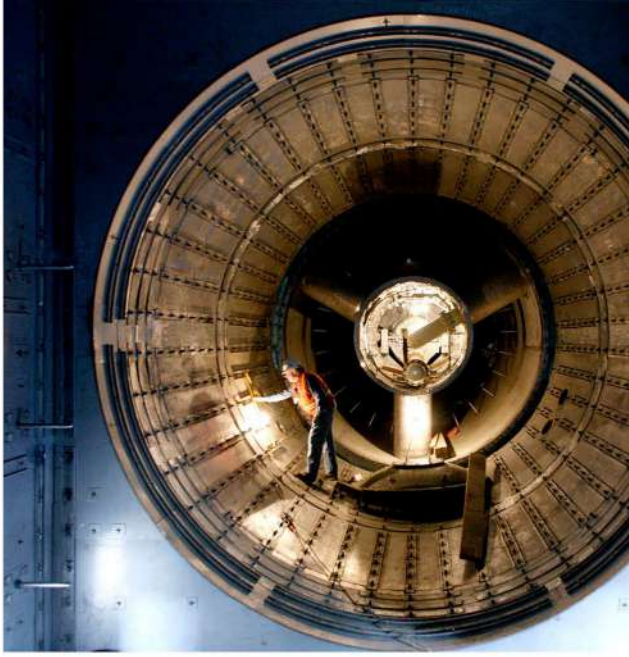

New Energy Outlook

India

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Contents

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Section 1. Summary and key policy recommendations

India's transition to a diversified and low-carbon energy system is already underway, driven by supportive national policies and favorable economics. The national and state governments, businesses and industries, research centres and innovators now have the opportunity to accelerate the deployment of established decarbonization technologies, and the development of others, to reach net zero.

This outlook explores India's energy transition pathways based on the two scenarios developed in BloombergNEF's *New Energy Outlook 2022*: the *Economic Transition Scenario* without emissions constraints, and the *Net Zero Scenario* subject to a carbon budget consistent with meeting the Paris Agreement goal. Using these scenarios, we explore the implications for India's power, industry, transport, and buildings sectors, and chart out the investments and policies needed to help India achieve net-zero emissions.

1.1. Key findings of the ETS

The Economic Transition Scenario (ETS) is BNEF's baseline assessment of how the energy sector might evolve as a result of cost-based technology changes, covering the power, transport, industry and buildings sectors. This explorative scenario developed for the *New Energy Outlook* employs a combination of near-term policies and market analysis, least-cost modeling, consumer uptake and trend-based analysis to describe the deployment and diffusion of commercially available technologies in the absence of new policy regimes, and uncover the underlying economic fundamentals of the energy transition. It is consistent with a 2.6C global warming outcome.

BNEF's base case for India shows **energy-related emissions rising by 21%** between 2022-50.

- **Power:** It sees India's power sector being driven mostly by renewables. Falling solar and energy storage costs continue to put pressure on the country's ageing coal fleet, which today remains the backbone of the power mix. As power demand rises sharply in India, a mix of competitive renewables, balanced with flexible generation technologies, emerges as the lowest-cost portfolio to reliably keep the lights on. Total **solar, wind and batteries installations reach 2,165 gigawatts (GW)**[1] by mid-century – more than 20 times as much as in 2021. Non-fossil fuel sources form 80% of the electricity generation in 2050. As a result, emissions from the power sector fall 29% from 1,385 million metric tonnes of carbon dioxide (MtCO2) in 2021 to 983MtCO2 in 2050 – the biggest contributor to India's economy-wide emissions reduction during this period.

[1] Solar capacity values are in DC, unless specifically mentioned as AC

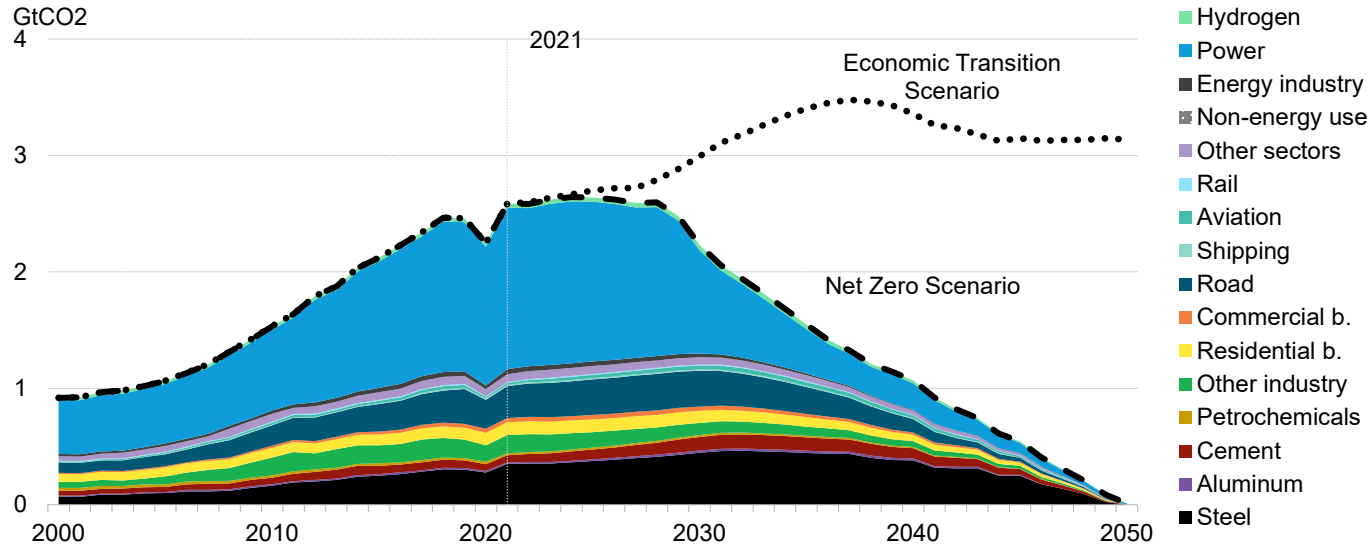
- **Fossil fuels:** The use of fossil fuels continues to rise under our base case, reaching 36,543 petajoules (PJ) by 2050, compared to 30,448PJ in 2021. Coal use peaks in 2037, reaching 1,098 million metric tons of coal (Mt of coal) and falling to 970Mt by 2050 – a 20% jump from 2021. Oil sees a similar trend, peaking in 2038 at 270 million tons of oil equivalent (mtoe) and falling to 249mtoe by 2050 – 28% higher than 2021. Gas use continues to decline to 2050, falling 6% from its low base in 2021 of 52 billion cubic meters (bcm). The relevance of gas in the electricity generation mix, which was at a high of an 11% share in 2000, falls to 1% by 2050.
- **Transport:** Under the ETS, electric two- and three-wheeler sales are set to reach more than 24.4 million and 2.7 million units, respectively, in 2050, compared to 233,971 and 384,063 units in 2021. Despite an increased adoption of electric vehicles (EV) from the 2030s in road transport, **direct transport-related emissions from road, aviation,shipping and rail sectors rise 38%** to 427MtCO2 by 2050 from 309MtCO2 in 2021. Continuously rising demand for air travel, coupled with the relatively poor competitiveness of clean fuels or electrification based on current technology costs, means emissions from aviation rise eightfold by 2050.
- **Industry:** BNEF finds that emissions from steel, aluminum, petrochemicals and cement continue to rise under the base case. Steel, India's largest emitting industrial subsector, sees emissions almost triple between 2021 and 2050 to **948MtCO2**, from 351MtCO2. Coal consumption in steel-making sees a similar growth, reaching 399 million metric tons (Mt) of coal by mid-century. Coal use in the cement industry, the second-largest emitting subsector, grows fivefold to 83Mt of coal by 2050 compared to 2021. Emissions from the cement sector rise by five times and reach 289 MtCO2 by mid-century.
- **Investment:** Total investment in India's energy system is nearly **$7.6 trillion** between 2022 and 2050 in the ETS, representing $262 billion each year on average. The rising uptake of EVs in this period represents a significant investment opportunity, amounting to $1.9 trillion. As India's power system grows while decarbonizing between 2022 and 2050, $1.3 trillion is invested on the power grid and $1.8 trillion on power capacity. This amounts to $106 billion per year on average invested in power capacity and the grid to 2050. Capital requirements for fossil fuel processes[2] add up to $1.2 trillion to 2050, representing 16% of overall investments.

