

Global Clean Energy Outlook

Energy and the Economy:
The New Energy Landscape

7th annual conference by Federal Reserve Bank of
Dallas & Federal Reserve Bank of Kansas City

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November 10, 2022



BloombergNEF

BNEF coverage

Strategies for a cleaner, more competitive future

BloombergNEF

Commodities



Gas & LNG



Power



Oil



Carbon & offsets



Coal



Metals



Chemicals



Agriculture

Sector transitions

Clean power



Solar



Wind



Storage



Advanced nuclear



Power systems & networks

Advanced transport



Electric vehicles



New mobility services & tech



Commercial transport



Aviation & shipping



Sustainable fuels

Buildings & industry



Low-carbon heating & cooling



Circular economy



Green steel & aluminum



Sustainable plastics & chemicals



Low-carbon cement

Agriculture / land



Agri-chemicals & biotechnology



Land & water management



Alternative proteins & food demand



Food waste management



Agricultural technology & supply chain

Cross-cutting technologies



Industrial digitalization



Hydrogen



Bioenergy



Carbon capture, utilization, storage & removal (CCUSR)



Energy efficiency

Sustainability



Corporate carbon & climate action



Regulation & reporting



Sustainable finance & ESG



Financial Institution transition



Climate risk

Technology & Innovation

Forecasts & scenarios

Countries & policy

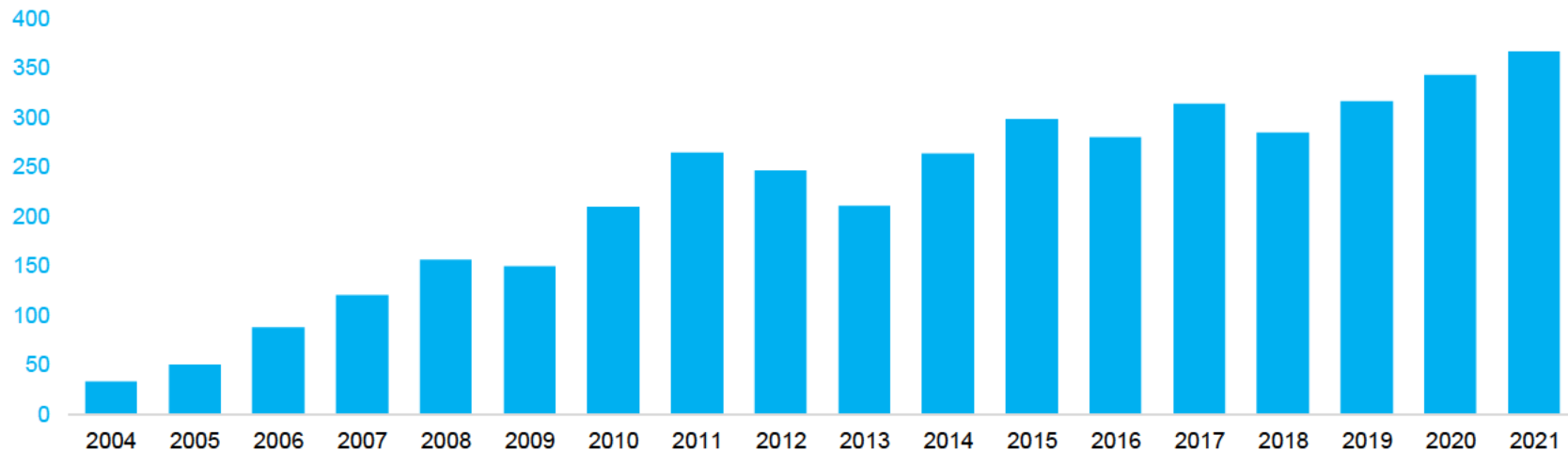
Finance & economics

Consumers

Renewable energy investments have risen, barring some hiccups...

Annual investments in renewable energy

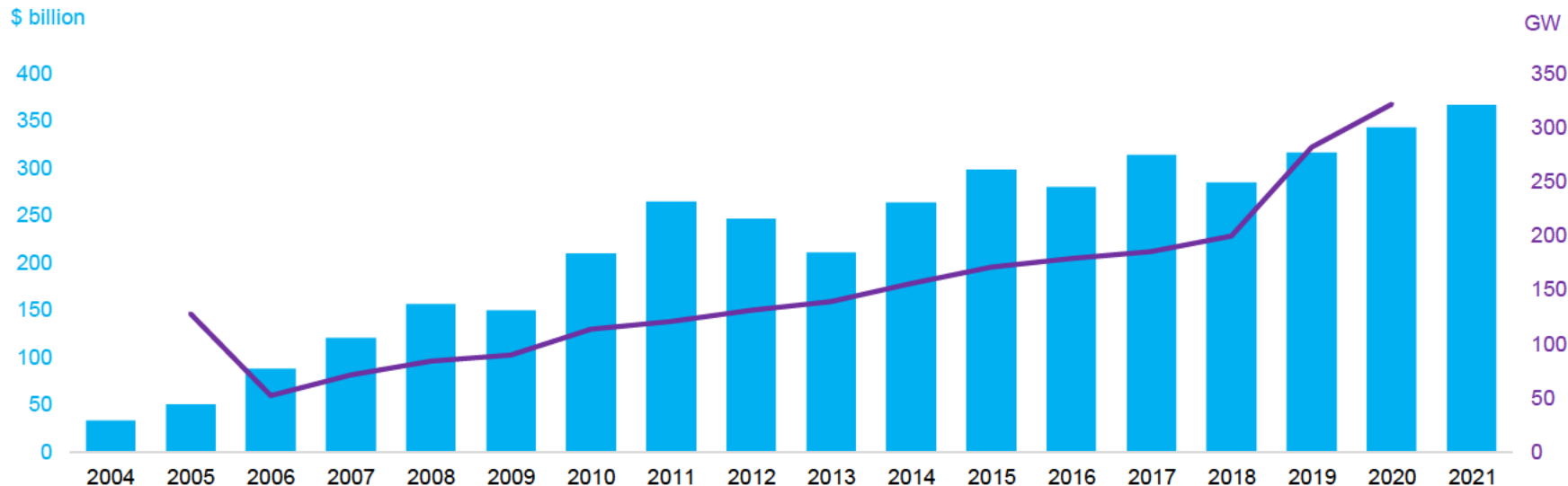
\$ billion



Source: BloombergNEF

...and capacity additions have grown continuously

Annual renewable energy investments and capacity additions

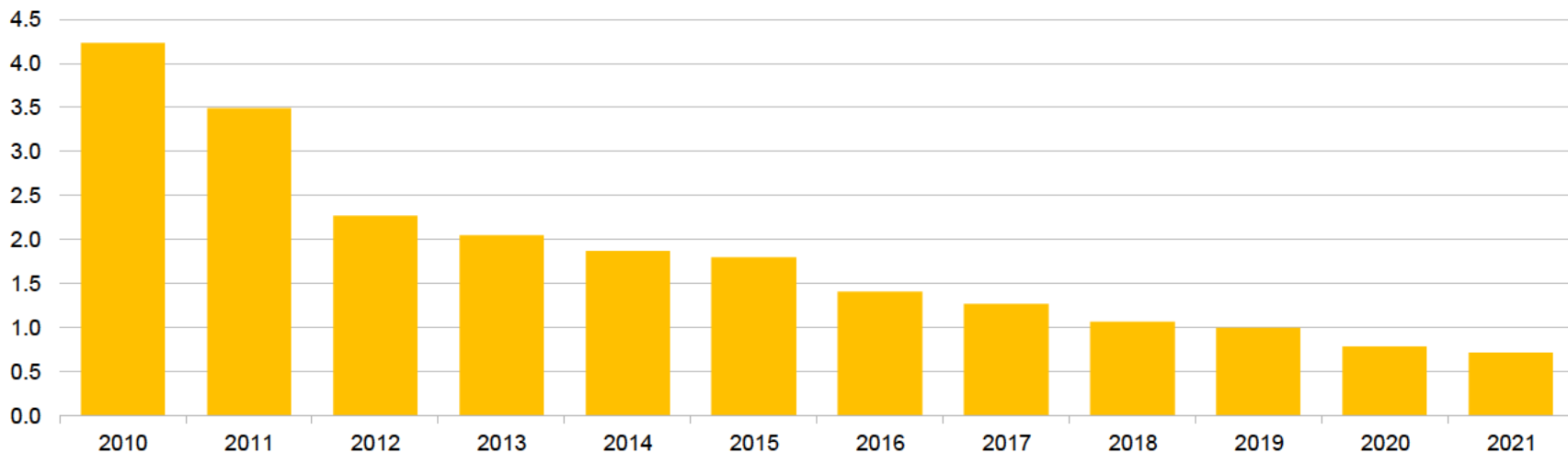


Source: BloombergNEF

Renewables capacity growth aided by cost declines...

