ÉTUDES
DE L'IFRI

CENTER FOR ENERGY & CLIMATE

JUNE
2021

India's Energy and Climate Policies Post COVID-19

Short Term Slowdown, Longer Term Boom in Renewables

Sanjay KUMAR KAR

The French Institute of International Relations (Ifri) is a research center and a forum for debate on major international political and economic issues. Headed by Thierry de Montbrial since its founding in 1979, Ifri is a non-governmental, non-profit organization.

As an independent think tank, Ifri sets its own research agenda, publishing its findings regularly for a global audience. Taking an interdisciplinary approach, Ifri brings together political and economic decision-makers, researchers and internationally renowned experts to animate its debate and research activities.

ISBN: 979-10-373-0379-0

How to quote this publication:
Sanjay Kumar Kar, "India's Energy and Climate Policies Post COVID-19: Short Term Slowdown, Longer Term Boom in Renewables", *Études de l'Ifri*, Ifri, July 2021.

Ifri

27 rue de la Procession 75740 Paris Cedex 15 – FRANCE

Tel.: +33 (0)1 40 61 60 00 – Fax : +33 (0)1 40 61 60 60

Email: accueil@ifri.org

Website: Ifri.org

Author

Sanjay Kumar Kar holds a Doctorate in Management and he is an Associate Professor of Department of Management Studies, Rajiv Gandhi Institute of Petroleum Technology (RGIPT). Prior to joining RGIPT, he worked at Pandit Deen Dayal Energy University, Gandhi Nagar, and the Indian Institute of Management, Ahmedabad. He has over 19 years of research and teaching experience. He teaches courses like Global Energy Scenario, Energy Policy, International Business, Marketing, and Retailing at his current institution. He edited/co-edited two books, namely "Energy Sustainability Through Green Energy", Springer 2015, and "Natural Gas Market in India: Opportunities and Challenges", Springer 2017. He regularly contributes articles to refereed journals and books. He also regularly contributes research/opinion articles to Economic Times Energy World, Financial Express, DNA, South Asia Monitor, Modern Diplomacy, Iran Review, and BBN Times. He serves as a reviewer to many prestigious journals like Energy Policy, Energy Research & Social Science, Renewable & Sustainable Energy Reviews, Vikalpa, Journal of Emerging Markets Case Studies, and Journal of Services Research. He regularly conducts training programs for participants from the corporates & government domains. He is a lifetime member of the Indian Econometric Society and a member of the International Association of Energy Economics.

Acknowledgment

Research assistance provided by Mr. Sidharth Harichandan to prepare this note is highly appreciated. Mr. Harichandan is a research scholar in Department of Management Studies, Rajiv Gandhi Institute of Petroleum Technology, India. He works in the field of energy and climate.

The author is highly thankful to Dr. Marc-Antoine Eyl-Mazzega, Director of the Ifri Center for Energy & Climate, for his review, comments, and observations to give the final shape to this note.

Executive summary

India has long been a positive and committed partner in global and domestic climate change mitigation efforts. It has taken various steps, including diversifying the energy mix, pushing green mobility, developing low carbon electricity production, and enhancing forest cover to reduce emissions intensity to its gross domestic product (GDP). Under the Paris Agreement, India has submitted its Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC), which outlines a reduction of emissions intensity of its GDP by 33-35% from 2005 level by 2030.

The National Action Plan on Climate Change (NAPCC), Climate Change Action Program (CCAP), and State Action Plan on Climate Change (SAPCC) are only a few of India's main initiatives. India is now among the world's pioneers in climate change mitigation efforts with its highly optimistic objective of installing 450 gigawatts (GW) of clean electricity generation capacity by 2030 (from 100 GW of combined wind, solar and biomass capacity in early 2021), of developing smart, sustainable and resilient cities, of deploying electric cars and two wheelers, adopting energy conservation measures, or having Indian Railways committing to become carbon neutral within ten years. India is already the world's fifth largest solar market by installed capacity and ranks among the top 5 in terms of solar panel manufacturing capacity, with over 20 GW production capacity within reach in a few years. India's solar boom is expected to continue once the pandemic is over, and move up a gear. Dozens of large offshore wind projects could also be developed. Yet rapid renewable capacity additions will boost grid expansion requirements. Capital for grid expansion could be a challenge in the coming years. Huge electricity storage capacities are also needed. Moreover, the country needs to expand its nuclear power generation capacity further. Energy efficiency is a priority with key low hanging fruits reaped, such as the deployment of LED lightings. Lastly, natural gas will play a role to develop and transform India's energy system, with LNG imports set to increase sharply in the coming years.

COVID-19 is a big hurdle as the coronavirus lockdown is unquestionably a significant setback for India's modern energy systems and even more so for everyday lives. The pandemic jeopardized the growing economy, raised the number of poor people and slowed down tax collection, which means the government has more limited options for funding sustainable projects. The deployment of renewable energy sources is thus unlikely to meet the set targets for 2022, with less than 100 GW installed while another 75 GW would need to be deployed within 22 months. Massive private local and foreign investments will be needed if India is to meet its 2030 targets, alongside reinforcing the electricity grid.

Yet despite the ongoing COVID-19 pandemic, India continues its mission to become an environmentally sustainable nation. There are valuable lessons that India should learn from this period to prepare for a greener economy. During the pandemic, coal fired power generation decreased and while it is expected to pick up again, lower utilization factors and poor economics will further push renewable deployment and halt new coal plant additions. Decisively, efforts to make cities more resilient and reduce air pollution are expected to be further fostered.

India is inclined to walk on the path of clean energy transition without a second thought. Climate & environmental protection are a collective responsibility, and India understands its role and responsibilities. Yet India's battle against climate change mitigation and adaptation needs support, cooperation, and financial assistance from developed nations. Multilateral funding agencies should strengthen their financial support. India's commitment to sustainable developments is partially dependent on access to green and clean technologies available in the developed nations. So, India must initiate necessary actions to enhance technology access at an affordable cost.

Most of the ministries have developed relevant policies for low carbon technologies. It's time for India to develop a comprehensive national strategy on low carbon technologies, which should address technology development and deployment as well as related sustainable and digital infrastructure creation. The pandemic has taught a lesson that India can develop home grown technologies to meet its citizen's expectations, and that comprehensive and urgent action is required to fight city air pollution.

Table of contents

Introduction

The protection and conservation of the land, resources, and biodiversity is embedded in Indian culture, history, and tradition. Today, the planet faces unparalleled environmental threats, be it from global warming or the COVID-19 pandemic. Human lives and natural ecosystems are being irreversibly impacted by anthropogenic climate change. In terms of per capita greenhouse gas (GHG) emissions, with approx. 2 tons per capita CO_2 equivalent emissions in 2019,[1] India remains at the bottom half of the ladder at 140th position. The *Washington Post* sensibly expects India's absolute emissions to go up due to industrialization, urbanization, and rising car penetration.[2] However, India's modern and sustainable mobility solutions combined with greener fuels and electricity generation will keep the growth of emissions as low as possible.

India is committed to demonstrating that sustainable economic growth with the protection of the environment is the new norm. With this in mind, India announced the National Action Plan on Climate Change (NAPCC) in 2008 with eight missions to solve climate change issues and encourage sustainable development. The state-level action plans were introduced in the second phase of the NAPCC. Finally, in Paris in 2015, India was among the progressive nations to set ambitious goals for the United Nations Framework Convention on Climate Change (UNFCCC) as part of its Nationally Determined Contributions (NDCs). India is supporting the International Solar Alliance and its commitment to ban all single-use plastics by 2022 has been commended by the United Nations. Several key initiatives like Solar Mission, Electric Mobility Mission, Hydrogen Mission, and Sustainable Alternative Towards Affordable Transportation have been taken by the concerned ministries to mitigate the climate change issues. India has also become an Association country to the International Energy Agency (IEA) and recently signed up to a Strategic Partnership[3]. Lately, India stated its support in favor of the G7 Nature Compact, aiming notably to protect at least 30% of land and seas.

---

1. Center for Climate and Energy Solutions, "Global Emissions", available at: www.c2es.org, accessed on May 28, 2021.
2. J. Slater, "Can India Chart a Low-carbon Future? The World Might Depend on It", *The Washington Post*, June 12, 2020, available at: www.washingtonpost.com.
3. IEA, "India and the IEA Enter New Phase of Closer Collaboration with Signing of Strategic Partnership Framework", *Press release,* January 27, 2021, available at: www.iea.org.

India's domestic policies and foreign commitments show a balance between economic and climate protection. According to India's NDCs, it plans to achieve 40% fossil-free electric power installation by 2030.