1.2. Key findings of the NZS

The Net Zero Scenario (NZS) is based on the global *New Energy Outlook*. This normative climate scenario is aligned with the Paris Agreement to keep global warming well below 2C. It describes a credible stretch to reach net-zero emissions in 2050, with no overshoot or over-reliance on net-negative carbon removal technologies post-2050. The NZS uses sector-level carbon constraints for an orderly transition and deploys technologies with credible cost pathways.

[2] Fossil fuel processes refers to upstream, midstream and downstream components of coal, oil and gas processes.

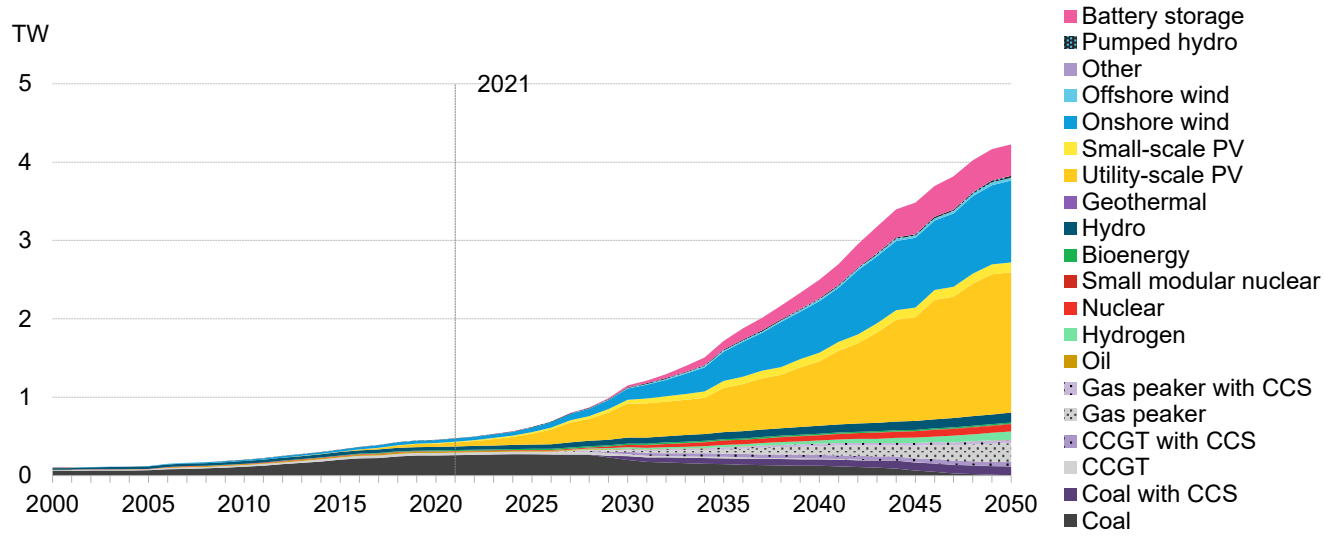
Figure 1: India's energy-related emissions and net-zero carbon budget



Source: BloombergNEF. Note: Commercial b. - Commercial buildings, Residential b. - Residential buildings.

- **Power:** A rapidly decarbonized power system becomes the backbone of India's energy transition in the NZS. Higher power demand from increased electrification in the Net Zero Scenario means **India reaches 3,000GW of wind and solar by 2050** – around 1,300GW more than in the ETS. Investment in power system flexibility is also crucial to back up and enable this rapid electrification and decarbonization of the power mix. Some 572GW of clean dispatchable capacity – in the form of batteries, pumped hydro, hydrogen-fired gas plants, and peaker gas plants paired with carbon capture and storage (CCS) – are operational under the NZS in 2050, 77GW more than in the ETS. Cumulatively, India reaches 114GW of coal paired with CCS, 54GW of gas with CCS, and 97GW of nuclear capacity.

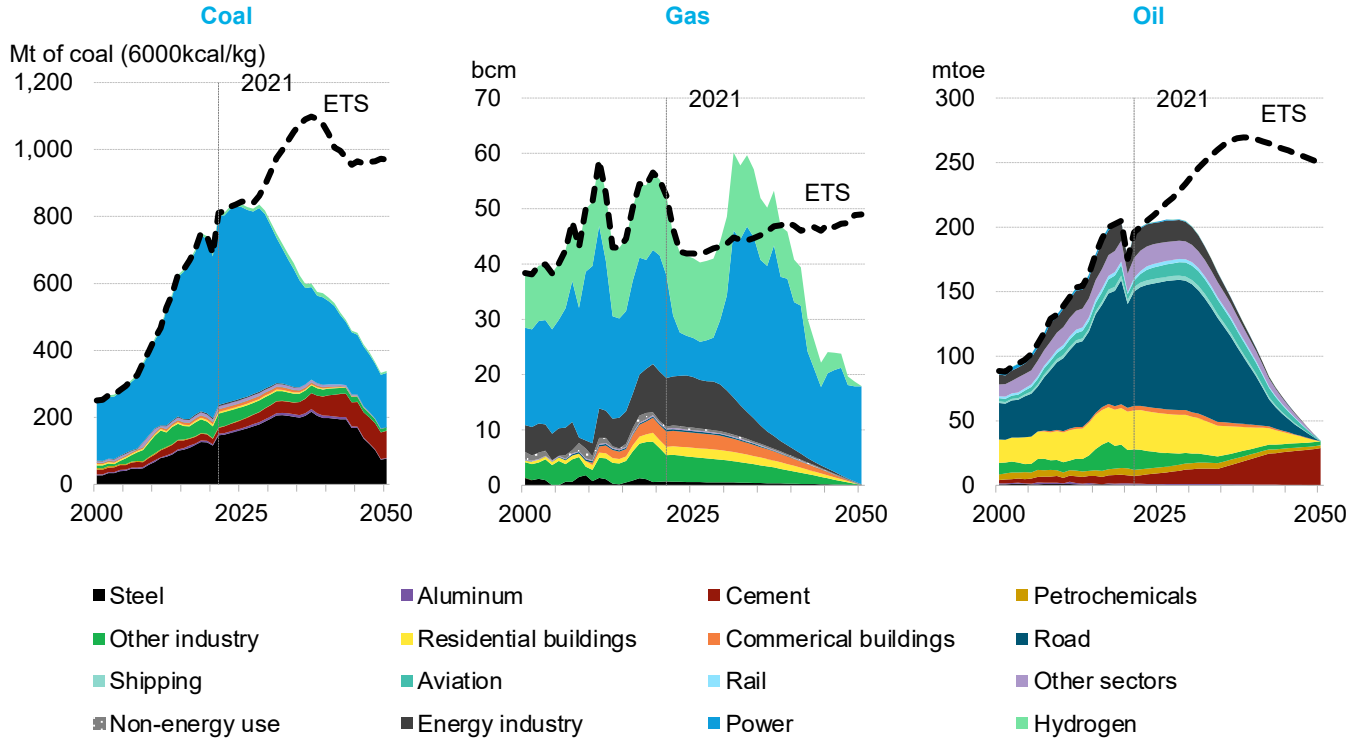
Figure 2: Installed generation capacity and batteries in India by technology/fuel, Net Zero Scenario



Source: BloombergNEF. Note: Includes electricity generation for hydrogen production. Note: CCS – carbon capture and storage, PV – Photovoltaic, CCGT – combined cycle gas turbine.

- **Fossil fuels:** India's reliance on fossil fuels continues to 2050 but their significance is largely muted. The share of abated fossil fuel use rises from 11% in 2030 to nearly all of the fossil fuel use in 2050. Under BNEF's NZS, India could stop imports of all fossil fuels by 2050. India consumes around 339Mt of coal in 2050 under the NZS, equivalent to 42% of demand in 2021. India's oil and gas use decline by 83% and 65% from 2021 levels under the NZS. Most of the demand destruction for liquid fuels arises from the complete electrification of the road transport sector. Domestic coal availability may not be a significant concern as the country had more than 360,000 Mt of coal reserve in March 2022 and cumulative coal use between 2021 and 2050 is 18,868Mt under the NZS. India's remaining domestic oil and gas reserves were around 6,000 mtoe in 2018 while total consumption between 2018 and 2050 under the NZS is 5,901 mtoe and 9,257 mtoe under the ETS. Hence, the NZS pathway appears more in line with India's aspiration to become energy independent by 2047.