Global solar PV capex benchmark

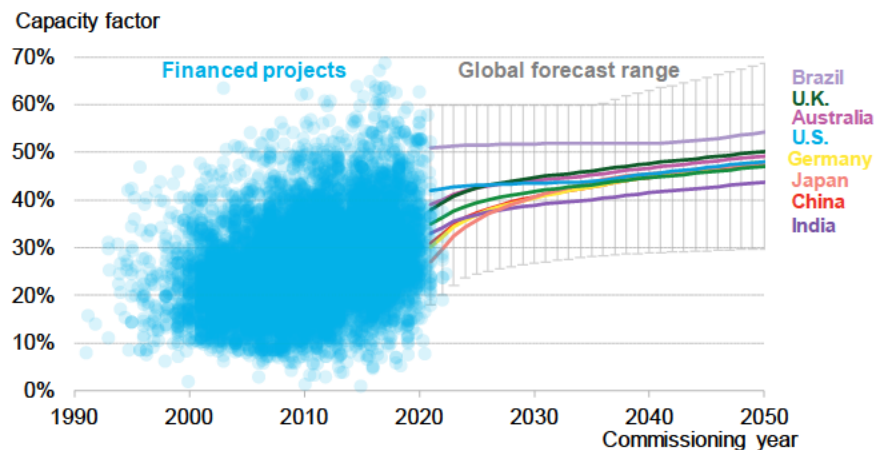
\$/W(DC) (Real 2021)



Source: BloombergNEF

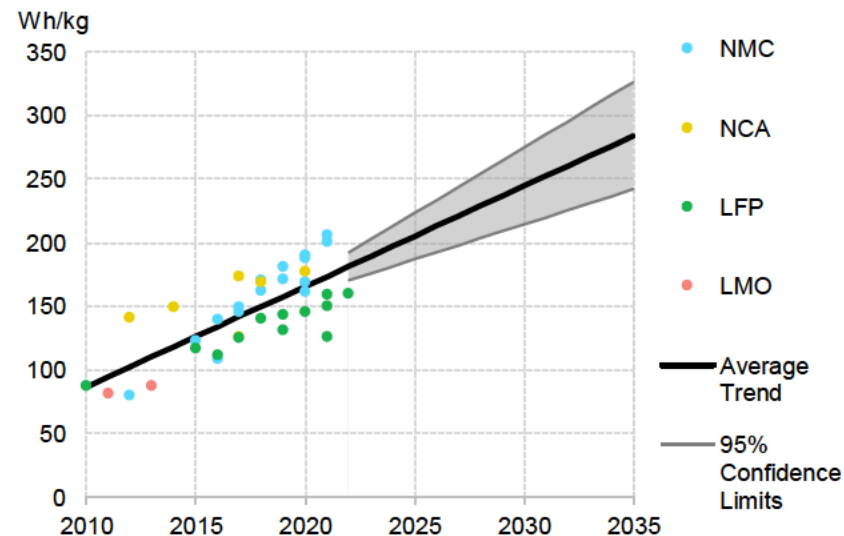
...and by rising efficiencies

Onshore wind capacity factors



Source: BloombergNEF

Battery energy density

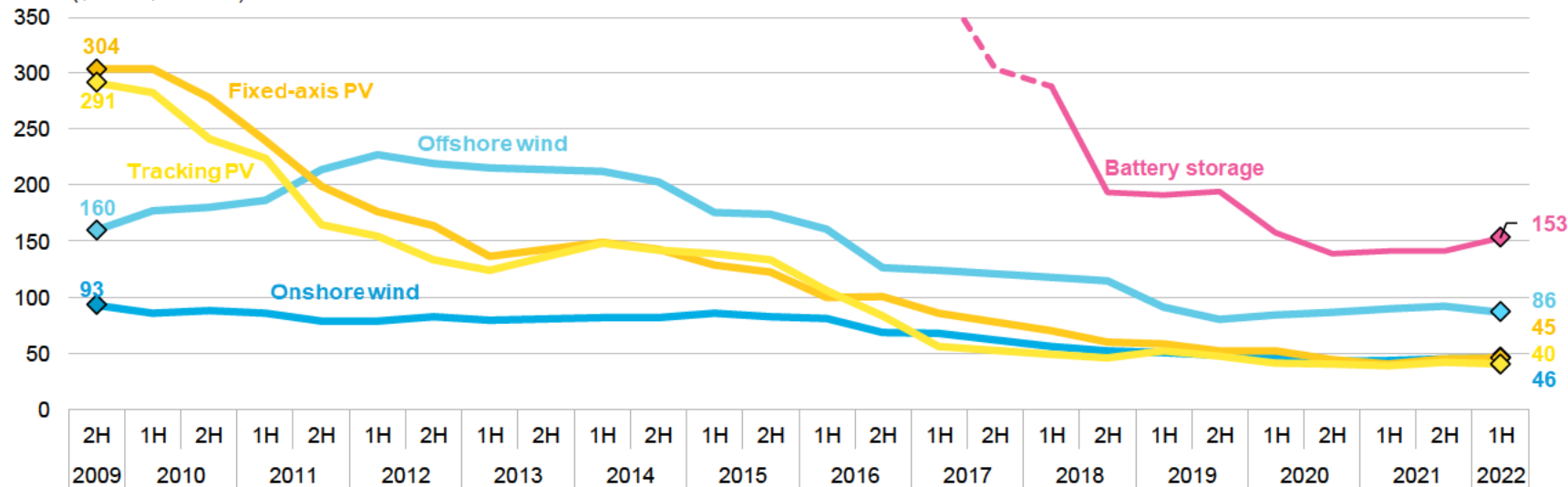


Source: BloombergNEF Note: NMC is Nickel, Manganese & Cobalt, NCA is Nickel, Cobalt & Aluminum, LFP is Lithium, Iron & Phosphate and LMO is Lithium Manganese Oxide.

...translating into lower power generation costs

Global levelized cost of electricity (LCOE) benchmarks

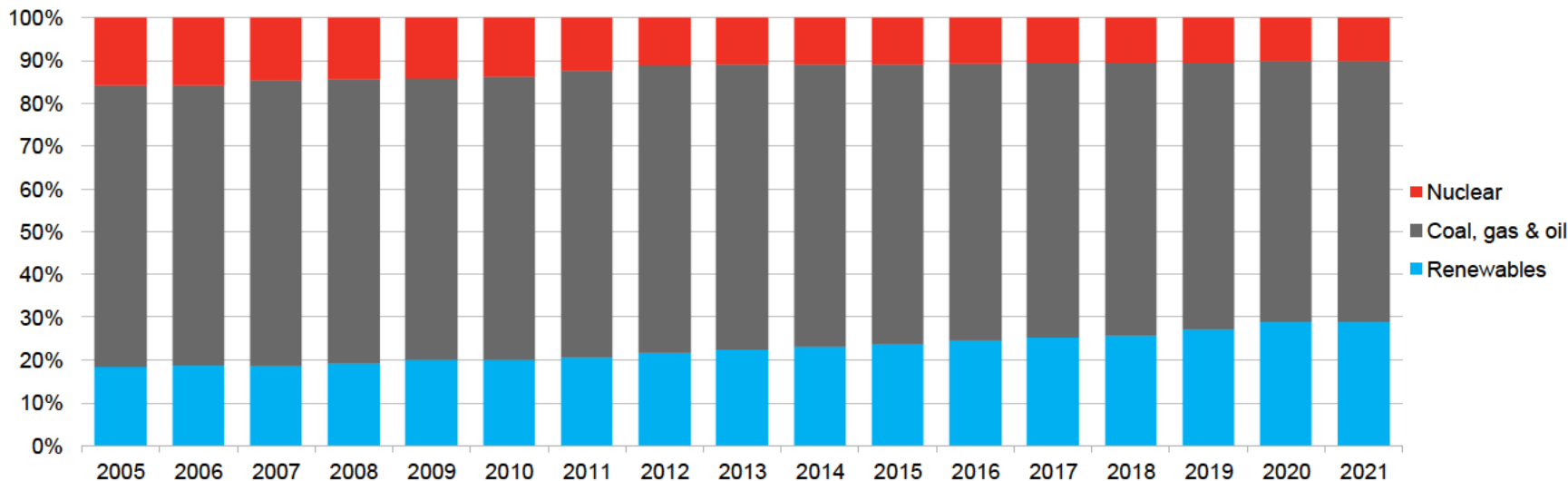
LCOE (\$/MWh, nominal)



