International Energy Agency

Net Zero by 2050: a Roadmap for the Global Energy Sector

The future of energy: an analysis by international stakeholders, Fondazione Courmayeur, 10 December 2021

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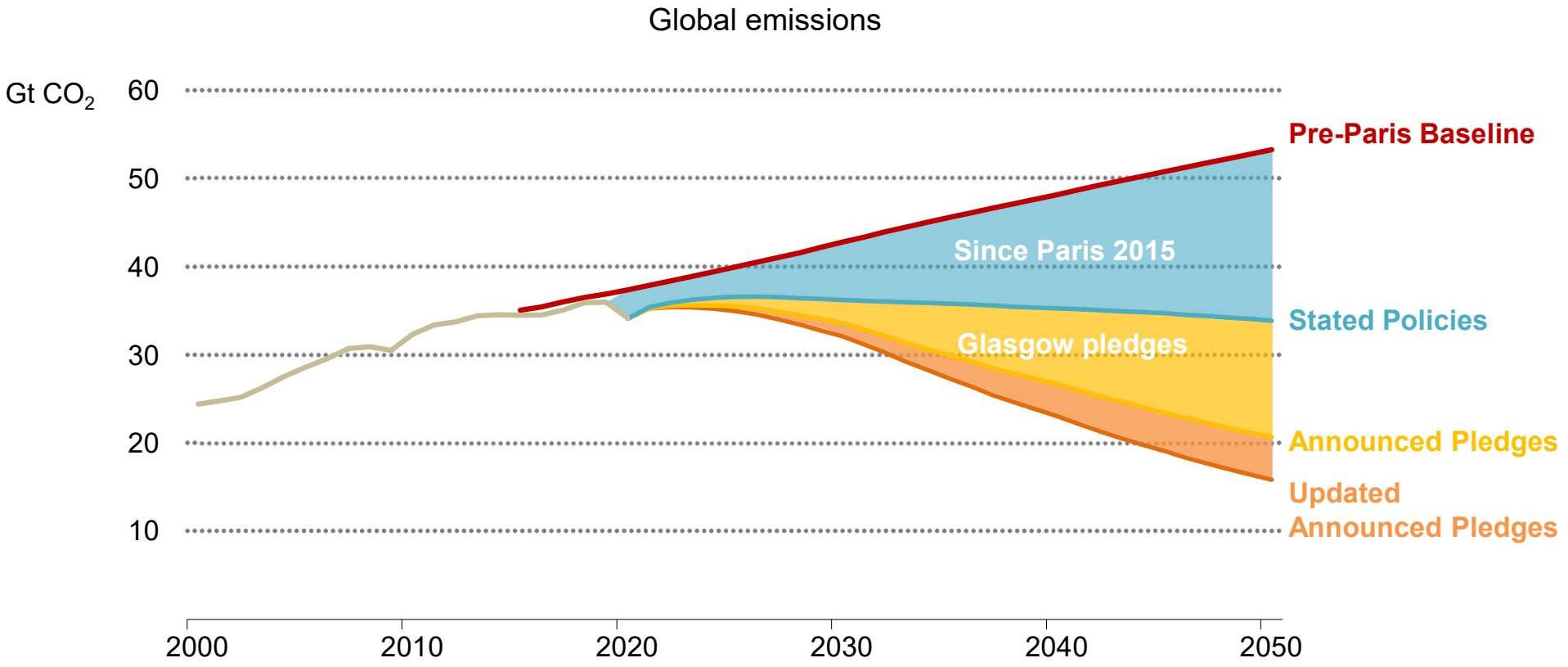
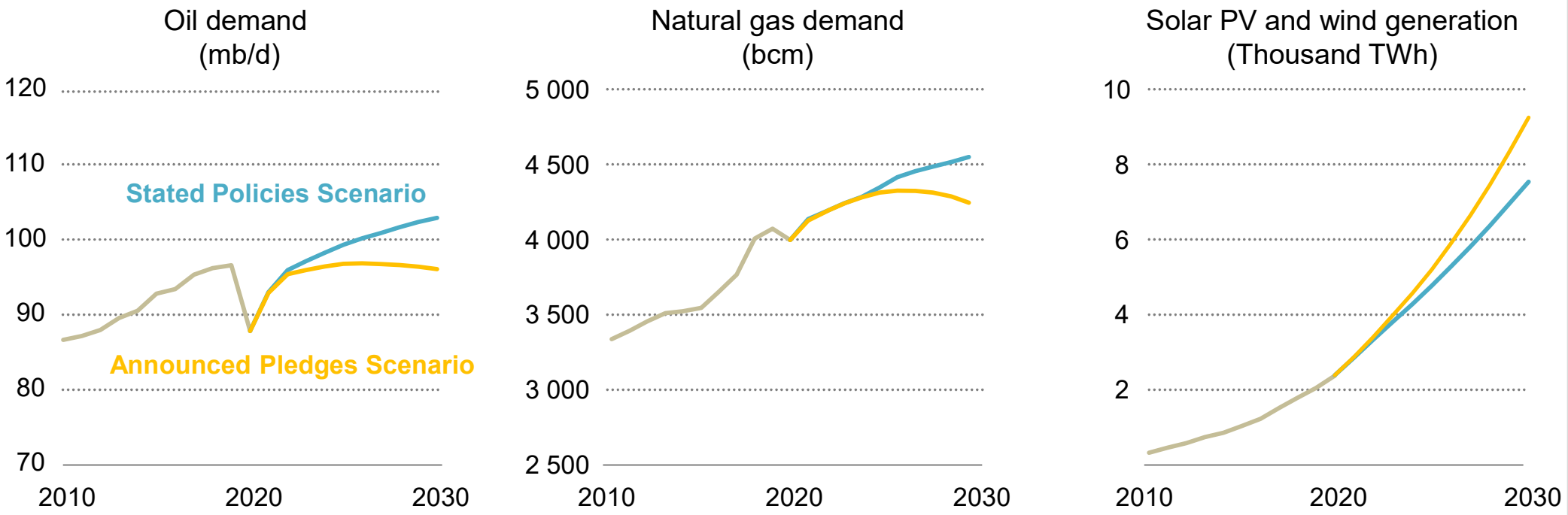
The world is starting to bend the emissions curve



