for consumers in terms of bringing prices down, but undermines investment in new generation capacity
 - Could even undermine investment in new unsubsidized REN

IEA estimate of share of zero price power



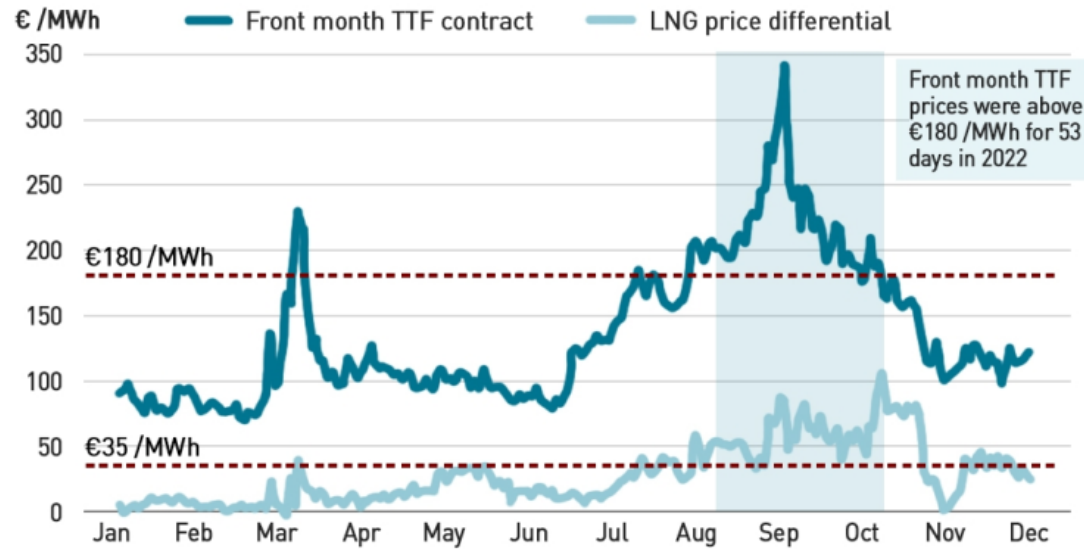
- The need for flexibility is going to increase just as average loads for “on demand” capacity decline
- Debate now ongoing about the need for a dual market and what form it should take
- Greater volatility an opportunity as well as a threat for those companies who can provide a full service



The role of governments versus markets

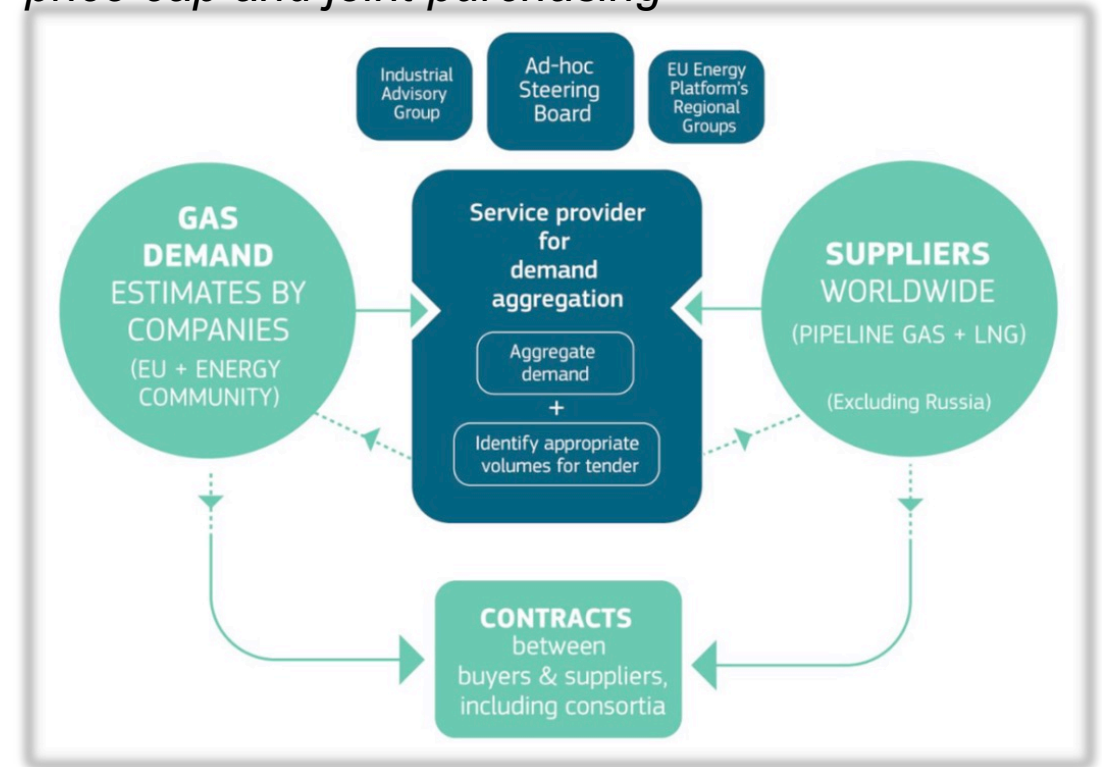
EU gas price cap

Examples of EU interventions in 2022 – price cap and joint purchasing



The LNG price differential is the difference between the TTF front-month futures price and the average of the Daily Spot Mediterranean Marker and the Daily Spot Northwest Europe Marker, published by S&P Global

Source: ICE, S&P Global, Bloomberg



- Temptation to interfere in price-setting mechanisms is obvious in a crisis
- Impact is rarely beneficial, except in the very short-term
- Identify and protect most vulnerable customers while allowing market forces to adjust supply and demand



The volatility of markets is not a negative per se, but it does increase the need for stable policy signals

- **Volatility of prices in energy markets can create a risk to the energy transition**
- Creates varying incentives to move away from hydrocarbons
- Creates instability of revenues for investment in all forms of energy
- Creates issues for consumers reacting to energy costs and trying to plan expenditures

- **However, it can also create opportunities**
- Creates incentives to provide new products to reduce consumer exposure
- Creates demand for flexibility management and storage
- Creates opportunities for companies to adopt a full value chain approach to optimise margins and diversify risks

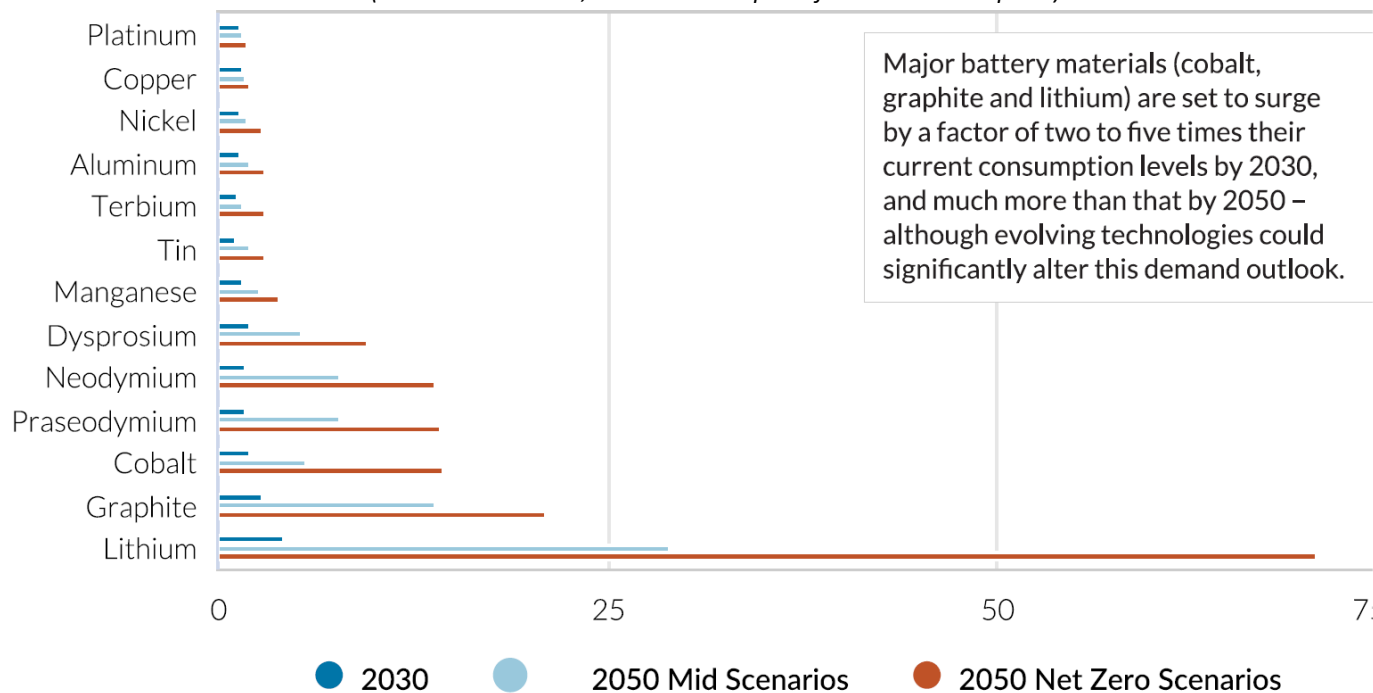
- Market signals need to be allowed to impact all players, while governments protect vulnerable consumers from short-term price impact