Source: BloombergNEF. Note: The global benchmark for PV, wind and storage is a country-weighted average using the latest annual capacity additions. The storage LCOE is reflective of a utility-scale Li-ion battery storage system with four-hour duration running at a daily cycle and includes charging costs.

...leading to higher share in the global power mix

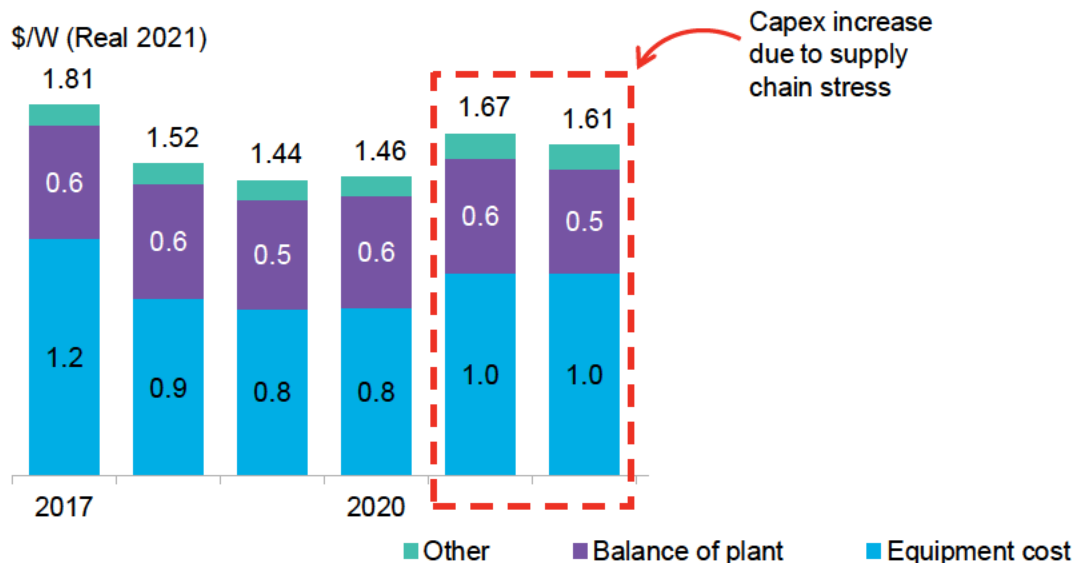
Share in global power generation



Source: BloombergNEF Note: renewables include large hydro and biomass.

However, renewable energy capex have risen for the first time in decades

Benchmark U.S. onshore wind capex

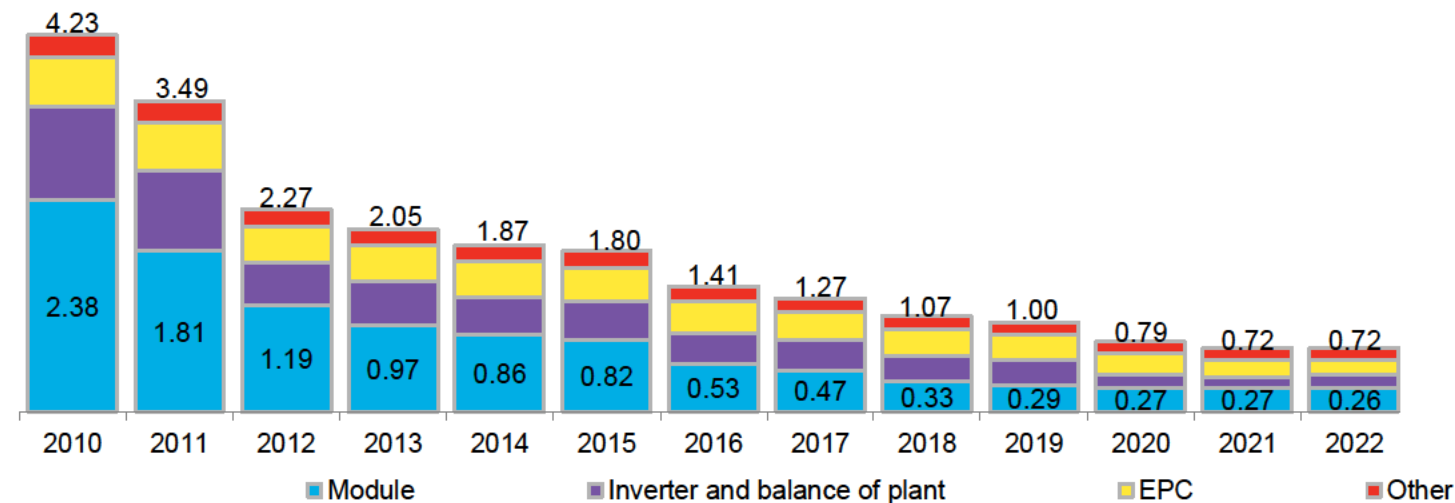


Source: BloombergNEF. Note: Capex chart is by financing year.

However, renewable energy capex have risen for the first time in decades

Global solar PV capex benchmark

\$/W(DC) (Real 2021)

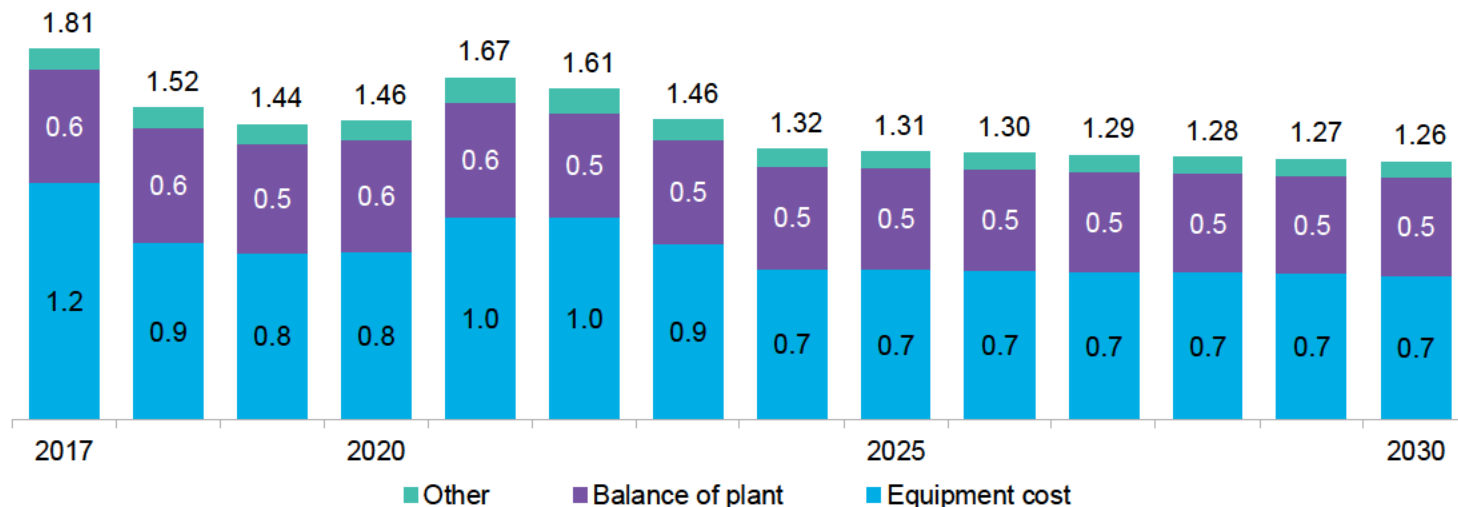


Source: BloombergNEF

But costs expected to decline again as supply chain constraints ease

Benchmark U.S. onshore wind capex

\$/W (Real 2021)