Figure 3: Fuel use in India by sector, Net Zero Scenario and comparison with ETS

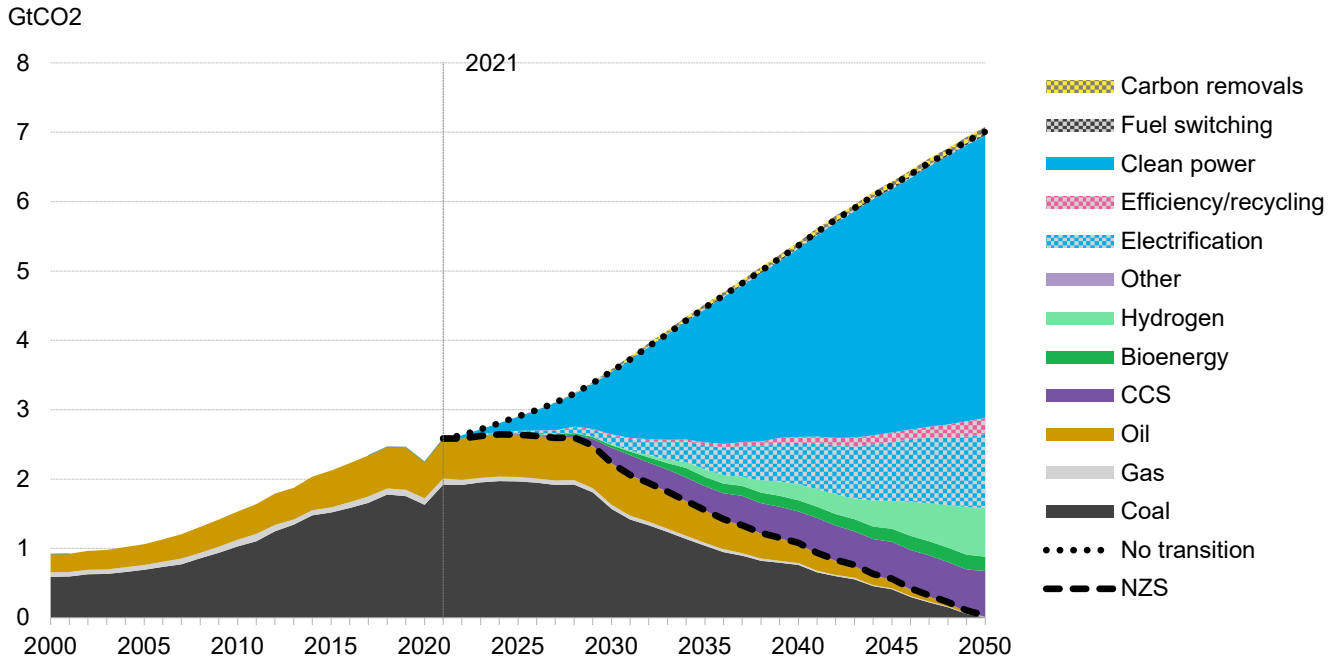


Source: BloombergNEF. Note: ETS – Economic Transition Scenario.

- **Transport:** Road transport electrification under the NZS picks up momentum much faster than in the ETS, accounting for all of India's emissions abatement in the sector over 2022-50. To reach net zero, **the share of EVs in new passenger vehicle sales reaches 100% by 2040** – a milestone not achieved in the ETS before 2050. India relies heavily on EV adoption in passenger and commercial transport to displace carbon emissions from internal combustion engines.
- **Industry:** **Steel sector emissions peak in the early 2030s, reaching 463MtCO2** before declining till 2050. Emissions from the cement industry, too, peak around the same time at 120MtCO2. Coal consumption in steel making declines to 77Mt, or half of that in 2021; meanwhile coal consumption in the cement industry stays similar to ETS, albeit paired with carbon capture and storage technologies.

- **Carbon capture and storage:** Our modeling suggests economic deployment of CCS technologies as a cost-effective way to spur the decarbonization of domestic industries, primarily in the cement industry. CCS gains in importance in the 2030s, as tightening sector carbon budgets force hard-to-abate sectors to tackle unabated fossil fuel plants through retrofits or clean greenfield projects. CCS accounts for 10% of total emissions abated over 2022-50 with applications in industry and the power sector. As the carbon budget bites, the annual rate of emissions captured by CCS grows from very low levels in 2022 to 221MtCO2 in 2030, 465MtCO2 in 2040, and 664MtCO2 in 2050. **India's power sector continues to consume coal even in 2050 in the NZS**, with 162Mt of coal (6000kcal/kg) consumed – nearly 40% of the amount used in the ETS. This is due to the presence of CCS-paired coal power plants in the power sector under the NZS.

Figure 4: India's carbon emissions reductions from fuel combustion, Net Zero Scenario versus no transition scenario



Source: BloombergNEF. Note: The 'no transition' scenario is a hypothetical counterfactual that represents a world in which no further actions are taken in the power and road transport sector to reduce carbon emissions, keeping the current fuel mix constant at 2021 levels and growing proportionally under the same ETS demand forecast. In industries, most sectors continue to use the same fuel mix through 2050 in the no transition scenario. NZS – Net Zero Scenario, CCS – Carbon capture and storage.

- **Hydrogen:** Domestic demand for hydrogen increases to **53MtH2** by 2050 under NZS, about a 10-fold increase from today. New demand for hydrogen is driven by rapid adoption of hydrogen-fired direct-reduction furnaces in the steel industry, taking the demand to 33MtH2 in 2050. Other significant sectors include 7MtH2 for energy industry own-use[3], and 5MtH2 for power production as critical back-up. In transport, some 3MtH2 is used either in its pure form or as derivative fuels such as methanol or ammonia to propel aircraft and vessels over medium to long distances. Today, most of the hydrogen in India is produced from unabated

[3] 'Energy industry' includes legacy uses (eg, as feedstock for ammonia and methanol production or in oil refining) as well as own use for energy producing industries, such as process heating, lighting, and equipment operations

fossil fuels. By 2050, hydrogen produced with flexible grid-connected electrolyzers powered predominantly by renewables becomes the dominant pathway in India under the NZS.

- **Investment:** To reach net-zero emissions by mid-century, a total of **$12.7 trillion** must be invested in India's energy system on the demand and supply side, representing an average of $438 billion per year. The increasing adoption of electrification in industrial processes, EVs and electrolyzers for hydrogen production requires a commensurate expansion of India's power grid. Under the NZS, around **$2.1 trillion** of investment flows toward the grid in India, doubling the length of the network to over 20 million kilometers from 2022 to 2050.

1.3. Policy considerations

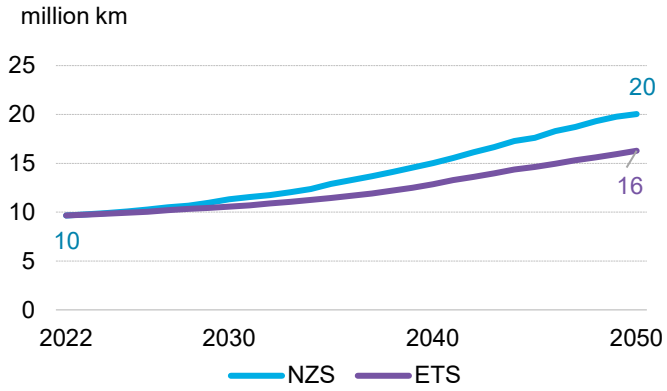
Our Net Zero Scenario and Economic Transition Scenario lead to very different outcomes for India's energy transition, and by extension for the global climate crisis. The Net Zero Scenario, by limiting global warming to 1.77C, meets the headline goal of the Paris Agreement, while the Economic Transition Scenario breaches it by leading to 2.6C of warming.

To bend the curve toward the Net Zero Scenario, and toward global net zero by 2050, we identify **five key policy action areas** that should be addressed in the immediate future. There is little time to waste, as the transition must accelerate immediately, and the ETS and NZS trajectories start to diverge as soon as 2023.