Demand side measures are also paramount and about 370 million light-emitting diode (LED) bulbs have been distributed, resulting in annual energy savings of 48 billion kilowatt hours (kWh) and carbon dioxide reductions of 38.6 million tons.[4] Over 11 million traditional streetlights have been replaced with LEDs throughout the nation, resulting in a 5.34 million tons CO_2 reduction.[5] Additionally, 1.5 million solar lamps have been delivered, and over 3,700 women from rural Self-Help Groups (SHGs) have been trained in solar lamp assembly and distribution.

Between 2005 and 2014, India reduced its emission intensity of GDP by 21%, compared to a voluntary goal of 20% to 25% reduction by 2020.[6] Despite major expansions of electricity and city utilities, as well as improved growth metrics, these declines were accomplished.

Massive investment in the infrastructure, especially in the green energy value chains, is the need of the hour. To maintain the decreasing trend in emission intensity, India will have to build low-carbon infrastructure and economic growth intensively through 2030 and beyond.

This paper analyses the development of India's energy sectors, key energy and climate policies and their short to medium term perspectives. It also assesses whether and how current very ambitious targets can be met, not least following the severe impacts from the pandemic, and their implications for India and beyond.

4. Ministry of Power of India, "National UJALA Dashboard", 2021, available at: www.ujala.gov.in.
5. Ministry of Power of India, "Street Lighting National Programme – SLNP", 2021, available at: https://eeslindia.org.
6. Press Information Bureau (PIB), "Development of Urban Forests", *Press Release,* Ministry of Environment, Forest and Climate Change of India (MOEFCC), June 5, 2020, available at: https://pib.gov.in.

India's Energy System: Renewables Grow, So Does Natural Gas

The government has embarked on a range of systemic and organizational reforms to overhaul the power system to meet the current and future energy challenges. The reforms were primarily aimed at bringing competition to various segments, setting up independent regulatory commissions (such as Central Electricity Regulatory Commissions, State Electricity Regulatory Commission), and creating a proper finance system. Total installed power generation capacity reached 382 GW by the end of March 2021. The transmission network increased from an isolated grid clustered across urban and industrial centers to a regional network. However, demand for power still exceeds availability.

India is one of the most diversified energy markets in the world. Power generation options vary include brown coal, lignite, natural gas, hydro and nuclear power to other feasible non-conventional sources such as wind, solar, agricultural and residential waste.

As of April 2021, India's power generation was thus still largely fossil fuel-driven, where coal, natural gas, and lignite contributed 53%, 6,5%, and 1.7% of total installed capacity of 382.7 GW, respectively. Low carbon electricity production capacity is currently 145 GW or 38% of total capacity. This includes renewable energy sources (92.55 GW), hydropower (46 GW), and nuclear power (6.78 GW). Wind, solar, small hydro, and biomass currently account for 38.68 GW, 38.79 GW, 4.7 GW, and 10.14 GW, respectively.[7] A number of 'waste to power' plants are operational with a combined capacity of 168 MW. The biomass and biogas programs intend to use more bio waste to produce energy.[8]

To meet the NDC target, India has set a goal of installing 175 GW of renewable energy capacity by 2022, including 100 GW of solar, 60 GW of wind, 10 GW of biofuel, and 5 GW of small hydropower.

---

7. Central Electricity Authority, "Executive Summary on Power Sector", 2021.
8. Ministry of New and Renewable Energy (MNRE), "Scheme to Support Promotion of Biomass Based Cogeneration in Sugar Mills and Other Industries in the Country", available at: https://mnre.gov.in, accessed on May 28, 2021.

Energy consumption will rise in the future. A significant increase in renewable generation capacity, biofuel production, and natural gas production are required to meet the rising demand and foster sustainable development, while coal and oil will progressively see a declining role in the long run.

India's net production of natural gas was 46 billion cubic meters (bcm) in 2010-11 and decreased to 27.7 bcm in 2020-21. With production ramp up from the fields jointly owned by Reliance Industries and British Petroleum, domestic natural gas supply is bound to go up. ONGC, the state-owned energy major, is expected to produce 35 bcm of natural gas by 2023-24, which is higher than the current total production.[9] This means the domestic net natural gas production will be closer to the production figure achieved in 2010-2011.

India's natural gas production is largely affected by limited proven reserves. By the end of 2019, India's proven natural gas reserves stood at 1.3 trillion cubic meters: at the current rate of production, this can last over 48 years. Hence why the government needs to find a way out to enhance recoverable reserves and explore more fields.

In 2020-21, India imported 32 bcm of liquefied natural gas (LNG). Government's draft LNG Policy (2021) indicates that there is massive scope for using LNG directly in transportation, mining, and other industries.[10] The government envisages creating 1000 LNG filling stations with an investment of $1.37 billion (US dollars) to fuel long haul automobiles including trucks. The first 50 LNG stations are under construction.

The Petroleum and Natural Gas Regulatory Board notified that "any entity can set up an LNG Station in any Geographical Area (GA) or anywhere else, even if it is not the authorized entity for that GA".[11] It is clear that imported LNG is part of India's future fuel mix to reduce emissions in various sectors. Therefore, the government is creating an enabling environment for the development of associated infrastructure across the country.

Use of natural gas in residential and transportation sectors has increased, but it has shrunk in power generation, where imported

9. K. Pathak, "India's Gas Output to Rise 25% Helped by Production RIL-BP, and ONGC Gas Fields", Mint, January 19, 2021, available at: www.livemint.com.
10. Ministry of Petroleum and Natural Gas of India, "Strategies to Increase LNG Usage as Transport Fuel and in Mining Sector – reg.", February 17, 2021, available at: https://mopng.gov.in.
11. Public Notice No. PNGRB/AUTH/1-CGD (02)/2020, Petroleum and Natural Gas Regulatory Board, June 2, 2021, available at: www.pngrb.gov.in.

natural gas is being squeezed by cheap renewables and coal. By 2030, the government wants natural gas to account for 15% of the country's energy mix, up from 6% now.[12] Existing operational LNG terminals in Dahej, Hazira, Dhabol, Kochi, and Ennore have a combined installed capacity of 37.5 million tons per annum (Mtpa). The recently completed LNG terminal in Mundra, Gujarat, with a 5 Mtpa capacity, will further strengthen the natural gas infrastructure in the country. Additional LNG terminals with a total of 24 Mtpa are under construction in various parts of the country. When completed, import capacity will be 66.5 Mtpa.

India's natural gas importing facilities offer significant business opportunities for natural gas exporters like Australia, Qatar, the United States (US) and Russia. Further, the availability of gas will spur demand for gas, provided that city gas distribution (CGD) infrastructure is developed. Increasing domestic natural gas supply should keep the transport (CNG) and domestic customers safe from currency fluctuations and rising LNG price to a greater extent. In the past, industrial customers have shown switching behavior, but to a smaller extent due to associated switching costs.[13] The industrial customers can always pass on the increased cost down the value chain. Hence, increases in LNG prices and/or a weakening of the Indian currency vs the US dollar may not seriously impact LNG imports and the gas market development in India. The unsaturated CGD market opens up plenty of opportunities for domestic and foreign players.

Moreover, the Ministry of Petroleum and Natural Gas has taken many initiatives to reduce greenhouse gas emissions. Under the Alternative Towards Affordable Transportation program, over 5,000 compressed biogas (CBG) plants will be installed by 2023-2024. This program has the potential to transform transportation, both in rural and urban areas. The oil marketing companies like Indian Oil and Bharat Petroleum have taken lead to establish CBG infrastructure.

The government plans to deploy natural gas as a transit fuel during the energy transition. Due to a shortage of domestic reserves and production, India's natural gas import dependency is bound to increase in the short to medium term and beyond.

12. IEA, India Policy Energy Review 2020, January 10, 2020, available at: www.iea.org.
13. S. Kumar Kar and S.Sahu, "Managing Natural Gas Business: A Case of Bharat Natural Gas Company Limited", *Emerald Emerging Markets Case Studies*, Vol. 2 No. 1, 2012, available at: www.emerald.com.

Reducing dependency on coal and oil

Since the early 2000s, India's production of coal has risen steadily, and coal continues to be the primary source of energy supply and power generation. Although coal-fired power plants are effective, scalable, and economically viable, they are not environmentally sustainable. Therefore, the government strategically aims to reduce dependency on traditional coal-fired power plants. India introduced clean coal cess (a form of tax whose revenues have a specific attribution) of ₹50/ton (Indian rupees per ton) in 2010, and gradually, the clean energy cess on coal has increased to ₹400/ton ($5.60). Moreover, clean coal technologies with carbon capture, storage, and utilization could be considered, yet are very expensive; hence why there are hardly any takers in India. In July 2020, the US-India Strategic Energy Partnership identified clean coal technology adoption as an area of mutual interest. In this context, global collaborations can be helpful to bring down the cost of clean coal technology adoption.