Availability and cost of critical minerals an emerging theme

Future increase in demand for critical minerals

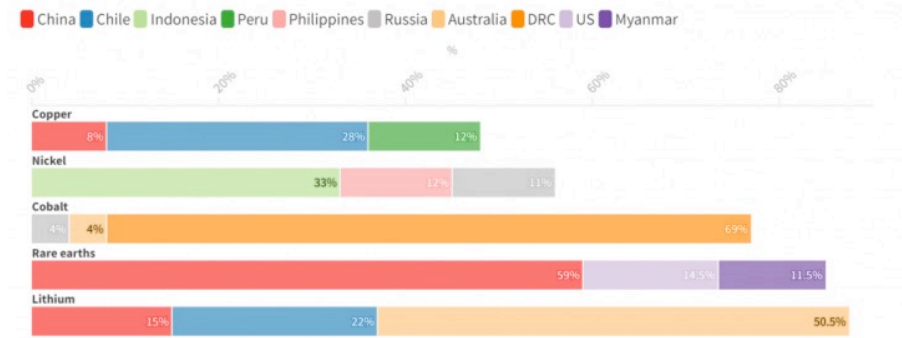
(Estimated increase, based on multiples of current consumption)



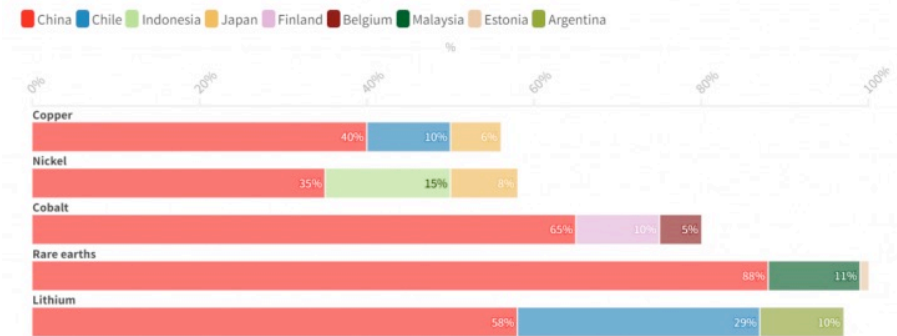
Source: Energy Intelligence

Exposure to China a key risk

Where critical minerals are mined (share of Top 3 countries)



Where critical minerals are processed



Source: IRENA, IEA

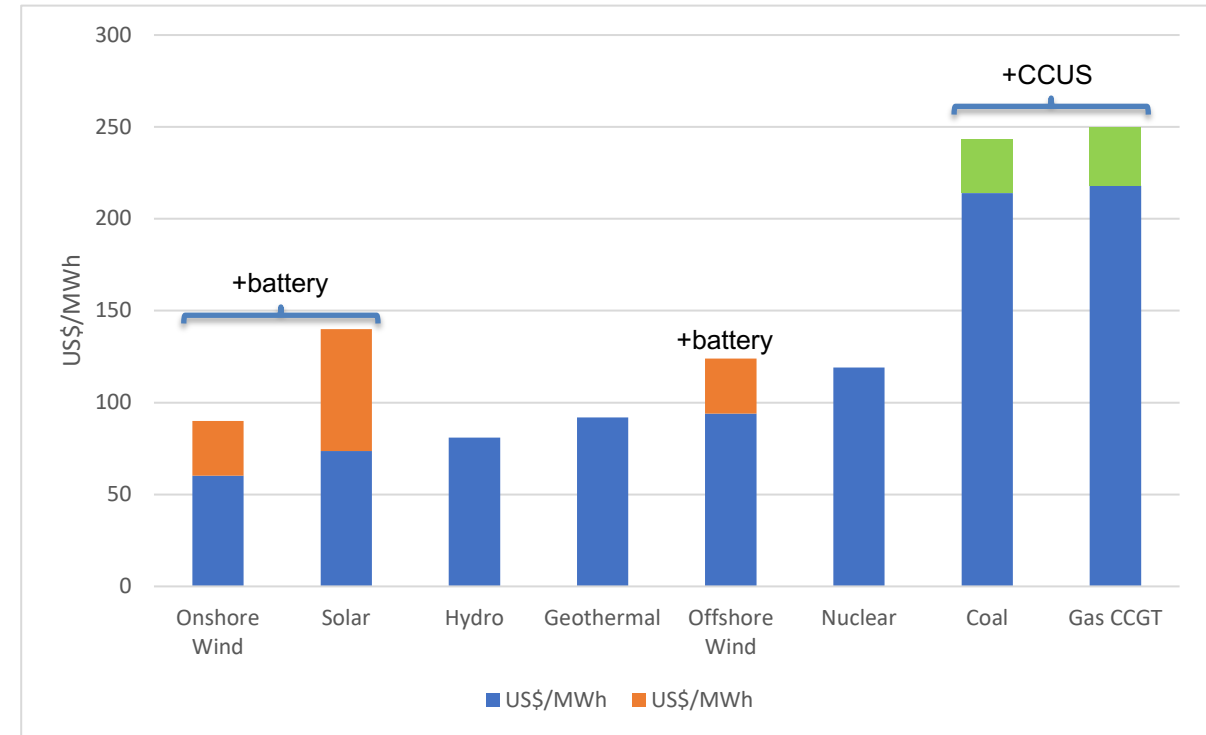
- Security of supply and price of critical minerals is already becoming a key theme
- Different challenge to security of hydrocarbon but emerging source of geopolitical influence
- Processing, refining and re-cycling will become important industrial policy issues



Cost inflation for renewables

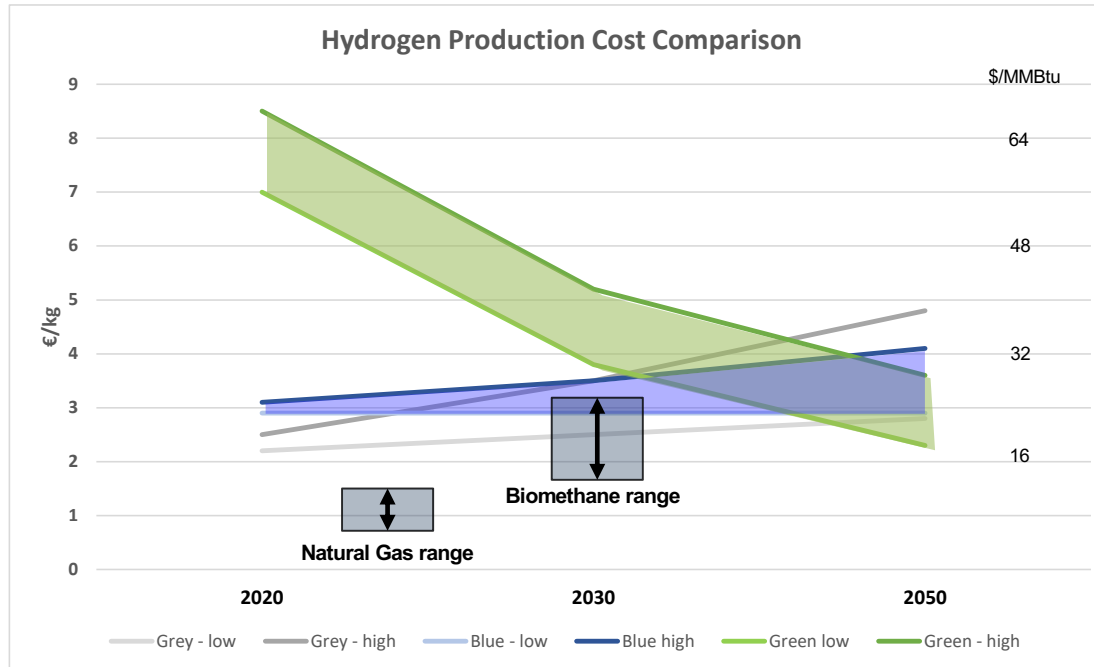
- Increasing material costs have halted the decline in renewable breakeven costs
- Onshore wind and solar costs are up by around 10% over the past 12 months
- Offshore wind is seeing even more pressure with costs up by 20-40%
- Viability of projects is being called into question and CfDs are being reviewed
- Adding grid connection and storage costs adds another level of cost
- Interest rates may be near their peak, and cost pressure could ease from 2024, but the era of dramatic cost reductions may be over

