

2023 ROAD FROM PARIS: INDIA'S PROGRESS TOWARDS ITS CLIMATE PLEDGE

Executive Summary

With 2023 now confirmed to be the Earth's hottest year in recorded history, climate change-related extreme heat, as well as increasing hurricanes, floods and droughts, are only highlighting the need for worldwide climate action.¹ As countries gear up for COP28 in Dubai and prepare to conclude the first Global Stocktake—the most extensive assessment of global action on climate change to date—Technical Dialogue meetings from the past year encourage all countries to increase ambition and implementation to protect people and communities from the most dire impacts of climate change.

The world is not without hope: according to a recent International Energy Agency assessment, progress made since the 2016 Paris Climate Agreement has reduced expected business-as-usual warming from 3.5°C to 2.5°C by 2100, and if current pledges are fully implemented, warming would be limited to 1.7°C by 2100.² As one of the largest economies in the world, India has a significant role to play in climate action.

With the G20 presidency this year, 2023 has brought India and its key role in climate change mitigation and impact reduction into the spotlight. Historically, India's emissions have not contributed significantly to the climate crisis, and India's per capita emissions remains well below those of other major emitters – China, the European Union and the United States. At the same time, India is particularly vulnerable to climate change impacts: the latest IPCC report warns that 2°C of warming could have dire impacts for India, putting billions of people at risk, with climate change increasing the severity and intensity of

extreme weather impacts such as heat, tropical cyclones and flooding. These extreme weather events disproportionately impact the poor and marginalized populations in the country, who are also struggling for basic sustenance.

India today is the world's largest democracy and fastest growing economy.³ As India's growth continues over the coming decades, its energy demand and emissions are estimated to double by 2040.⁴ Going forward, India's biggest climate challenge remains providing energy access and security to millions, while decarbonizing its growth trajectory and achieving its climate mitigation goals.

India is uniquely situated to create a new model for a low-carbon, sustainable and inclusive development that provides clean energy solutions to millions without locking them into carbon-intensive developmental pathways to growth. India's climate action has the potential to secure a livable future not only for its own populations but also provide a working model for climate-friendly development across the Global South. As countries gear up for the 2023 Climate Change Conference (COP28) to take stock of actions to date, continuation of successful climate actions as well as increased ambition and implementation can help support the goal of limiting global warming to 1.5°C.

This is the fifteenth edition of NRDC's Series on India's Climate Actions.



India's five-fold Strategy to fight climate change



2023 has been the year of India raising its climate ambition by reiterating and expanding on its commitments, both at national and international levels. At COP26, held in 2021 in Glasgow, Prime Minister Narendra Modi had announced India's five-pronged goals – dubbed Panchamrit, or 'five nectars' – to achieve net zero emissions by 2070. By August 2022, India had incorporated some of the Panchamrit elements in its updated Nationally Determined Contributions (NDC) submitted to the United Nations Framework Convention on Climate Change (UNFCCC). This included two key commitments for renewables and emissions reduction: 1) meeting 50 percent of overall power capacity by 2030 with non-fossil fuel energy, and 2) increasing the goal to reduce the emissions intensity of the economy from 35 percent to 45 percent by 2030. In 2023, India announced a program called Mission LiFE (Lifestyle for the Environment), focused on encouraging sustainable, zero-carbon lifestyles and promoting citizen action for climate change. Key highlights on India's climate action are discussed below.

India's Climate Leadership

On the global stage, India recently assumed the presidency of two major international forums – the G20 and the Clean Energy Ministerial. Under its G20 presidency, India led efforts on a variety of climate-related issues, especially advocating for low-carbon transition solutions for Global South countries that balance development with emissions reductions. India championed the issue of energy access and energy efficiency during its G20 presidency and steered consensus building to promote renewable energy to accelerate universal energy access. In September 2023 in New Delhi, G20 leaders agreed to encourage a tripling of renewable energy capacity and doubling the rate of energy efficiency improvement globally by 2030 under the New Delhi Leaders' Joint Declaration.⁵ India also launched the Global Biofuel Alliance on the sidelines of

the G20 Leaders' Summit. India, Brazil and the United States are the founding members of this alliance, which aims to bring together governments, international organizations and industry to facilitate the uptake of biofuels globally.

The Clean Energy Growth Story

Renewable energy, including solar and wind, continues to drive India's climate action. Globally, India ranks fourth in renewable energy installed capacity (excluding large hydro), fourth in wind power capacity and fifth in solar power capacity.⁶ India's solar growth has been largely led by utility-scale solar—large scale solar projects were 87 percent of installations in 2022, a 33 percent year on year increase.⁷

In addition to large scale renewable energy programs, India has been investing smaller, localized solutions linked to peoples' livelihoods. In 2022, India released its "framework for promotion of decentralized renewable energy livelihood applications," geared towards developing an ecosystem that will enable widespread distributed renewable energy (DRE) solution adoption. DRE solutions have been gaining traction given their potential to address last-mile connectivity and technology accessibility issues, improve energy access, especially in rural areas, contribute to meeting India's climate commitments and become the fulcrum of economic development across India.

In January 2023, India officially launched the *National Green Hydrogen Mission*, which aims to make India a leading supplier of green hydrogen (defined as hydrogen produced from renewable energy sources). In August 2023, the Ministry of New and Renewable Energy notified the official Green Hydrogen Mission standards, or the emissions thresholds that must be met to for hydrogen to be considered 'green'.

Energy Conservation and Energy Efficiency

India is on track to reach its goal of reducing its emissions intensity – the total amount of greenhouse gas emissions emitted for every unit increase of gross domestic product (GDP) – by 45 percent by 2030. According to its Third National Communications report submitted to the UNFCCC this year, India's rate of emissions intensity fell by 33 percent from 2005 to 2019.⁸

India's announcement at COP26, held in 2021 in Glasgow, on achieving net zero by 2070 has galvanized climate action across a range of energy conservation and energy efficiency measures. The Energy Conservation (Amendment) Act of 2022 remains a significant legislation, which is aimed at promoting renewable energy to meet India's climate commitments of achieving 500 gigawatts (GW) of non-fossil energy capacity and 50 percent of its energy requirements from renewable sources by 2030.⁹ The amended act also established the framework for India's first domestic carbon credit market. In June 2023, India's Ministry of Power notified the Carbon Credit Trading Scheme, which employs a cap-and-trade mechanism. Under this scheme, every ton of carbon dioxide equivalent (CO₂e) reduced or avoided is assigned a value, known as a carbon credit. Such programs are designed to help ensure that industries will play a large role in achieving India's emission reduction goals.¹⁰ Next steps for the scheme include the formation of a National Steering committee to govern and provide direct oversight over carbon market, as well as links to international registries.¹¹

With India's growing economy, rising temperatures and skyrocketing cooling (air conditioning) demand, advancing energy efficiency will be critical to preventing increased CO₂ emissions, to increasing energy access, and to combating pollution. Significant energy efficiency measures are being adopted by Indian states across different sectors such as in buildings, appliances, industry, and transportation. In April 2023, the state of Telangana launched its first of its kind *Cool Roof Policy*, aimed at addressing extreme heat, reducing energy consumption, and lowering carbon emissions. The policy focuses on four key objectives related to cool roofs: promoting adoption of cool roofs (that is, roofs using light colors or other means to reflect sunlight and absorb less heat), establishing an institutional framework, identifying financing mechanisms, and supporting workforce development. Cool roofs are mandated for government, non-residential, and commercial buildings, and larger residential buildings, while smaller residential ones can voluntarily adopt them. As of June 2023, India ranks first in the world for Leadership in Energy and Environmental Design (LEED) certified green building projects (with 73 such projects, comprising 45% of the more than 150 LEED projects worldwide).¹²

Transportation Takes Off

Last year, India surpassed Japan to become the third largest auto market in the world. India's electric mobility policies include the 'National Electric Mobility Mission Plan 2020' and the 'FAME (Faster Adoption and Manufacturing of Hybrid & Electric Vehicles) India Scheme.' The FAME India scheme supports electrification of public and shared transportation and aims to provide demand incentive for e-vehicles and support for charging infrastructure. A total of 26 Indian states and territories have notified Electric Vehicle (EV) policies as of February 2023.¹³

Climate Resilience

In 2023, extreme heat was once again in the spotlight. After record-breaking heat in 2022, 2023 brought India the hottest February since 1901. Climate change has increased the probability of extreme heat event events in India by a factor of about 30.¹⁴ This crisis has brought India's heat adaptation measures into the spotlight, especially National Heat Guidelines developed by the National Disaster Management Authority (NDMA), the India Metrological Department (IMD), and partners. The guidelines expanded Heat Action Plans (HAPs) to states and cities in India to provide local frameworks for advancing heat resilience. Since the launch of Ahmedabad's HAP in 2013, more than 23 states and over 100 cities in India have announced HAPs, with Jodhpur, Rajasthan being the latest to launch its HAP in April 2023.

Climate Finance

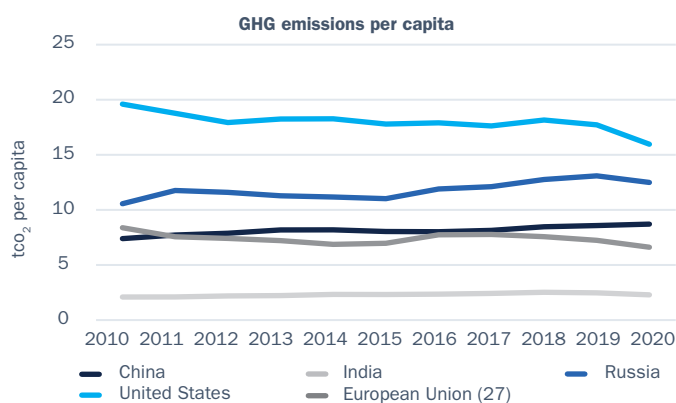
Investment in India's green energy sectors is gaining steam, with some estimates saying India could see as much as USD 800 billion cumulatively in the next decade.¹⁵ Tracked green investment in India is approximately USD 44 billion as of 2020.¹⁶ After COVID-19 related delays, investments in 2022 grew exponentially, more than doubling from investment rates seen in 2015.¹⁷

India has long argued for the developed world to meet their commitments of providing developing nations USD 100 billion annually by 2020 through the Green Climate Fund. At COP27, India played a key role behind in countries coming together to take the ground-breaking decision to establish a new "loss and damage" fund to assist vulnerable, developing countries hit hardest by the impacts of climate change.