Scale up grid investments to enable a renewables-heavy power system

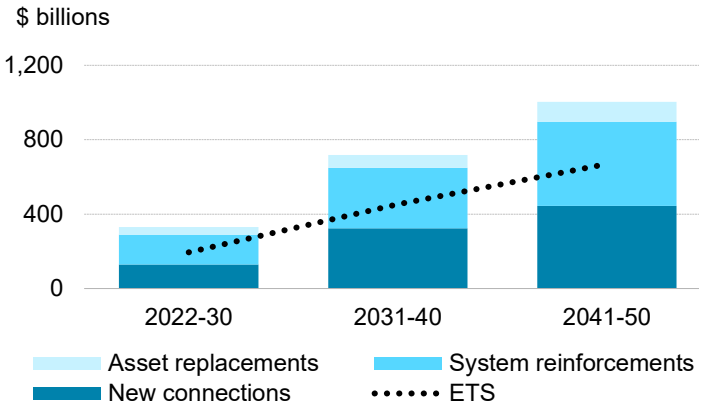
Electricity network operators face challenges from the rapid expansion of variable renewables on the supply side and evolving demand in the form of air-conditioning, electric vehicles and production of green hydrogen. Therefore, higher grid investments are needed to prepare India for a net-zero power system that relies heavily on renewables.

Figure 5: India's grid length by scenario



Source: BloombergNEF. Note: NZS – Net Zero Scenario, ETS – Economic Transition Scenario.

Figure 6: India's grid investment by driver, Net Zero Scenario



Source: BloombergNEF. Note: ETS – Economic Transition Scenario.

Grids need $2.1 trillion of investments to support the power sector

Under NZS, India will need $2.1 trillion of grid investment over 2022-2050, of which $1.2 trillion is spent to sustain the existing grid and replace existing assets, and $897 billion to expand the grid for new electricity consumption. In the NZS, the length of the grid doubles to over 20 million kilometers between 2022 and 2050. Over 43% of total grid investments are needed for long distance transmission of power, and the remainder for the distribution segment that supplies electricity to end users. The government needs to consider reforms to enable more grid investments, particularly from the private sector.

Scale up investments in renewables

India's domestic banks alone may not be able to match the scale or speed required to meet financing requirements under the NZS. India's cumulative investments in expanding the power generation capacity reaches $2.8 trillion by 2050 under the NZS, of which $2.7 trillion is spent on low-carbon sources. This translates to an average of more than $90 billion of investments annually. Financing for fossil fuel energy supply falls by 55% in NZS, compared to ETS.

An average annual investment of $90 billion is needed until 2050 for building low-carbon power capacity

Therefore, India needs to tap into all sources of financing. Most Indian power producers rely on commercial loans and some recourse-based debt for building projects, and green bonds are increasingly being used to refinance operating projects. Eight of the global top 10 pension funds and sovereign wealth funds are yet to invest in India's renewables sector. Investments by India's pension and life insurance funds are strictly regulated and the institutions are not allowed to invest in renewables. Therefore, the government needs to issue favourable policies and international investors should explore more thoroughly the opportunities for transition investment in India.

Figure 7: India's investment in energy supply by timeframe, Economic Transition Scenario

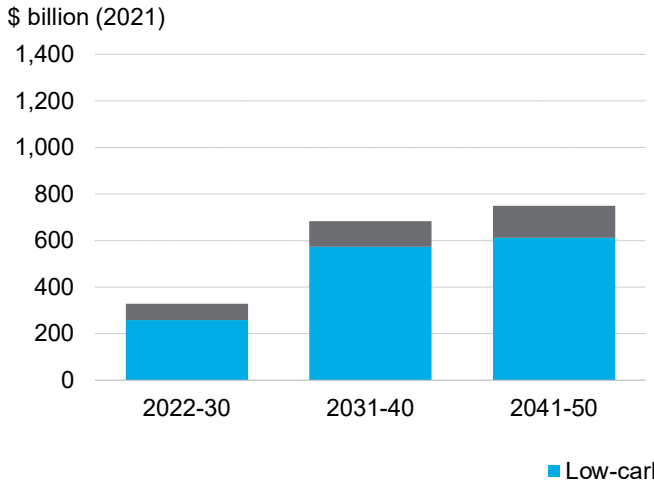
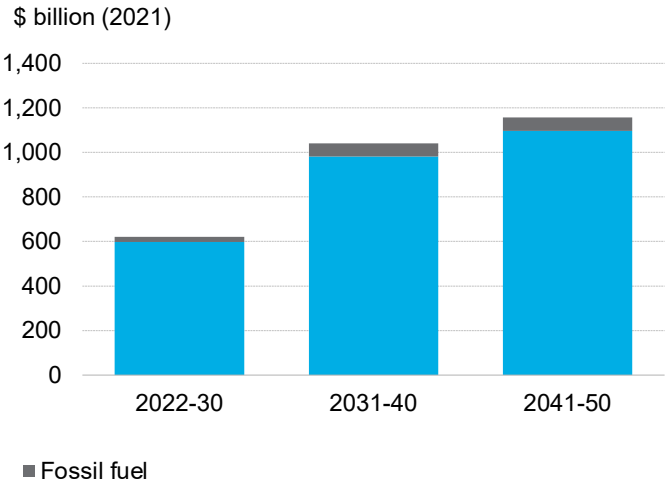


Figure 8: India's investment in energy supply by timeframe, Net Zero Scenario



Source: BloombergNEF.

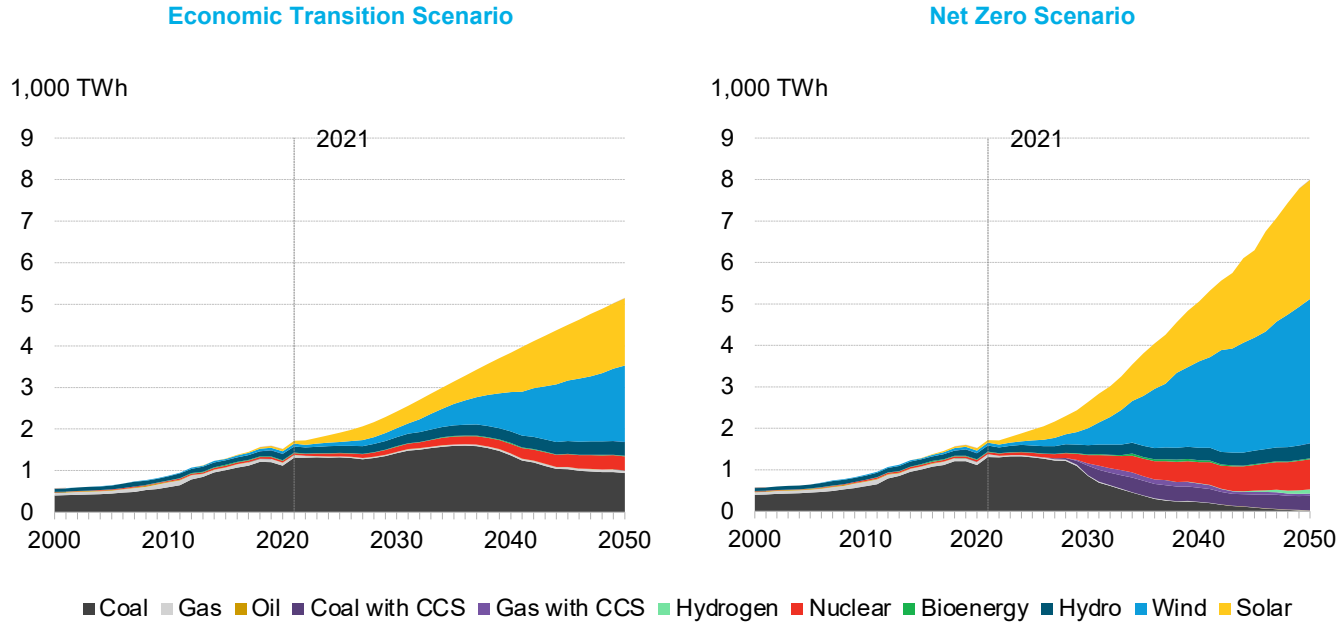
Reduce reliance on fossil fuel plants and boost carbon capture technologies

India added 0.6GW of coal power projects in 2022 compared to 15GW of non-fossil capacity. Our NZS shows India can reduce its reliance on unabated coal power plants and invest to capture carbon from any residual fossil-based power projects. Up to 114GW and 54GW of CCS-paired

coal and gas capacity help decarbonize India's energy sector under our NZS; yet despite this opportunity, carbon capture technologies have not seen significant policy support or development in India.