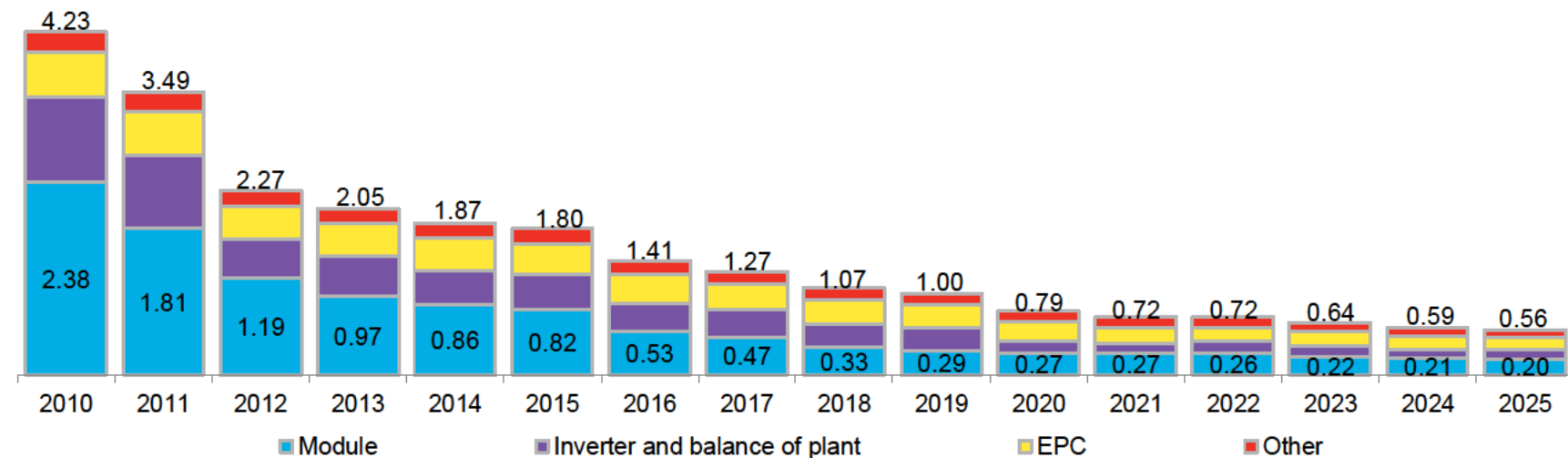


Source: BloombergNEF. Note: Capex chart is by financing year.

But costs expected to decline again as supply chain constraints ease

Global solar PV capex benchmark

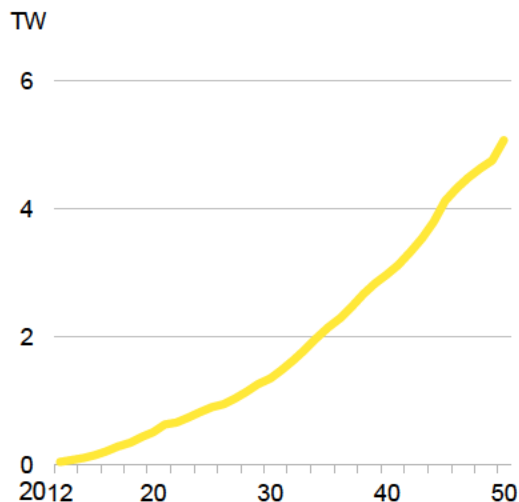
\$/W(DC) (Real 2021)



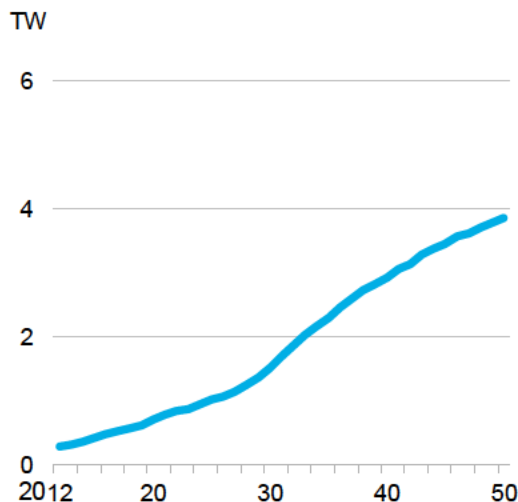
Source: BloombergNEF

Renewables will continue to grow rapidly in an Economic Transition Scenario...

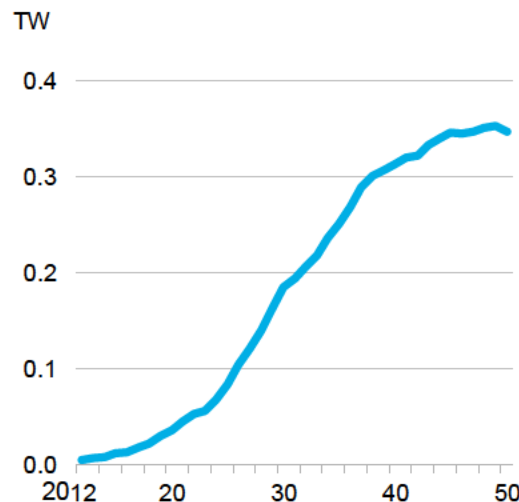
Utility-scale PV, cumulative installed capacity



Onshore wind, cumulative installed capacity



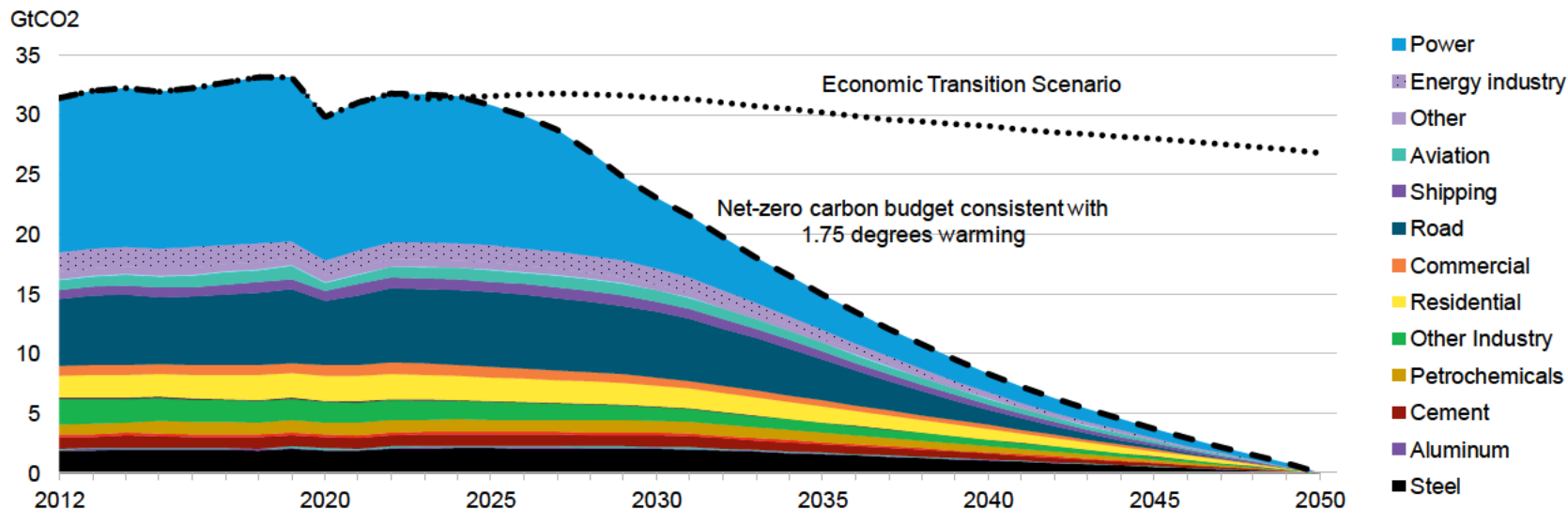
Offshore wind, cumulative installed capacity



Source: BloombergNEF

But for net zero, we need to decarbonize everything (not just the power sector)...