Energy Transition and the Power Sector

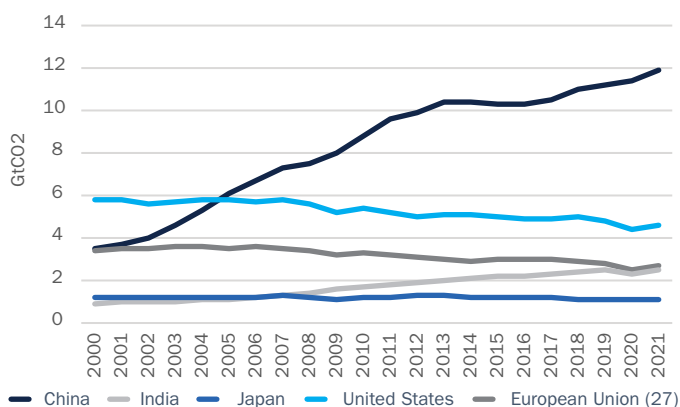
As of April 2023, India has overtaken China as the world's most populous country.¹⁸ India is also an economic powerhouse with an average GDP growth rate of 6.7 percent over the last decade, and despite COVID-induced slowdowns, India's projected growth is the highest of any major economies at 6.1 percent and 6.3 percent in 2023 and 2024, respectively.¹⁹ As India's economy continues to grow, the country's absolute emissions are expected to rise in the near-term. India's cumulative CO₂ emissions reached a record high in 2022 with 2.7 billion metric tons (Mt), broadly equivalent to emissions in the European Union, even though it remains very low on a per capita basis.²⁰

Fig 1: Emissions per capita for China, US, India, EU & Russia



(Data Source: Climate Watch)

Fig 2: CO₂ emissions of each country



(Data Source: IEA)

India's CO₂ emissions from January-August 2023 are 136 Mt or 7.6 percent higher than emissions from the same time period in 2022.²¹

Non-fossil fuel energy installed capacity continues to grow, with the share of fossil-free energy capacity increasing to

more than 40 percent (more than 178 GW out of 425 GW) in October 2023.²² Though fossil fuels still account for the majority of India's power generation, the share of thermal capacity has decreased to 56.25 percent.²³ However, given the strong economic growth and hotter than usual summer, coal demand has also expanded and driven up CO₂ emissions. In the first half of 2023, coal production grew by 10 percent up to 107 Mt in March, reaching a new single-month production record.²⁴ Coal-fired electricity generation is still expected to be a major source of energy generation through 2030 even as the share of renewables continues to grow.²⁵ Factoring in large hydro and nuclear, India's fossil-fuel-free power totaled 42 percent of the country's installed capacity, moving it closer to the country's 2030 goal.²⁶

In support of its net zero by 2070 goals, India submitted its Long-Term Low Emission Development Strategy (LT-LEDS) to the UNFCCC during COP27 held in 2022 in Sharm El Sheikh, Egypt. The strategy focuses on rational resource utilization with energy security in mind. Smart city initiatives, urban planning for climate resilience, and green building codes will drive sustainable urban development. The industrial sector will prioritize energy efficiency, material efficiency, and circular economy expansion while maintaining energy security and employment. However, fully realizing this transition to low carbon development will require significant financial support, including from developed countries, to cover technology and infrastructure costs.

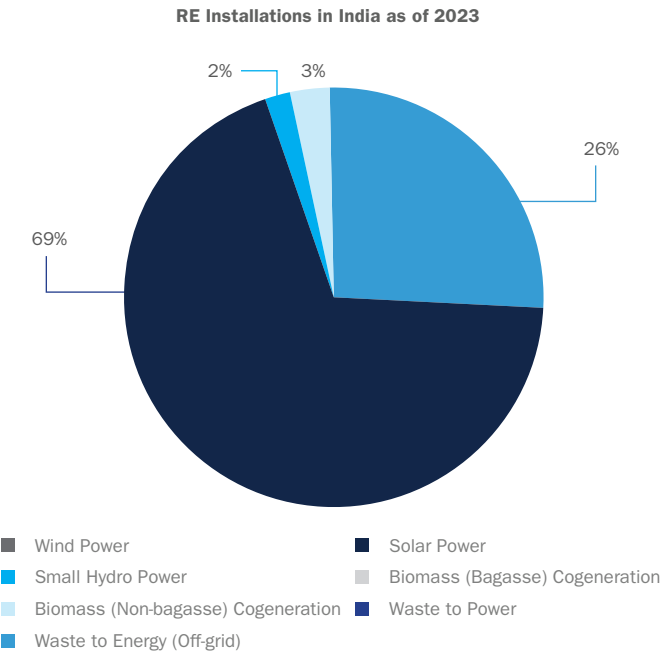
Renewable Energy



Photo Courtesy: NRDC India

Annual electricity demand growth in India grew at a strong 8.4 percent in 2023 due to India's continued post-pandemic economic recovery and high summer temperatures.²⁷ To meet ballooning demand, India is expected to double its total power capacity from 423 GW in July 2023 to over 800 GW by 2030.²⁸

Fig 3: Renewable Energy Mix for India



(Data Source: MNRE)

As of October 2023, India's total installed renewable energy capacity, excluding large hydropower, stands at 132 GW, still short of its goal to have 175 GW of renewable energy by 2022.²⁹ Though installed capacity continues to increase, growth slowed as a result of 2020 and 2021 COVID-19 disruptions, land and transmission bottlenecks and financial uncertainties.³⁰ As of 2022, India ranked fourth in the world for renewable energy installed capacity (excluding large hydro), fourth in wind power capacity and fifth in solar power capacity.³¹ Latest projections from the Central Electricity Authority (CEA) indicate total installed capacity could reach 777 GW in 2030, with non-fossil fuel sources increasing from 42 percent in 2023 to 64.4 percent by 2030.³² The growth of solar-wind hybrid projects provides a solution for providing round-the-clock renewable supply and managing peak power loads.³³

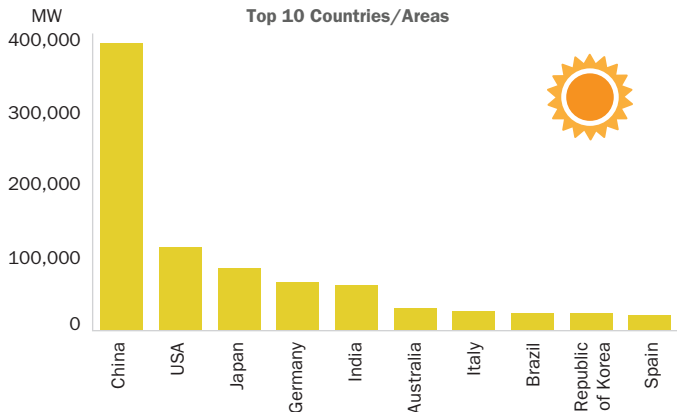
The Energy Conservation Act 2022, which mandated national Renewable Purchase Obligations (the purchase of a minimum amount of renewable energy out of the total consumption by obligated entities such as distribution companies, open access consumers and power producers) and the Green Open Access Rules 2022 make it easier for small-scale consumers to choose renewables based power options.³⁴ Another critical policy shift last year was an announcement by the Ministry of New and Renewable Energy (MNRE) to move wind

energy away from the reverse auctions that have defined the renewables space towards more traditional closed bidding auctions.³⁵ Industry players have long raised concerns that reverse auctions artificially drove down tariffs and affected the commissioning and deployment of projects when component prices increased.³⁶ Such national policy redesign lays a strong foundation for accelerating renewable energy growth towards India's long-term capacity targets.

Solar Energy

India has an estimated solar energy potential as large as 750 GW.³⁷ India's solar energy capacity is approximately 70 GW as of July 2023.³⁸ India installed 17.4 GW solar capacity in 2022, up 23 percent from 14.2 GW in 2021.³⁹ While solar capacity fell short of India's near-term goal to install 100 GW by 2022 due to module availability and project delays, India is expected to reach the 100 GW goal by early 2024. Solar expansion forms the bedrock of India's net-zero and climate goals, and the National Solar Mission aims to reach 280 GW of solar power capacity by 2030.⁴⁰ Due to India's strong long-term policy goals and rapidly declining technology costs, solar energy is expected to continue to grow quickly.⁴¹ India's most recent 14th National Electricity Plan (NEP), notified in May 2023, sets out solar capacity targets of 185 GW by 2027 and 365 GW by 2032.⁴² If India successfully meets the NEP targets, then the share of solar energy in India's power mix is projected to see a five-fold increase from 5 percent to 25 percent between the years 2022 and 2032.⁴³

Fig 4: 2022 Solar Energy Capacity Ranking by Country



(Source: IRENA)

Solar growth has been largely due to utility-scale solar, driven by private investors and long-term leases. India's large scale solar projects were 87 percent of installations in 2022—a 33 percent year on year increase.⁴⁴ The pipeline of planned new large-scale solar projects stands at 58 GW, with another 55 GW pending auction.⁴⁵ India has also focused on developing large-scale renewable energy parks, including some of the largest utility scale and floating solar projects in the world.