To accelerate the march towards net-zero emissions, the country needs a CCS/CCUS policy framework that incentivizes setting up a manufacturing base as well as subsidizes consumption of by-products emerging from the CCUS plants. In addition, identifying areas and market platforms for sale of captured CO2 or converted products, such as urea emerging from CCU plants, can improve the economic case for carbon capture technologies.

Figure 9: Electricity generation in India under different scenarios



Source: BloombergNEF. Note: CCS – Carbon capture and storage.

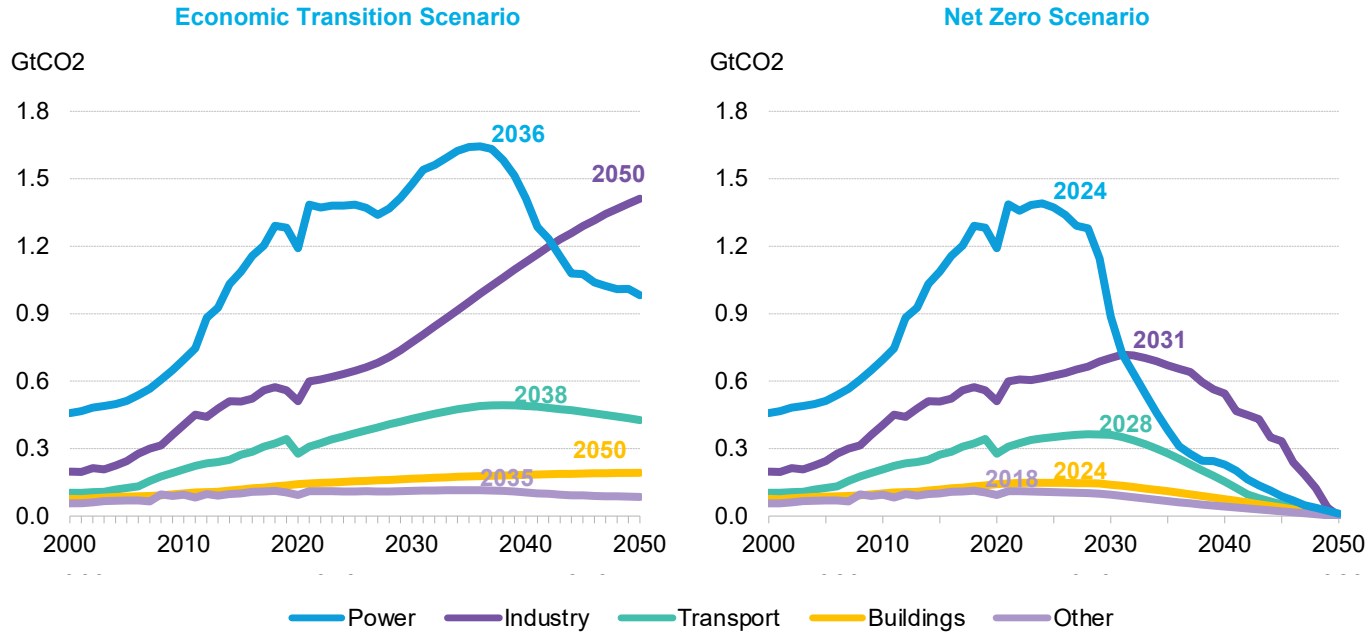
Aim for peak industrial emissions within a decade

Accelerating green hydrogen and CCS is essential for ensuring an early peak for industrial emissions

Industry emissions are set to surpass the power sector by the early 2040s under our base case. Green hydrogen and CCS could play primary roles in decarbonizing the industrial sector. BNEF modelling shows that 54% of emissions abatement between 2022 and 2050 can come from the use of green hydrogen in making steel in the NZS. Whereas CCS helps reduce 56% of emissions from cement manufacturing.

While India has agreed to reach net-zero emissions by 2070, these targets still need to be translated into actions for the companies operating in various industrial sectors. Sector-specific targets – particularly for the various industrial sub-sectors – will give policy direction and timelines for emission reduction by corporates. This can persuade industry players to plan their own decarbonization roadmaps. Under the NZS, India's industrial sector emissions peak in 2031 and begin a steep decline in the mid-2030s as the use of hydrogen and carbon capture increase to decarbonize steel, cement and petrochemical production. Even though the power and transport sectors have a viable path for decarbonization, they too need to achieve peak emissions as early as 2024 and 2028 to reach net-zero.

Figure 10: Emissions by sector and peak year, India



Source: BloombergNEF. Note: Labels show year of peak emissions. 'Other' includes agriculture, forestry, fishing, energy industry own energy consumption, and other final energy consumption no further specified.

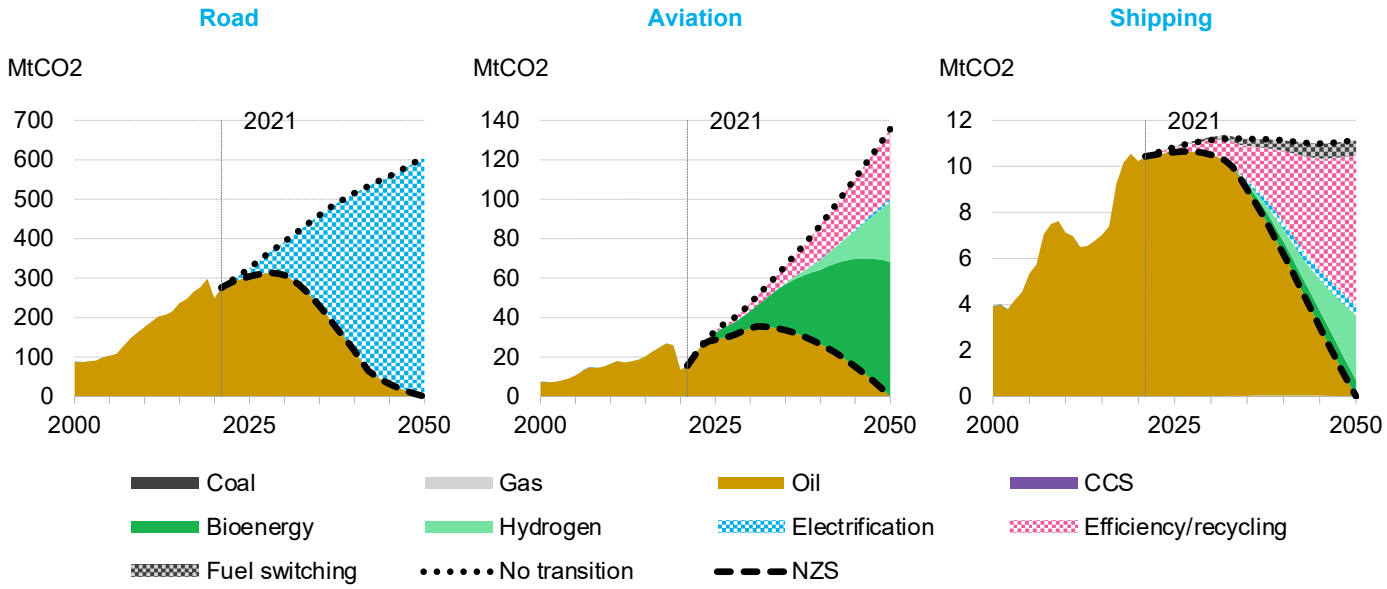
Full electrification holds the key to eliminating road transport emissions

Road transport is the largest emitter in the transport sector, surpassing shipping and aviation. If left unchecked, emissions could rise to nearly 600MtCO2 by 2050, according to BNEF modeling. Unlike in other sectors, where there could be multiple pathways to achieving net zero emissions, the easiest way to decarbonizing road transport lies in rapid and complete electrification.

A rise in electrification needs to be matched with charging infrastructure that provides access to clean, affordable power. Electricity demand from commercial and passenger vehicles (including India's growing fleet of electrified two- and three-wheelers) reaches 629TWh in 2050, or less than 10% of total demand under the NZS. While the technology platforms to achieve this outcome are increasingly clear, providing electricity to customers at an affordable rate could be daunting.