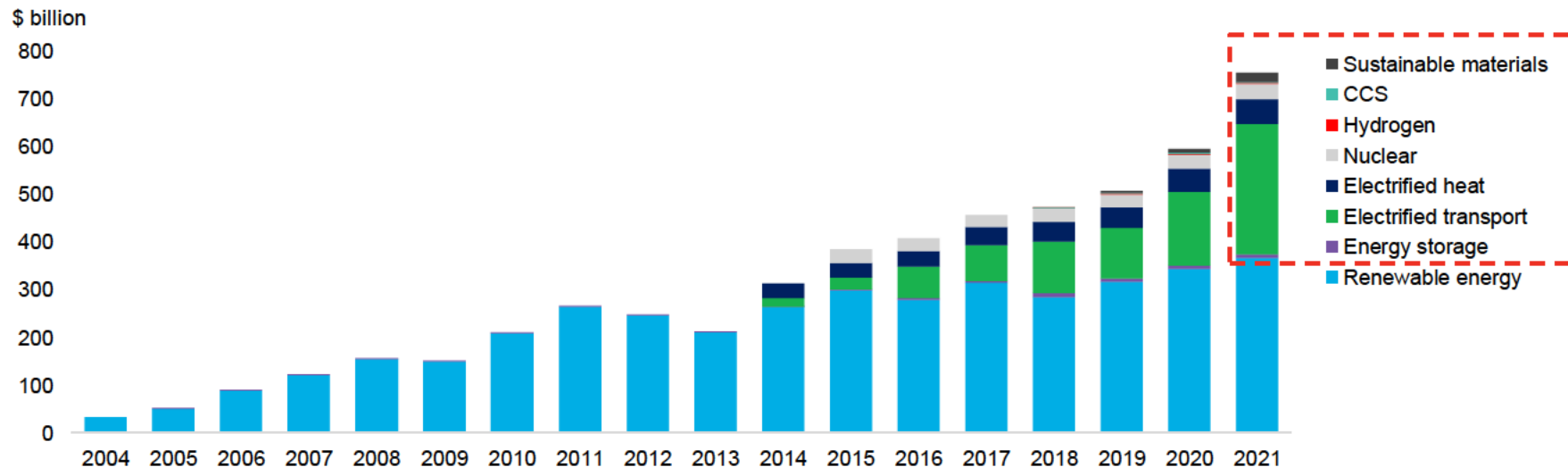
Energy emissions and carbon budget, by sector



Source: BloombergNEF

Rising investments in other forms of known clean energy raises hopes...

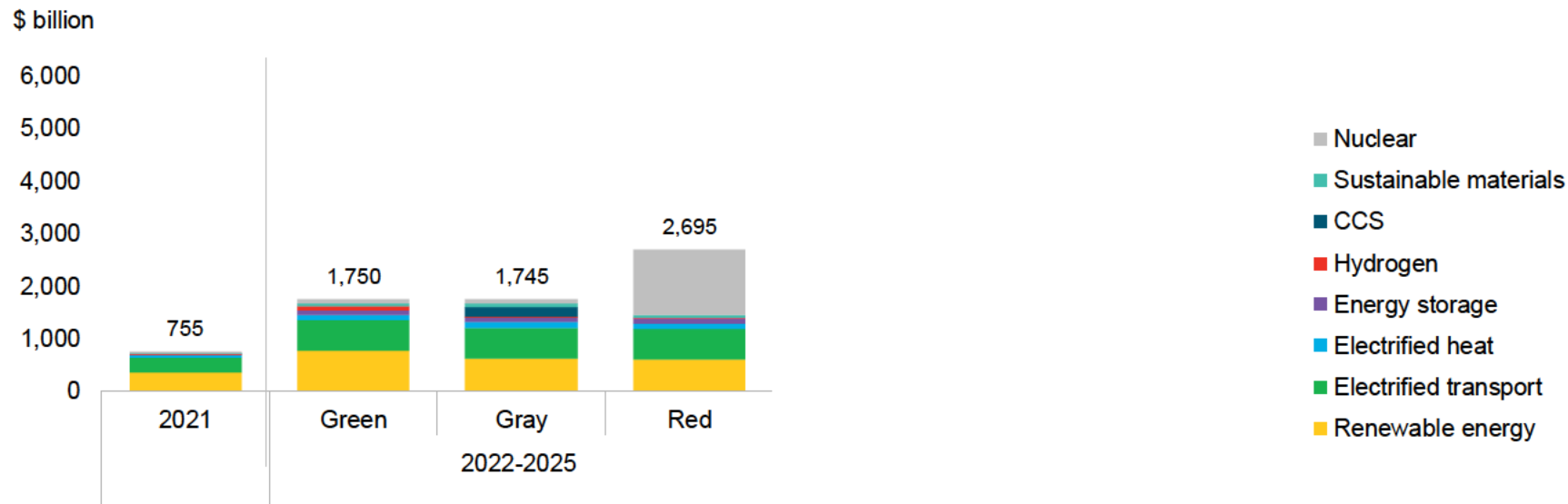
Global new investment in energy transition by sector



Source: BloombergNEF Note: CCS is carbon capture & storage. Start-years differ by sector. However, all sectors are present from 2019 onward; see Appendix for more detail.

...but investments need to scale rapidly

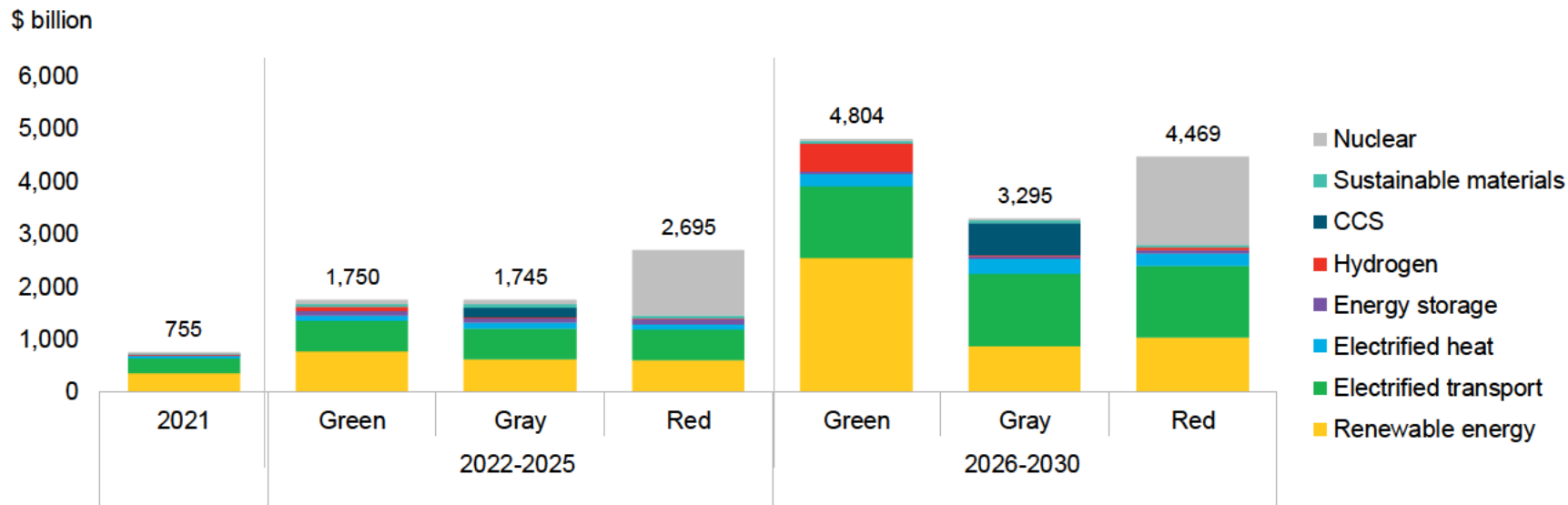
2021 energy transition investment versus required investment to reach net-zero



Source: BloombergNEF Note: Green scenario sees higher share of electricity in energy mix and growth for renewable power, carbon capture and storage (CCS) grows significantly in the gray scenario, high electrification and growth of nuclear power drive the red scenario.