LCOE for various source of electricity





Hydrogen faces a cost challenge– green significantly more expensive with “normal” natural gas prices



Source: OIES analysis, Zero Emissions Platform and McKinsey data, includes assumed carbon price

“Grey” = SMR without CCS
“Blue” = SMR with CCS
“Green” = Electrolysis from renewable energy

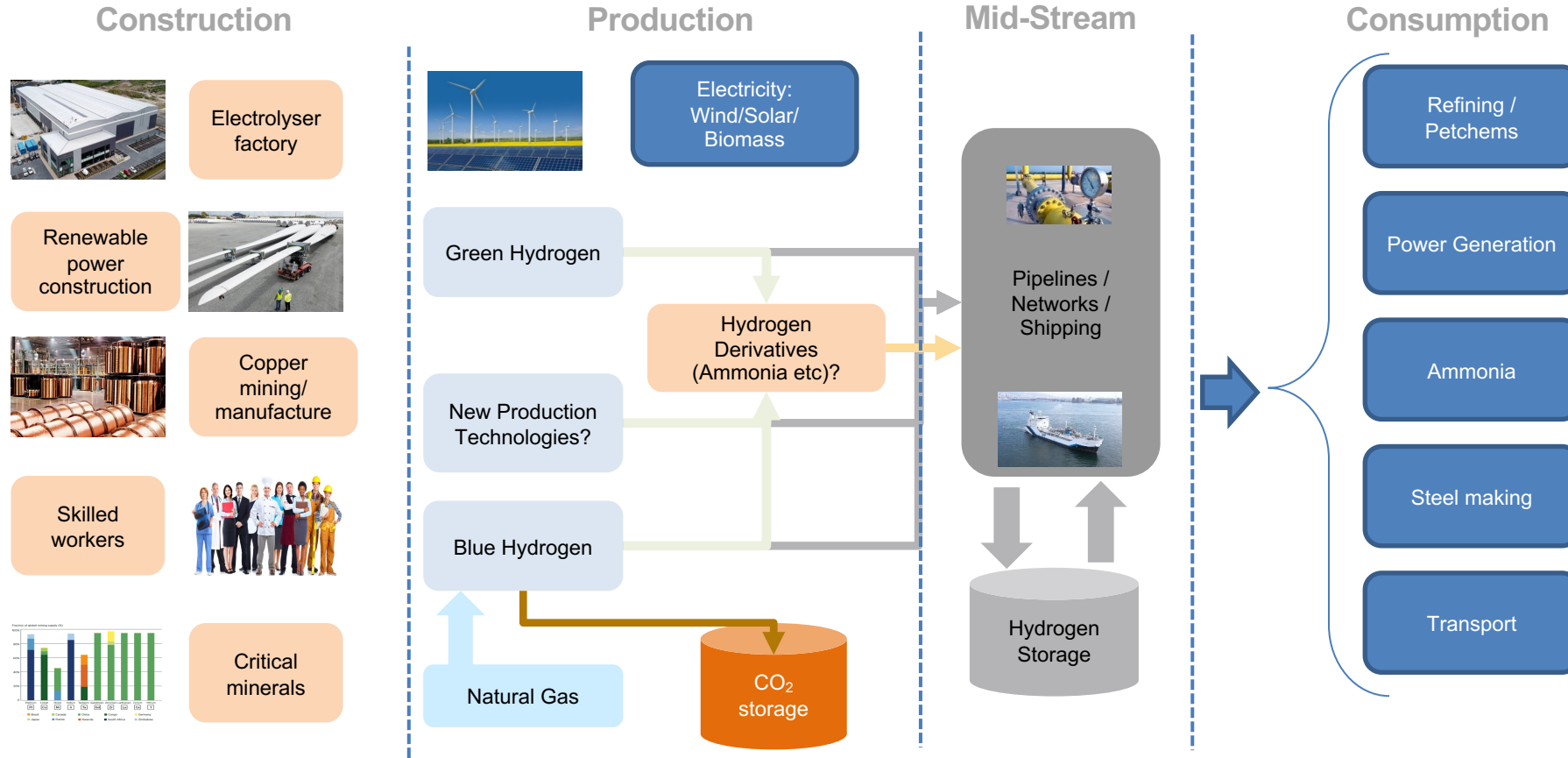
1 EUR/kg ≈ 25 EUR/MWh
 ≈ 8\$/MMBtu

- Green hydrogen cost – both renewable electricity and electrolyzers – expected to fall
- Scale up needed to drive standardisation and cost reductions
- Renewable electricity should target grid decarbonisation before large-scale green hydrogen production
- Is there a viable business model for hydrogen as a stand-alone business?
- Are industrial clusters the optimal strategy both domestically and internationally?



The need for a whole system approach is an opportunity and a challenge for policy-makers and regulators

Operating across the decarbonised energy value chain



- Companies are developing integrated strategies to optimise returns and mitigate risk



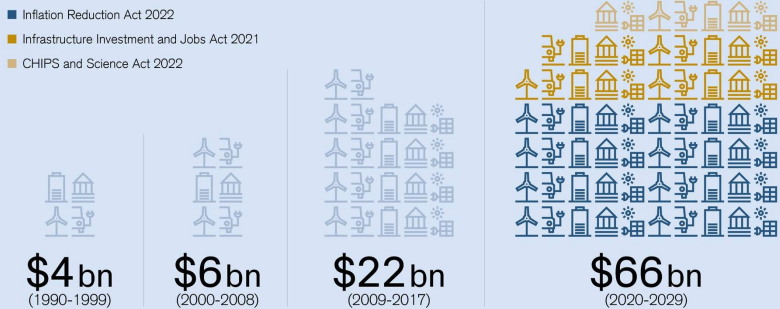
Industrial policy for the energy transition – competition or collaboration?

EU Green Deal



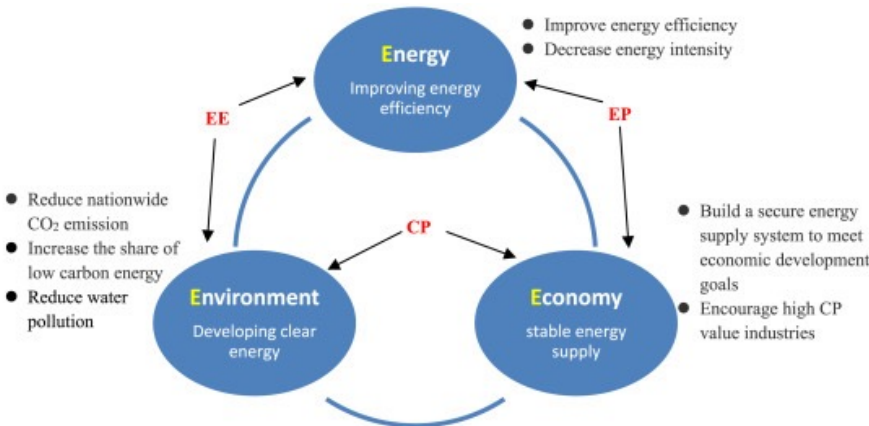
Impact of IRA in US

US federal government's average annual climate spending (\$ billions)