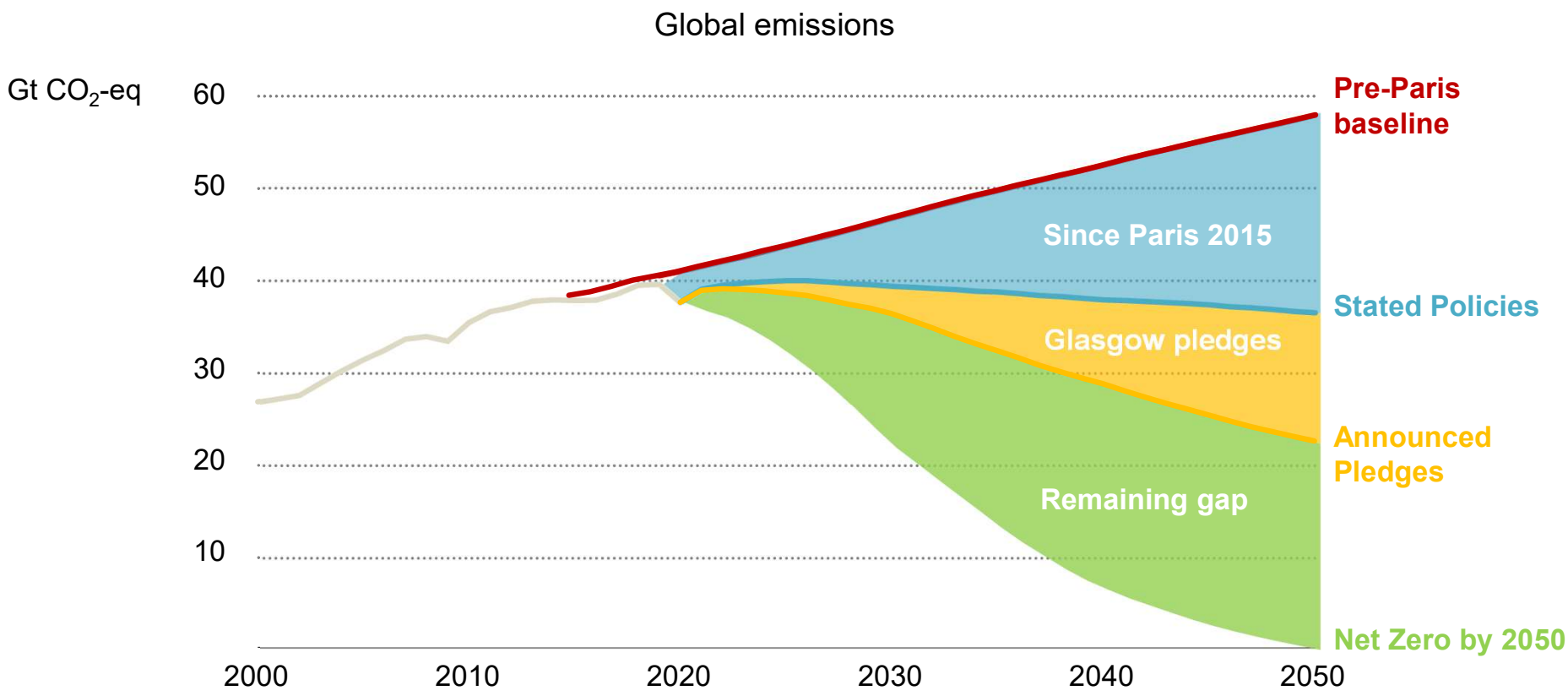
New policies, technology cost reductions, and the pandemic have pulled the projected emissions curve down. Updated NDCs & long-term net zero pledges decouple emissions and economic growth this decade.