The recent intention to privatize coal mines has often been interpreted as an indication of India's continued support for a coal driven economy. On the contrary, privatization is aimed at increasing participation of private investors, enhancing efficiency, and increasing domestic production to meet current domestic demand and thus, reduce coal imports.

India is the third-largest buyer of oil globally, the fourth-largest refiner of oil, and a net exporter of refined petroleum products. India's oil consumption growth is projected to exceed that of China in the mid-2020s, rendering it a very lucrative market for refining activity. To improve oil supply security, the government sets a target of 10% oil import reduction by 2022, which looks stiff to achieve. However, such a target could be achieved by 2025.

Policy reforms like the Hydrocarbon Exploration and Licensing Policy, and Open Acreage Policy are intended to attract higher investment and enhance domestic oil & gas production. With greater operational flexibilities, liberal pricing, and taxation, the government wanted more participation from global operators. Unfortunately, the level of global participations in oil & gas exploration and production is below expectations. Furthermore, Indian exploration & production (E&P) companies like Indian Oil, Oil India, ONGC, and BPCL are encouraged to actively invest in oil & gas fields abroad.

Many countries have built strategic storage facilities to address possible strategic emergency situations. India's existing strategic reserve potential of 40 million barrels will accommodate just over ten days of net imports. The IEA forecasts that the exact amount will cover just four days of net imports in 2040, considering the projected increase in oil demand. Thus, it is necessary for the government to begin the second stage of its strategic stockholding strategy. Foreign investment in the development of strategic storage is thus welcomed.

Renewable energy sources on course to drive the electricity system

The overall share of renewables in power generation has been steadily increasing over the last decade, thanks to robust growth in electricity generation from wind, solar photovoltaic, and bioenergy.[14]

During 2010-2020, wind power production grew at an average annual rate of 20%,[15] accounting for 10% of overall electricity generation in 2020.[16] So far, due to relatively higher costs, offshore wind power has not picked up in India. India targets to install offshore wind capacity of 30 GW by 2030. The national offshore wind energy policy (2016) aims to facilitate wind project demonstrations and installations. A few demonstration projects are underway. The government is determined to explore and exploit the existing and future offshore wind opportunities.

Solar energy has recently begun to gain traction, supported by revised targets under the Solar Mission and new PV auctions. Solar power capacity installation expanded 5.7 times over the five years, from 6.8 GW in 2016 to 39 GW by February 2021.[17]

Power generation from bioenergy is also on the rise. The main source is co-generation units using bagasse residues from India's huge sugar industry. The use of biomass to generate electricity is more sustainable compared to conventional use followed in Indian households. Biomass power currently accounts for 10.9% of total grid-connected renewable power generation and 2.7% of total installed capacity.[18] Biomass could aggressively continue to add to power generation in the short to medium term. However, the use of biomass

14. IEA, *India Policy Energy Review 2020*, *op. cit.*
15. In 2010 wind production was 13,184 MW and in 2020 wind production was 38,624 MW. Annual growth= ((38,624 MW-13,184 MW)/ 13,184)10 * 100.
16. Central Electricity Authority, "Executive Summary on Power Sector", *op. cit.*
17. MNRE, "Solar Energy", 2021, available at: https://mnre.gov.in.
18. *Executive Summary on Power Sector*, Central Electricity Authority, March 2021, available at: https://cea.nic.in.

for biofuel generation could be a better option.

As of February 2021, Energy from Waste (EfW) utilizing municipal, manufacturing, and agricultural waste and residues contributed 169 MW. EfW will supply electricity at the point of use and support India's waste management industry. Due to rapid urbanization and economic growth, Indian cities are facing insurmountable challenges in managing wastes. EfW has the potential to address multiple issues linked to waste management and energy supply. Municipalities and local administration are coming forward to deal with waste to energy value chain, especially waste collection. Waste management is a big priority for the government, which can be effectively addressed through energy from waste.

But as the saying goes on, in every happy tale there has to be a twist that largely impacts the climax. COVID-19 has had an impact on the power market, slowing down reform efforts in the clean energy sector in particular. As businesses cut back on demand, workers work from home, and cities go into lockdown, initiatives such as expanding the natural gas distribution network got delayed. In certain cases, such projects came to a halt.

Due to the shutdown of factories and the re-allocation of funds to the pandemic, various renewable energy projects and power sector investments were adversely impacted. Moreover, restrictions on mobility and import of goods have impacted ongoing projects. Due to trade sanctions on imports from China, up to 3 GW of solar projects have been postponed. Due to the COVID-19 pandemic, several government-supported renewable projects got delayed, and the government granted permission for completion for up to 5-6 months beyond the committed timeline.

While India currently holds the 5th global position for overall installed renewable energy capacity, the country will be facing delays in meeting this 2022 target of deploying 175 GW of renewable energy capacity. In the longer term, India's renewable target of 450 GW by 2030 is ambitious but achievable. The renewable value chain is now fairly established. Across the value chain, domestic competencies and capabilities are gradually expanding and India has world class solar modules manufactures such as Waaree Energies, Adani Solar, Vikram Solar, and Tata Power Solar. Currently, India has solar module and solar cell manufacturing capacity of 10 GW and 3 GW, respectively. Rising demand for solar modules and cells necessitates boosting the production capacity of the manufacturers. Adani Solar is in the process of expanding module production capacity from 2 GW to 3.5 GW. Going by the trend, India's solar module and cell manufacturing capacity will

reach 20 GW within a couple of years' time.

India's concerted efforts and policy initiatives, which include the National policies on repowering of wind power projects, offshore wind energy, wind-solar hybrid, and wind data sharing, will expand wind power installation, generation, and consumption. The domestic wind turbine manufacturing industry is quite strong, with 35 suppliers registered with the concerned ministry.

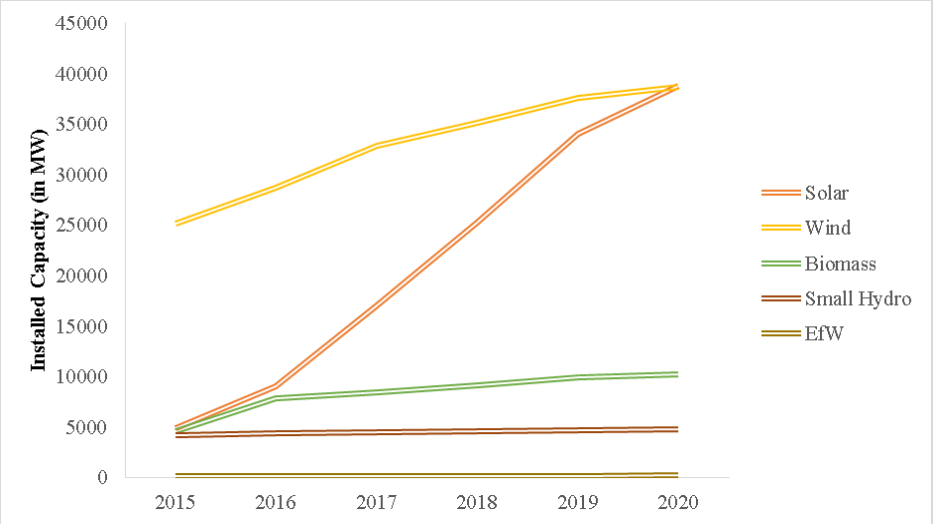
Generally, electricity transmission and grid integration of renewable power has been a serious concern. Under the Green Energy Corridor, 12,835 circuit kilometers (ckm) of transmission lines are planned to be built in order to address bottlenecks. Already 6,258 ckm of intrastate transmission lines have been constructed. Further, 2,467 ckm of interstate transmission lines have been constructed and 601 ckm of interstate transmission lines are under construction. The Green Energy Corridor would facilitate transmission, grid balancing, and consumption of renewable power. Rapid renewable capacity addition will boost grid expansion requirements. Rapidly mobilizing the large amount of capital needed for grid expansion could be a challenge though.

India's electricity shortage could continue to be a serious concern in future, but need to be addressed by renewable production, storage, and consumption at both centralized and decentralized levels.