...but investments need to scale rapidly

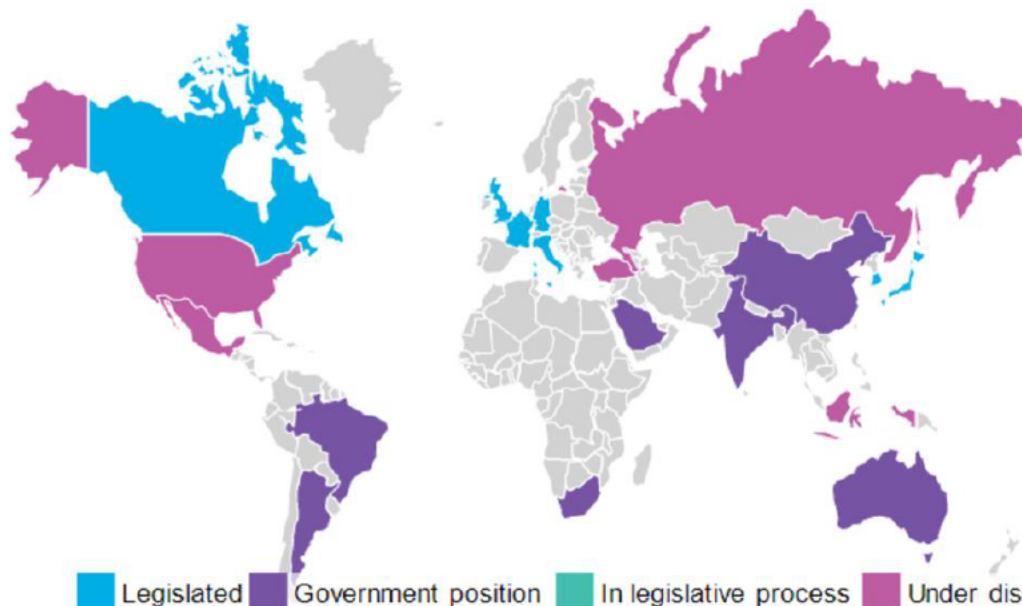
2021 energy transition investment versus required investment to reach net-zero



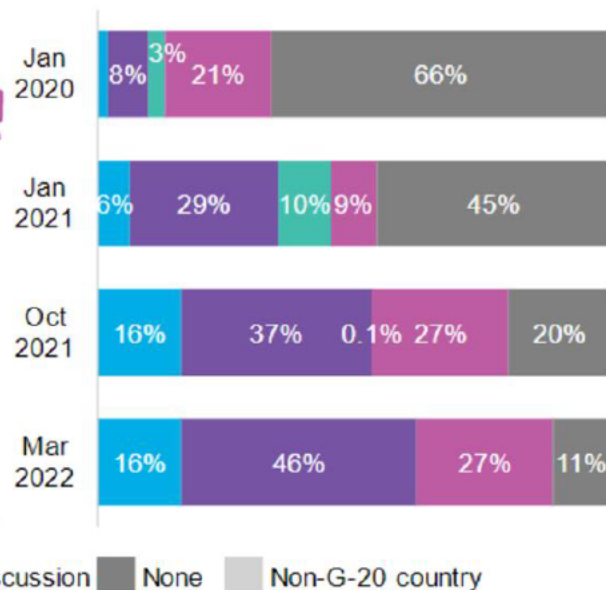
Source: BloombergNEF Note: Green scenario sees higher share of electricity in energy mix and growth for renewable power, carbon capture and storage (CCS) grows significantly in the gray scenario, high electrification and growth of nuclear power drive the red scenario.

Net-zero commitments are a good to have...

Status in G-20 countries



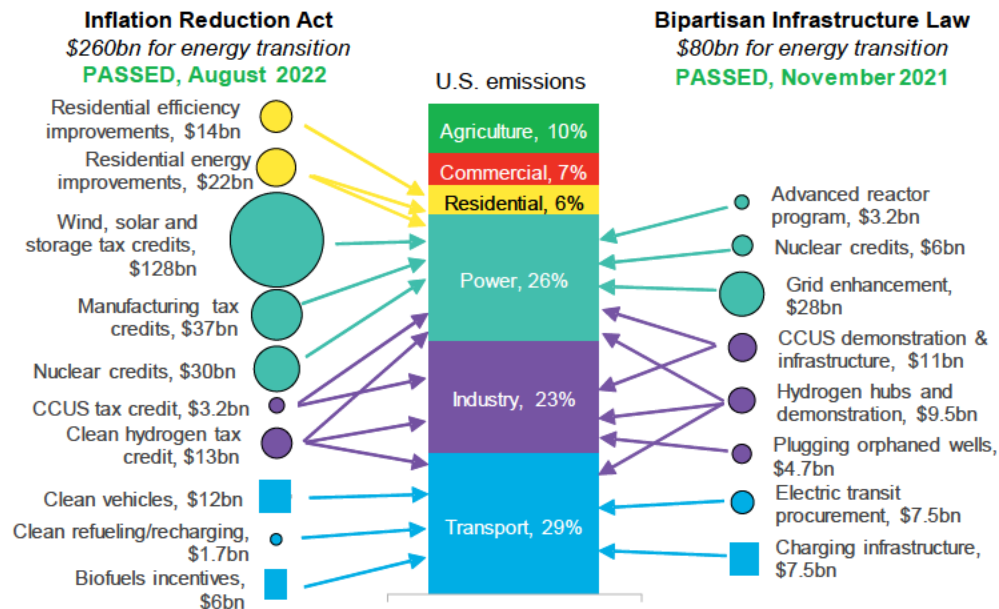
Share of global emissions by status



Source: WRI CAIT, BloombergNEF. Note: Includes land use, land-use change and forestry, 2018

Inflation Reduction Act (IRA) a potential game changer

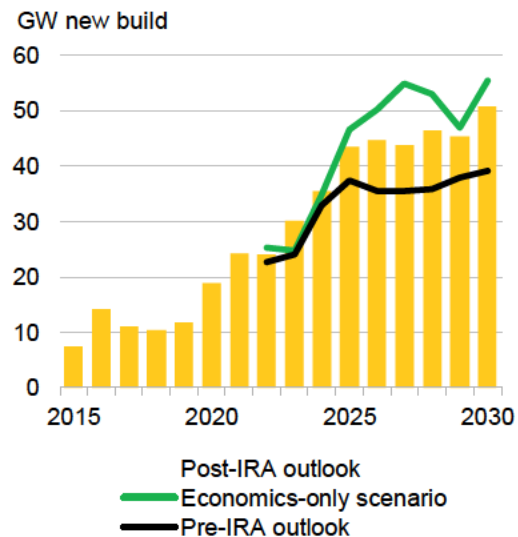
Estimated 2022-31 energy transition spending in 2021-22 laws