And announced pledges re-shape global energy markets



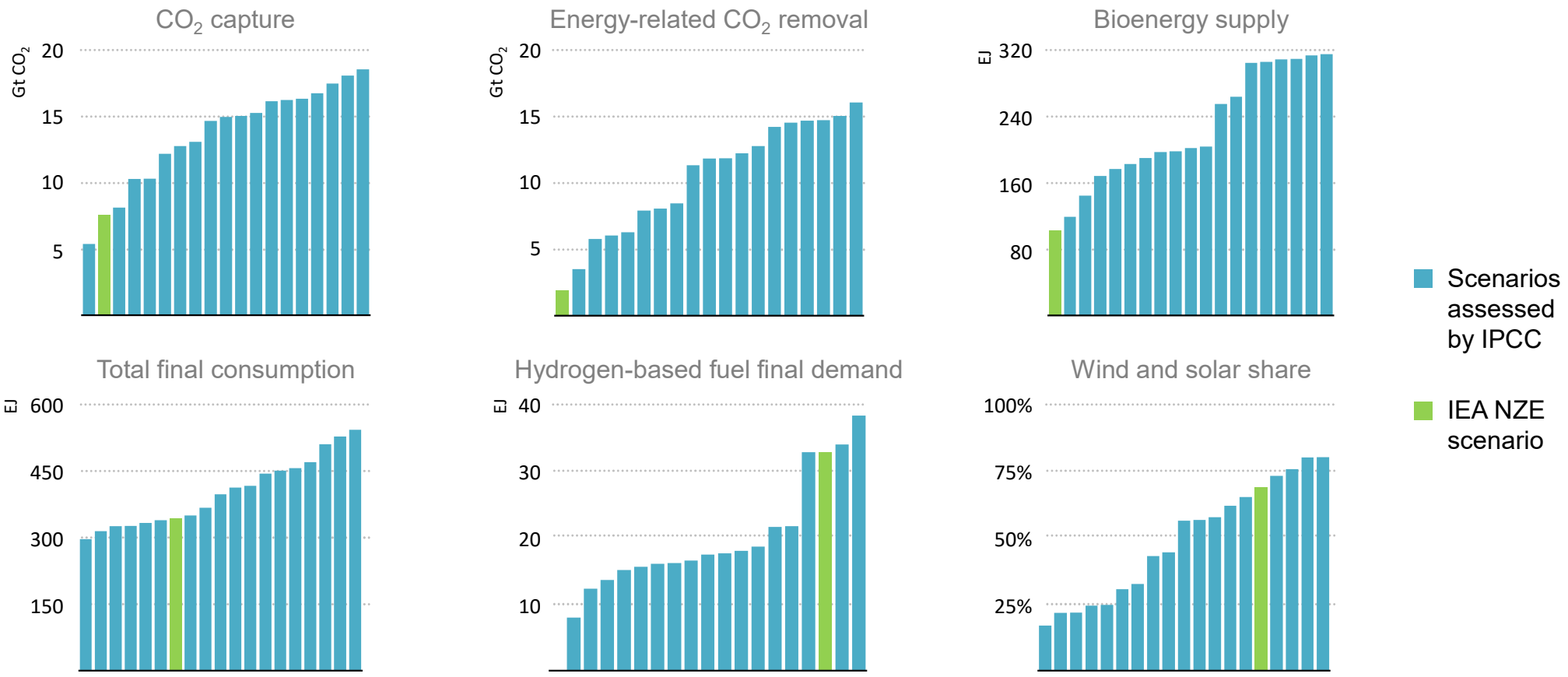
Full realisation of all announced pledges sees peak oil and natural gas demand occurring in the current decade, while annual solar PV and wind capacity additions reach 470 GW in 2030

A large ambition gap remains in 2030



Despite some positive signs, today's pledges close less than 20% of the gap to the Net Zero by 2050 scenario: countries with net zero pledges and countries without each account for about half the remaining ambition gap

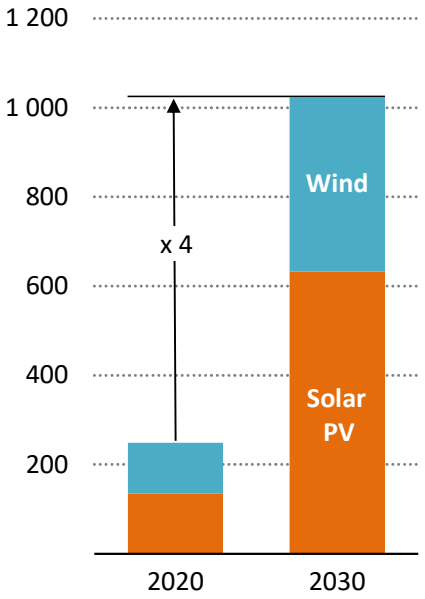
The IEA's NZE in 2050 compared with IPCC net-zero scenarios