Growth in the rooftop solar sector, while comparatively smaller, has grown in recent months due to declining solar module costs: solar capacity addition between April and July 2023 was nearly 2GW—only slightly less than the total amount added in all of FY 2022 (April 2022 to March 2023).⁴⁶ Historically the rooftop solar market has been slow in India, but it is witnessing a significant upward trend due to rising demand for cost savings, government subsidies and increasing consumer awareness that has helped boost rooftop solar uptake in residential and rural areas.⁴⁷ Projections also suggest India could achieve self-sufficiency in producing solar modules by 2026, which could have significant impacts on India's role in the global PV market.⁴⁸

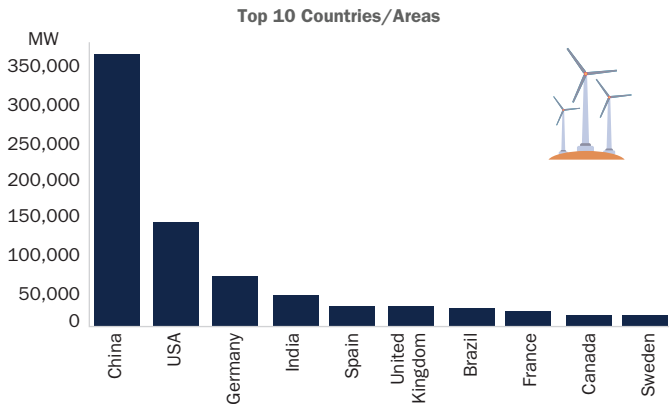
Solar energy growth has occurred at different rates across India's states as each state pursues its own policy framework.⁴⁹ Global supply chain challenges and India's import tax introduced in April 2022 have had an impact on solar prices.⁵⁰ This import tax as well as other policies are intended to spur the domestic solar manufacturing ecosystem. However, the pace of domestic manufacturing facilities has not yet matched the rate of new installations needed.⁵¹

India's solar industry has also experienced challenges with issues such as land availability, the uncertainty of compliance with power purchase agreements, decreased subsidies, and outstanding dues from distribution companies that purchase solar energy.⁵² New legislations, such as the Energy Conservation Act 2022 and the Electricity Amendment Rules 2023, are aimed at boosting demand for solar energy, simplifying regulation and enhancing transparency in the sector.⁵³ As investment in solar power in India rises, policy modifications can help solar continue to play its spotlight role in meeting India's climate goals.⁵⁴

Wind Energy

India is the fourth largest in the world by wind-installed capacity, with a net capacity of 43.773 GW as of July 2023.⁵⁵

Fig 5: Wind Capacity Ranking – Top 10 countries



(Source: IRENA)

Wind makes up over 33 percent of total installed renewable energy capacity.⁵⁶ With substantial onshore and offshore resources, India has enormous capacity for wind energy production. Installed wind capacity is estimated to be 99.9 MW by 2030.⁵⁷ Onshore, India could ultimately produce up to 300 GW from wind energy at 100-meter hub height, and more than 700 GW at 120 meters.⁵⁸

India added 1.8 GW installed wind capacity in 2022, and with annual installations expected to continue to grow to 2.8 GW in 2023, 3.7 GW in 2024 and 5 GW in 2025. ⁵⁹ This growth comes on the heels of several years of average wind power capacity additions of 1.5 GW. In January 2023, India shifted the e-reverse auction system, which had significantly low tariffs and resulted in low industry involvement, to closed bidding, offering a cumulative capacity of 8 GW through 2030.⁶⁰ India recently announced its first tender under the new “closed bidding” system for 2.5 GW.

In addition, India has emerged as a major turbine manufacturer—responsible for 8.5 percent of worldwide turbine supply.⁶¹ As a result, Indian wind energy production has the room to withstand disruptions other industries may not, as well as the capacity to become a larger exporter of key turbine components. After a draft tender for seabed licensing was released in November 2022, official tender in for 4 GW off Tamil Nadu is expected before the end of 2023.⁶² India's immense offshore wind capacity and goal to develop 30 GW of this capacity by 2030 provides a strong foundation for rapid acceleration of wind energy production. For offshore wind's potential to be realized, the prices of this relatively new technology must fall to become competitive with other renewable energy sources.⁶³

Green Hydrogen

India officially launched its Green Hydrogen Mission in January 2023.⁶⁴ Green hydrogen, or hydrogen fuel produced by splitting water with renewable electricity, is a key player in India's renewable energy story. First announced in 2021, India has marked out green hydrogen as key to reducing emissions in many hard-to-abate sectors such as longer-range and heavy-duty truck transportation, longer-term energy storage in the power sector, and heavy industries like cement and steel.⁶⁵ To help green hydrogen become commercially viable, India aims to reduce the cost to a fifth of current rates and transform it from an emerging technology into a fossil fuel competitor.⁶⁶ In August 2023, India notified the official Green Hydrogen Mission standards, or the emissions thresholds that must be met for hydrogen to be considered green.⁶⁷

National Green Hydrogen Mission Outcomes



India aims to make the country a global center for green hydrogen production and export by 2030.⁶⁸ The Green Hydrogen Mission has two 2030 goals: (i) to reach a Green Hydrogen production capacity of 5 million metric tonnes per year by 2030, contributing to reduction in dependence on import of fossil fuels, and (ii) to reduce a cumulative INR 1 lakh crore worth of fossil fuel imports by 2030. Nearly 50 million metric tonnes per year of CO₂ emissions are expected to be averted through production and use of the targeted level of Green Hydrogen in India.⁶⁹ Projections indicate that green hydrogen production could grow by a factor of four by 2050, when India's production is expected to account for a tenth of global hydrogen demand.⁷⁰ Scaling up green hydrogen to meet India's goals will require 115 GW of installed renewable capacity to support hydrogen plants, or the equivalent of 23 percent of India's 2030 goal of 500 GW of non-fossil fuel installed capacity.⁷¹

In order to actualize the country's goals, India has cleared 48 proposals from various industries that could have a combined green hydrogen production capacity of 3.5 million tonnes a year by 2030, according to government data released in July 2023.⁷² Since the government's national announcement of the project in 2022, the private sector started announcing green hydrogen expansion commitments, including a USD 75 billion commitment from Reliance Industries to develop renewable energy infrastructure in order to support green hydrogen.⁷³ The first commissioned plant will be in Assam, and another has been announced in Tamil Nadu—and 25 more plants are in the pipeline by 2025. Both private and public institutions have committed to making green hydrogen a critical part of India's future renewables mix.⁷⁴

Renewable Energy Job Growth

Employment across the renewable energy sector has remained one area of consistent growth, despite the COVID-induced slowdown in 2020-21. The wind and solar sectors employed 111,400 people by the end of 2021.⁷⁵ This number is expected to grow dramatically as India works towards its target of 50 percent non-fossil fuel energy sources, with a projected one million people employed by clean energy in 2030.⁷⁶ According to recent estimates by the International Renewable Energy Agency (IRENA), the solar photovoltaic (PV) sector in India alone engaged 284,000 persons in both on-grid and off-grid systems.⁷⁷

As India becomes a global leader in renewable energy, a commitment to national skilling programs have also strengthened renewable energy employment. The Skills Council for Green Jobs (SCGJ), established by the Indian Government as part of the National Skill Development Mission in 2015, has developed skills standards and trained more than half a million candidates, with 100,000 people trained in solar and other renewable energy domains, and the rest in waste and wastewater management across the country.⁷⁸ Additional initiatives have been established to support training in other areas or niches: for example, the Suryamitra Skill Development Programme, a complementary initiative of SCGJ, was instituted in 2017 and focuses specifically on training youth in solar power project installation, operation, and maintenance, the Vayumitra Skill Development Programme focuses on wind energy, and organizations like the Ministry of New and Renewable Energy (MNRE) are providing support for postgraduate research in renewable energy.⁷⁹

With increasing numbers of potential jobs, the renewable energy job market seems set to transform dramatically over the next years. However, many current renewable energy jobs are contractual with a focus on construction and installation activities.⁸⁰ To compete with and replace other traditional sectors of energy employment, renewable energy jobs also need to offer better benefits and labor protections.⁸¹ As jobs emerge in new areas of renewable energy in India—including distributed renewable energy efforts as well as green hydrogen—renewable energy employment is an avenue for millions of people in India to find both skilled and unskilled opportunities for employment.⁸²

Energy Access

In 2019, India brought electricity to almost 100 percent of its households after years of effort under the flagship scheme “Pradhan Mantri Sahaj Bijli Har Ghar Yojana” (SAUBHAGYA). Under this scheme, 28.6 million households have been electrified since September 2017.⁸³ Though no small feat, challenges with the reliability, quality, and affordability of electricity persist at the last mile, especially in rural areas. As censuses improve, these last few unelectrified communities will likely be connected in years to come.⁸⁴

However, grid access has not guaranteed reliable electricity: energy poverty still affects approximately 65 percent of Indian households with stark differences between urban and rural areas.⁸⁵ Urban areas receive, on average, one hour more of electricity per day than rural areas.⁸⁶ In many rural areas, no electricity is available anywhere from four to nine hours a day.⁸⁷ Many households deal with frequent daily outages.⁸⁸ Last year, the debts of power distribution companies stood at INR 900 billion—equivalent to almost US 108 million—delaying payments for power procured, and increasing market volatility.⁸⁹ The Electricity (Amendment) Bill 2022 has the potential to create opportunities for investments throughout the power sector value chain and help bring more stability to electricity access.



Woman talking about shift from traditional to biogas cooking method in Hariyali Gram village, Gujarat, India

© Photo Courtesy: NRDC India

The Government of India brought these issues of energy poverty to the spotlight at the 2022 G20 Summit.⁹⁰ New national policy and regulations have been directed to help distribution companies improve functionality and the Electricity (Rights of Consumers) Rules 2020 have mandated service standards that ensure reliable supply.⁹¹ In addition, energy subsidies continue to make electricity access affordable for vulnerable consumers. India spent close to INR 195,000 crore (USD 26 billion) on electricity subsidies in 2019, targeting primarily domestic and agricultural consumers.⁹² The Ministry of Power also issued the Draft Electricity Amendment Rules 2023 to support the growth of green energy capacity by streamlining the creation of power transmission infrastructure.⁹³

In addition to large scale renewable energy programs, India has been investing in smaller, localized solutions linked to peoples' livelihoods. In 2022, India released its “framework for promotion of decentralized renewable energy livelihood applications,” geared towards developing an ecosystem that will enable widespread distributed renewable energy (DRE) solution adoption. DRE solutions have been gaining traction given their potential to address last-mile connectivity and technology accessibility issues, improve energy access, especially in rural areas, contribute to meeting India's climate commitments and become the fulcrum of economic development across India.