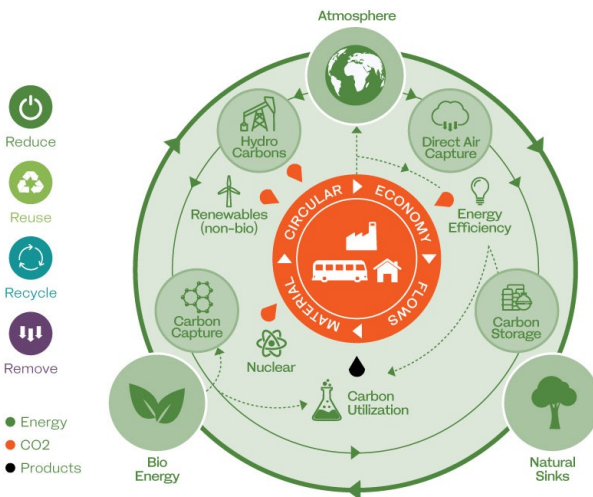
Source: RMI, Credit Suisse estimates

China's plan for energy and environment



Saudi Arabia's Vision 2030

THE CIRCULAR CARBON ECONOMY (CCE) PRINCIPLE
CCE is a framework for understanding how carbon can be managed



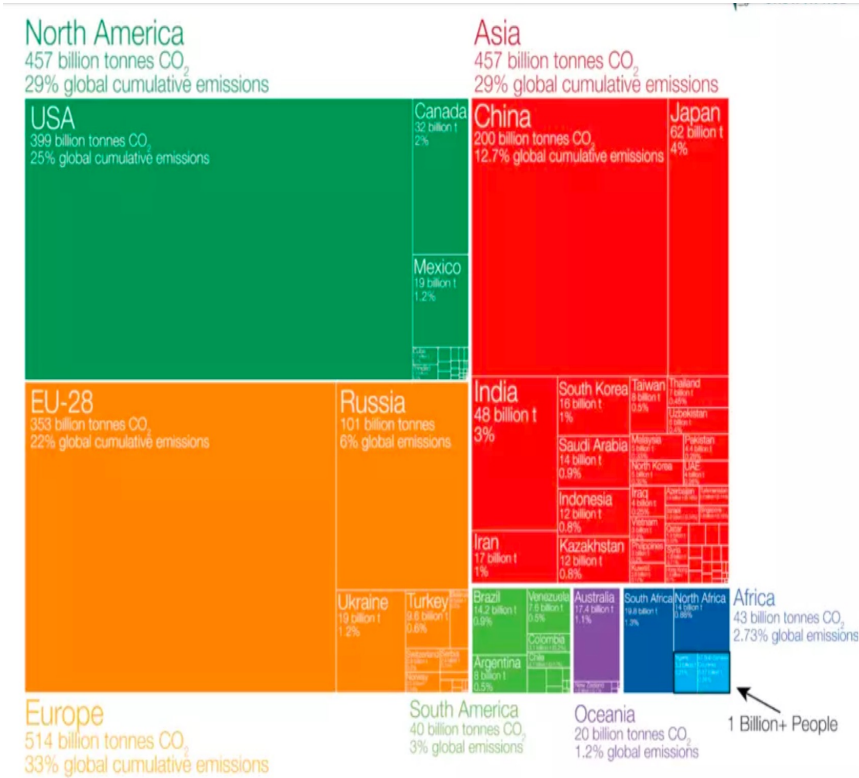
ARAB NEWS

Source: King Abdullah Petroleum Studies and Research Centre (KAPSARC)



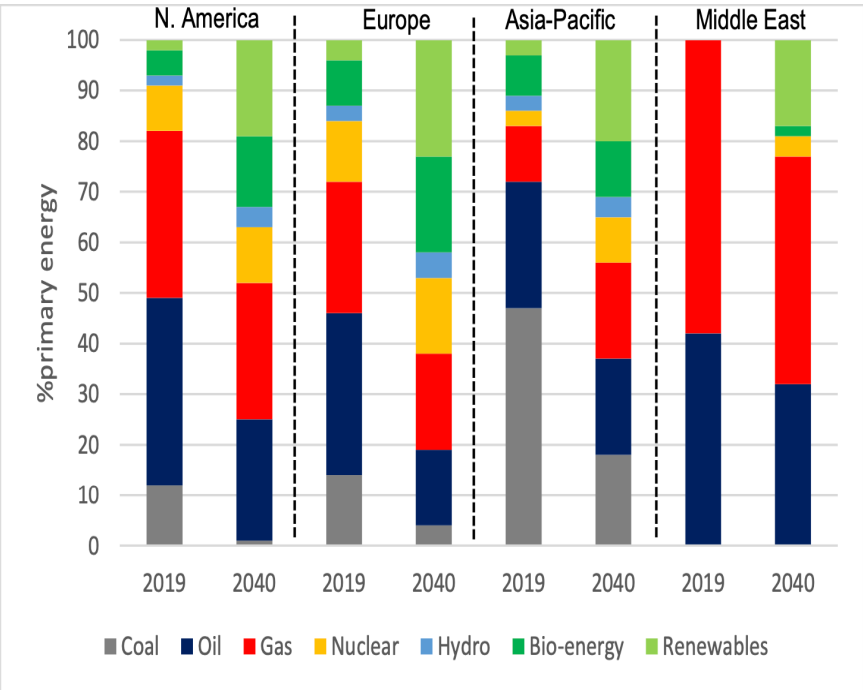
Developing world starting in a very different place

Contribution to Carbon Budget



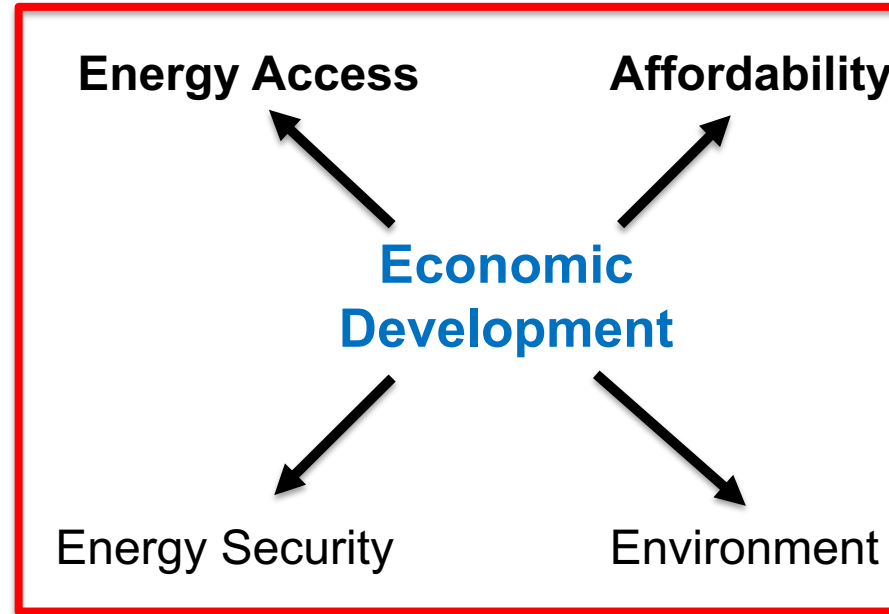
Cumulative carbon dioxide (CO₂) emissions over the period from 1751 to 2017. Figures are based on production-based emissions which measure CO₂ produced domestically from fossil fuel combustion and cement, and do not correct for emissions embedded in trade (i.e. consumption based). Emissions from international travel are not included.
Figures for the 28 countries in the European Union have been grouped as the 'EU-28' since international targets and negotiations are typically set as a collaborative target between EU countries. Values may not sum to 100% due to rounding.
Data source: Calculated by Our World in Data based on data from the Global Carbon Project (GCP) and Carbon Dioxide Analysis Center (CDIAC).
This visualization has been adapted with permission by the Energy for Growth Hub based on the original work by OurWorldinData.org.