India had 26,700 EV chargers at the end of 2022 and wants to scale the number up to 365,000 with at least one charging station for every 3 square kilometers.

Figure 11: India's end-use CO2 emissions in transport subsectors by type/technology, Net Zero Scenario



Source: BloombergNEF. Note: y-axes differ in scale. Bioenergy in Aviation is sustainable aviation fuel. NZS – Net Zero Scenario, CCS – Carbon capture and storage. Efficiency gains in shipping sector come from operational improvements (lower travel speed to improve fuel economy) and technical improvements (hull retrofits, turbulence/drag reduction and better engine design). Operational improvements are expected to deliver greater gains than technical enhancements.

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Section 2. Introduction

India has a target of achieving net-zero emissions by 2070. In the interim, the country wants to reduce the emission intensity of its GDP and also have 50% of its power generation capacity based on non-fossil fuel sources by 2030. India's power sector is decarbonizing rapidly but other areas of the economy need more support.

2.1. National context

India's decarbonization target

India announced its net-zero target for 2070 at the 2021 COP26 summit in Glasgow. This was aside from other short-term commitments geared toward decarbonizing the power sector such as setting up 500GW of non-fossil fuel based cumulative power generation capacity by 2030. Setting another target, India on Independence Day in 2021 declared the intention to become energy self-reliant by 2047, when the nation marks 100 years of independence.

India wants 500GW of non-fossil-fuel based cumulative power generation capacity by 2030

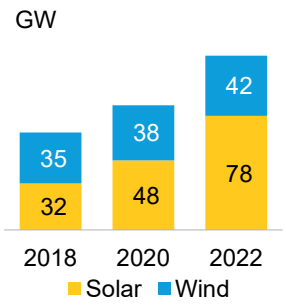
Less than a year later, India revised its 2030 Nationally Determined Contributions (NDCs), appending the original NDC with a new target of committing to 50% of **cumulative power generation capacity** from non-fossil fuel based energy sources by 2030. India also intends to reduce its **emission intensity of GDP** by 45% by 2030 compared to a 2005 baseline, up 10-12 percentage points from its previous commitment made in 2015. Furthermore, climate action has been turning up at the state and city levels with Mumbai, the most populous city in India, announcing its commitment to reach net zero by 2050. State-level climate action plans are under discussion too. At the same time, sectoral targets have begun to emerge, with the Ministry of Steel having set a net-zero commitment by 2070.

Power is the largest emitting sector, but also has a clear path to decarbonization

India's power system remains primarily coal-driven despite record renewables addition

India has seen a significant amount of renewable capacity deployment, with 53GW of solar and wind added between 2018 and 2022. A record high of 16GW of utility-scale solar was installed in 2022 alone. Yet solar and wind still account for less than a quarter of the power generation capacity (including pumped hydro) in 2022. The trend is also seen in the energy generation mix, with coal being the backbone that accounts for nearly three-quarters of the total power generated in 2022. However this will change quickly as renewables are set to overtake thermal power capacity by the end of this decade, as per the Central Electricity Authority's (CEA) Report on Optimal Generation Capacity Mix for 2029-30.

Figure 12. Installed solar and wind capacity



Source: BloombergNEF. Note: Solar capacity values in DC.

National government to auction 250GW of renewables by March 2028

To meet its NDC commitments, the national government has announced plans to tender 50GW of renewable capacity every fiscal year from FY 2023 to FY 2028 (India's fiscal year is from April to March). Standalone wind auctions will represent at least 10GW of the total 50GW tenders, giving a boost to the wind sector. At the same time, coal power capacity expansion is limited to projects that are already under construction – a total of 26GW as per the CEA.

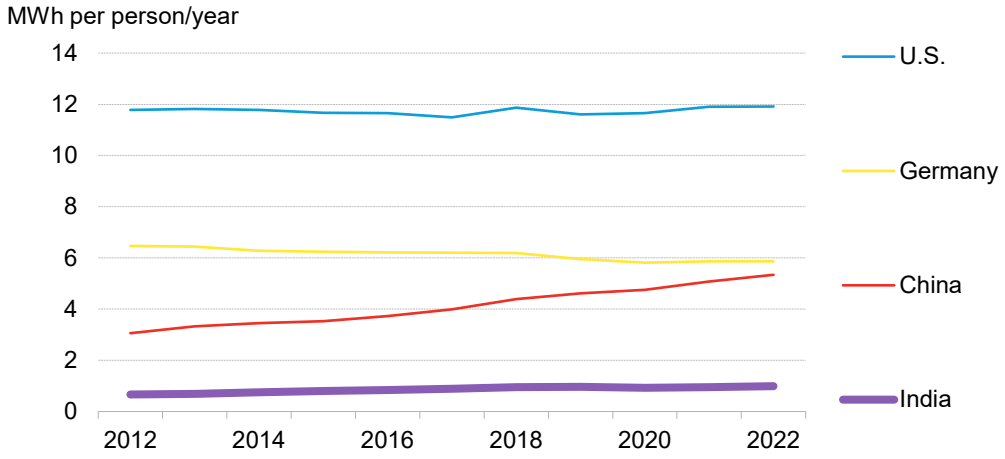
The need for maintaining grid balancing has risen owing to rising renewable penetration. Auctions, a driving force for the renewable build-up, have witnessed an increasing trend in complexity in order to improve overall project capacity factors and offer flexible power supply[4]. Recent auction projects incorporate flexible capacities, such as grid-scale batteries and pumped storage capacity, to deliver round-the-clock or peak power.

Growing electricity demand requires grid expansion while also decarbonizing

Per-capita electricity consumption has grown by 50% in the last decade

Per capita gross electricity demand in India grew by nearly 50% between 2012 and 2022 to about 991 kWh per person per year (Figure 13). India's per capita electricity usage continues to remain below major developing economies like Brazil, owing to its higher economic reliance on agrarian, low-energy intensity manufacturing and a services-based economy. Population and economic growth over the next three decades mean India's power system will need to expand and decarbonize simultaneously and at a rapid pace.

Figure 13: Per-capita gross electricity demand across major economies



Source: BloombergNEF, World Bank

India's transport electrification is steadily growing, but needs to speed up

Policy support shifting from demand side to supply side

India's population aged between 16-59 will grow by 13% between 2022 and 2040, the United Nations says. The country's GDP per capita will triple in the same period. These rises in wealth and working-age population will drive annual passenger vehicle kilometers up by 2.5 times to over 1 trillion in 2040, according to BNEF's Economic Transition Scenario.

India's electric vehicle sales are growing across all segments, supported by policy, favorable operating costs, more model launches and falling technology costs. Policy support in India for

[4] See *Renewables Meet Peak Power Demand in Latest India Auction* (web | terminal)

EVs remains strong. In addition to offering demand-side support, the government is now focusing on strengthening local supply chains by subsidizing production.

The Faster Adoption and Manufacturing of Electric Vehicles II (FAME II) scheme launched by the national government in 2019 has been extended till March 2024. This scheme, intended to ramp up EV penetration, has seen some success, becoming an important driver for the two-wheeler transition.

Electric two- and three-wheelers are the fastest growing segments and over the next two decades nearly all sales will be electric. Passenger EV sales have tripled annually in the three years to 2022. Private sales rose due to greater interest in compact SUVs as well as increasing availability of models. Demand from shared mobility services (taxi, ride-hailing, car rentals, government purchases) has also helped boost passenger EV sales as demand for public transport increases steadily. In contrast, bulk procurement tenders, where demand is aggregated across multiple states, are propelling annual electric bus sales. Commercial vehicles will be the hardest to electrify and will need government support to gradually decarbonize.

India has set ambitious hydrogen targets and it has its work cut out to turn them into reality

The National Green Hydrogen Mission intends to scale India's annual green hydrogen production to 5Mt-H2 by 2030

The national government has ambitious intentions in mainstreaming green hydrogen in line with its intent to become energy independent by 2047 and meet its decarbonization commitments. The National Green Hydrogen Mission sets a goal of producing at least 5 million metric tons of hydrogen (Mt of H2) annually by 2030, a figure equivalent to the current demand for hydrogen in India. It also intends to capture export markets as they mature and possibly reach a potential 10 Mt of H2 per year.