The IEA projects India's battery storage to reach 140-200 GW by 2040.[19] The Modi government already approved the National Program on Advanced Chemistry Cell (ACC) battery storage, which aims to develop 50 GWh of ACC and 5 GWh of niche ACC battery storage facility. The program expects to attract direct investment of $6 billion. The cabinet already approved Production Linked Incentive of approx. $2.5 billion to ramp up domestic production and reduce import dependency.[20]

19. IEA, *India Energy Outlook 2021,* available at: www.iea.org.
20. PIB, "Cabinet Approves Production Linked Incentive Scheme 'National Programme on Advanced Chemistry Cell Battery Storage'", *Press Release*, Government of India, May 12, 2021, available at: https://pib.gov.in.

Figure 1: Growth of renewable energy generation capacity in India (2015-2020)



Source: Prepared by the author based on data obtained from Central Electricity Authority.

Expanding nuclear power

Prior to 2015, India's nuclear applications for civilian purposes were constrained by multiple factors, including access to nuclear fuel. Nuclear Suppliers Group's consideration of nuclear exports to India in 2015 boosted nuclear energy. Currently India has 22 nuclear reactors operating in seven nuclear power plants. As of April 2021, India's total nuclear-installed capacity was 6,780 MW, 1.8% of the overall installed capacity of power stations. One more reactor with a capacity of 700 MWe got connected with the grid in January 2021. As of January 2021, nuclear power produced a total of 3.21 TWh and provided 3% of India's electricity. Five more reactors with a combined generation capacity of 3,100 MWe are currently under construction in various projects in Kakrapar (Gujarat), Rajasthan, and Kudankulam (Tamil Nadu). India's planned nuclear capacity is 22,480 MW[21] by 2031. Renewed push for nuclear energy will augur well for renewable energy market development in India.

A nuclear park in Jaitapur (Maharashtra) having 6 reactors with a combined capacity of 9,900 MWe got environmental clearance[22] way back in 2010, but construction yet to take place. Multiple issues, including the availability of technology, cost, safety, and local concerns, are reasons for the delay.

21. PIB, "Nuclear Energy Production", *Press Release*, Department of Atomic Energy, Government of India, February 3, 2021, available at: www.pib.gov.in.
22. P. Bhawan, "Jaitapur Nuclear Power Park", November 26, 2010, available at: ww.npcil.nic.in.

On April 22, 2021, EDF-French nuclear operator submitted a binding techno-commercial offer to the Nuclear Power Corporation of India Limited (NPCIL) to supply engineering studies and equipment for setting up EPR nuclear reactor at Jaitapur. EDF's interest in the Jaitapur plant brings a potential solution to the technology problem. The estimated cost of building six EPRs would be $40-45.5 billion. High cost is a big concern, which must be addressed. Some analysts have even been calling for cancelling the EDF-NCIL deal.[23] The Jaitapur project has its own merits, which include enhancing energy security, emission reduction, additional employment and economic value addition. The nuclear plant at Jaitapur has the potential to generate up to 75 TWh of electricity annually, which could lead to a 80 million tons reduction of CO_2 emissions per year.[24] Based on a considered opinion, both parties should work to develop a comprehensive binding solution to make the project successful. EDF must bring down the cost of technology and its services for the Jaitapur project, which would make a strong business case for both parties.

Tariff for nuclear power is determined on the cost plus basis, so lower capital and maintenance costs will lower the levelized tariff of nuclear power. NCIL being a government owned company, higher cost of Jaitapur project would burden the government. Currently nuclear power is competitive with other sources. As long as the nuclear based electricity remains cost competitive, there will be enough takers, either through power purchase agreements or recently developed power exchange.

Given lower renewable capacity use, fossil fuel costs, and ever-increasing emissions issues, nuclear power's promise must be completely realized.[25] During 2020-21, nuclear power plants offered capacity utilization of 81%,[26] the highest among the competing fuels. Despite several merits, nuclear power capacity expansion has been sluggish. Safety issues and resistance of the local communities have become significant concerns for opening new nuclear power plants.

23. S. Raju and M.V. Ramana, "Jaitapur: A risky and expensive project", *The Hindu*, January 8, 2019, available at: www.thehindu.com; R. Nayar, "Time for India to Cancel Jaitapur Nuclear Power Project", May 2, 2021, available at: https://mediaindia.eu.
24. "EDF Submits to the Indian Nuclear Operator NPCIL the French Binding Techno-Commercial Offer to Build Six EPRs at the Jaitapur Site", *Press Release*, EDF, April 23, 2021, available at: www.edf.fr.
25. S. Kumar Kar, "How Important Is Nuclear Power in India's Energy Transition?" Energyworld.com, October 1, 2018, available at: https://energy.economictimes.indiatimes.com.
26. Nuclear Corporation of India, "Nuclear Power Generation: 2010-11 to 2021-22", available at: https://www.npcil.nic.in.

Despite all emerging challenges, the government is working hard to finish three ongoing projects in Kakrapar, Rajasthan, and Kundankulam with a combined capacity of 3,800 MW by 2023. The government is tackling concerns such as land acquisition at new sites, approvals from different departments, and seeking timely foreign partnerships as part of the pre-project activities. Furthermore, attempts are being made to reduce the capital cost of nuclear power plants. Nuclear power provides a potential solution to reduce dependency on fossil fuel in the medium to long run. Therefore, all the stakeholders, including local communities, must look at the larger national picture and recognize the importance of nuclear power.

Clean Cooking

India is pushing forward the concept of clean cooking. Consumers are gradually looking for access to modern fuels like natural gas, LPG, electricity, and biogas for domestic applications. The government introduced the Pradhan Mantri Ujjwala Yojana, a path-breaking initiative to liberate millions of domestic consumers from polluting fuels. Under the scheme, as of 31 January 2021, 83 million households below the poverty line (BPL) got LPG connections free of cost. The government created the budgetary provision for an additional 10 million domestic LPG connections in 2021-2022. Due to this scheme, the LPG penetration has improved drastically. However, a vital concern is the cost of LPG refilling, especially for the BPL families. The pandemic adversely affected income of millions, notably BPL families, resulting in worsening LPG affordability. Post pandemic the situation will improve.

The government entrusted the Petroleum and Natural Gas Regulatory Board (PNGRB) to expand the City Gas Distribution in the country rapidly. The government granted CGD network a public utility status to boost natural gas penetration. Further, priority allocation of natural gas for domestic PNG and CNG would enhance natural gas adoption.

By the end of 2020, over 7.25 million households got piped natural gas connections. PNGRB authorized 232 geographical areas for Pan-India CGD network development with coverage of over 400 districts in 27 States/Union Territories. Government targets to achieve 10 million PNG connections by 2024. The target is certainly achievable. Considering growing natural gas infrastructure and CGD networks, India can increase PNG penetration to 50 million households by 2030. This would reduce not only the carbon footprint but also the LPG subsidy burden on the government.

Immediate impacts of COVID-19: coal power is further weakened, CGD projects face delays

COVID-19 severely dented India's economic development and India suffered one of the world's highest declines in energy production. As the contribution of domestic crude is just 18% of overall domestic demand, India's domestic oil supply was partially affected. India's provisional oil production figures for 2020-2021 show a 5.2% year on year decline.

COVID-19 triggered a 28% decrease in energy demand by the end of March 2020.[27] Under the conditions of strict lockdown, which started on March 25, 2020, power demand from hospitals, essential services, and the residential sector was on the rise, while industrial demand and commercial activity dropped substantially.

During the lockdown, the electricity production mix was changed to make up for a decline in demand, much of which was modified by a decrease in coal electricity output. As evident from *table-1,* coal power generation decreased from an average of 2,511 GWh between March 1 and March 24 to 1,873 GWh between March 25 and April 19 (25%). The total coal contribution to power generation decreased from 72.5% to 65.6% on average in these two periods, because of: (i) promoting renewable sources of energy (solar, wind, and small hydro) as a part of MUST RUN status, which means assigning them the highest priority by distribution companies and (ii) operational costs of the renewable power plants are significantly lower than thermal plants.