Solar-based irrigation has received significant national attention as a DRE solution to expand adoption of clean energy in the agriculture sector and enhance energy security for the farmers. In 2019, India launched Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM-KUSUM), which has three major components: A and C components focus on feeder-level solarization, and the B component focuses on standalone or off-grid solar water pumps.⁹⁴ The PM-KUSUM has an objective to deploy 10 GW of ground-mounted grid-connected decentralized renewable energy plants, two million standalone solar powered agricultural pumps, and 1.5 million grid-connected solar-powered agriculture pumps.⁹⁵ The scheme aims to increase farm productivity and reduce expenditure on fossil fuel to operate water pumps. Once fully implemented, the PM-KUSUM scheme could potentially reduce 32 million tons of CO₂ emissions per annum and generate employment opportunities for 755,000 skilled and unskilled workers.⁹⁶ Due to implementation challenges, the scheme has since been extended to 2026.⁹⁷ Steps to accelerate the installation of solar-powered pumps include improving coordination between different state departments (such as agriculture, irrigation, and power), providing small and marginal farmers easy access to bank finance, and creating a level-playing field for distributed solar plants.⁹⁸

Clean cooking has also remained a national DRE priority. The uptake of clean cooking increased largely through subsidy support for liquefied petroleum gas (LPG) under Pradhan Mantri Ujjwala Yojana (PMUY) launched in May 2016. The LPG subsidies cost INR 87,830 crore (USD 11.71 billion) in 2017. However, the prices of LPG have risen steadily with the Russia-Ukraine conflict and subsidies have rolled back. The central government's budget for subsidy support to LPG almost halved to INR 12,480 crores (USD 1.67 billion) in 2022 from INR 25,500 crores (USD 3.4 billion) in 2021.⁹⁹ As a result, many households have moved back to traditional means of cooking, such as firewood or dung cakes—increasing indoor pollution and health risks, particularly in rural areas.¹⁰⁰ Better-designed subsidies could improve the affordability of clean cooking for poorer households. The Ministry of New and Renewable Energy is also making efforts to promote alternate clean cooking solutions.¹⁰¹ However, many challenges persist in scaling up these efforts to reach all vulnerable households.¹⁰²

In November 2022, India notified the National Bioenergy Programme, designed to transform surplus biomass, cattle dung, industrial and urban biowaste available in the country into reusable energy.¹⁰³

The potential of DRE solutions to accelerate the energy transition in India remains high, especially in rural India. Two-thirds of India's population live in the villages, making villages central to the development objectives.¹⁰⁴ DRE technologies can empower families by enhancing living standards and provide livelihood opportunities. NRDC, Self Employed Women's Association (SEWA), and Association of Renewable Energy Agencies of States (AREAS) are implementing Hariyali Green Villages initiative in more than 75 villages in India. This is a unique initiative led by women that aims to enhance accessibility and affordability of clean energy technologies and improve livelihood opportunities at the household level in rural India. This initiative brings together local communities, technology suppliers, financiers, and government officials to implement effective clean energy solutions for villages. NRDC and partners aim to scale up this initiative across India. This rural-focused and gender-inclusive initiative, if scaled up across India, has the potential to avoid 8,500 metric tons of CO₂ emissions every year and act as a model for sustainable economic development.¹⁰⁵



A solar trap light installed in a farm field in Aravalli District, Gujarat, India. The trap captures insects and helps reduce the use of pesticides.

© Photo Courtesy: Self-Employed Women's Association (SEWA)

Energy Efficiency

With skyrocketing urbanization rates, energy demand from buildings, appliances, and industry is rising. Already, buildings and industry account for over 60 percent of India's annual energy usage.¹⁰⁶ At the same time, with deadly heatwaves becoming more frequent and more intense, access to affordable cooling can be a matter of survival, not just comfort, for millions of people. To date, less than 10 percent of households in India have air conditioning. This demand is set to increase exponentially: space cooling demand is projected to increase 8 times by 2038.¹⁰⁷ With rising temperatures, India's growing economy and skyrocketing cooling demand, advancing energy efficiency will be critical to preventing increased cooling-related emissions, increasing energy access, and combating pollution.

In 2021-22, India achieved significant energy savings of 44.43 million tons of oil equivalent (equivalent to 6 percent of the country's total primary energy supply) as a result of various energy efficiency schemes and programs across different sectors. The BEE played a pivotal role in coordinating these efforts. Among the key schemes and programs, the Perform, Achieve, and Trade (PAT) scheme for energy intensive industries, the Standards & Labeling (S&L) for appliances, and the Unnat Jyoti by Affordable LEDs for All (UJALA) program. PAT alone accounted for 54.85 percent of the total energy savings, while S&L and UJALA combined contributed 38.78 percent.¹⁰⁸ They translated into monetary savings of INR 160,721 crores and avoided roughly 280 million tonnes of CO₂. Over the years, these interventions have been successful in creating a culture of energy efficiency in India. They have not only resulted in substantial energy savings but also contributed to reducing the carbon footprint of the nation. These efforts align with the



The facade of an apartment building with several window-mounted air conditioners in Mumbai, India.

© Photo Courtesy: iStock

voluntary action plan proposed by India at the G20 summit for doubling of pace of energy efficiency by the year 2030.¹⁰⁹

Buildings



High-rise buildings under construction in Mumbai, India, silhouetted by the sunset.

© Photo Courtesy: Kuntal Saha/iStock

Buildings in India will shape the future of India's energy demand and consumption. Today, residential and commercial buildings in India are the second-largest consumer of energy in the country, after industry.¹¹⁰ Buildings accounted for nearly 33 percent of the nation's energy use in July 2021.¹¹¹ By 2030, they will become the top consumer of energy nationwide; by 2042, they are expected to account for at least half of total energy demand.¹¹² Estimates suggest that about 70 percent of India's 2030 urban infrastructure was yet to be built.¹¹³ Ensuring that this construction occurs sustainably, and that these buildings are constructed to be energy-efficient and climate-resilient from the beginning, will, therefore, have cascading, long-term impacts on India's emissions.

Several voluntary certification programs have encouraged efficient construction in India to date. As of June 2023, India ranks first in the world for number of buildings with Leadership in Energy and Environmental Design certification, with 45 percent (73 out of the 150) out of world green building projects.¹¹⁴ The India Green Building Council, formed in 2001, has a Green Building Rating System that has assessed more than 700 million square meters of space to date.¹¹⁵ The Green Rating for Integrated Habitat Assessment was adopted as a national tool for building assessment in 2007 and has



Residential high-rise buildings under construction in Gurugram (Gurgaon), India, at sunset.

© Photo Courtesy: iStock

assessed more than 52 million square meters of space.¹¹⁶ Several states have adopted it as a framework to create incentives for efficient construction.¹¹⁷ Meanwhile, the Bureau of Energy Efficiency's star rating program has certified over 250 commercial buildings.¹¹⁸ If states across India adopt the Energy Conservation Building Code (ECBC), which sets minimum efficiency standards for new commercial buildings, and leading developers go beyond minimum code requirements for commercial buildings, an estimated 3,453 Terawatt hours (TWh) of electricity could be saved cumulatively by 2030, enough energy to power 358 million Indian homes annually between 2014 and 2030.¹¹⁹

Simultaneous state policy efforts have also increased the efficiency mandated by the minimum code. In 2017, BEE released an updated ECBC.¹²⁰ The ECBC sets minimum energy standards for commercial buildings and designates state agencies to certify and enforce ECBC by notifying the code. To date, 23 states and two Union Territories have notified ECBC, including: Andaman and Nicobar, Andhra Pradesh, Assam, Haryana, Karnataka, Kerala, Madhya Pradesh, Mizoram, Odisha, Puducherry, Punjab, Rajasthan, Telangana, Uttarakhand, Himachal Pradesh, Sikkim, Tripura, Uttar Pradesh, and West Bengal.¹²¹ Five states have incorporated the ECBC into their by-laws: Andhra Pradesh, Haryana, Punjab, Telangana, and Uttar Pradesh. Four states have taken additional steps to add transparent compliance processes and enforcement mechanisms: Andhra Pradesh, Karnataka, Telangana, and Uttar Pradesh.¹²² The potential impacts of ECBC implementation are high, even on state-levels. For example, it is projected that Gujarat could save 83 TWh of energy and USD 9 billion with basic building compliance.¹²³ The 2022 Energy Conservation Act amended the scope of the ECBC to apply not just to commercial buildings, but also residential buildings, expanding the number

of construction projects in India that must adhere to efficiency standards.¹²⁴ Critically, the act also expands the definition of efficiency under ECBC to also mandate a minimal amount of renewable energy for a sustainable building.¹²⁵

Sustainable Cooling and Appliances

Cooling efforts in India are also taking critical steps towards climate-friendly futures. India was one of the first countries to release a national plan on cooling, the India Cooling Action Plan (ICAP), in 2019. ICAP is a comprehensive plan that prioritizes energy-efficient, climate-friendly, and affordable cooling for all. The government of India has worked with civil society groups like NRDC to strategize implementation of ICAP.



Window-mounted air conditioners on a building in Ahmedabad, India.

© Photo Courtesy: Michael Wong via Flickr, CC BY-NC 4.0

India has made significant progress on energy-efficient appliances with the expansion and penetration of standards and labeling programs across most major appliances, as well as widespread implementation of energy-efficient lighting. Established in 2006, BEE's Standards and Labeling Program consists of both mandatory and voluntary schemes for 30 major appliances, including refrigerators, air conditioners, tube lights, televisions, and electric geysers.¹²⁶ India has successfully implemented one of the most extensive light-bulb replacement programs in the world. As of July 2021, the UJALA program distributed more than 368 million LED lights resulting in an annual emission reduction of 38.6 million tons of CO₂.¹²⁷ The UJALA program transformed the lighting sector in India: nearly two-thirds of the lighting stock in Indian homes now comprises LED bulbs and tube-lights.¹²⁸

In July 2022, BEE expanded its certification program to mandate star ratings of all new ceiling fans, a decision with implications for government procurement decisions as well as empowering consumers to choose clean energy options.¹²⁹ A star rating

ranges from 1 to 5 in the ascending order of energy efficiency, thus informing consumers of the energy consumption of similar products. In July 2023, Energy Efficiency Services Ltd, a joint-venture of state run power companies, also announced its plans to deploy 10 million energy efficient fans in India.¹³⁰

India has implemented policies that have significantly improved the overall energy efficiency of room air conditioners (RACs) and promoted the adoption of energy-efficient inverter technology. As of January 2020, India requires that all RACs have a default temperature setpoint of 24 (75.2°F), potentially resulting in significant energy savings.¹³¹ BEE has also released an updated room air conditioner standard that requires an Indian Seasonal Energy Efficiency Ratio (ISEER) of 3.3-5.0 for split air conditioners and an ISEER of 2.7-3.5 for window air conditioners.¹³² The new STAR standards for air-conditioners started on July 1, 2022.¹³³ Per BEE's recent data, the energy efficiency improvement for split room RACs is 43 percent for 1-Star and 61 percent for 5-Star rated units.¹³⁴ For window RACs, the improvement is 17 percent for 1-Star and 13 percent for 5-Star rated units. The government's interventions have also boosted the market share of highly efficient inverter RACs. In 2015, inverter RACs accounted for less than 1 percent of the market, but with the introduction of a voluntary labelling program for inverter RACs and the mandatory adoption of ISEER ratings in January 2018, the market share of inverter RACs increased to 77 percent by 2022-23, while fixed speed RACs decreased to 23 percent.¹³⁵ According to BEE reports, its star-labelling program for room ACs kept almost 38 million tons of CO₂ out of the atmosphere.¹³⁶