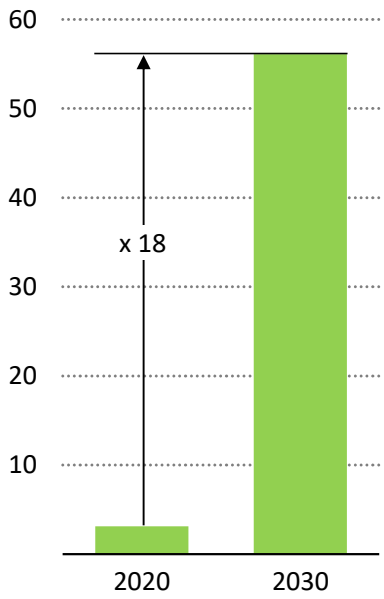
The IEA NZE scenario uses more renewables, energy efficiency, and hydrogen – and less CO_2 capture, negative emissions and bioenergy – than IPCC scenarios of a comparable ambition

Make the 2020s the decade of massive clean energy expansion

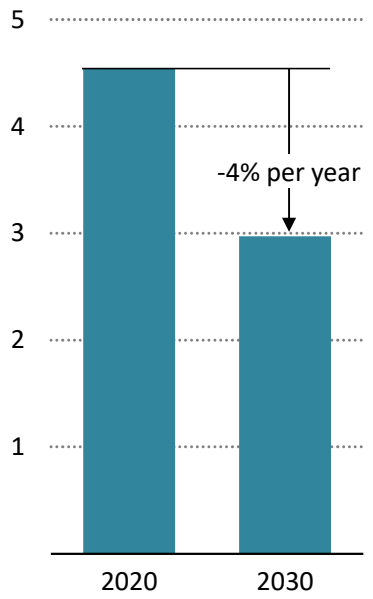
Solar PV and wind capacity additions (GW)



Electric car sales (millions)

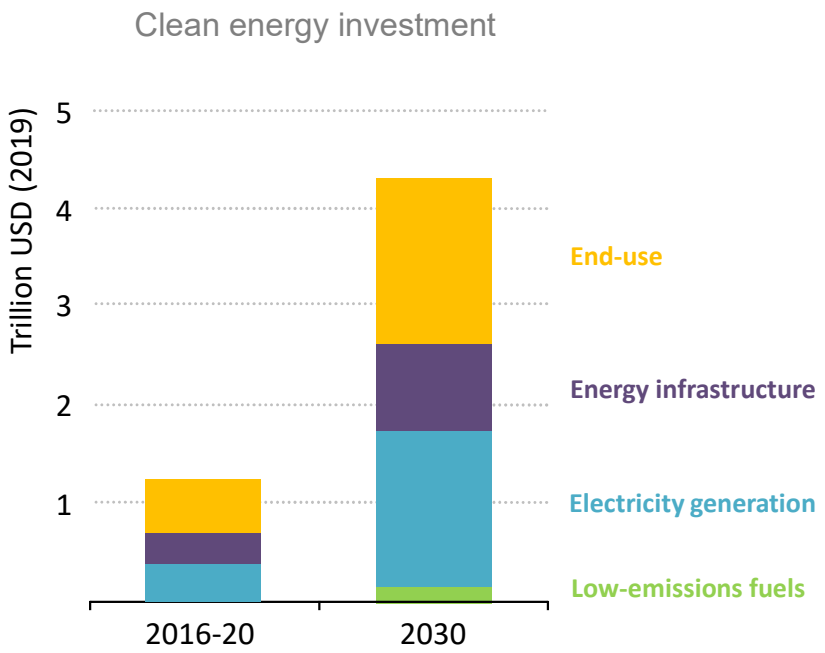


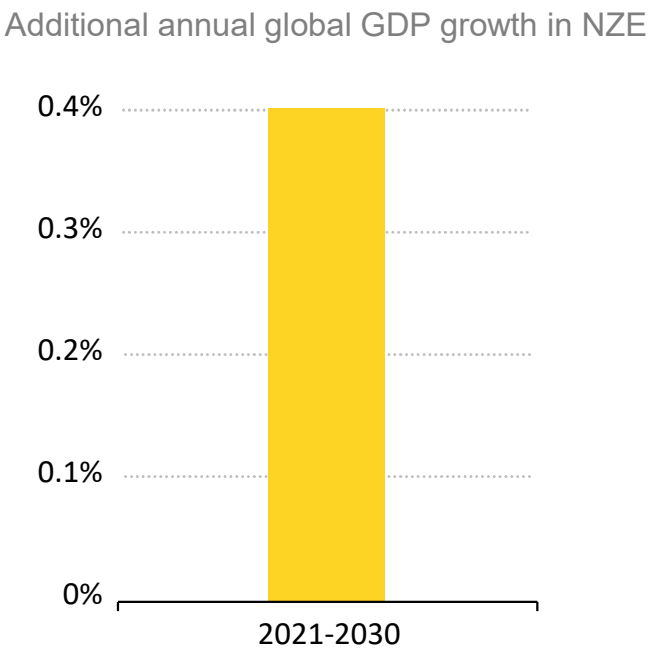
Energy intensity of GDP (MJ per USD PPP)



Technologies for achieving the necessary deep cuts in global emissions by 2030 exist, but staying on the narrow path to net-zero requires their immediate and massive deployment.