The national government alone has set aside $2.4 billion for the mission. Of the total allocation, 88% is directed toward providing subsidies to bring down the cost of green hydrogen production under the Strategic Interventions for Green Hydrogen Transition (SIGHT) program. The rest of the outlay is allocated for developing green hydrogen hubs, pilot projects and research and development. The mission is expected to bring in nearly $100 billion of total investment as well as contribute toward adding 125GW of renewable capacity by 2030. Waiver of inter-state transmission charges for green hydrogen/ammonia production is expected to improve viability of projects by lowering the cost of building renewable energy and electrolyzer plants in different locations. As per the document, the first phase of the Hydrogen Mission, up to March 2026, is expected to lay the initial foundations through technology advancement and pilot projects across steel, heavy transport and shipping. The focus will shift toward accelerating growth and ensuring competitiveness of green hydrogen with fossil fuels in the second phase. Corporate activity has been buzzing in the relatively nascent sector, and India's government-owned oil and gas majors have initiated actions on their green hydrogen plans.

The mission could bring in $100 billion of investments and 125GW of renewable capacity

India's focus on localization of clean-tech manufacturing

India has been focusing on boosting indigenous manufacturing through the national government's production-linked incentive (PLI) schemes. The PLI initiative has been deployed across multiple sectors, aimed at creating national champions that can set up large-scale domestic manufacturing capacity. The incentives under the scheme are linked to actual sales and local value addition, while also factoring in product performance. The scheme also sees a tapering of incentives provided over the years, with the intent being to wean firms off state support and encourage competitiveness.

Figure 14: India's financial outlay for the PLI schemes

Source: BloombergNEF.

India's manufacturing incentives in four energy transition sectors

PLIs for localization of the PV supply chain[5] have seen two successful auctions, which are expected to add 48GW of module manufacturing capacity over the next 3 years. The auctions had 13 distinct winners, with 4 of them to set up 24GW of fully integrated capacity.

In 2021 there were two PLI scheme announcements aimed at catalyzing the EV local supply chain. A $3.5 billion scheme for the automotive industry also covers EV manufacturers focused on domestic production of battery and fuel-cell electric vehicles. Local manufacturing of EVs is also set to advance from the $2.3 billion PLI scheme aimed at establishing 50GWh of advanced cell chemistry battery manufacturing set up[6].

The PLI scheme for boosting green hydrogen in India has been allocated $2.4 billion by the national government, of which $1.6 billion aims to incentivize green hydrogen production and another $0.6 billion for electrolyzer manufacturing. Incentives will be disbursed to the lowest bidders for an aggregated green hydrogen demand, with the production route also covering biomass pathways. Eligible bidders for setting up local electrolyzer manufacturing will be assessed on selection parameters such as local-value addition, performance of electrolyzers and bid capacity.

2.2. Scenarios and outlooks at BloombergNEF

This research forms part of the library of energy transition scenarios at BNEF.

The core scenario used in BNEF research is our Economic Transition Scenario (ETS). This scenario employs a combination of near-term market analysis, least-cost modeling, consumer uptake and trend-based analysis to describe the deployment and diffusion of commercially available technologies in the absence of new policy regimes and uncover the underlying economic fundamentals of the energy transition.

In addition to the ETS, BNEF develops a range of global, sector-based, and country-level scenarios. This includes a set of normative climate scenarios that investigate pathways to reduce greenhouse gas emissions in line with the Paris Climate Agreement.

[5] See *India's $2.4 Billion Solar Manufacturing Tender Decoded* (web | terminal)

[6] See *India EV Production Incentives to Aid Tata and TVS* (web | terminal)

Scenarios are future-focused simulations combining several uncertain parameters into an internally consistent narrative. They are predominantly used for medium-to-long-term investigative studies and may also include sensitivities to key variables. Scenarios differ from forecasts, which are usually shorter-term predictions of what we think will happen.

Scenarios in the New Energy Outlook

New Energy Outlook 2022 (web | terminal)

This report builds and expands on results from our *New Energy Outlook*, published in November 2022. The report presents country-level harmonized net-zero pathways for nine economies that show what a credible pathway to net zero could look like.

The *New Energy Outlook* (NEO) is BloombergNEF's long-term scenario analysis on the future of the energy economy covering electricity, industry, buildings and transport and the key drivers shaping these sectors until 2050. As part of NEO, we use our in-house NEFM-2 power model to determine a least-cost system that can reliably meet electricity demand throughout the year.

The *New Energy Outlook 2022* covers two main scenarios:

- The **Economic Transition Scenario** (ETS) is our baseline assessment of how the energy sector might evolve from today as a result of cost-based technology changes. The ETS combines near-term market activity, the uptake of new consumer-facing energy products, least-cost system modelling and trend-based analysis to describe the deployment and diffusion of commercially available technologies. Technology transition only occurs in this scenario where it lowers system cost or offers an attractive pay-back proposition for consumers. Population and economic activity across the world continue to expand in line with historic trends and demographic shifts, taking into account changing demand.
- The ETS incorporates legislated and firm near-term policy, but does not assume either country-level, or corporate, long-run energy and climate objectives are met. In this way the ETS describes how the energy sector might evolve in the absence of further major climate policy intervention.
- Global greenhouse gas emissions under our NEO 2022 ETS are consistent with a global temperature rise of 2.6C by 2050, with a 67% confidence interval.
- The **Net Zero Scenario** (NZS) describes an economics-led evolution of the energy economy to meet net-zero emission in 2050 with no overshoot or reliance on carbon removal technologies post-2050. We take a sector-led approach to decarbonization. Countries' carbon budgets are largely determined by the sectoral make-up of their economies, and the expected growth in those sectors. Neither historical responsibility nor availability of finance are taken into consideration.
- The NZS combines faster and greater deployment of renewables, nuclear and other low-carbon dispatchable technologies in power with the uptake of cleaner fuels in end-use sectors, most notably hydrogen and bioenergy. Carbon capture and storage (CCS) emerges toward the end of the decade, allowing fossil fuels to continue to be used in electricity generation and industry. Additionally, accelerated electrification and increased recycled materials production further contribute to emissions reductions. The NZS is therefore not an extension of the ETS, it describes a fundamentally different energy economy.
- While the technological choices in the NZS are primarily guided by economics, we also account for country strategic priorities and strengths, firm and legislated existing policy, and local resources.
- Global greenhouse gas emissions under our NEO 2022 NZS are consistent with a global temperature rise of 1.77C by 2050, with a 67% confidence interval.

Section 3. Emissions and abatement

In the NZS, India's emissions drop and the country reaches net zero by mid-century, compared to ETS where India sees a 21% rise in emissions from 2021 levels. The power sector contributes the most and the fastest to emission reductions under both scenarios. Clean power and electrification are the main drivers behind this. Hydrogen and CCS play important roles in hard-to-abate sectors.

3.1. Emissions

A plausible net-zero scenario consistent with 1.77C of warming

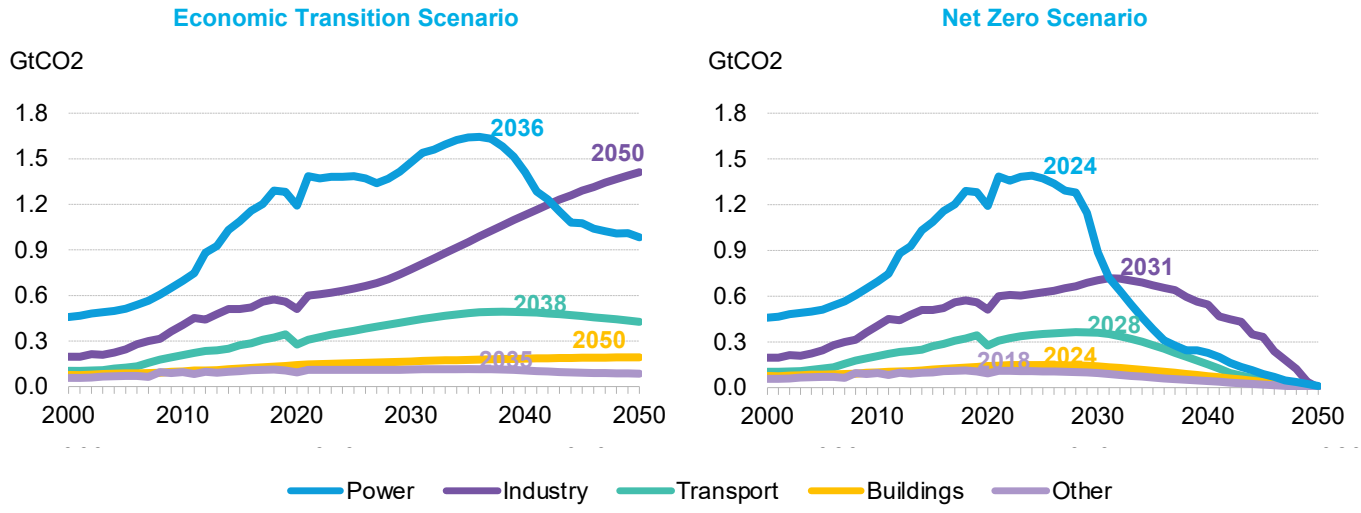
Energy-related emissions set to peak in 2037 under the ETS, and in 2024 under NZS

