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

Annual investments in renewable energy

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

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.

Source: BloombergNEF

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...translating into lower power generation costs

Global levelized cost of electricity (LCOE) benchmarks

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

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

$/W (Real 2021)

2017 2020
1.2 1.52 0.6 0.9
1.44 0.8 0.6 0.8
1.46 0.6 0.5 0.5
1.67 0.6 0.5 0.5
1.61 0.6 0.6 0.5

Capex increase due to supply chain stress

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.


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

![Bar chart showing energy transition investment](chart)

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…
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 |

### Inflation Reduction Act
- $260bn for energy transition
- PASSED, August 2022

- Residential efficiency improvements, $14bn
- Residential energy improvements, $22bn
- Wind, solar and storage tax credits, $128bn
- Manufacturing tax credits, $37bn
- Nuclear credits, $30bn
- CCUS tax credit, $3.2bn
- Clean hydrogen tax credit, $13bn
- Clean vehicles, $12bn
- Clean refueling/recharging, $1.7bn
- Biofuels incentives, $6bn

### Bipartisan Infrastructure Law
- $80bn for energy transition
- PASSED, November 2021

- Advanced reactor program, $3.2bn
- Nuclear credits, $6bn
- Grid enhancement, $28bn
- CCUS demonstration & infrastructure, $11bn
- Hydrogen hubs and demonstration, $9.5bn
- Plugging orphaned wells, $4.7bn
- Electric transit procurement, $7.5bn
- Charging infrastructure, $7.5bn

### U.S. emissions
- Agriculture, 10%
- Commercial, 7%
- Residential, 6%
- Power, 26%
- Industry, 23%
- Transport, 29%

Inflation Reduction Act (IRA) a potential game changer
...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

Post-IRA outlook
Economics-only scenario
Pre-IRA outlook

Post-IRA outlook
Economics-only scenario
Pre-IRA outlook

Pre-IRA outlook
Additional IRA boost

Source: BloombergNEF
…IRA also brings promise to carbon capture and hydrogen

Effect of production tax credits on US LCOH₂

![Graph showing the effect of production tax credits on US LCOH₂.](image)

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

![Graph showing nth-of-a-kind capture costs with previous and new 45Q credit levels.](image)

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
- Under consideration
- Asia
- North America
- Europe

Global sustainable aviation fuels demand

- Billion gallons per year
- Million barrels per day
- Economic Transition Scenario
- Accelerated Policy Scenario

RNG supply and demand outlook in U.S.

- Tcf
- Billion gallons per year
- Million barrels per day
- Incremental RNG demand (high)
- RNG demand (low)
- Transportation
- Supply (high)
- Supply (low)

Source: BloombergNEF, IEA
Multiple options for oil & gas firms to invest in the energy transition

Scope 1 and scope 2 decarbonization options
- Curb methane flaring/venting
- More efficient operations
- Renewable energy to power own operations

Scope 3 decarbonization options
- Fossil-based
  - Natural gas and LNG
  - Chemicals
- Substitution
  - Biofuels
  - Alternative road fuels
  - Renewable power generation
  - Recycled polymers

Technology and management
- LNG
- Alternative energy use in own operations
- CCS in own operations

Strategic shift
- Residential retail
- Business energy solutions
- Mobility services
- Underground gasification and CCS
- Natural carbon sinks
- Emissions trading

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

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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