Regional energy consumption comparison (2019 & 2040)





Different priorities in much of the developing world

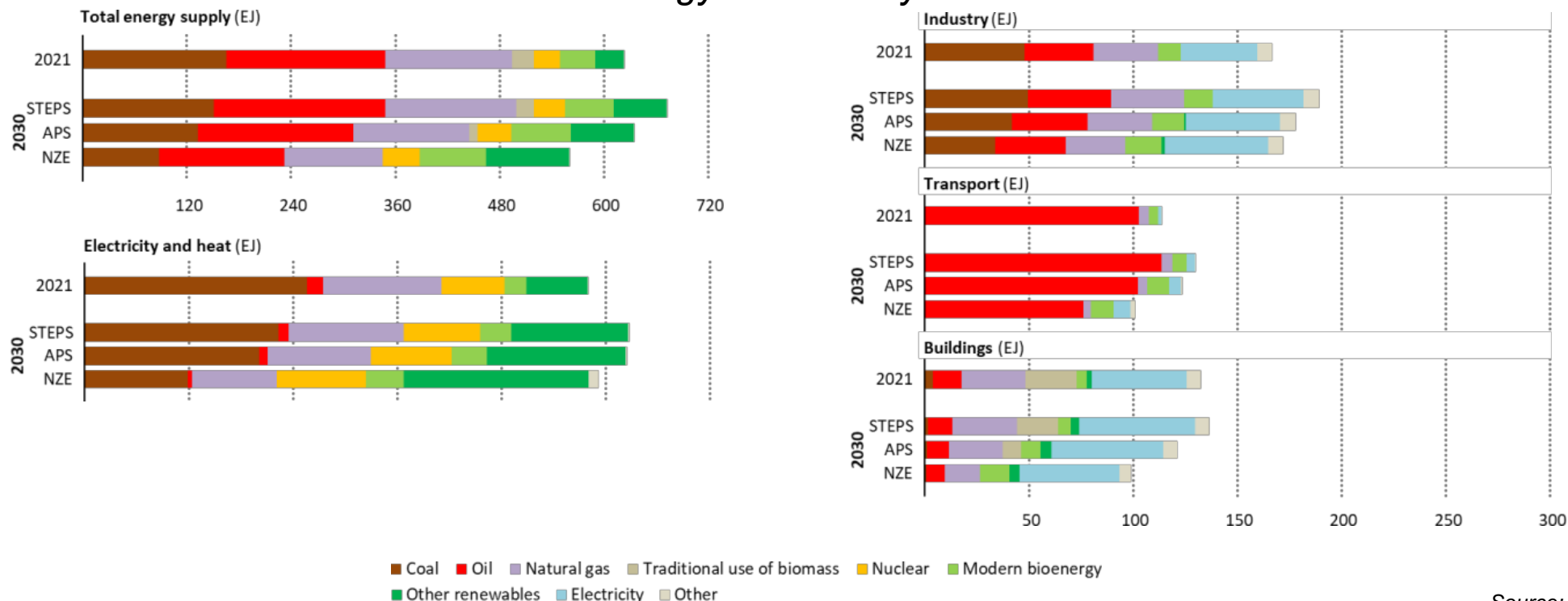


- In developing countries economic growth is the priority and often involves the necessity of gaining greater access to energy at an affordable price
- Equally, people need access to energy for cooking and heating/cooling
- Energy access also involves development of indigenous energy resources, whether they are hydrocarbons or not



The role of hydrocarbons in the energy transition

The outlook for energy demand by source to 2030



Source: IEA WEO 2022

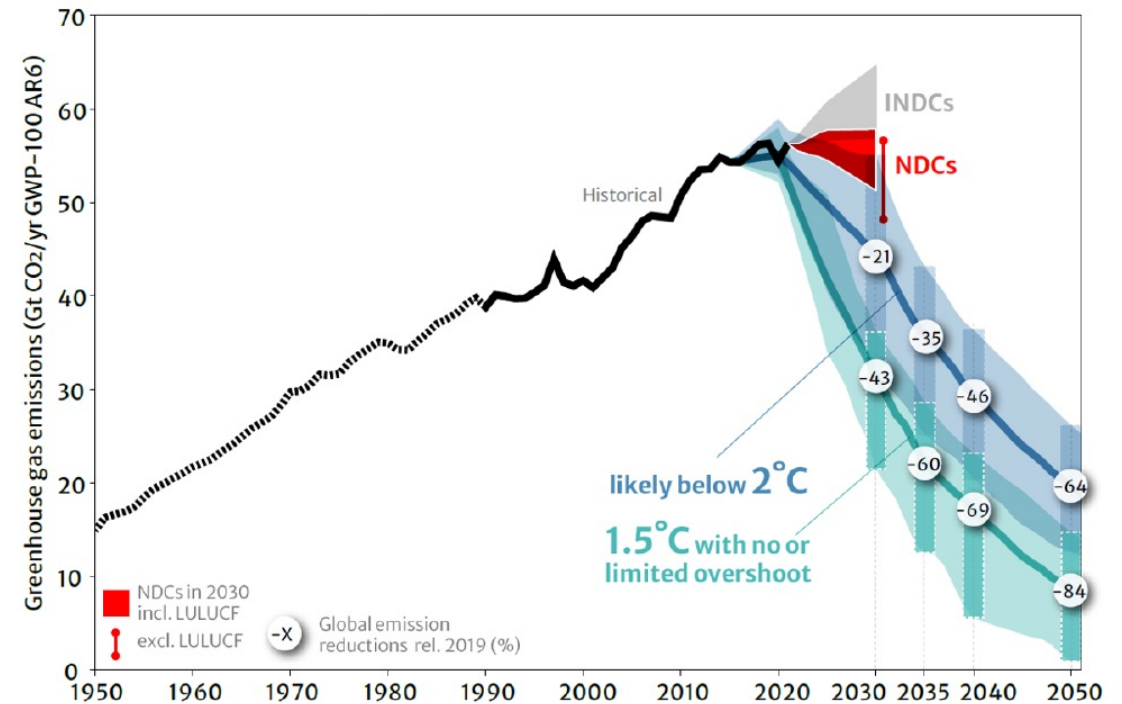
- Hydrocarbons will continue to play an important role in the energy system for at least two decades
- It is essential to understand the differing regional implications for the phase-out that is required
- Economic, energy security, energy access and social implications mean that a technology neutral energy transition strategy will be needed to underpin global cooperation



Environmental diplomacy – Key issues for COP28

- Absorbing and reacting to the results of the Global Stocktake
- Addressing the financing issues of the Developing World
 - Loss and Damage Fund
 - Mitigation finance (the \$100bn question)
 - Adaptation finance
- Realistic assessment of the role of hydrocarbons
 - CCUS and decarbonizing the value chain
 - Methane emissions
- Carbon markets and offsets
 - Article 6 resolution
- Multilateral agreements and co-operation
- Will the big emitters be talking to each other?

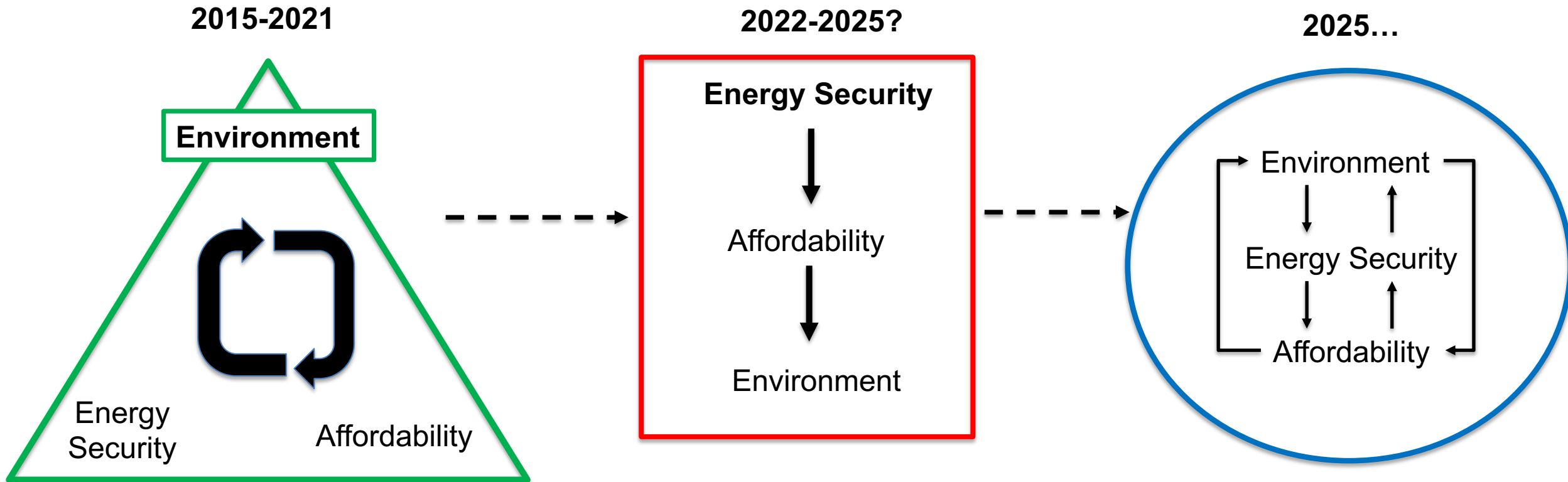
The Global Stocktake – facing a stark reality