Drive a historic surge in clean energy investment

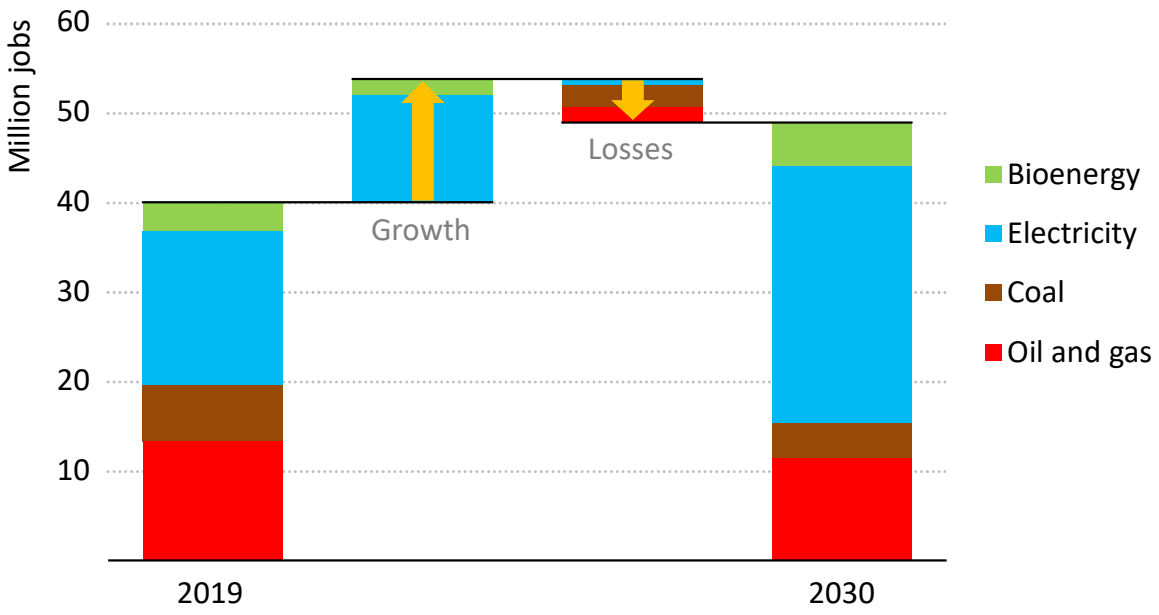




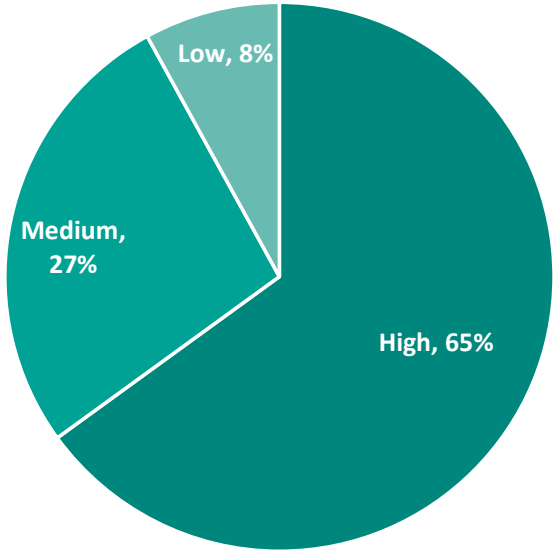
Annual clean energy investment more than triples by 2030 in the NZE scenario, driving an average 0.4% per year increase in global GDP to 2030 & speeding the recovery from the COVID-19 shock

Clean energy jobs will grow strongly but must be spread widely

Jobs in energy supply in the NZE



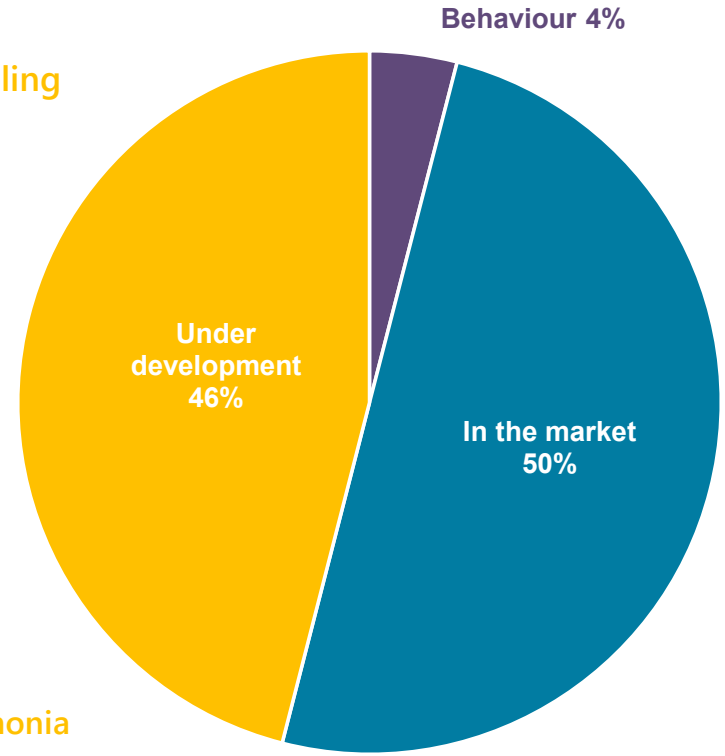
Skill level of new workers in the NZE, 2030