India's inverter air conditioning market has also been proactive in its efforts to reduce the emissions of high-global warming potential (GWP) refrigerants called hydrofluorocarbons (HFCs) that are used in traditional air conditioning units, instead leapfrogging to the more climate-friendly R32 refrigerant. An NRDC-TERI event indicated most industry leaders are already ready and beginning transitioning away from high-GWP refrigerants.¹³⁷

Passive Cooling

Passive cooling techniques such as cool roofs, energy-efficient buildings, mobile air conditioning and cold-chain improvements are also part of ICAP's efforts to reduce the demand for cooling. Cool roofs, roofs with low-cost reflective paint, offer an affordable, simple heat mitigation cooling pathway and can reduce indoor temperatures by 2.1 to 4.3°C compared to traditional roofs. Across India, 23 states and over 100 cities have developed Heat Action Plans (HAPs) and several of them have included cool roofs targets as part of HAPs.¹³⁸ According to one study, mortality rates on days at or above 45°C (113°F) daily maximum temperature dropped by 27 percent after the HAP was implemented, relative to pre-HAP years.¹³⁹

In April 2023, the state of Telangana in India launched a first of its kind Cool Roof Policy, which focuses on four key objectives: promoting cool roof adoption, establishing an institutional framework, identifying financing mechanisms, and supporting workforce development. Cool roofs are mandated



A rooftop solar panel on a building in a village in Aravalli District, Gujarat, India.

© Photo Courtesy: Self-Employed Women's Association (SEWA)

for government, non-residential, and commercial buildings and larger residential buildings, while smaller residential ones can voluntarily adopt them. Compliance is ensured through integration into the Telangana State Building Permission Approval and Self-Certification System. By 2028, Telangana aims to cover 300 sq. km with cool roofs, with the goals of mitigating urban heat island effects, saving 600 million Units (GWh) of electricity annually, and offsetting 30 million tons of CO₂. This policy aligns with the India Cooling Action Plan's goal to reduce cooling demand by 25 percent by 2037-38. Telangana's ambitious targets envision widespread cool roof integration, setting an example for other regions to combat climate change and rising temperatures while promoting energy efficiency and environmental sustainability.

Industry

In 2020-2021, the industrial sector represented the largest share of energy usage, accounting for 41 percent of India's total electricity consumption.¹⁴⁰ This sector is expected to offer the highest potential for energy savings in India over the coming decades through effective energy management and the implementation of innovative technologies.¹⁴¹

The National Mission for Enhanced Energy Efficiency, one of eight national missions under the National Action Plan on Climate Change, aims to improve efficiency in industry and implement demand-side management programs. The main program, Perform Achieve Trade (PAT), establishes an energy trading program for high emitting industries – cement, aluminum, steel, iron, textiles, and paper and pulp. The adoption of energy efficiency schemes and programmes has thus far led to an estimated overall energy savings of 44.43 million tons of oil equivalent (Mtoe), representing 6 percent of India's total primary energy supply for the year 2021-22.¹⁴² Under PAT Cycle I (from 2012-2015), 8.6 Mtoe were avoided.¹⁴³ PAT Cycle II (from 2016-2019), which included an expanded list of sectors, is estimated to have avoided an additional 14 Mtoe. PAT Cycle III, which expanded coverage to thermal power plants, cement, aluminum, pulp and paper, iron and steel, and textile, energy consumption was reduced a further 1.06 Mtoe.¹⁴⁴ As of 2023, seven PAT cycles have been enacted. PAT Cycles IV, V and VI expanded the certified energy trading to more industry sectors and players. PAT Cycle VII was notified in 2021, with an overall energy saving target of 6.627 Mtoe.¹⁴⁵

The Bureau of Energy Efficiency is the primary implementation agency, and as part of the PAT program, has ensured that each state has Dedicated Consumers that are responsible for building capacity and providing technical expertise in Energy Efficiency. As of 2021-22, there are Adjudicating Officers in twenty-seven states. Specifically, thirteen states have EE programs dedicated to large industries, seventeen states have programs for Micro, Small, and Medium Enterprises, and four states

have initiatives aimed at Public Sector Undertakings. Most of these programs are administered under the PAT or the National Motor Replacement Programme. Furthermore, six states have allocated budgets to government authorities to support energy efficiency efforts in industries. Notably, a total of 356 industrial units located in twenty-four states and Union Territories have received recognition and energy conservation awards through various state, national, and industry association awards.

India's usage of market-based mechanisms, such as the PAT scheme, is set to expand this year with the Energy Conservation Act 2022, which created a national domestic carbon market and mandated the minimum use of renewable energy for industry.¹⁴⁶ India is a major industrial hub globally, and the decarbonization of industry will be critical for India to continue to chart a low-carbon future. India has taken steps to form international alliances to help curb emissions in hard-to-abate sectors such as steel and cement.¹⁴⁷



Photo Courtesy: Freepik

Transportation

Home to the third largest road network in the world, India had a total of 326.3 million vehicles in fiscal year 2022.¹⁴⁸ Indians travel nearly 5,000 kilometers each year, a threefold increase since 2000.¹⁴⁹ Approximately 60 percent of the population uses a personal or shared vehicle to commute.¹⁵⁰ Vehicle ownership has grown five-fold since 2000, with two and three wheelers accounting for most of the fleet.¹⁵¹

Last year, India surpassed Japan to become the third largest auto market in the world.¹⁵² Currently about 60,000 to 75,000 vehicles of all types are sold on a daily basis, and there are now at least 42 cities and towns in India that have over a million vehicles each.¹⁵³ India is expected to have 14 times growth in the passenger kilometers travelled between the years 2018 and 2030.¹⁵⁴ The auto sector's contribution to the National GDP has risen to about 7.1 percent in 2023 from 2.77 percent in 1993, providing direct and indirect employment to over 19 million people.¹⁵⁵

The past several years of unprecedented challenges impacted the automotive industry in various ways: a liquidity crunch, higher acquisition costs, supply chain constraints and weaker customer demand all contributed substantially to the downturn the industry has been grappling with.¹⁵⁶ However, the industry bounced back with domestic production and the automotive components sector in India growing by 23 percent in 2022, while recording its highest-ever revenue and a massive trade surplus.¹⁵⁷

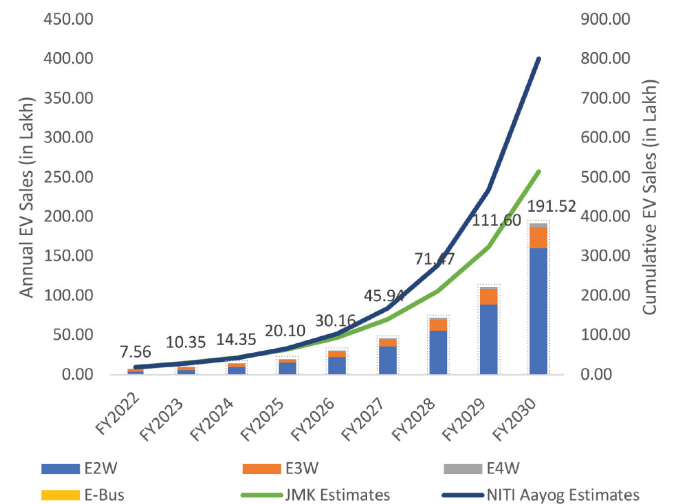
As India's transport sector grows, greenhouse gas emissions are also expected to grow. Automobiles already accounted for 3 billion metric tons of CO₂ emissions in 2020.¹⁵⁸ The transport sector emits the third most greenhouse gases of any sector and accounts for 14 percent of India's energy-related CO₂ emissions, with road transportation contributing more than 92 percent of transport sector emissions.¹⁵⁹ The transport sector's emissions could increase 65 percent by 2030 and 197 percent by 2050 relative to 2020 levels.¹⁶⁰ To address this growing environmental impact, India has been leaning on regulatory support to promote the use of clean vehicle technologies, including electric vehicles (EVs), and tightening emission norms to meet its carbon reduction targets.

Zero emission vehicles - Electric Vehicles

Over 21.70 lakh electric vehicles have been registered in the country through March 2023.¹⁶¹ Ninety percent of these EVs are two-wheelers (E2W) and three-wheelers (E3W).¹⁶² Electric vehicle sales in India increased by 174 percent year on year from 4,55,773 units in FY 22 to 12,47,120 units in FY 23.¹⁶³ E2W held

the largest share with 48.76 percent. E3W passenger vehicle was just behind with 43.33 percent. The sales of E3W Cargo and E-Cars were almost the same at 3.65 percent and 3.85 percent, respectively. E-bus accounted for just 0.17 percent and others, 0.24 percent.¹⁶⁴

Fig 6: Actual and Projected EV Sales (Annual & Cumulative)



(Source: JMK Research, Vahan Dashboard, Rocky Mountain Institute (RMI) and NITI Aayog, Expert Interviews)

India's electric vehicle journey started with the government putting out the National Electric Mobility Mission Plan 2020 and FAME (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles) India Schemes with a total budgetary support of INR 10,000 crores (USD 1.4 billion) in 2019 for a period of five years.¹⁶⁵ The FAME India schemes supports electrification of public and shared transportation, and aims to provide demand incentive for e-vehicles and support for charging infrastructure. To date, over 8,32,824 vehicles have been supported and more than 2,877 Electric Vehicle Charging Stations have been sanctioned. The Ministry of Heavy Industries has also sanctioned INR 800 Cr. as capital subsidy to the three Oil Marketing Companies of the Ministry of Petroleum and Natural Gas for setting up 7,432 electric vehicle public charging stations.¹⁶⁶ To further boost the adoption of electric vehicles and ease range anxiety (fear of running out of electric charge while in transit) among customers, India is implementing initiatives to make EV charging experience simple and convenient.¹⁶⁷