Source: UNFCCC Global Stocktake Synthesis Report



The changing shape of the energy trilemma

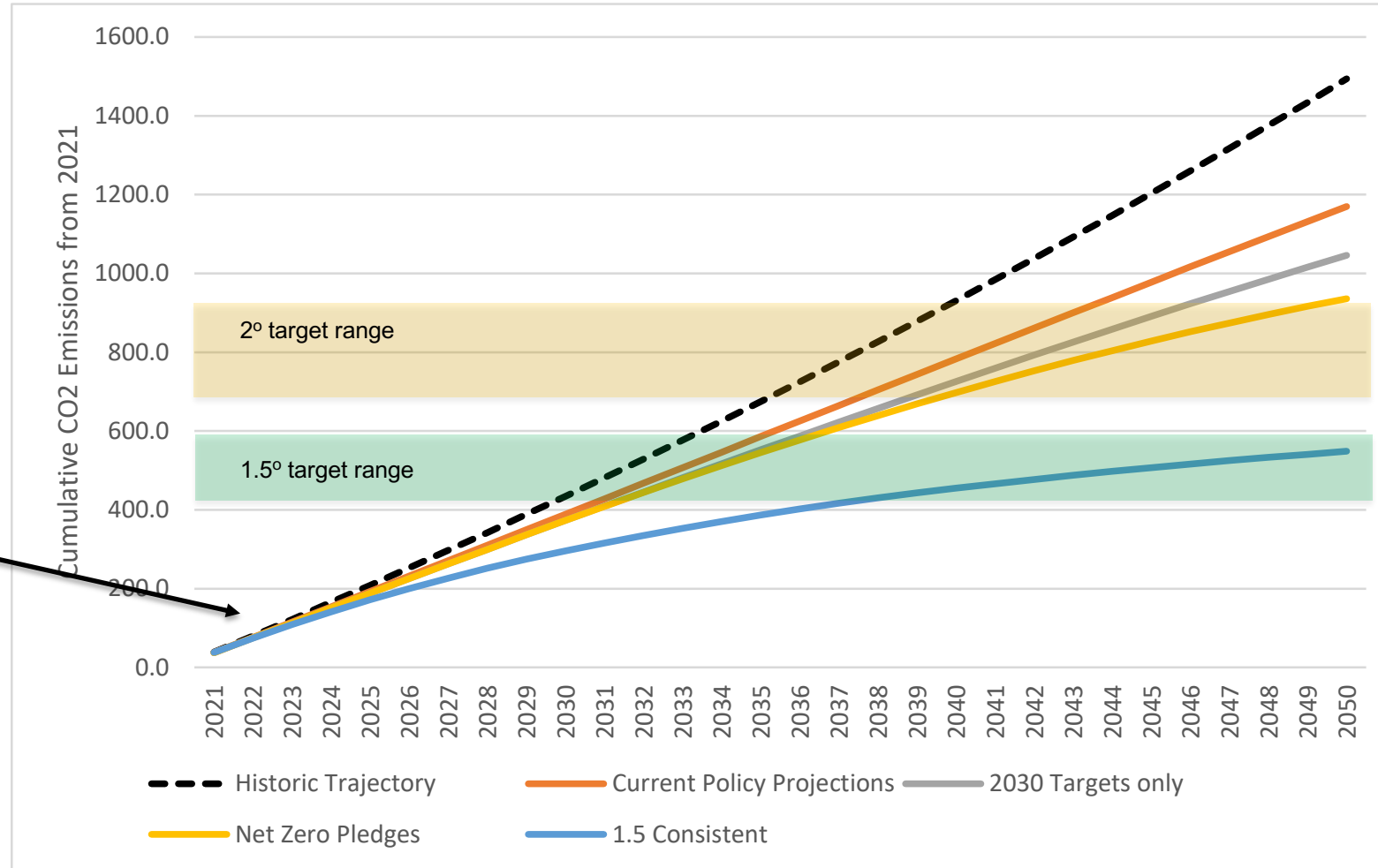


- Policy-makers priorities with regard to the energy economy have shifted over the past decade
- Environment, combined with affordability, became a major issue after COP21 in 2015
- Currently energy security is the priority, with affordability a major political concern
- All three elements of the trilemma can operate in harmony as the transition progresses



At what point will the trajectory of emissions become a key political issue?

2022 emissions 0.9%
above 2021 and 1%
above pre-pandemic level



NB: Historic trajectory – 2021-2023 +4.8%, 2024 on +1.4%



Thank you!

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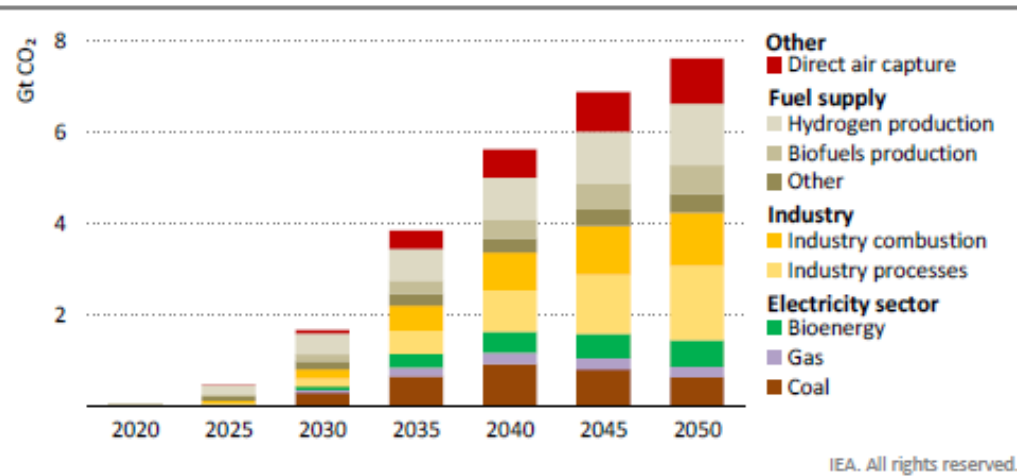
Appendix





CCS needed for hard to decarbonise sectors and blue hydrogen, but not enough is really happening

Figure 2.21 ► Global CO₂ capture by source in the NZE



Equinor:

“Converting 50% of EUs Oil & Gas to Blue Hydrogen yields 1000 Mill Tons/Yr of CO₂”:

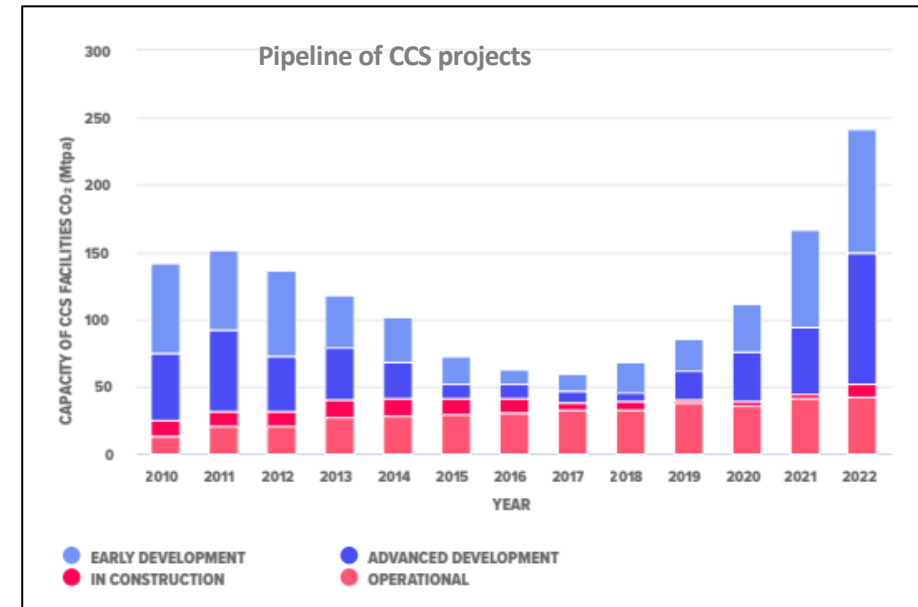
- Requires 1000 wells to store 1000 million tonnes / yr CO₂
- Northern Lights is 5 million tonnes / yr – 200 Northern Lights would be needed”

Policy initiatives in US, EU and UK could act as new catalyst for progress, but rapid development is needed

IEA Net Zero Scenario envisages **1500** million tonnes / year CO₂ injection globally by 2030.
Total global CCS today = 40 million tonnes.