By 2030 there are 14 million jobs created in global energy supply, and a further 16 million in clean energy end-uses; but inclusive policies are needed to support reskilling & diversification in fossil-fuel dependent communities

Prepare for the next phase of the transition by boosting innovation

CO_2 savings by technology maturity in 2050, NZE scenario



Refrigerant-free advanced cooling

Advanced batteries

Next-generation biofuels

CO_2 capture from cement

Hydrogen-based steel

Small modular reactors

Synthetic liquid fuels

Electrolytic hydrogen for ammonia

Autonomous trucks

Optimised heat pump with storage

Direct air capture

Ammonia-powered ships

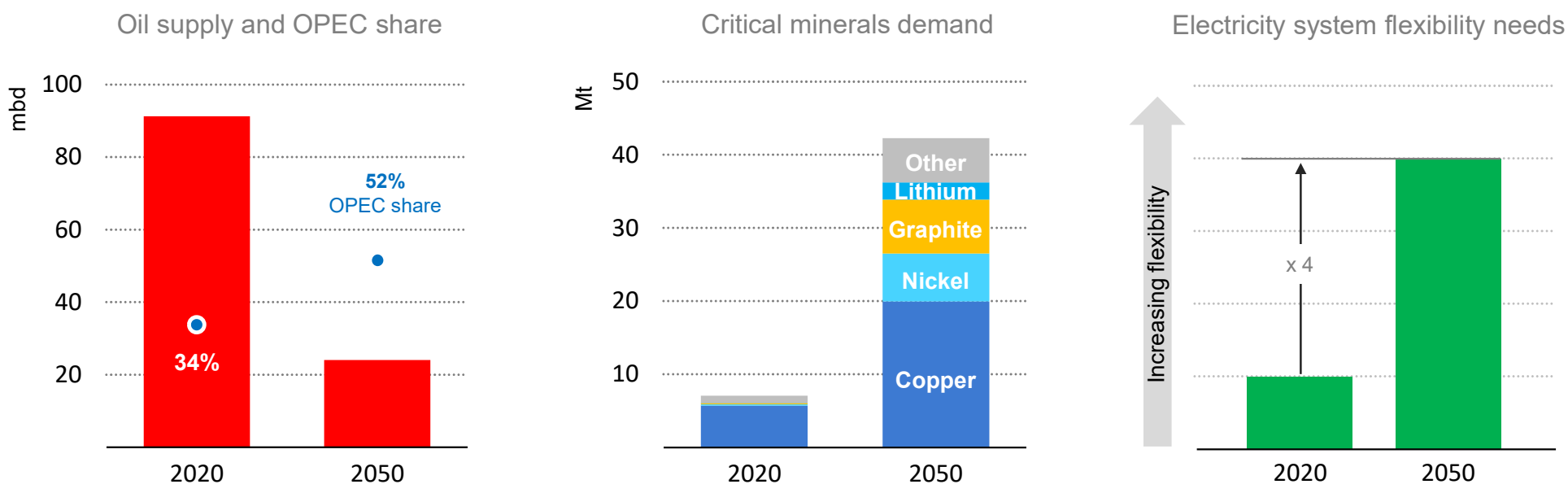
Electrolytic hydrogen for methanol