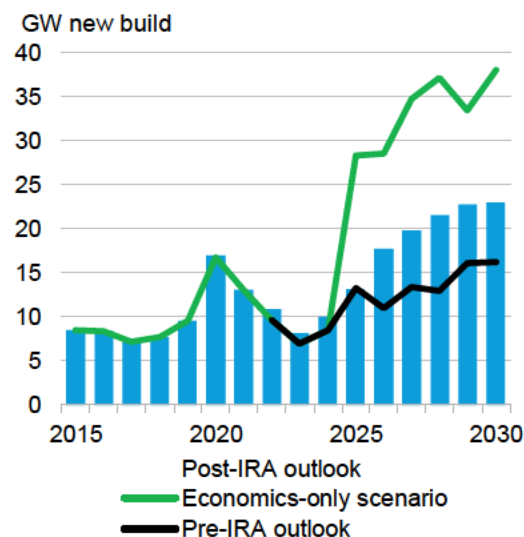
Source: EIA, EPA, Joint Committee on Taxation, BloombergNEF. Note: Not comprehensive

...IRA can help accelerate clean power

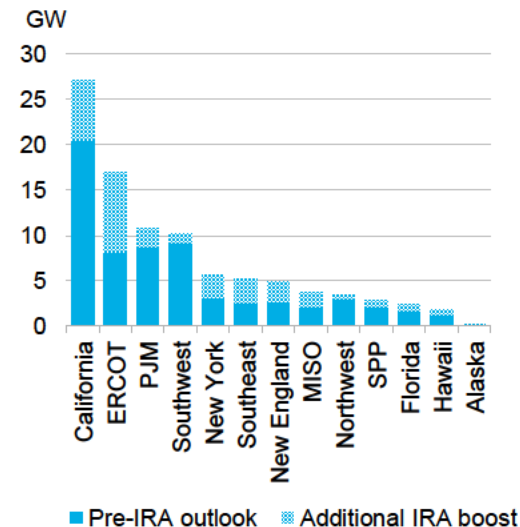
U.S. annual solar PV build



U.S. annual wind power build



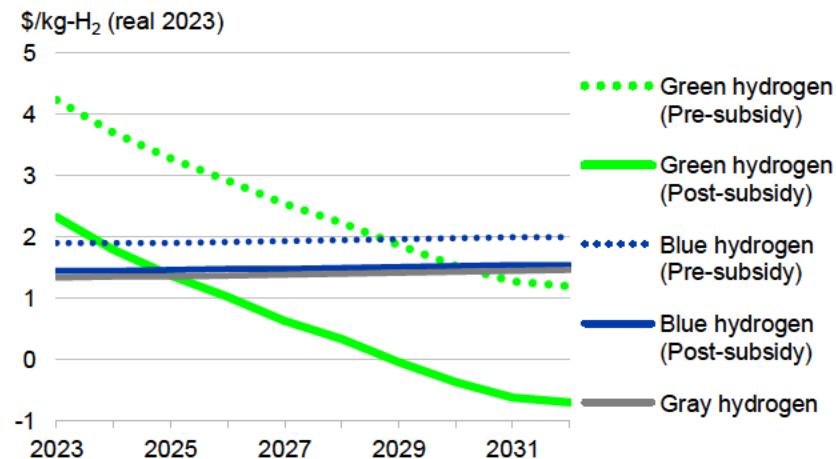
U.S. battery storage build 2022-30



Source: BloombergNEF

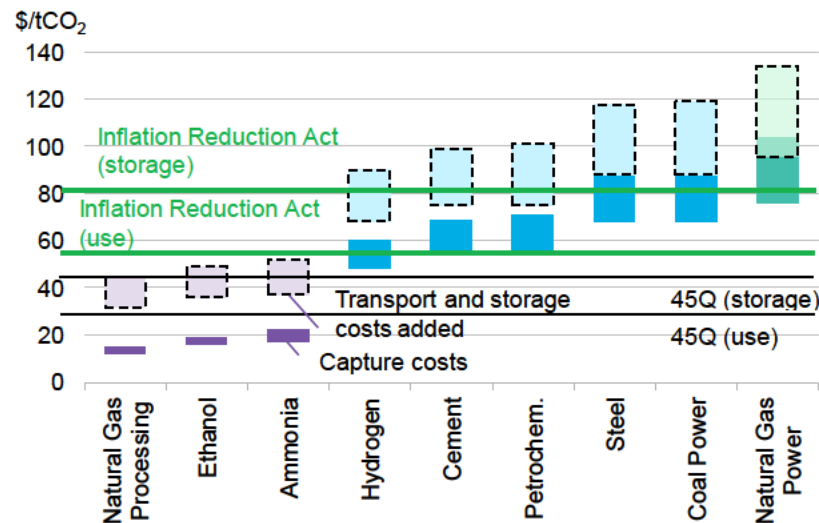
...IRA also brings promise to carbon capture and hydrogen

Effect of production tax credits on US LCOH₂



Source: BloombergNEF. Note: This modeling uses project level assumptions available in BloombergNEF's H2val. Green hydrogen calculation assumes production tax credit of \$3/kg taken over equal production in each year. Blue hydrogen calculations assume projects choose 45Q credit.

Nth-of-a-kind capture costs with previous and new 45Q credit levels

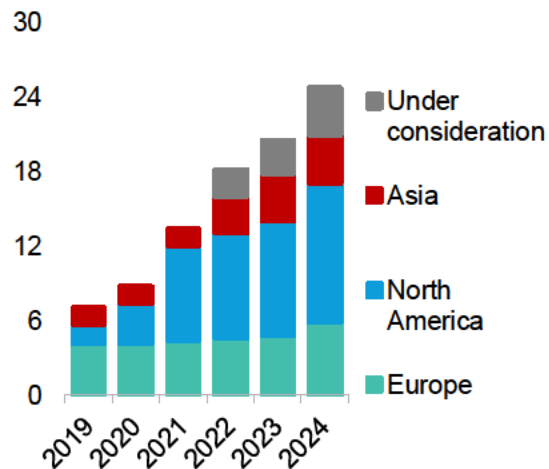


Source: Great Plains Institute, BloombergNEF. Note: Petrochem is petrochemicals, which are used to make plastics.

...and IRA can help other clean fuels too

Renewable diesel production capacity

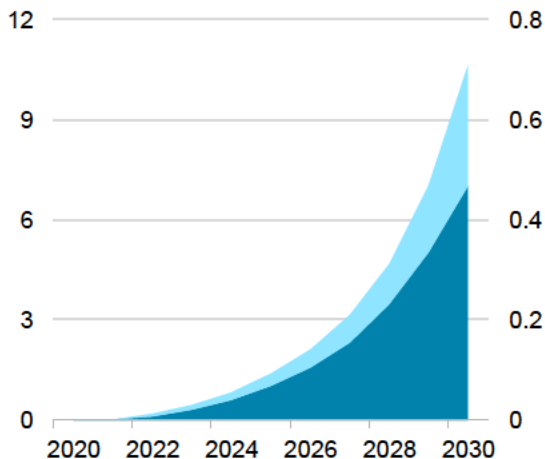
Million tons



Global sustainable aviation fuels demand

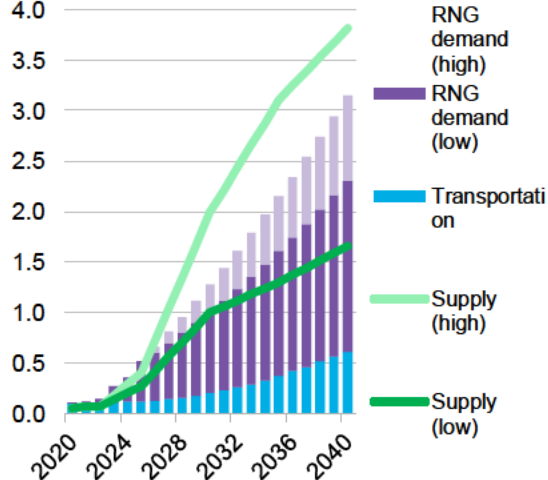
Billion gallons per year

Million barrels per day



RNG supply and demand outlook in U.S.