Global CCS Institute sees additional 200 million tonnes capacity at various stages of development – and a long road to FID

How will sufficient projects be developed?

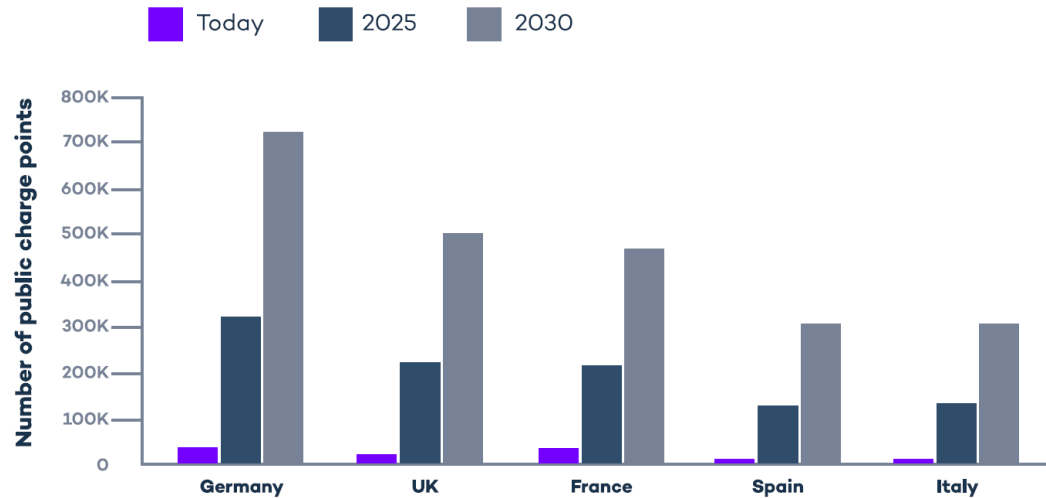


Source: Global CCS Institute, 2022



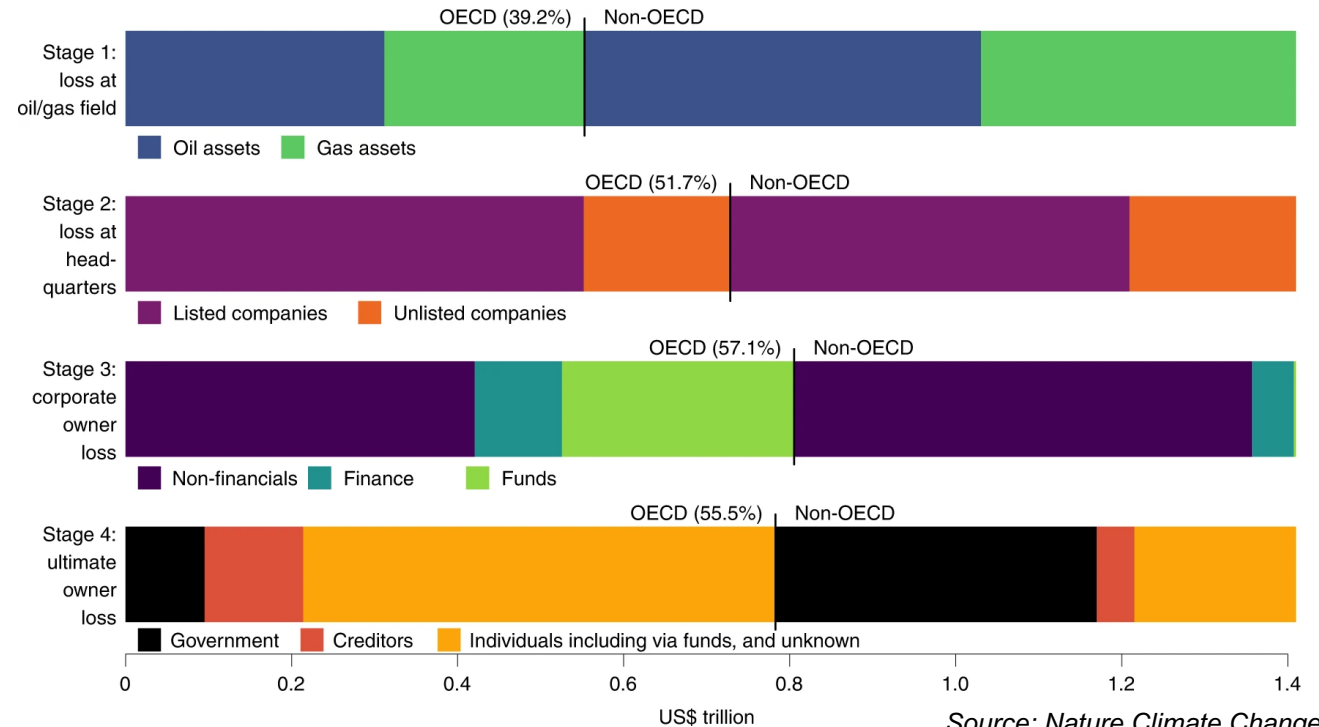
Infrastructure development and potential stranded assets

Plans for EV charging in Europe



Source: Transportenvironment.org

Stranded asset risk could destroy significant economic value



Source: Nature Climate Change

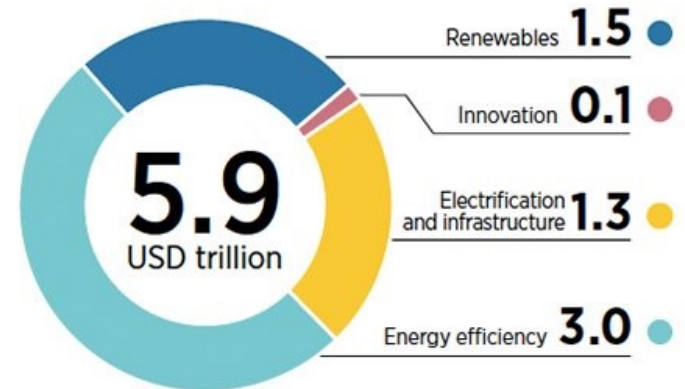
- Hydrogen infrastructure decisions epitomize challenges for energy system planners
- Need to incentivise new capacity in decarbonised system to underpin future demand growth
- Risk of stranded asset losses from existing system is significant and can create short-term mismatches in supply and demand



The availability of finance for the energy transition is in question

- The world is currently spending US\$2 trillion per annum on clean energy investment
- This needs to reach US\$5 trillion if we are to meet climate targets
- A “wall of private money” worth US\$150 trillion is apparently waiting for the right opportunities
- However, risk allocation is a problem in finding “bankable” projects
- The role of the World Bank and other MLBs needs to be re-considered
- Developing country policy-makers also need to improve investment environment

Cumulative clean energy investments (USD₂₀₁₉ trillion)

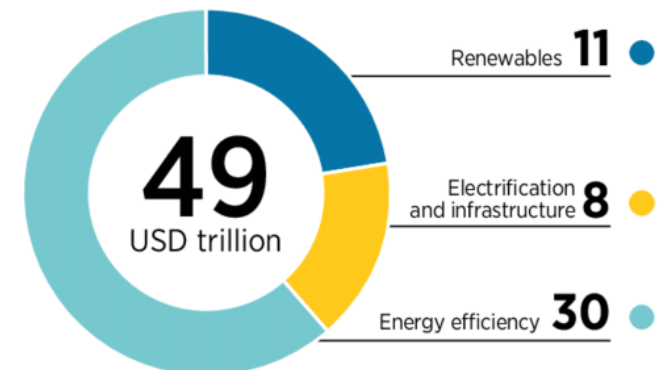


Clean energy average annual investments, 2021-2023:
USD 2 trillion per year

Source: IRENA

Source: Based on IRENA (2020), *Global Renewables Outlook: Energy Transformation 2050*.