Building-integrated storage

Electric steam crackers

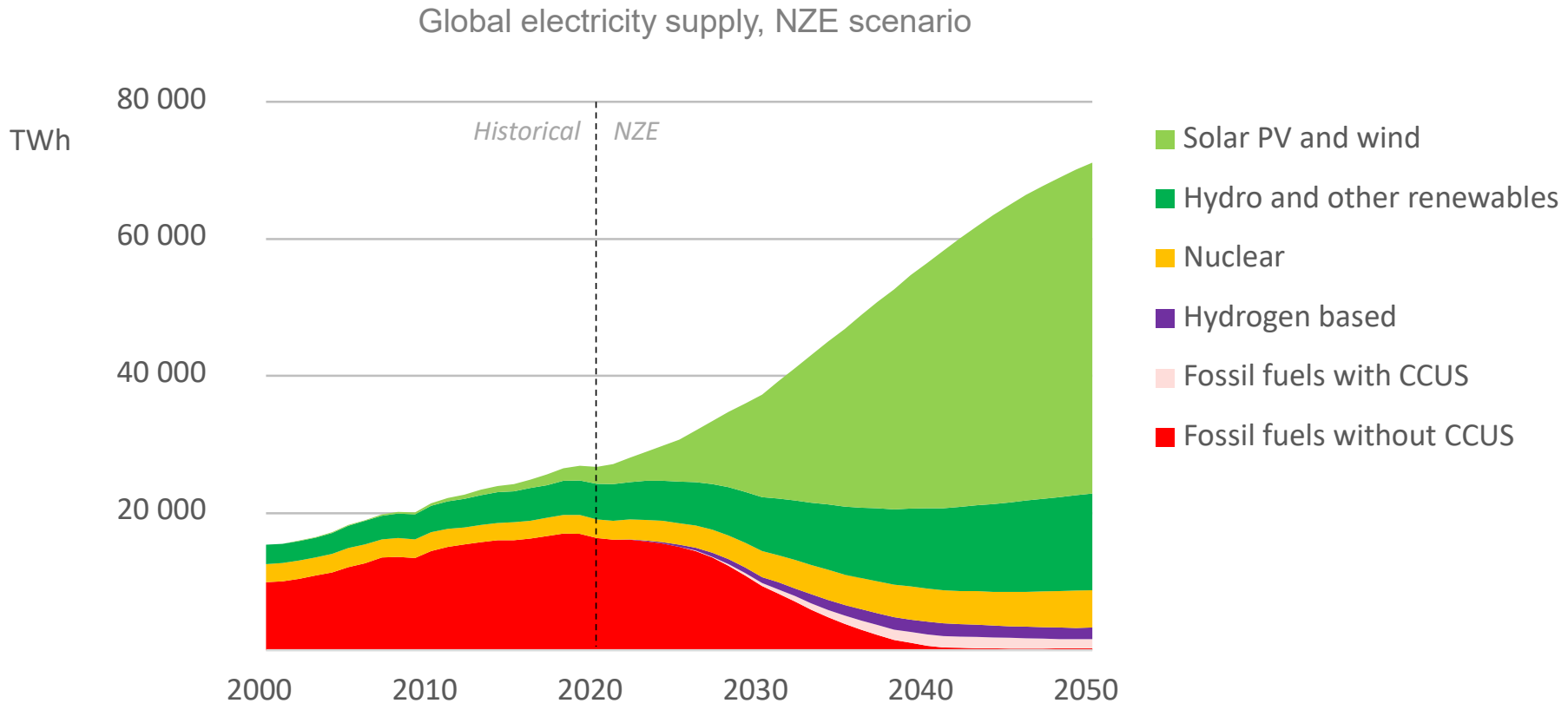
Unlocking the next generation of low-carbon technologies requires more clean energy R&D and $90 billion in demonstrations by 2030; without greater international co-operation, global CO_2 will not fall to net-zero by 2050.

Address emerging energy security risks now



New energy security concerns emerge, and old ones remain; governments need to proactively plan for energy security risks related to market concentration, critical minerals and electricity systems.

Electricity leads the way to net zero



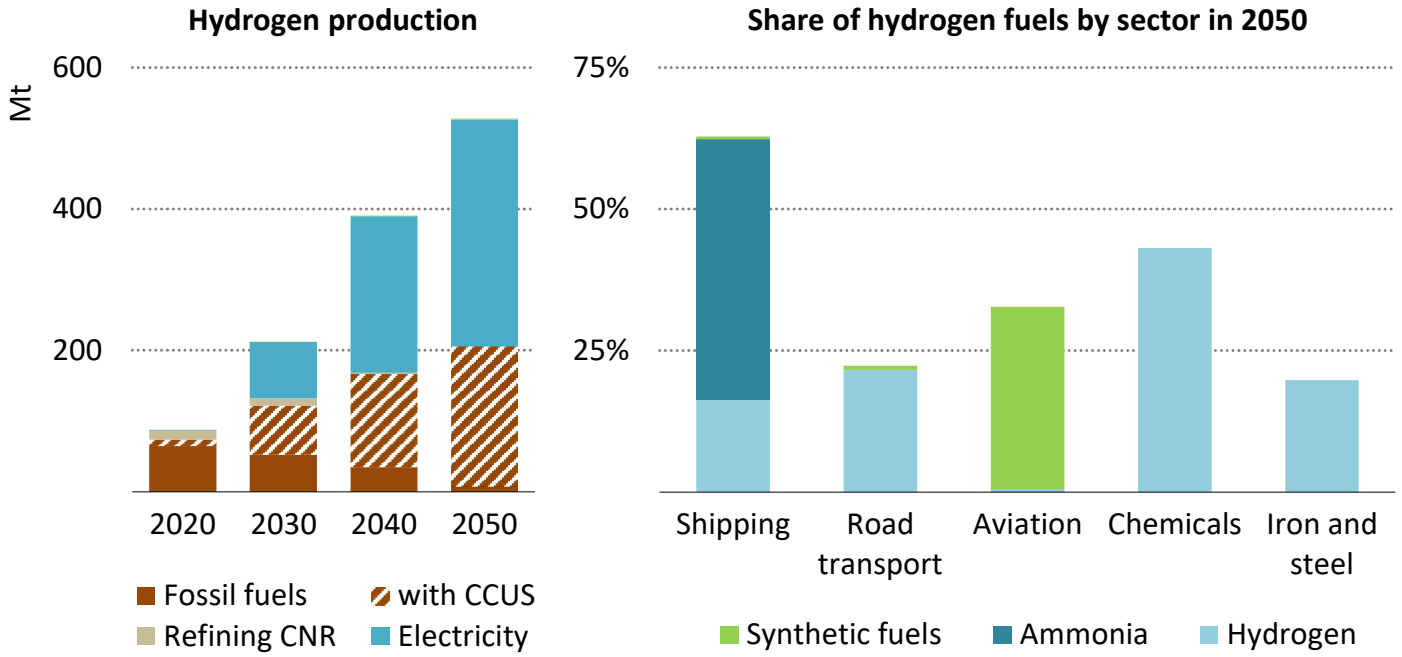
In our net zero pathway, renewables make up nearly 90% of electricity generation in 2050, propelled largely by solar PV and wind