Table 1: Status of decreasing coal power during the emergence of COVID-19 in India

Energy Sources (in 2020)	Average generation (in GWh)			Contribution to total (in%)	
	1st March - 24th March	25th March- 19th April	Percent Change	1st March - 24th March	25th March - 19th April
Coal	2,511	1,873	-25.40	72.5	65.6
Hydro	302	331	9.60	8.7	11.6
Solar	157	162	3.18	4.5	5.7
Wind	97	96	-1.03	2.8	3.4

27. IEA, "Global Energy Review 2020", April 2020, available at: www.iea.org.

Gas, Naphtha, Diesel	132	146	10.60	3.8	5.1
Nuclear	113	114	0.88	3.3	4
Lignite	82	78	-4.87	2.4	2.7

Source: Power System Operation Corporation Limited (POSOCO).[28]

This indicates that the detrimental effect on coal power stations will be stronger if growth in demand for electricity remains slower than other energy sources. This would also result in lower demand for coal, as the power sector absorbs nearly 87% of domestic coal output. The thermal power plant load factor (PLF) has declined dramatically over the years, from 77.5% in 2009-2010 to 53.37% in 2020-2021.[29] Low PLF means some power plants will stand idle. Coal power stations have substantial fixed costs, and even though the plants lay still, they bear those costs. The decreasing power use, intensified by lower demand, would further weaken their financial viability. This will have a positive effect on promoting renewable energy sources as an alternative. The IEA expects post pandemic, subject to recovery of economy, coal stands to rebound and push up emissions in India.[30] As per our assessment, the existing coal plants will remain relevant in the short-medium term with similar PLF. Renewables will further weaken coal's dominance in the years to come.

Due to the pandemic and associated challenges, the domestic gas production dropped from 31.18 bcm in 2019-2020 to 28.67 bcm in 2020-2021, marking an 8% decline.[31] Demand was sluggish due to the lockdown, travel constraints, and closure of the factory. Consumption of natural gas slowed down in industry and transport segments.

City Gas Distribution (CGD) entities are scrambling to deal with Force Majeure notices, market disruption, labor shortages, and liquidity restrictions. This will have an effect on the schedules for pipeline and city gas delivery projects which are currently underway around the nation. In a recent meeting organized by the Federation of Indian Petroleum Industry, executives from Adani Gas, Gas Authority (India) Limited, and Indraprastha Gas Limited publicly expressed their concern about these issues.[32]

28. POSOCO, "Daily Electricity Generation", 2020, available at: https://posoco.in.
29. Ministry of Power of India, "Power Sector at a Glance: All India", available at: https://powermin.gov.in, accessed on May 14, 2021.
30. IEA, "Electricity Mix in India, January-December 2020", January 15, 2021, available at: www.iea.org.
31. Ministry of Petroleum and Natural Gas, "Monthly Production Report for March 2021", *op. cit.*
32. FIPI, "Impact of COVID-19 on Oil & Gas Sector", 2020.

Small private players and CBM operators had to shut down their gas wells as factories in the region declined to buy gas due to the temporary suspension of industrial production. Invoking force majeure and renegotiations to lower the prices of old contracts are some of the obstacles that the CGD industry is currently facing.

During the lockdown, project executions came to a complete halt. In addition, owing to a shortage of sufficient staff and facilities, significant delays in resuming activities have been observed even after lifting of the national lockdown. A gap in meeting the minimum job program is inevitable, and all CGD businesses will see a rise in working capital needs as receivables are overdue.

Some gas customers have received Force Majeure warnings, and some industrial sectors have asked for conditions to be relaxed for payments to be made and cash flow problems to be addressed. Similarly, contractors and CGD entities are facing cash flow challenges. As a result, pipeline construction and CGD ventures have taken a hit, and it will take some time for things to return to normal. We expect CGD business to pick up by the first quarter of 2022.

As the Government throws its weight behind the production, distribution, and consumption of natural gas and compressed biogas (CBG), CGD business has a bright future.

Perspectives in the post COVID-19 recovery

Climate and sustainability remain priorities

India faces a greater risk than any other country in coping with climate change impacts due to its ever-increasing population and fastest-growing economy. India's climate policy centres around two core pillars. One is the National Action Plan on Climate Change (NAPCC), launched on June 30, 2008. The second pillar is the INDC submitted to the UNFCC. The NAPCC emphasizes planning at the national level. Simultaneously, INDC is India's statement of intent, a global pledge announced at the Paris Summit on Climate Change.

The NAPCC addresses India's quest for environment-friendly developments and the steps to be taken to accomplish it. It recognizes that climate change and energy stability are equally important.[33] India is on its energy transition path, which outlines a timely and successful transition from its present reliance on fossil fuels to green and clean energy. Such moves will improve India's energy security and lead to mitigate climate change risks.

India's climate change action plan underlies a co-benefit approach. The NAPCC recognizes that it is closely related to a parallel multi-lateral agreement to establish a global climate change agenda focused on the principles and requirements of the UNFCC. Though India has made significant strides in introducing various National Missions, the push for a global climate justice system that insists on equitable responsibilities among countries primarily remains aspirational.

Prime Minister Narendra Modi takes a keen interest in climate change issues. In the Paris Climate Summit run-up, India decided to adopt a more positive, ambitious, and constructive approach. Looking at India's INDC, its contribution to environmentally sustainable economic development is related to its ancient civilizational values of respect for nature, integration of the principle of freedom, and collective identity. Compared to the 2005 base year, India strives hard

33. Government of India, "National Action Plan on Climate Change", 2009.

to reduce its energy intensity/GDP by 33-35% by 2030, which means that, for every additional dollar of GDP, it will absorb significantly less energy.[34] As India is one of the world's largest emerging economies with rising energy needs, this is an essential addition to tackling global climate change.

India has just re-set its renewable target from 175 GW by 2022 to 450 GW by 2030, demanding massive investment in the renewable value chain and a clear commitment by the government to the progressive decarbonization of its electricity mix. Proposed amendments (Renewable and Hydro) to the Electricity Act 2003 could strengthen the deployment of renewable electricity.

The Energy Conservation Act, 2001 identifies 15 energy-intensive industries, including "aluminum, fertilizers, iron & steel, cement, pulp & paper, etc." to become more energy efficient. Further, the act, through Energy Conservation Building Code, envisages energy-efficient buildings.

The use of energy-efficient equipment, machinery, and appliances by the industry and households remains central to energy conservation.

Many states have begun to develop and enact their State Action Plans on Climate Change (SAPCC).[35] So far, 33 states and territories have formed SAPCCs to incorporate climate change issues into their planning processes. SAPCCs draw on the state government's current policies by considering ongoing programs and projects at the state level as well as at the NAPCC. The SAPCC must be incorporated into the state-level planning process to identify the distribution of resources for implementing the adaptation/mitigation steps. SAPCCs should contain a climate profile for the administration, a plan for intended measures, and an overview of relevant implementation tasks, according to the common framework. This should be focused on a state-by-state evaluation of climate change vulnerability and related threats, as well as climate change impacts. The SAPCC should recognize the adaptation and mitigation strategies that will reduce the state's vulnerability in the short, medium, and long term. India is grappling with its ambitious aspirations with the declining economic condition seriously impacted by the pandemic.

Global coordination is required to fight climate change as an individual country's commitment will not yield results unless it is supplemented by appropriate efforts on the part of others. India has

34. IEA, "India 2020 - Energy Review Policy", 2020, available at: www.iea.org.
35. Centre for Science and Environment, "Coping with Climate Change", Vol. II, 2018.

often stressed the importance of justice and the convention's principle of separate obligations in all the collective efforts. India achieved a 26% reduction in carbon intensity, and it is well on course to meet its Paris Agreement targets. To fast-track progress, government formed an inter-ministerial Apex Committee for Paris Agreement Implementation.[36]

Efforts and select initiatives by various ministries will curb India's carbon footprints and reduce the emission intensity of its GDP by 33-35% by 2030 and beyond. The Ministry of Railways is in the process of gradually phasing out diesel-driven engines. The railway can migrate to renewable energy in the long run, which can substantially reduce carbon footprint.

The Smart Cities Mission aspires to build cities with healthy and sustainable lifestyle. Government already identified 100 cities with 5,771 projects worth $24 billion of planned investment.[37] So far, 2,546 projects valued $5.8 billion have been completed. Smart Cities implement projects ranging from waste management to information and communication technology. A number of cities including Ahmedabad, Surat, Coimbatore and Mumbai have taken adaption measures to deal with climate change risks.[38] With the help of global partners like the World Bank, GIZ, the UK government, USAID, AFD, and many others, the Indian government is making important efforts to make cities climate resilient.

Most of the ministries have developed relevant policies for low carbon technologies, which may not prove adequate to address emerging climate risks. It's time for India to develop a comprehensive national policy on low carbon technologies, which should address technology development, allied infrastructure development, technology diffusion, and adoption.