The EV industry in India is gearing up for exponential growth in the coming years with new EV sales expected to surpass 2 million in the current fiscal year.¹⁶⁸ India is not only focusing on boosting EV adoption through schemes like FAME, but also setting up a robust manufacturing ecosystem for EVs and its components to further domestic value creation and

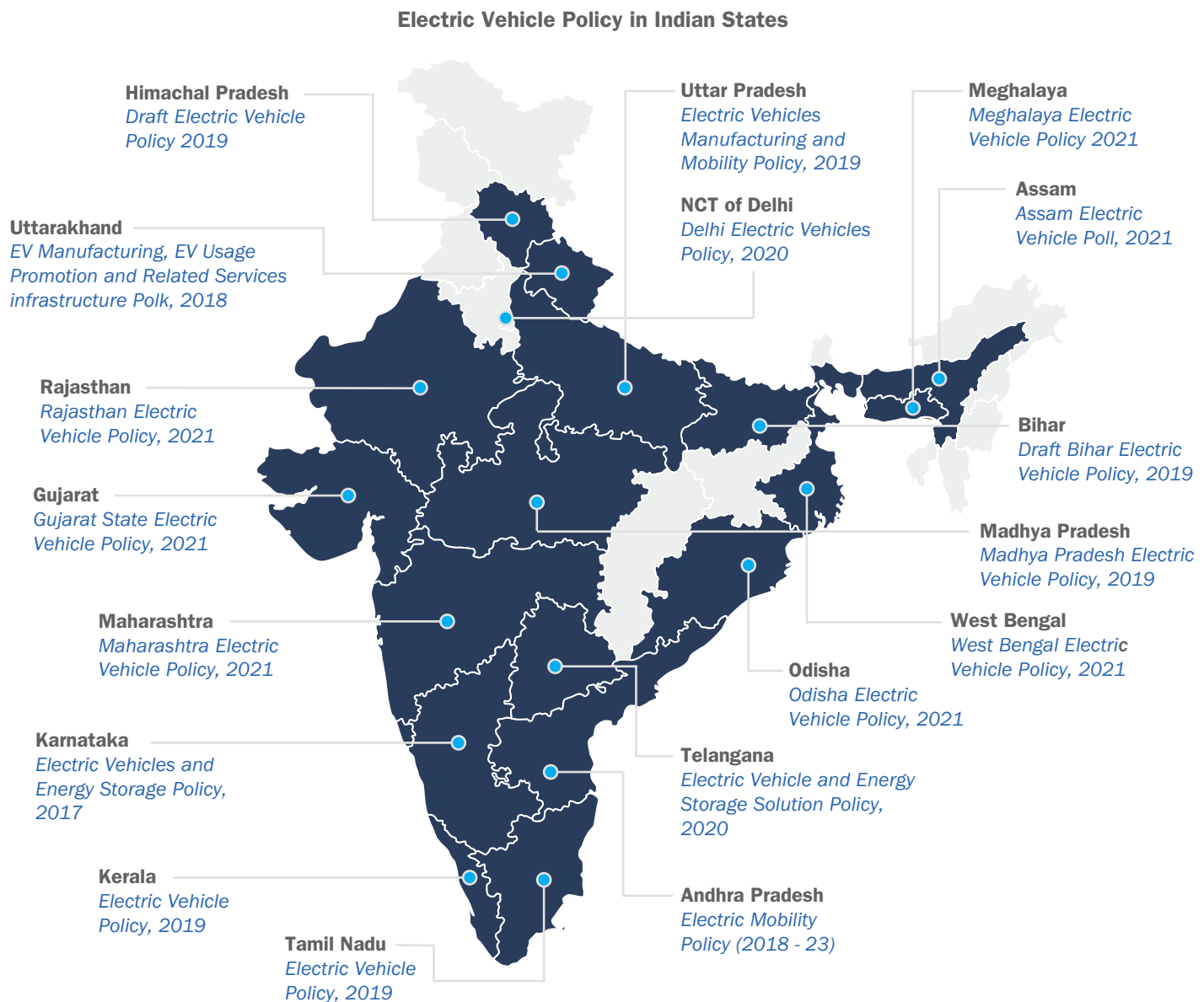
create more livelihood opportunities. As an example, for vehicles to be eligible for demand incentives under the FAME-II scheme, vehicle original equipment manufacturers need to meet the localization criteria as specified under the Phased Manufacturing Program. Specifically, the scheme requires half of the vehicle components to be locally sourced in India.¹⁶⁹ The entire EV value chain in India, from manufacturing of batteries to vehicles, is estimated to be a USD 100 billion opportunity by 2030.¹⁷⁰

On the supply side, India has leveraged its Productive Linked Incentive (PLI) scheme with the objective to enhance India's Manufacturing Capabilities for Advanced Automotive Products. The Auto PLI scheme, for instance, has been successful in attracting proposed investment of INR 67,690 crore over a period of five years. Another investment of INR 27,000 crore

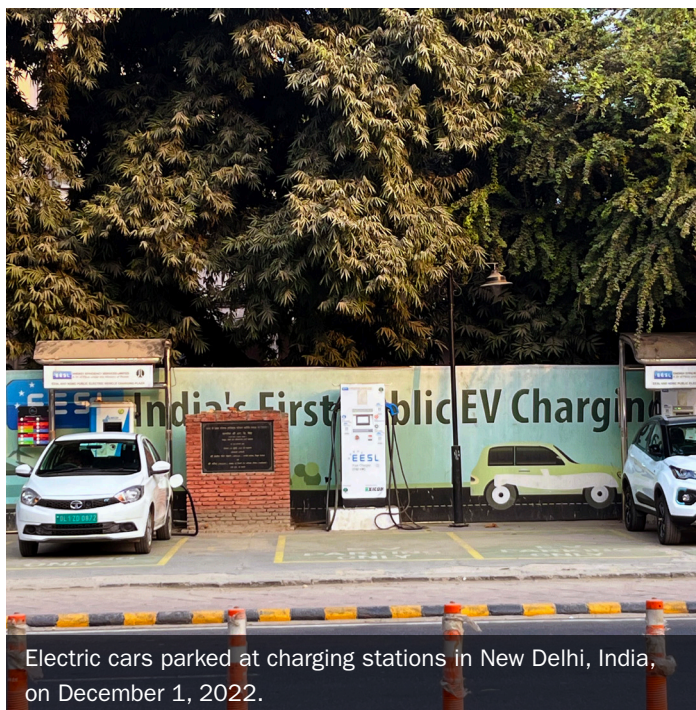
is being envisaged under the Advanced Chemistry Cell (ACC) battery PLI scheme which aims to create manufacturing capacity of 50 Giga Watt Hour of ACC and 5 GWh of "Niche" ACC.¹⁷¹ The Indian EV sector has already seen USD 3.7 billion private equity and venture capital investments in this space over the past three years, and this number looks set to increase significantly as the industry transforms.¹⁷²

States and municipalities can play a pivotal role in accelerating EV adoption. A total of 26 Indian states and territories have notified EV policies as of February 2023.¹⁷³ State concessions can act as a catalyst to attract more investments, promote technology advancements and create additional job opportunities within each state.

Fig 7: Electric Vehicle Policy in Indian States



(Source: Graphic@AsiaBriefingLtd)



Electric cars parked at charging stations in New Delhi, India, on December 1, 2022.

© Photo Courtesy: Prateek Joshi/NREL, 73601

Large automotive manufacturers in India are changing their business models to focus more on EVs. Audi signaled they would focus only on EVs from 2030 onwards; other companies are expected to follow suit.¹⁷⁴ As India builds up its domestic capabilities, local manufacturing of EVs is expected to scale rapidly and become competitive with overseas companies.¹⁷⁵ By 2050, 75 percent of the passenger vehicles sales in India are expected to be EVs.¹⁷⁶ Supportive policy support both at national and sub-national levels can help ensure this growth.

Over the past few years, India has made tremendous progress in decarbonizing its road transportation sector especially in urban centers. Going forward, there's an opportunity to expand this transition to clean mobility beyond urban centers to India's villages, which are home to more than 65 percent of the population. Newer segments like tractors, and medium and heavy-duty vehicles, also have significant impacts on emissions and could be a useful focus for separate lines of funds for democratizing clean mobility systems in rural India.

Biofuels in the Indian automotive Industry

India, along with the leaders of Singapore, Bangladesh, Italy, USA, Brazil, Argentina, Mauritius and UAE, launched the Global Biofuel Alliance on 9 September 2023, on the sidelines of the G20 Summit in New Delhi. As the G20 Chair, India helped shepherd this Alliance, which intends to expedite the global uptake of biofuels through facilitating technology advancements, intensifying utilization of sustainable biofuels, shaping robust standard setting and certification through the participation of a wide spectrum of stakeholders. India has achieved unprecedented growth in ethanol blending during the

past few years: by comparison, the United States took nearly five decades to achieve similar levels of penetration. India met its objective of supplying 10 percent ethanol-blended petrol by June 2022, five months ahead of schedule, up from 0.67 percent blending in 2012. The country now plans to increase the blend to 20 percent by 2025–2026.¹⁷⁷

Vehicle Emissions Standards

Emissions standards are critical both to India maintaining its commitment to its climate goals as well as to protecting citizen health. Despite pressure from manufacturers, India has maintained its stated timelines for new vehicle sales emissions standards, noting that the industry meets stringent anti-pollution standards in countries to which they are exporting vehicles, and therefore can adhere to strict domestic standards as well.¹⁷⁸

Key to the Auto Fuel Policy is the Bharat Stage (BS) VI vehicular fuel emission standards for new vehicle sales. Effective April 2020, India now has ultra-low sulfur fuel (10 parts per million or ppm) in use across the country. The BS VI emission norms for two-wheelers are also among the most stringent in the world. The BS VI emissions standards are expected to result in 79 per cent reduction in particulate matter (PM) and 81 per cent reduction in NOx by 2025 as compared to BS IV emission standards.¹⁷⁹ India achieved a milestone earlier this year by regulating real driving emissions (RDE) from newer vehicles as it introduced RDE testing as part of Bharat Stage 6 Phase II emissions.¹⁸⁰ The RDE test measures the pollutants, such as NOx, emitted by vehicles while being driven on the road. RDE does not replace the WLTP laboratory test but acts as a supplement to ensure that cars deliver low emissions over on-road conditions.¹⁸¹

Additionally, India introduced the second phase of Corporate Average Fuel Efficiency standards in April 2022, aimed at increasing the efficiency of internal combustion engine vehicles, with a target to bring emissions down to an average of 113 grams of CO₂ per kilometer, amounting for a reduction of about 13 percent over the earlier standard.¹⁸² There is scope for these limits to tighten further to 108 or 104 g/km.¹⁸³

Manufacturers are responding to the increased public and policy pressure, with major domestic manufacturers announcing timelines for exiting the diesel space as a result of the emission limits.¹⁸⁴ In addition, regional policy makers are tightening emission goals further as a result of air quality mandates, with Delhi issuing an instruction banning high-emission vehicles from the road during low air quality days.¹⁸⁵ Such local mandates, especially in highly populous areas, could generate additional pressure for reducing vehicular emissions.