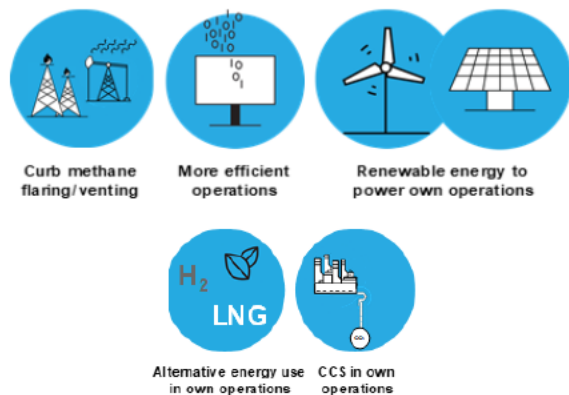
Tcf



Source: BloombergNEF, IEA

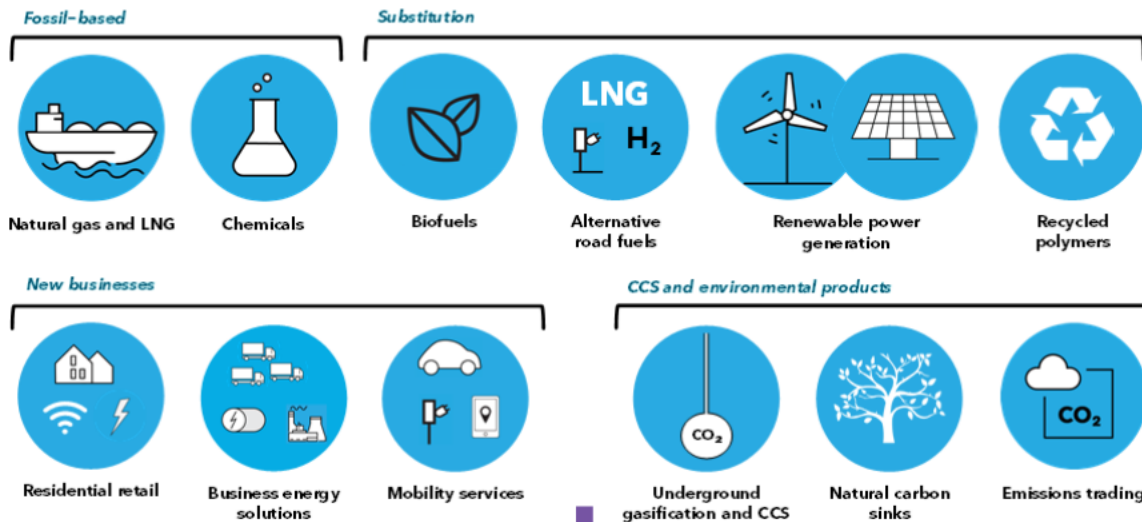
Multiple options for oil & gas firms to invest in the energy transition

Scope 1 and scope 2 decarbonization options



Technology and management

Scope 3 decarbonization options

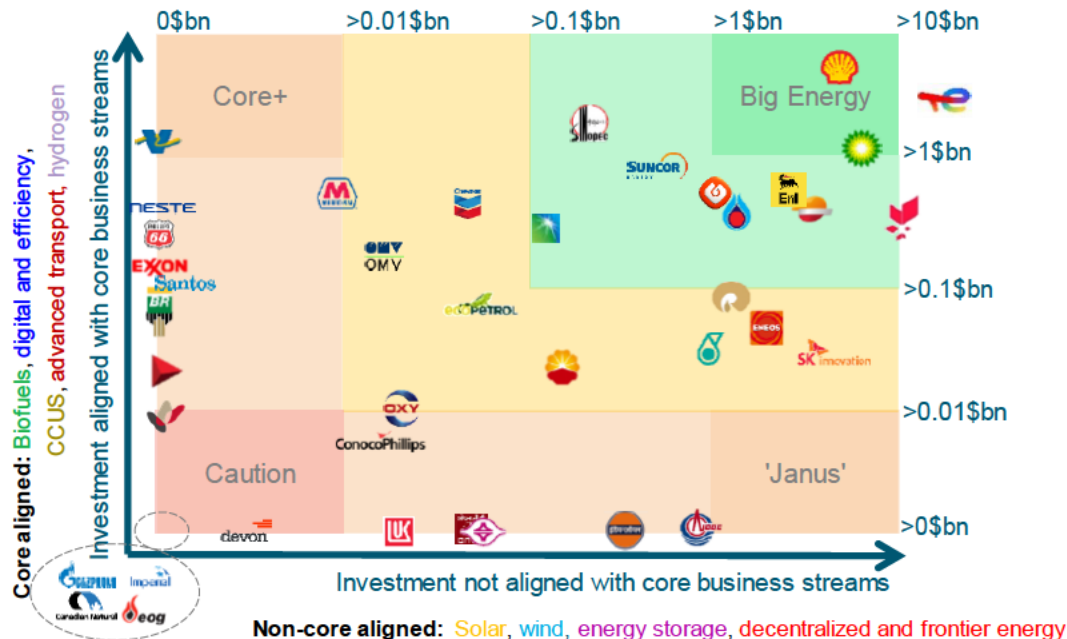


Strategic shift

Source: BloombergNEF

Leading to diverging strategies emerging

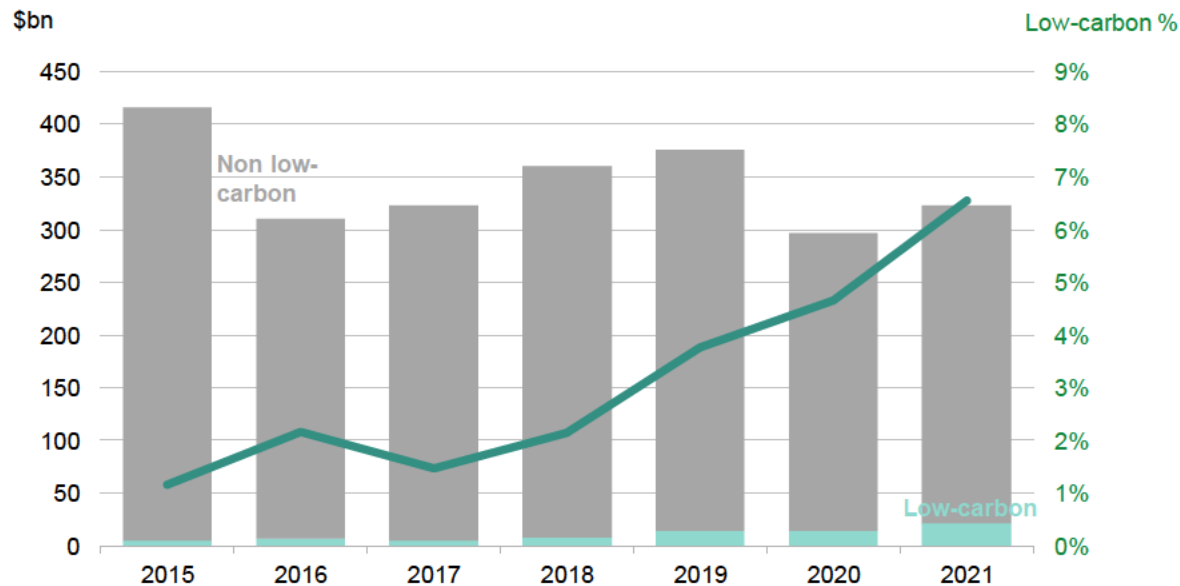
Cumulative low-carbon investment, 2015- 2021



Source: BloombergNEF. Note: Since the previous update, hydrogen investment has been moved to "core aligned". Janus is the roman god of beginnings, usually depicted with two faces, one looking into the past and the other into the future. Logarithmic scale used.

Still, low-carbon investment of oil & gas firms are at an all time high

Low-carbon investment for oil and gas



The share of low-carbon expenditure from the 41 oil and gas companies analyzed has reached **6.6%** of capex, a **new high in 2021**.

2021 saw over **\$21 billion** invested, compared to about \$14 billion across all of 2020, and almost \$17 billion in 2019.

Source: BloombergNEF, Bloomberg terminal, company announcements

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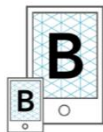
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