Cumulative clean energy investments between 2019-2030 in the Transforming Energy Scenario (USD₂₀₁₉ trillion)



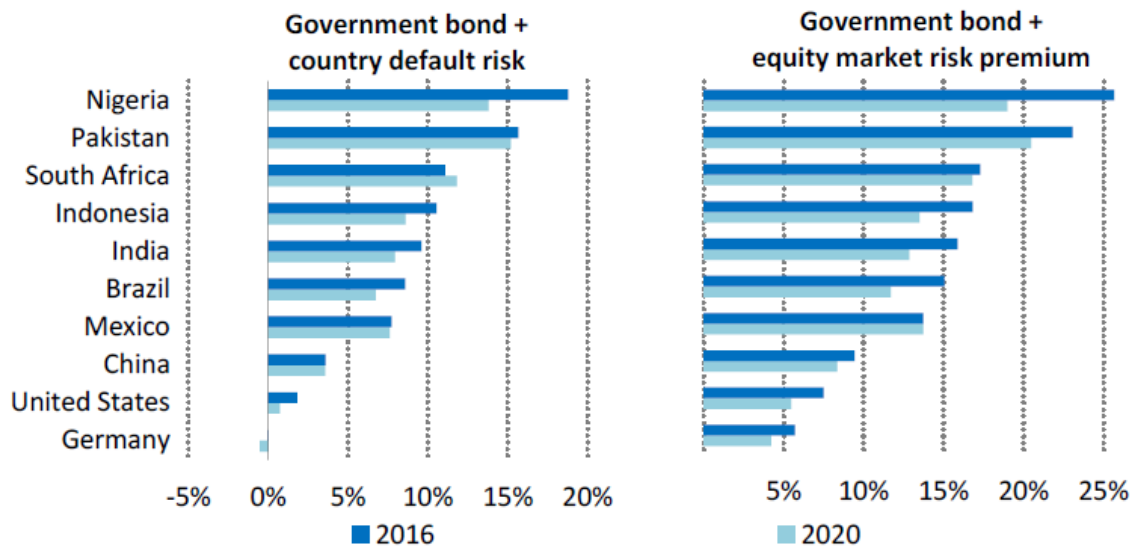
Clean energy average annual investments, 2019-2030:
USD 4.5 trillion per year

Source: IRENA



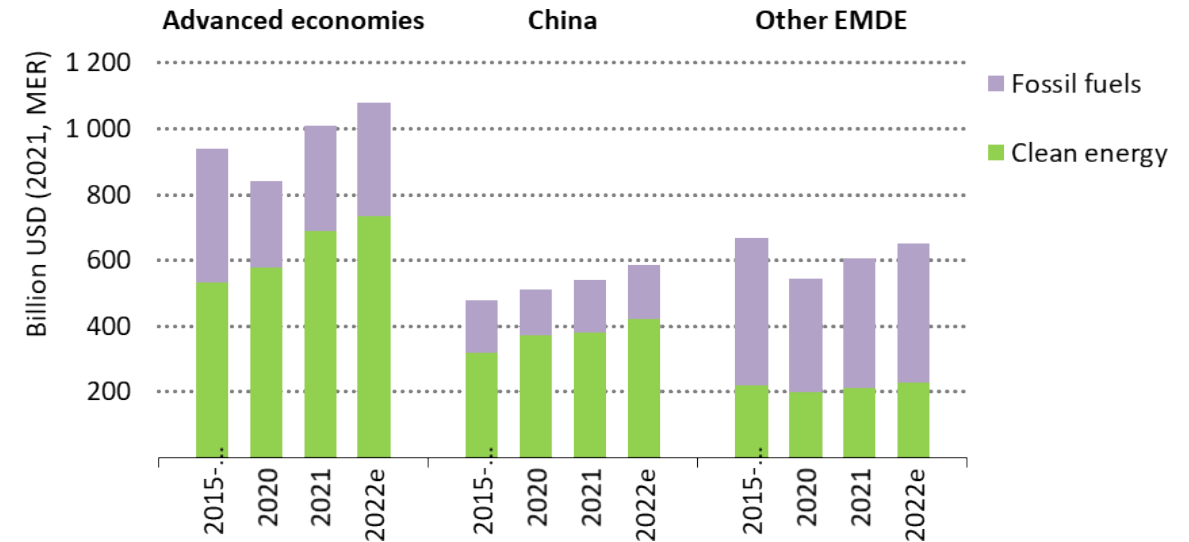
The cost of financing for the developing world needs to be addressed

Cost of capital indicators for debt and equity



IEA. All rights reserved.

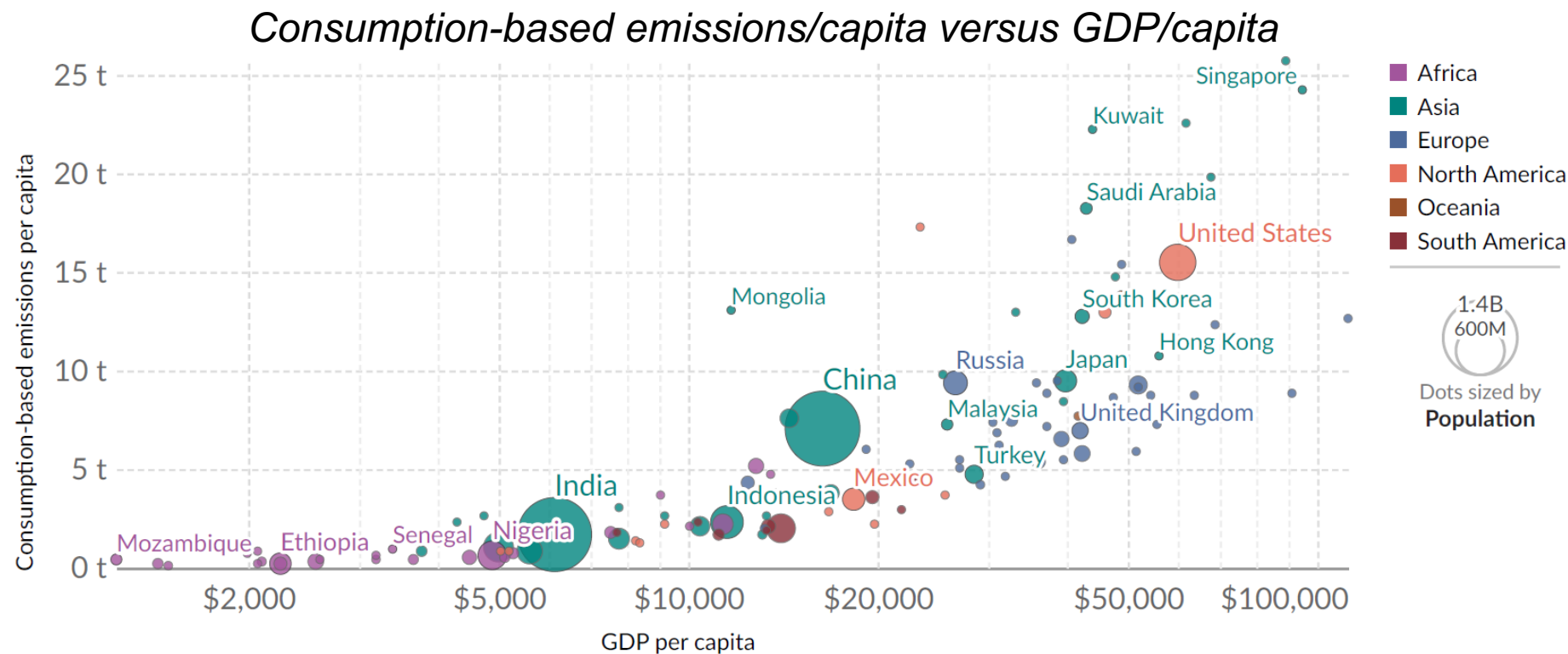
Fossil fuels continue to dominate investment in EMDE



- Finance for the developing world is a critical issue – developing world needs to fulfil commitments
- Higher risks mean higher financing costs and a demand for higher returns, which slows investment
- Also, energy sector focus remains broad, across hydrocarbons as well as green energy, with energy for export often seen as the safest investment



Need to focus on carbon consumption, not just production



Source: Global Carbon Budget (2022); Gapminder (2022); UN (2022); HYDE (2017); Gapminder (Systema Globalis); Data compiled from multiple sources by World Bank

- Although the ratcheting of NDCs and net zero emission targets are important, in developing countries the issue of carbon consumption cannot be ignored
- Will consumers be prepared to face the consequences of their purchasing patterns?