Boosting renewables further

According to the National Electricity Program,[39] India's overall power addition target for 2017-2022 is about 176 GW. This includes 118 GW from renewable energy sources, 6.8 GW from hydro sources, and 6.4 GW from coal sources (excluding 47.8 GW of coal-based power

36. *The Gazette of India*, November 27, 2020, available at: https://static.pib.gov.in (in Indian), accessed on May 16, 2021.
37. Ministry of Housing and Urban Affairs of India, Smart Cities Mission, available at: https://smartcities.gov.in, accessed on June 1, 2021.
38. C. Singh, "Climate Change Adaptation in Indian Cities: A Review of Existing Actions and Spaces for Triple Wins", Elsevier, 2021, available at: www.sciencedirect.com.
39. PIB, "India Prepares for a Change in Electricity Sector through Proposed Electricity (Amendment) Bill", Ministry of Power of India, 2021.

projects already in multiple production stages).

As part of its climate change promises, India has set a target of building 175 GW of renewable power capacity by 2022. With concerted efforts by the various stakeholders, 92.7 GW of grid-connected renewable energy has been installed by the end of February 2021, so that another 3.8 GW would need to be added every month until December 2022 in order to meet the 2022 target. Karnataka was leading the renewable capacity installation leaving behind states like Tamil Nadu, Gujarat, and Maharashtra (Table 2). The top ten states contributed 93.5% of India's total renewable capacity, which means that renewable installation is still skewed. Uttar Pradesh -the most populous state lies at 9th position, which means enormous potential for renewable growth in the state.

Table 2: States leading renewable installation in India (as on February 28, 2021)

State/UTs	Installed Capacity (MW)	Share
Karnataka	15,428	16.6%
Tamil Nadu	14,977	16.1%
Gujarat	12,531	13.5%
Maharashtra	10,267	11.0%
Rajasthan	9,945	10.78%
Andhra Pradesh	8,762	9.4%
Madhya Pradesh	5,206	5.6%
Telangana	4,361	4.7%
Uttar Pradesh	3,834	4.1%
Punjab	1,605	1.7%
Total of top ten States	86,916	93.5%
Other States/UTs	6,055	6.5%
Total of India	*92,970*	*100.0%*

The Parliamentary Standing Committee on Energy stated in January 2020 that India had installed 82% and 55% of its annual renewable energy capacity addition commitments in 2017-2018 and 2018-2019, respectively.[40] As of January 2020, 67% of the target set for 2019-2020 had been met.[41] Further, by the end of February 2021, only 41% of the target set for 2020-2021 was achieved.

Due to COVID-19, the energy capacity addition targets are already adversely impacted. It is expected that the progress will be slow in the short term. Construction activities were halted during the lockdown and may take some time to resume. Disruption in the global

40. MNRE, "Standing Committee on Energy (2019-2020)", vol 1941 (2020).
41. CEA, "Electricity Dashboard", 2020, available at: https://cea.nic.in.

supply chain could cause difficulties with the availability of key components, causing delays in project execution. Reduced revenue for businesses due to weak demand would leave firms with less room for capital spending.

In a move to support the sector, the Reserve Bank of India granted "Priority Lending" status to many sustainable and green projects, through which project developers will have access to funding from the commercial banks. Renewable project developers can now borrow up to ₹300 million – approx. $4.12 million – from any commercial bank. An individual household can get bank loan up to ₹1 million ($13,736) for renewable electricity installations.

National Mission on Electric Mobility

India has embraced a national roadmap for faster adoption of electric vehicles (EVs) and their manufacturing, with a goal of achieving 30% EVs by 2030. It includes a target for the sale of 6-7 million hybrid and EVs from 2020 onwards. Under the National Mission on Electric Mobility, the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme was launched on April 1, 2015 to promote manufacturing, sales, and use of electric and hybrid vehicles. The FAME-I scheme (2015-2019) brought limited success due to multiple challenges, which include insufficient EV infrastructure. The government addressed some of the bottlenecks and with budgetary support of ₹96.34 billion ($1.34 billion), it launched FAME-II (2019-2022) scheme on April 1, 2019. To create charging infrastructure, the government allocated ₹10 billion ($140 million) under FAME-II. For rapid adoption of EV, government allocated total budgetary support of ₹100 billion ($1.38 billion) during 2019-2022, which included ₹3.66 billion ($50 million) of committed expenditure under FAME-I in 2019-2020.

As of May 15, 2021, under the FAME scheme, sales of EVs reached 73,269. This resulted in savings of (i) 19 million liters of fuel and (ii) 47712 tons of CO_2 reduction. Currently, Maharashtra leads the EV adoption, followed by Rajasthan, and Delhi. All states and Union Territories (UTs) are racing towards E-mobility. The central government advised the states and UTs to offer fiscal and non-fiscal incentives to the rapid adoption of e-mobility.

As per Society of Indian Automobile Manufacturers, in 2019-2020, about 21.54 million vehicles were sold in India. The two wheelers, passenger cars, commercial vehicles, and three wheelers contributed 80.7%, 12.9% 3.2%, and 3%, respectively. According to

Society of Manufacturers of Electric Vehicles (SMEV), in 2019-2020, 155,400 EVs were sold in India, of which four wheelers and two wheelers contributed 2.2 percent and 97.8%, respectively. The SMEV lists over 15 members involved in manufacturing of e-two wheelers, which include Hero Electric, Ather Energy, and Avon Cycles. Leading home-grown auto makers like Tata Motors, Maruti Suzuki, Mahindra, and Ashok Leyland are manufacturing EVs in India.

Import of battery cells and lithium remains a stiff challenge. The National Program on Advanced Chemistry Cell (ACC) Battery Storage promotes local manufacturing, which will address battery import imbalance within five years. A recent 1600 tons of lithium resources discovery in Karnataka[42] could support the domestic battery-cell manufacturing industries.

India's e-mobility definitely gathered momentum, which is visible from the fact that a large number of operators are entering into EV manufacturing domain. India offers excellent market opportunities for global automobile makers to meet the rising demand for EVs. India's push for higher indigenization and domestic value addition might incentivize the global automakers to strengthen their manufacturing base in India. Moreover, it offers cost-competitive manufacturing and market access to Asian and European markets. India will be expecting more international collaborations from developed countries to fulfil its target sale of 6-7 million hybrid and EVs by 2030. COP-26 is one such platform where India will seek to gather more momentum for its FAME scheme and other e-mobility opportunities.

Developing a hydrogen strategy

The Indian government recently announced that it is soon going to roll out a new Hydrogen Energy Mission and roadmap for the country. It will aim to foster the growth of green hydrogen technology and to promote commercial applications of hydrogen in transport, power generation, and industries.

Indian Oil Corporation Limited (IOCL) has launched a pilot project to test hydrogen-enriched compressed natural gas (H-CNG) for transport applications. In terms of lowering emissions, H-CNG has shown promising results and more environment friendly than CNG. IOCL has designed a new method for the blending of hydrogen with CNG, and the resulting blend is expected to reduce emissions

42. Department of Atomic Energy, Lok Sabha Unstarred Question No.317 to Be Answered on 03.02.2021: Deposits of Lithium, available at: https://dae.gov.in.

and be cost-effective. Respecting the rulings of Honourable Supreme Court of India to conclude the pilot project as soon as possible, IOCL has decided to run HCNG buses between Delhi and Jaipur.[43]

The NITI Aayog, India's nodal policy-making think-tank, has also proposed that H-CNG be used in Delhi by using the current piped-gas system. It also suggests that H-CNG be designated as automated gasoline, with BIS issuing guidelines for its use. The Petroleum and Explosive Safety Organization granted approval for H-CNG storage cylinders for cars.

Other oil companies, such as ONGC and Hindustan Petroleum, are working on hydrogen technology too. 'Green' hydrogen got the potential to reduce pollution and carbon footprint.

Currently, research is being conducted to provide grid-scale storage solutions as well as green hydrogen transportation in the nation. The Energy Research Institute (TERI) predicts the share of green hydrogen to reach 80% by 2050.[44] It also forecasts that by 2030, the cost of 'green' hydrogen to gain parity with 'grey' hydrogen.

In India, fuel cell hydrogen vehicle use is currently limited to testing and trial runs only. More than 100 academic institutions are currently working on hydrogen in collaboration with oil producers and other Multi-National Corporations. Fuel cell technology is incredibly expensive in India. The government must closely work with Japan to increase fuel cell in the long run. India should devise a cost-effective strategy for adoption of fuel cell technology. It would also need to spend a significant amount of money on building the necessary facilities, including a hydrogen transmission network, storage and transportation systems, and refueling stations. The country needs to develop strategies across the hydrogen value chain to make hydrogen commercially available and adoptable.