Green Finance

Investment in India's green energy sectors is gaining steam, with some estimates saying that India could reach as much as USD 800 billion in the next decade.¹⁸⁶ Tracked green investment in India is approximately USD 44 billion as of 2020.¹⁸⁷ After COVID-induced slowdowns, investments in 2022 grew exponentially, more than doubling from investment rates seen in 2015. Along with this, debt financing saw a sixfold increase in 2022.¹⁸⁸ According to one report, debt bonds linked to green, yellow (solar) and blue (marine) bonds accounted for USD 20 billion in the Indian debt market as of January 2023.¹⁸⁹ While green investment is growing, even more investment is needed: according to some estimates, more than USD 1 trillion in investment is required to achieve India's 2030 climate goals.¹⁹⁰ Investments needed in renewable energy generation alone come to approximately USD 223 billion over the next eight years.¹⁹¹ Concurrently, USD 175 billion must be invested in strengthening and preparing the national electricity grid to support the increase in RE capacity.¹⁹²

India is working to provide funding for clean energy through government programs, private investments, and international climate finance.¹⁹³ As public funds alone will not suffice the total capital required, institutions are focusing on catalytic finance, which leverages limited public funds to attract private investment, to expand the clean energy sector. Catalytic financial mechanisms and institutional facilities such as "green windows," which act as dedicated facility within existing institutions, can help develop markets that are otherwise financially underserved.

India has two dedicated clean energy finance institutions, the Indian Renewable Energy Development Agency (IREDA) and Tata Cleantech Capital Limited (TCCL). IREDA's plans to set up a green window can go a long way to demonstrate the significance of blended finance in stimulating investments into underserved clean energy markets.¹⁹⁴ India's support for the green window could attract more concessional funding and open up the Indian clean energy sector to new classes of international investors. TCCL is the world's first private sector Green Bank. As a member of the global Green Bank Network, it represents the first private sector entity to partner with Green Climate Fund, a UNFCCC fund established to support developing countries with adaptation and mitigation strategies, to mainstream rooftop solar financing in India.¹⁹⁵ An increased focus on environmental and social governance (ESG) metrics has also solidified the place of green funding in investment portfolios. The Securities and Exchanges Board of India (SEBI) made Business Responsibility and Sustainability Reports mandatory for the largest 1,000 listed businesses in the country, starting from the beginning of the 2022 fiscal year; this move

ensures large businesses must consider ESG compliance in their work in India and ensures a commitment to green investments among large corporate portfolios.¹⁹⁶ However, few standardized frameworks for ESG metric reporting exist to date, particularly for independent power producers.¹⁹⁷

First introduced in India in 2015, green bonds have been an important mechanism to refinance projects after initial investment stages. In February 2023, India issued its first green sovereign bond, which raised USD 1 billion at a lower cost of capital than conventional debt. However, plans to sell additional sovereign bonds were delayed due to investor desires for higher yields.¹⁹⁸ To further help facilitate climate investment, the Reserve Bank of India, India's central bank also announced the development of new guidelines on climate stress testing, climate disclosure and green deposits at banks.¹⁹⁹

There is dramatic potential and need for a continued mass mobilization of green investments in India. Especially with the increases in oil prices as a result of global events, investing in clean energy solutions for energy independence has only become more important.²⁰⁰ However, increasing investments, especially when attracting more offshore investors to India, will require addressing the current bottlenecks constraining financial institutions and investments. Chief among these are anxieties about financial returns from clean energy investments, exacerbated by the worsening financial health of domestic power distribution companies (DISCOMs). The Electricity Amendment Bill 2022 can help improve RE returns and investor confidence. In addition, the Government in June 2022 notified the Late Payment Surcharge (LPS) Rules. As a result, the Discom due reduced by a third, showcasing that rule has been effective in enhancing payment security for the power generators.²⁰¹

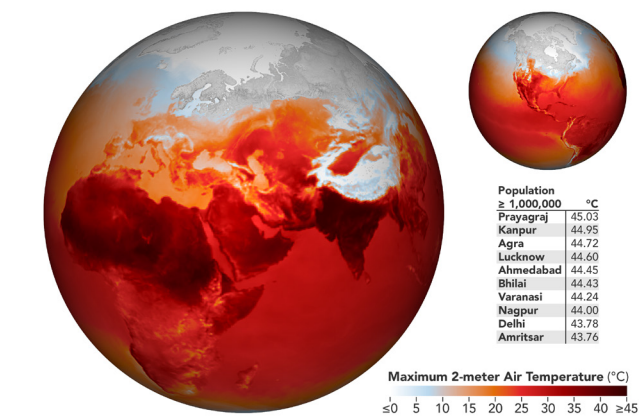
Policy measures and solutions like the Electricity Amendment Bill 2022 can be the key to unlock the green finance India needs to create its zero-emission future. To help India meet its clean energy finance needs, the OECD's Clean Energy Finance and Investment Mobilisation team and NRDC have jointly developed a roadmap for Clean Energy Finance Investment in India to put forward those solutions for select clean energy segments, including green hydrogen, offshore wind, ethanol, and energy efficiency upgrades by MSMEs that require investment support over the next five years.²⁰² The Roadmap brought together government and private sector stakeholders to present a clear action plan to address bottlenecks constraining financial institutions and investments, outline opportunities to tailor market and policy interventions to unlock further private finance, and focus on specific solutions for high-potential clean energy segments.

Climate Resilience

Extreme Heat

In 2023, extreme heat was once again in the spotlight. After record-breaking heat in 2022, 2023 brought India the hottest February since 1901.²⁰³ A 2022 analysis found that because of climate change, the probability of extreme heat event events has increased by a factor of about 30.²⁰⁴ The unprecedented temperatures shone light on the effects of heat in India and urgent demand for increased adaptation measures. A 2022 Lancet study stated that India saw a 55 percent rise in deaths due to extreme heat between 2000-2004 and 2017 – 2021.²⁰⁵ Globally, studies estimate that future death rates due to heat stress will be remarkably high, similar in scale to all cancers or all infectious diseases by the end of the century, and unequal with poorer countries having a higher burden.²⁰⁶ This rising heat poses a great threat not just to the health of the people but also to the key sectors of the economy such as agriculture, energy, infrastructure, transport, livelihoods and economies at large. As climate change prompts deadly heat waves to become more frequent, intense, and prolonged, increased heat is expected to cost India 2.8 percent and 8.7 percent of its Gross Domestic Product (GDP) by 2050 and 2100, respectively, as businesses, schools, and people nationwide are forced to transform their operations to keep people inside.²⁰⁷

Fig 8: An intense heat wave in April 2022 brought temperatures 4.5 to 8.5°C (8 to 15°F) above normal in east, central, and northwest India



© Photo Courtesy: Nasa.gov

The 2022 heat wave created months of power crises in India as power demand soared for cooling and power reserves simultaneously dipped to unprecedented lows, creating the worst power shortfall in six years.²⁰⁸ This perfect storm of challenges harmed India's most vulnerable the most. Rural women, who manage much of agriculture production when men leave for urban migrant labor, were the ones left outside in many places continuing with the backbreaking manual labor through sweltering afternoons.²⁰⁹

The crisis brought India's heat adaptation measures into the spotlight, especially National Heat Guidelines developed by the NDMA, the India Metrological Department (IMD), and partners. The guidelines expanded heat action plans to states and cities in India to provide local frameworks for advancing heat resilience. The city of Ahmedabad, which implemented South Asia's first-ever heat action plan in 2013, continues to provide an early warning and preparedness system to increase residents' resilience to extreme heat events.²¹⁰ The HAPs include emphasis on early "heat alert" warning systems, such as color-coded heat categories to alert residents of predicted highs, capacity-building for healthcare professionals, and emphasis on adaptation for the most vulnerable groups.²¹¹ Since the launch of Ahmedabad's HAP, more than 23 states and over 100 cities in India have followed suit.²¹² However, several key cities still lack HAPs, including Delhi, India's capital.²¹³

Heat action plans deploy a variety of approaches and combine different climate solutions to help heat adaptation. Cool roofs are one example of a common solution; cool roofs are shown to yield a 2 to 5 °C (3-5°F) reduction in indoor air temperature and can reduce energy demand for cooling in buildings. The cities of Ahmedabad and Hyderabad are developing city-wide cool roofs program pilots.²¹⁴ India also established the National Adaptation Fund for Climate Change in 2015 to help states become more resilient to the adverse effects of climate change. States can submit project proposals to the NAFCC program to request funding.²¹⁵

NDMA, along with some sub-national disaster management authorities and local governments, have initiated the inclusion of medium- and long-term adaptive measures for building community level resilience to extreme heat. This includes incorporation of better thermal efficiency principles in model building codes, as well as the integration of other ongoing government projects, such as state action plans on climate change and smart city programs.

As part of the national efforts, NDMA held a virtual workshop to help administrators get ready for the 2022 heat wave, examining how to prepare for, prevent, and mitigate the worst of the heat's impacts on vulnerable populations.²¹⁶ Several emerging studies also address and map where and how heat impacts people across India.²¹⁷ NDMA and IMD released a report together to address city-specific heat hazards. IMD's forecasts have transitioned towards more impact-focused assessments of heat. In summer 2021, they also began issuing warnings for "warm or very warm nights."²¹⁸ The accuracy of IMD's forecasts, which help cities know when to begin implementing HAPs, have improved to 92 percent with the expansion of their monitoring network across the country. However, IMD administrators warn

climate change will only make heat waves more unpredictable in years to come, as heat waves strengthen and last longer.²¹⁹

Air Quality



Thick winter season smog obscures buildings and traffic in Gurugram (Gurgaon), southwest of New Delhi, India.