New coal power is on its way out

After decades of growth, construction of unabated coal power plants sharply declines under announced pledges, and cancellations could cut 20 Gt of emissions to 2050, comparable to savings from the EU reaching net zero by 2050

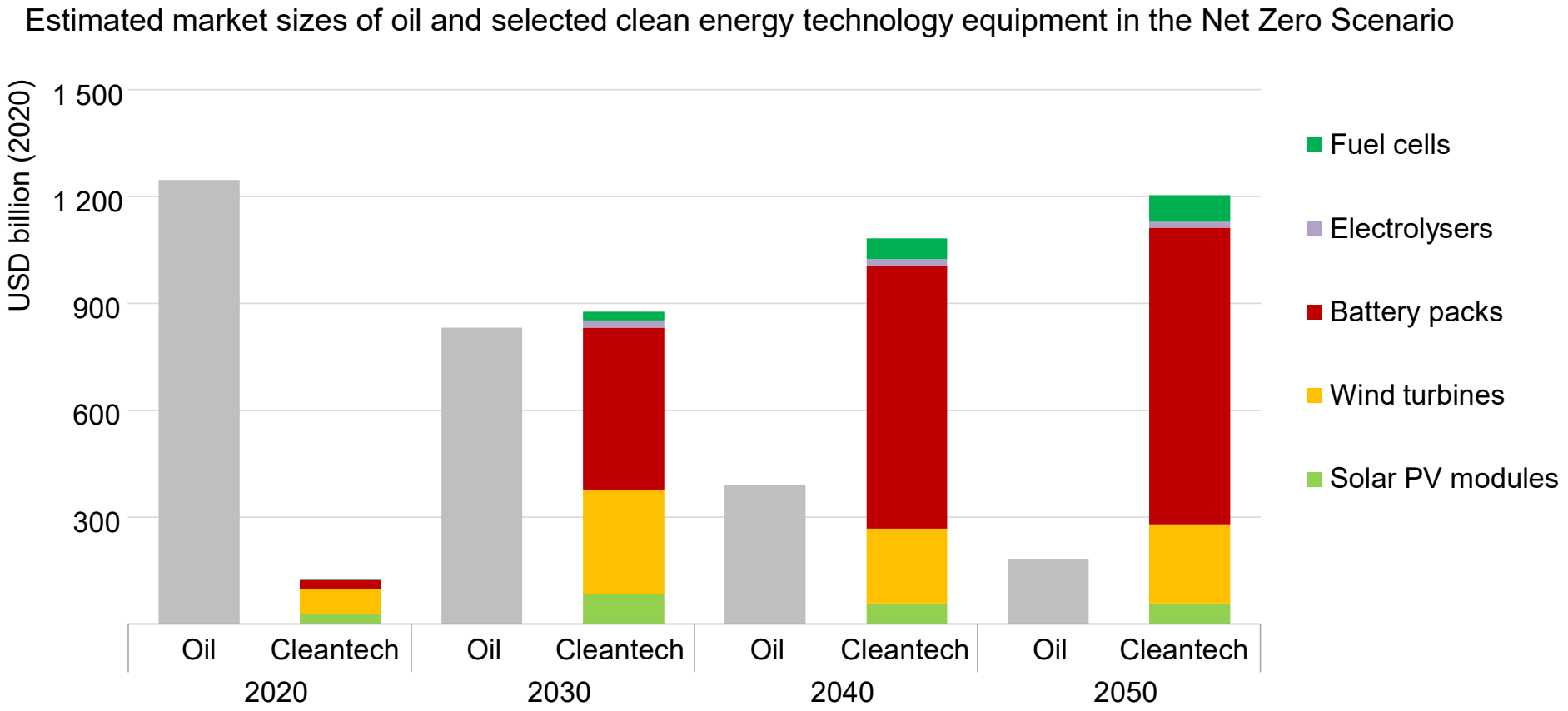
A much greater and different hydrogen industry

Global production of hydrogen by fuel and hydrogen demand by sector in the NZE



Hydrogen production jumps six-fold by 2050, driven by water electrolysis and natural gas with CCUS, to meet rising demand in shipping, road transport and heavy industry

A new global energy economy is emerging



Explosive growth in clean energy deployment over the next decades could create a market opportunity for manufacturers of key equipment worth a cumulative USD 27 trillion through to 2050

Set near-term milestones to get on track for long-term targets