In our Net Zero Scenario (NZS), India reaches net-zero emissions in 2050, consistent with the Paris Agreement goal to keep temperature increases well below 2C compared to pre-industrial levels. This contrasts with the Economic Transition Scenario (ETS), in which India's emissions increase is consistent with a 2.6C warming trajectory. India's energy-related emissions peak in 2037 at 3,478MtCO2 in the ETS, and at 2,643MtCO2 in 2024 under the NZS.

Our modeling shows that while 1.5C looks increasingly out of reach, there are still plausible pathways to stay within 1.77C of warming, with a 67% confidence interval – the outcome of our NZS. Even then, a revolution will be needed in the energy sector to increase momentum and accelerate emissions reductions.

In the NZS, the power sector rapidly ramps up renewables to displace carbon intensive coal generation. Carbon capture and storage (CCS) and hydrogen also begin to scale this side of 2030, albeit at a slower rate.

Figure 15: Emissions by sector and peak year, India



Source: BloombergNEF. Note: Labels show year of peak emissions. 'Other' includes agriculture, forestry, fishing, energy industry own energy consumption, and other final energy consumption no further specified.

Emissions in the NZS need to decline much faster than in the ETS. Power sector emissions decline due to the increasing displacement of fossil-fuel generators by wind and solar capacity and peaks in 2024 in the NZS. Transport sector emissions peak in 2028 and fall quickly particularly due to the electrification of road transport.

Hydrogen and carbon capture technologies are crucial to decarbonize industrial emissions

Industrial sector emissions in India are the last to peak in 2031 and then begin a steep decline in the mid-2030s as the use of hydrogen and carbon capture increase to decarbonize steel, cement and petrochemical production. Building sector emissions, already lower than industrial and transport emissions, decline relatively slowly from their peak. In the ETS, emissions from all sectors except industry and buildings peak before 2050 and are on a declining path, albeit at a slower pace than in the NZS.

A sector-led approach to net-zero modeling

BNEF defines the pace of emissions reductions by economic sector, not by country. Sector budgets account for historical emissions trends, projected emissions growth and available abatement options. Our bottom-up sector modeling relies on commercially available technologies today, and those that have shown technology readiness and a conceptual pathway to scale. Countries' carbon budgets are largely determined by the sectoral make-up of their economies, expected growth in those sectors, and their relative progress under the Economic Transition Scenario. Neither historical 'responsibility' nor availability of finance are taken into consideration. For more, see methodology section in New Energy Outlook 2022 (web | terminal)

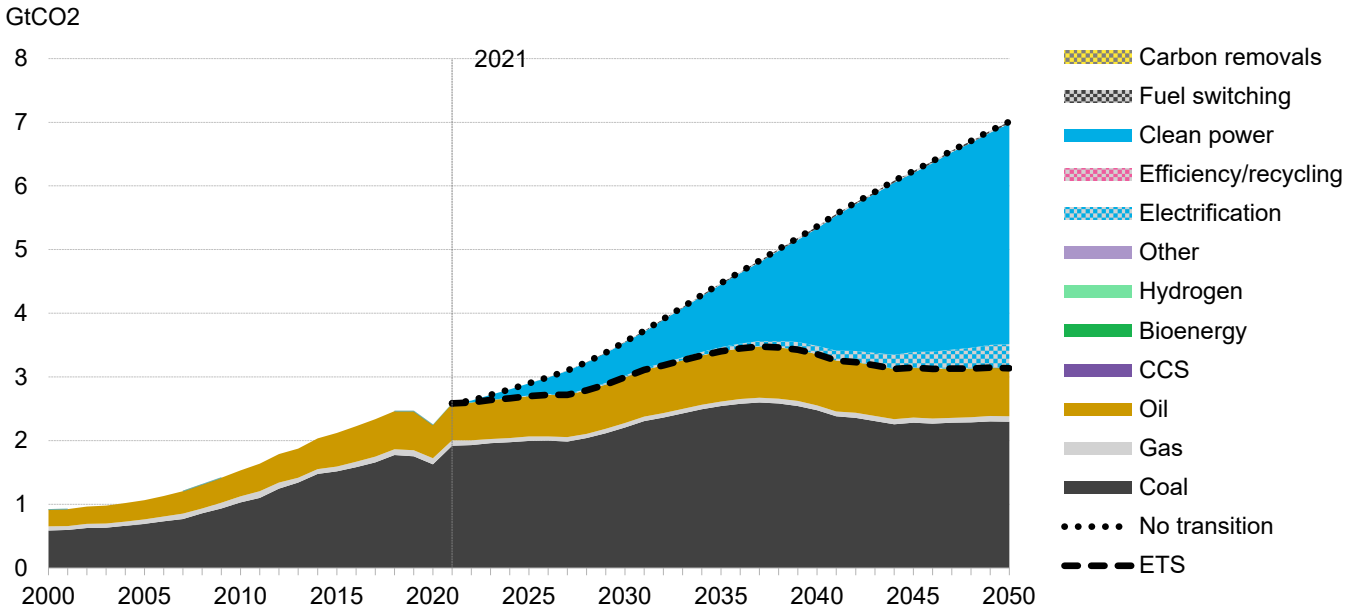
3.2. Abatement

In order to illustrate the scale of the abatement required under the ETS and NZS, BNEF has constructed a 'no transition' counterfactual emissions profile in which no further actions are taken to decarbonize the power sector or road transport. It holds the current fuel mix constant, with emissions growing proportionally to energy demand expected in the ETS and NZS.

Economic Transition Scenario

The combination of near-term policies and an economics-led pathway in the Economic Transition Scenario leads to a significant carbon emissions reduction. Carbon emissions fall from their peak in 2037 at 3,478MtCO2 to 3,135MtCO2 in 2050. Emissions from coal and oil combustion peak in 2037 and 2039, respectively. Coal emissions fall by 12% by 2050 from their peak. Emissions from gas consumption do not peak until 2050 under the ETS.

Figure 16: India's carbon emissions reductions from fuel combustion, Economic Transition Scenario versus no transition scenario



Source: BloombergNEF. Note: The 'no transition' scenario is a hypothetical counterfactual that represents a world in which no further actions are taken in the power and road transport sector to reduce carbon emissions, keeping the current fuel mix constant at 2021 levels and growing proportionally under the same ETS demand forecast. In industries, most sectors continue to use the same fuel mix through 2050 in the no transition scenario. ETS – Economic Transition Scenario, CCS – Carbon capture and storage.

Clean power transition responsible for 91% of emissions abatement under ETS

Against the 'no transition' counterfactual, switching power generation from fossil fuels to clean power is the single biggest contributor to India's emissions reductions, accounting for 91% of all emissions abated over 2022-50 in ETS. This includes displacing existing unabated fossil fuel generation with low-carbon technologies such as wind and solar and competing on economic grounds for new power demand. The second-biggest category is electrification in direct energy use, especially in road transport, using increasingly lower-carbon electricity. This accounts for 8% of emissions reductions over the period. The remaining 1% is accounted for by fuel-switching in direct energy use.

Carbon emissions reduction in the ETS falls significantly short of delivering an emissions reduction pathway consistent with a 1.5C trajectory under the scenario, landing instead on a **carbon budget consistent with a 2.6C global temperature rise by 2050.**