National and state-level strategies must focus on (1) ensuring sufficient hydrogen production at a competitive rate; (2) create pan-India hydrogen infrastructure; (3) enabling sufficient production of cost-competitive hydrogen/fuel cell vehicles & power generators, and (4) building hydrogen export infrastructure.

43. *ET News*, "In a First, Hydrogen Fuel Bus Service to Start on Delhi-Jaipur Route", February 21, 2021, available at: www.timesnownews.com.
44. W. Hall *et al.*, "The Potential Role of Hydrogen in India", 2020.

India's action plan for COP26 and beyond: fostering international partnerships

India's priority issues for the upcoming COP26 will be focusing on:

- Strengthening *community, technological, and environmental adaptation* and resilience by interconnected socio-economic and ecological processes.
- The power of *natural technologies to improve livelihood* benefits and environmental services, as well as to mitigate pollution and carbon footprint.
- The future of *clean transportation* towards a resilient economic recovery through an e-mobility revolution in India.
- Mobilizing private *green finance* on a global scale for climate change – in developed nations as a whole and India.

National Adaptation Fund on Climate Change

The Ministry of Environment, Forest, and Climate Change launched the National Adaptation Fund for Climate Change in 2015-2016 to cover vulnerable sectors across the country, including water, agriculture and animal husbandry, forestry, ecosystems, and biodiversity. The fund's ultimate goal is to promote tangible adaptation activities that aren't protected by existing activities through state and national government schemes to mitigate the adverse effects of climate change on populations, industries, and states. The fund is designed to help the federal and state governments to support the most adversely impacted areas to cover the cost of climate change mitigation measures. So far, the government approved 30 projects totaling ₹8.47 billion (approx. $116 million).[45]

45. National Bank for Agriculture and Rural Development (NABARD), "National Adaptation Fund for Climate Change", available at: www.nabard.org.

India faces socio-economic problems and financial constraints, which create hurdles in the fight against climate change. The lack of advanced technology at affordable prices also adds more pressure on the adoption of sustainable technologies. The partially estimated conditional cost of climate mitigation in India is $834 billion.[46] Like every other developing country, India faces a much more difficult challenge in allocating adequate funds for climate mitigation.

The developed economies were supposed to provide funding of $100 billion through the Green fund for developing and least developed countries. This is of tremendous importance to India.

The developed countries and multi-lateral funding agencies must provide financial assistance to least developed countries, and developing countries, including India, to achieve their INDCs targets. The UNFCCC has established a Green Climate Fund (GCF), but the GCF has its financial constraints. Currently, GFC committed $8.4 billion for global climate mitigation and adaptation activities. India received financial assistance of $416.3 million, which is 4.95% of total committed funding by GFC. Climate financing is a prime challenge in India, which needs systematic redressal. India must highlight this aspect in COP26. Climate change risk mitigation and adaptation project financing should not be viewed through the prism of global social obligation. Instead, it is a socio-economic proposition that can immensely offer business opportunities for companies looking for market opportunities.

Taking the International Solar Alliance forward

As of January 15, 2021, 89 member countries have signed the Framework Agreement of the ISA, and 72 of them submitted their ratification.[47] India, in collaboration with France, has launched two new initiatives: 'World Solar Bank' and 'One Sun One World One Grid Initiative'.

Currently, India ranks 5th globally in terms of cumulative installed solar capacity. It is among the world's lowest solar power production costs.[48] India will be looking forward to COP26 for

46. W.P. Pauw *et al.*, "Conditional Nationally Determined Contributions in the Paris Agreement: Foothold for Equity or Achilles Heel?", 2020, available at: https://doi.org.
47. Ministry of External Affairs of India, "Universalization of the Membership of the International Solar Alliance (ISA)", *Press Release*, January 15, 2021, available at: www.mea.gov.in.
48. The International, Renewable Energy and Agency (IRENA), "Renewable Power Generation Costs in 2018", 2018.

promoting its Solar Charkhas (Spinning wheels) and Solar pumps. Mission Solar Charkha has been launched to implement 50 solar charkha clusters across the country, with a budget of the US $77 million for the years 2018-2020.[49] In another program, the Indian government is funding the installation of solar streetlights, solar pumps, solar power packs, and other solar applications in rural areas to fulfil the energy and lighting needs of local cities, agencies, and individuals. Under the scheme, 237,120 solar pumps were deployed. Solar PV off-grid power packs/power plants with a combined capacity of 212 MW have been built. Besides, as of 2019, 659,218 solar streetlights, 1.7 solar-powered home lights, and 5,823,800 solar lanterns had been installed. India in September 2020 had also organized First World Solar Technology Summit.[50] India will be hoping to highlight these accomplishments at the forthcoming COP26 in order to gain more international collaborations and funding's in order to strengthen the solar alliance.

Strengthening bilateral climate partnerships

India firmly puts its step forward to mitigate climate risks through building partnerships with like-minded nations. For instance, India forged an alliance with the United Kingdom to accelerate: production, distribution, and consumption of green energy, including green hydrogen; forest protection; and developing resilient infrastructure for climate-vulnerable nations.[51]

New Delhi considers the European Union (EU) as one of the strongest partners in multiple areas including trade, security, and climate change. The EU has been an able ally in supporting India's renewable ambitions. The EU Smart Cities Knowledge & Innovation Program extends support to India's Smart Cities Mission. The European Investment Bank already financed about €2 billion for implementing metro projects,[52] key to public transport, decongestion of cities, and pollution management. The EU has been extending financial and technical support for implementation of several projects on offshore wind, solar park, solar roof-top, smart grid, thermal-biomass hybrid

49. MSME, "Mission Solar Charkha", 2021, available at: www.kviconline.gov.in.
50. PIB, "Sustainable Development Core to India's Development Strategy; Substantive Economic Stimulus and Wide Ranging Economic Reform to Drive the Same : Economic Survey", Ministry of Finance, January 29, 2021.
51. UK Cabinet Office, "UK and India Deepen Work on Climate Change on the Road to Successful COP26", May 4, 2021, available at: www.gov.uk.
52. E. D'Ambrogio, "EU-India: Cooperation on Climate", *Briefing*, European Parliament, November 2020, available at: www.europarl.europa.eu.

power plant, green housing, urban mobility and many more.

In April 2021, the "US-India Climate and Clean Energy Agenda 2030 Partnership"[53] was launched to fast-track actions and measure to meet the goals of Paris Agreement. The partnership clearly aims at addressing bottlenecks to adoption of clean energy, including mobilization of finance for demonstration, deployment, and scalability of clean technologies.

India already has strong partnership with Japan and Australia. Strengthening climate diplomacy with the EU, the US, Japan, Australia and other friendly nations are on top of Modi Administrations agenda.

Fostering sustainable climate finance

The COP26 will focus on achieving consensus on the long-term climate finance mechanism and accountability process. India's sustainable energy ambitions will largely depend on the success of global climate finance models. India is working to establish a Social Stock Exchange through which organizations can raise funds to realize social objectives. This will be a big step to arrange funds for climate finance.

According to the Economic Survey 2020-2021, India has the second-largest green bond market for emerging markets after China. Eight Environmental, Socioeconomic, and Governance (ESG) mutual funds have been introduced in India as of December 24, 2020. Further, strengthening the existing green bond market will bridge the rising gap of climate finance.

In addition, the Reserve Bank of India has begun lending to social infrastructure and small clean energy ventures to achieve the primary goals and targets. National Voluntary Standards for Responsible Finance is being promoted in the country for encouraging sustainable practices and adopt the best international standards in the business.

53. "U.S.-India Joint Statement on Launching the 'U.S.-India Climate and Clean Energy Agenda 2030 Partnership'", Media Note, Us Office of the Spokesperson, April 22, 2021, available at: www.state.gov.

Conclusion

India requires over $20 billion each year for at least in the short to medium term to accelerate its energy transition. It should continue to concentrate on renewable capacity expansion, production, and adoption. India's forward-looking energy policies and plans must retain their core values. During the transition, relying on natural gas as a complementary resource seems to be a good option. In the long term, though, clean energy, like green hydrogen, could emerge as a better alternative to meet rising energy demand.

There is a real emphasis from the government on sustainable community building, manufacturing, transportation, agriculture, and the sustainable lifestyle of its citizens. The government is dedicated to the creation of smart and green cities, as well as more resilient villages. Measures to decarbonize critical components of the economy are appreciable. India will not sit back on the past achievements; instead, strive to reach the 'Net-Zero' scenario by 2050. Yet very little has been achieved to decarbonize surface transport, shipping, mining, and manufacturing. A massive challenge lies ahead of the government to live up to the global expectations, more importantly, its ambitions.

