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price over time to drive energy efficiency and the transition to new fuels and technologies. In addition, such a strategy will provide targeted and time-limited fiscal and financial incentives for the development and adoption of innovative lower-carbon energy solutions. This also makes it easier to attract domestic and foreign investment into these areas.

To create societal support, social policies to manage inevitable frictions and dislocations will be essential in the early stages of the energy transition.

5. Harness the energy transition to drive wider sustainable development goals

Long term, a net-zero emissions energy system will produce significant societal benefits – through greater access to energy, more efficient energy consumption and better and more resilient environmental

outcomes. There will, however, be impacts as economic activity and resources shift towards lower-carbon energy sources, for example from coal to renewables. That impact will not be spread uniformly across states, industries and demographic groups. Ensuring the energy transition moves at pace and does not disadvantage the most vulnerable is at the core of a fair transition.

Well-designed policies at the national and sub-national level are required to ensure that vulnerable and disadvantaged communities have access to affordable and reliable energy and are resilient to potential climate impacts. Labour market policies to retrain and reskill workers in carbon-intensive industries will be important for a smooth and orderly transition, as will policies to support states and regions negatively affected by the transition.



REFLECTIONS

Raising the climate ambition

India has set major targets to grow its economy and progress its national development in the years to come. In tandem, it is determined to manage its emissions to address local pollution and climate change. Together, these two goals pose a significant challenge for the country, but by setting clear objectives and a trajectory, creating an enabling policy environment and making the right investments, India can make major progress.

Importantly, the two goals need not compete. In fact, sustaining economic growth in the long-term will require a healthy environment to support economic activities and well-being.

At this stage in its growth, there is an opportunity for India to take a leading position in the development and deployment of modern energy technologies and infrastructure that generate domestic industrial advantages and unlock economic opportunities in the process, while also supporting domestic emissions reductions and the transition to a prosperous lower-carbon economy. In doing this, India also has a crucial role to play in bolstering the global response to climate change, benefitting vulnerable populations both in India and elsewhere.

This scenario sketch sets out a pathway for India to achieve net-zero emissions from its energy system. Key elements of the pathway are:

- increase the generation of electricity fourfold from 2,000 terrawatt-hours (TWh) in 2020 to nearly 9,000 TWh in 2050, and raise electricity's share of final energy from 18% today to 45% in 2050;
- shift the electricity mix from about 65% generated by fossil fuels in 2020 to almost 90% generated by wind and solar in 2050; phase out coal by 2050, with some gas (up to 5% of generation) remaining;



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- raise the share of hydrogen from negligible levels today to around 13% of final energy consumption in 2050, mainly as a fuel for industry and heavy duty transport;
- increase the use of bio-resources (biomass and liquid biofuels) more than twofold, with residential biomass use declining and commercial biomass use (primarily in industry) increasing substantially to account for two-thirds of all uses by 2050;
- invest in infrastructure – particularly urban and industrial infrastructure – to reduce the energy intensity of the economy by around 50% between 2020 and 2050; and
- establish significant carbon removal projects (using technology and nature) to achieve net-zero emissions in India’s energy sector by 2050, primarily to capture residual emissions from hard-to-abate industries such as cement and to offset emissions from fast-growing sectors like aviation.

Primary energy demand will double between 2020 and 2050, but will still remain 20% lower than a business-as-usual pathway due to the significant energy efficiency gains from electrification and the deployment of lower-carbon energy infrastructure.

These are hard choices, but India has an enormous opportunity ahead – to become a prosperous pioneer in deploying lower-carbon energy resources and approaches that help to address both domestic and international climate challenges while simultaneously improving the economic well-being of its citizens. Together, Shell and TERI offer this analysis to assist decision-makers in India, as the government continues to shape policy to meet its growth ambitions while making progress in its transition to a lower-carbon energy system.



The Energy and Resources Institute

GLOSSARY

Article 6 of the Paris Agreement	Article 6 of the Paris Agreement was established to allow cross-border cooperation between countries attempting to fulfil their nationally determined contributions (NDCs). Parties to the agreement are crafting the details of Article 6 to create a foundation for trade in carbon units.
Article 6.2 (internationally transferred mitigation outcomes)	Article 6.2 establishes an accounting framework for the transfer of mitigation outcomes between Parties to the Paris Agreement, which could be in the form of tradable carbon credits or allowances from compliance systems such as the EU Emissions Trading System.
Article 6.4 Mechanism	Article 6.4 establishes a central UN mechanism to create carbon credits from emission reductions generated through specific projects.
Bioenergy	Bioenergy is one of many diverse resources available to help meet demand for energy. It is a form of renewable energy that is derived from recently living organic materials known as biomass, such as agriculture crops, animal and plant waste, algae or wood. It can be used to produce transport fuels, heat, electricity and other products and includes solid biomass, biofuels and biogases.
British Columbia's Carbon Tax	In 2008, the Canadian province implemented North America's first broad-based carbon tax, proving that it is possible to reduce emissions while growing the economy. The carbon tax applies to the purchase and use of fossil fuels and covers around 70% of provincial greenhouse gas emissions.
Competitive auctions in power markets	In most cases involving electricity auctions, the sellers, such as generators, are the ones bidding their products, as they are interested in selling power contracts to government, large consumers or distribution companies, with the bidding process designed in part to select the lowest price. In renewable energy markets, an auction is a competitive process for procuring electricity generated from renewable energy. An auction enables a policymaker to secure renewable energy at competitive prices while advancing specific country development and energy policy goals.
Demand-side response measures and technologies	Demand-side response is an approach used in power markets that allows end-use customers to reduce their electricity use during periods of higher power prices. Customers need to be willing to reduce power consumption – within seconds – whenever the grid requires it. Various technologies enable these fast switches, which happen automatically.
Electric-arc furnaces	An electric-arc furnace uses high-current electric arcs to melt steel scrap and convert it into liquid steel of a specified chemical composition and temperature. About a quarter of the world's steel is produced by this method.

EU Emissions Trading System

The EU Emissions Trading System (EU ETS) is a cap-and-trade style mechanism that covers all large point sources of emissions (mainly thermal power stations and industrial facilities) across all 27 countries of the EU. The overall emissions cap is agreed by the 27 countries and has been progressively lowered since the system started in 2005. The intention is that it will reduce to zero in 2050. Facilities within the system are either allocated tradable allowances by national governments or must buy them in auctions or from the market. The total number of allowances introduced into the system each year is equivalent to the agreed cap for that year. These allowances, each representing a tonne of carbon dioxide emitted, must be surrendered against emissions from any given facility.

GST Compensation Cess

The Goods and Services Tax (GST) in India was launched with the cooperation of the states and the central government. The GST Compensation Cess is imposed as a levy in addition to the regular GST taxes. The cess (also called a tax or levy) is imposed on the supply of certain luxurious and demerit goods and services that attract 28% GST. The cess rate usually ranges from 1% to 25% and is levied over and above the GST rate.

Intergovernmental Panel on Climate Change's Special Report

The Intergovernmental Panel on Climate Change is the United Nations body for assessing the science related to climate change.

Nationally Determined Contribution (NDC)

The proposed actions countries will take to reduce greenhouse gas emissions under the Paris Agreement over a future five or ten-year period.

Power purchase agreements

A power purchase agreement (PPA) is a contract between two parties which defines the commercial terms for the sale of electricity between the two parties. A PPA is the key instrument for project finance and is widely used for renewable energy projects.

Star-labelling

Star-labelling in India is the hallmark or certificate of energy-efficient product quality. The star label allows consumers to make informed choices on energy and money saving potential, in addition to an assurance of a better quality product.