With on and off international travel restrictions, economic slowdown, and other allied constraints, the energy value chain could face unprecedented challenges in the short and medium-term. Nonetheless, some of the current reforms may have a positive effect on the energy environment and lead to a shift to a greener lifestyle and economy. Companies and their staff are becoming more familiar with remote working practices, which, if maintained to certain degrees, would limit transport and energy consumption in industrial buildings. In addition, the metropolitan areas are seeing the benefits of reduced carbon emissions on local air quality, which have given communities a glimpse of the future if they are to follow cleaner modes of transport.

Amid the ongoing pandemic, financing climate change mitigation is a serious challenge. This can only be accomplished by global- mutual collaborations between developed and developing countries. Multi-lateral organizations such as the UN, the World Bank, and Asian Development Bank will have a greater role to play in the global energy transition.

Annex

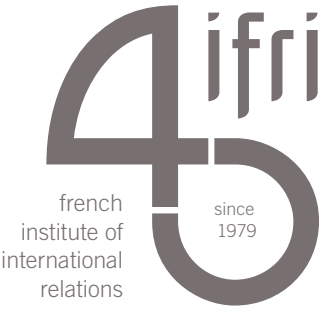
Exhibit 1: Programs and initiatives of India to mitigate climate change risk

Program/Scheme and Sectors	Objective	Achievements
Ministry of New and Renewable Energy		
Small Hydro and Biomass, Renewable Energy	Deployment of 15GW small Hydro and Biomass-based power by 2022	India has already achieved the target by Feb 2021
Green Rating for Integrated Habitat Assessment (GRIHA), Energy Efficiency	To recognize energy-efficient buildings, as well as to stimulate their large-scale replication	Currently, 2000+ ongoing/completed projects with 52.5 million sqm declared as carbon footprint-free area
Ministry of Power		
Perform Achieve and Trade (PAT), Energy Efficiency	Market-based mechanism to enhance Energy Efficiency through certification of energy saving which can be traded.	Currently, 737 designated consumers are participating under PAT scheme from eight energy-intensive sectors, aluminum, cement, chlor-alkali, fertilizer, iron & steel, paper & pulp, thermal power plant, and textile.
Energy Conservation Building Code 2017	To establish minimum energy performance standards for buildings in India	Twenty-six industrial units have been awarded for excellent performance in energy efficiency.
Agricultural Demand Side Management, Energy Efficiency	Reduce energy intensity of agricultural pumping sector by upgrading the efficiency of pump sets	Solar pumps installed as of March 2021: 77,142 Annual CO_2 reduction: 1,47,832 tons Annual energy saving: 200 MU Financial benefit: ₹1000 million ($13.7 million)
Street Lighting National Program (SNLP), Energy Efficiency	Installing LED street lights that are 50% more energy-efficient than traditional incandescent and Sodium based lighting	LED streetlights installed as of March 2021: 11.54 million LED Annual energy saving: 7751 MU energy Annual CO_2 reduction: 5.34 million tons
Unnat Jeevan by Affordable LEDs and Appliances for All (UJALA), Energy Efficiency	Distributing LED bulbs to Indian households for energy efficiency	LED bulbs distributed as of 16 May 2021: 367 million Annual energy saving: 47.7 billion kWh Avoided peak demand: 9.55 GW Financial saving: ₹ 190.74 billion ($2.62 billion) Annual CO_2 reduction: 38.6 million tons
PAVAN- Energy Efficient Fans, Energy Efficiency	Distributing energy-efficient fans to households	Fans distributed as of 16 May 2021: 2.34 million as of March 2021 Energy-saving: 218 million kWh energy per day Annual financial saving: ₹270 billion ($3.7 billion) Annual CO_2 reduction: 657 million tons
National Smart Grid Mission, Crosscutting	Accelerate Smart grid installations across the country	Ongoing Projects: 05 Completed projects: 11 projects completed
Energy Efficiency Financing Platform (EEFP), Crosscutting	Create a platform to interact with Final Institutions (FIs) and project developers for implementing energy-efficient projects	Beneficiaries of training as of Mar 2019: 682 participants from 72 banks/ NBFC's

Ministry of Environment, Forest, and Climate Change		
National Afforestation Program (NAP) **National Mission for a Green India** **Forest Fire Prevention & Management Scheme**	Promote afforestation and reforestation on degraded lands Enhancing the quality of forest and forest cover Preventing forest fire	Under NAP the Government spent ₹38.74 billion ($53 million) for treatment/afforestation of 2.1 million hectare (Ha)[54]. Total forests cover growth: 3976 sq. km[55] (0.56% of forest cover during 2017-2019. Tree cover growth: 1212 sq. km (1.29% of tree cover) during 2017-2019.
Compensatory Afforestation Management and Planning Authority (CAMPA), Forestry	To promote regeneration activities as a way of compensating for forest land diverted to a non-forest use.	As of 2019-20: Compensatory afforestation (CA) projects: 30,482 Embarked land for CA: 2.68 million Ha area cover under plantation: 1.4 million Ha.
National Clean Air Program (NCAP), Crosscutting	Strategy to tackle the increasing air pollution in a phased manner. The target is to reduce 20-30% PM2.5 and PM 10 concentration by 2024. Reduce 20 percent pollution in 100 cities.	The Ministry signed a Memorandum of Understanding with various State Governments to reduce air pollution in 132 cities. Fund allocated for procurement of 6,000 e-buses across 26 states/UTs. The fund is underutilized as only 600 buses are procured by the cities.[56] All industrial units currently running on clean fuel.
Ministry of Housing and Urban Affairs		
Smart Cities Mission, Crosscutting	Urban restructuring by providing a clean and sustainable environment by adapting smart measures	Hundred cities have been selected under 5151 projects amounting to ₹2050 billion ($28 billion). Of the 5151 projects, 2255 projects amounting to ₹ 366.6 billion ($5 billion) have been completed so far.
Atal Mission for Rejuvination and Urban Transformation (AMRUT), Crosscutting	To provide clean water supply, sewerage, and urban transport to households for improving quality of life. To promote a switch to public transport.	The government allocated ₹500 billion for AMRUT activities. Energy audits of water pumps: 446 cities registered, and 358 cities completed so far.
Ministry of Petroleum and Natural Gas		
National Policy on Biofuels-2018, Energy	Target to achieve 20 percent blending of biofuel with hydrocarbons by 2030	As of 2019-2020, 1.1 billion liters ethanol blended biofuel have been produced, achieving an ethanol blending percentage of 5.12 percent
Sustainable Alternative Towards Affordable Transportation	Government targets 5,000 compressed biogas gas (CBG) plants by 2024 with an approximate investment of ₹2,000 billion ($27 billion).	Reserve bank of India granted Priority Lending status to CBG projects 1,500 CBG plants are at various stages of execution Nine CBG plants commissioned in March 2021

54. PIB, "National Afforestation Programme", MOEFCC, December 13, 2019, available at: https://pib.gov.in.
55. "Executive Summary" *in India State of Forest Report (ISFR) 2019*, Forest Survey of India, available at: https://fsi.nic.in.
56. PIB, "MoU signed towards Execution of Planned Actions…", *Press Release*, MOEFCC, March 26, 2021, available at: www.pib.gov.in.

Ministry of Agriculture and Farmer's Welfare		
Pradhan Mantri Kisan Sinchayee Yojana, Agriculture	It provides end-to-end solutions in the irrigation supply chain and extensive use of micro-irrigation technologies to save water.	As of Mar 2020, 257.97 thousand Ha. of land have been covered under the micro-irrigation project which has led to an emission reduction of 22.82 $MtCO_2$.
National Bamboo Mission, Forestry	Increase the green cover of the country	As of Mar 2021 India, has 13.96 million Ha area covered with 136 bamboo species in India.
Rainfed Area Development (RAD), Agriculture	To explore potential utilization of natural resources base/assets available through watershed development and soil conservation.	Of the defined target of 4.31 million Ha area, 7,878.83 Ha have been achieved.
Sub- Mission on Agroforestry	To enhance tree plantation on farmland along with cropping system.	640,695 plantations have been made at 23,871 nurseries covering 3,897 Ha of land.
Ministry of Road Transport & Highways		
National Green Highway Mission, Forestry	Avenue plantation on highways aiming to develop 140,000 km long tree line in five years 1,915.53 km length national highways	The project is currently undergoing across 780 km of national highways cutting across four states of Himachal, Rajasthan, Uttar Pradesh, and Andhra Pradesh.



27 rue de la Procession 75740 Paris cedex 15 – France

Ifri.org