© Photo Courtesy: Prateek Joshi/NREL, 73601

After the temporary improvements in air quality experienced in India during the COVID-19 lockdown, air quality worsened in 2022 as economic activity resumed.²²⁰ India's cities have had some of the worst air pollution levels in the world: the country is home to 18 of the world's top 20 cities for biggest increases in PM 2.5 concentrations over the last decade.²²¹ Domestic efforts have devoted more attention to regional and national coordination for managing air quality. India's National Clean Air Program (NCAP), launched in 2019, aims to reduce dangerous fine particulate matter pollution by 20 to 30 percent by 2024, compared to 2017 levels.²²² Under the program, 132 cities have prepared city-level action plans to meet the specified NCAP targets.²²³ Several cities, such as Ahmedabad, Pune, and New Delhi, have developed city clean air plans, including a focus on air quality index and health risk communications. In addition, several states are expanding the New Delhi's Graded Response Action Plan to respond to air pollution emergencies, including shutting down thermal power plants, limiting construction and industrial activities, and other measures.²²⁴

The NCAP is the first of its kind national level policy formulated to address air quality in Indian cities. State-level implementation and budgetary monitoring are needed to achieve NCAP goals. As of February 2022, most Indian cities have under-utilized their allocated NCAP funds and only Varanasi, Hoogly, and Talcher have met their pollution reduction goals.²²⁵ In several cities, such as Mumbai, pollution has increased over the last three years despite NCAP efforts.²²⁶

The Fifteenth Finance Commission report for 2020-2021 recommends a new grant program for ambient air quality improvements. The grant program targets cities with 1 million or more residents and Urban Agglomerations (UAs). The Finance Commission recommends INR 4,440 crore (USD 604

million) per grant used for air quality improvement measures, monitoring, and local body capacity building. In February 2021, this grant program was deepened and renewed, with the total allocation of INR 12,139 crore (US 1.65 billion) over a period of 5 years.²²⁷ To date, 42 cities have received the grant, and these funds have been linked to the improvement of air quality indicators in the UAs, with better performing cities receiving greater funding.

Another major development is the establishment of a national Commission for Air Quality Management (CAQM), to develop roadmaps for regional airshed level air quality management.²²⁸ So far, the CAQM has convened an expert group that recommended updating Delhi's Graded Response Action Plan, and its revisions have come into effect from October 1, 2022.²²⁹ Such efforts can potentially be replicated in other air quality hotspots across the country.

The Ministry of Health's National Centre for Disease Control has rolled out air quality preparedness and capacity building initiatives for states, including improving air quality-linked health surveillance in major cities across India. These include developing air quality forecasts for key Indian cities, as well as strengthening health care service provisions and response actions during high air pollution episodes. In 2022, the Central Pollution Control Board continued to work towards revising India's National Ambient Air Quality Standards, which have been unrevised since 2009. With changes in fuel use, technology and demographics as well as advances in air pollution measurement techniques, risk and exposure assessment, revisions of air quality standards are an important step towards improvement in public health.

With satellite-based air pollution measurement becoming more accessible, some states and cities have strengthened existing monitoring systems. Research indicates that overall average pollution levels continue to remain high, across urban and rural levels, indicating that air pollution is not confined to specific urban regions but is, in fact, a nationwide issue. Improved monitoring indicates that small towns experience poor air quality, representing the expansion of air pollution beyond megacities. This pollution comes from a combination of pollution from vehicles, industry, power plants, waste burning, and dust sources and wind-blown dust, aggravated by heat and arid conditions. More regional approaches will be required to manage air pollution sources.²³⁰ However, climate change induced disruptions in weather patterns can also affect air quality concentrations in the short term. For instance, unusually heavy rainfall over western and north-western India have resulted in the National Capital Region recording the cleanest July in 2023 in the last 4 years.²³¹ Long term improvement in air quality and health outcomes continue to remain one of India's largest public health challenges.

International Engagements

India has over the years emerged as a global leader in climate action, especially advocating for low-carbon transitions for countries in the Global South that balance development with emissions reductions. As the country models its energy transition, the government has worked to partner with other nations across the world to share resources, trainings, and technologies to realize these goals.

During COP21 held in 2015 in Paris, India and France jointly launched the International Solar Alliance (ISA), an important multilateral partnership aiming to mobilize USD 100 billion by 2030 to promote solar power globally. As of August 2023, 94 countries have signed and ratified the framework agreement.²³² At the First Assembly of the International Solar Alliance in October 2018, PM Modi put forth the idea for One Sun, One World, and One Grid (OSOWOG) plan that aims to support greater renewables penetration through interconnected grid systems and continues work on capacity building efforts in developing countries.²³³ At COP26 held in 2021 in Glasgow, India, United Kingdom and the ISA launched the Green Grids Initiative-OSOWOG and adopted the 'One Sun Declaration' with the aim to connect different regional grids and realize the full potential of solar energy.²³⁴ At COP27 held in 2022 in Sharm El-Sheikh, the countries came together to take the ground-breaking decision to establish a new "loss and damage" fund to assist vulnerable, developing countries hit hardest by the impacts of climate change.²³⁵ India played an instrumental role in reaching the final agreement, which included an endorsement of sustainable lifestyles and consumption as conceived in India's Mission LiFE movement.²³⁶

This year, the theme for India's G20 Presidency was "One Earth, One Family, One Future," with the aim to share, collaborate and build on the sense of responsibility and solidarity amongst the G20 members in accelerating clean, sustainable, just, affordable, and inclusive energy transitions, following various pathways, as a means of enabling secure, sustainable, equitable, shared and inclusive growth.²³⁷ At the G20 Leader's Summit in September 2023, India steered the consensus between G20 countries on a Green Development Pact for a Sustainable Future, which recognizes various issues such as a just and inclusive clean energy transition, mainstreaming lifestyles for sustainable development (Mission LiFE), and the need for timely and adequate mobilization of resources for climate finance to support transition activities in line with country circumstances.²³⁸

G20 New Delhi Leaders' Declaration

Key Highlights on Climate and Energy



Green Development Pact for a Sustainable Future to pursue a low-carbon, climate-resilient, sustainable, and inclusive pathway in addressing development and climate challenges.

G20 High-Level Principles on Lifestyles for Sustainable Development to promote sustainable lifestyles for climate action and a global net-zero future.



G20 Report on Macroeconomic Risks Stemming from Climate Change and Transition Pathways to assess and account for the short, medium and long-term macroeconomic impact of climate change and energy transition.

Green Hydrogen Innovation Centre steered by the International Solar Alliance (ISA) to build a sustainable and equitable global hydrogen ecosystem that benefits all nations.



Voluntary Action Plan for Promoting Renewable Energy to Accelerate Universal Energy Access to encourage efforts to triple renewable energy capacity globally through existing targets and policies.

Voluntary Action Plan on Doubling the Rate of Energy Efficiency Improvement by 2030 to accelerate the implementation of various energy efficiency and energy savings policies.



Global Biofuels Alliance recognizing the importance of sustainable biofuels in low-emission development strategies.

New Collective Quantified Goal (NCQG) on Climate Finance calling on parties to set an ambitious, transparent, and trackable goal, from a floor of USD 100 billion a year.



India has also worked on several bilateral partnerships for renewable energy development. Several partnerships have focused on funding for renewable energy from developed countries. A 2022 Indo-Japan partnership aims to bring USD 5 million in funding to 10 states in order to help India meet its climate pledges, while the 2022 Indo-German Cooperation on Sustainable Development and Climate Action will bring USD 10 billion euros to energy innovation, hydrogen development, and more.²³⁹ The 2016 EU-India Clean Energy and Climate Partnership has agreed to help India improve its technology to accelerate energy efficiency, with a goal of implementation by 2023.²⁴⁰ A June 2023 meeting between President Joe Biden and Prime Minister Narendra Modi reaffirmed both leaders' commitment to the U.S.-India Climate and Clean Energy Partnership, launched in April 2021.²⁴¹ The two countries named a shared commitment to develop and deploy energy storage technologies, expand collaboration for the countries' respective national hydrogen strategies, and announced plans for a payment security mechanism to support the acceleration of zero emission vehicles, including 10,000 made-in-India electric buses.²⁴²

Beyond clean energy, India has also worked towards helping phase down other climate pollutants. India played a central role in the formation of the Kigali Amendment, the global pact to phase down HFCs, super-pollutants used in refrigerants and air-conditioners. As of June 2023, 151 countries, including China, India and the United States, have ratified the Kigali amendment.²⁴³ Indian industry players and government bodies are committed to meeting or exceeding the Kigali Amendment goals, according to a July 2022 roundtable.

India has also made substantial steps towards global leadership in building climate resilience. To support the construction of climate-resilient infrastructure, India launched an international Coalition for Disaster Resilient Infrastructure at the September

2019 Climate Action Summit in New York.²⁴⁴ At COP26 held in 2021 in Glasgow, India also launched the Infrastructure for Resilient Island States initiative to support the development of infrastructure of small island nations particularly vulnerable to climate change.²⁴⁵ This initiative was developed along with the U.K. and Australia and included the participation of leaders of small island nations such as Fiji, Jamaica and Mauritius.

India also co-created the Leadership Group for Industry Transition, a cooperative to promote innovation and technology exchange. The initiative will target steel, cement, and aviation to reach net-zero emissions from heavy industry by mid-century.²⁴⁶ In March 2020, this collaborative was extended to support energy research and innovation, and India and Sweden established a co-funding mechanism to support the research and development of smart grid technologies.²⁴⁷

At the COP28 meeting to be held from 30 November to 12 December 2023 in Dubai, countries will undertake the First Global Stocktake of collective progress towards the goals of the Paris Agreement, with the next round of updates to NDCs due in 2025. India's previously updated NDCs in 2022 have so far set a positive tone for the rest of the world on scaling up climate ambitions. With the passage of the Inflation Reduction Act in the United States, and China's commitment to reaching peak carbon emissions by 2030 and carbon neutrality by 2060, the three largest economies of the world have begun to chart a common low carbon future.²⁴⁸

India is a critical international stakeholder in combating climate change. The country has set ambitious national goals and taken strong early steps to modelling a transition away from fossil fuels and towards a zero-carbon, climate-resilient future. The success of India's efforts will impact not just hundreds of millions of its citizens, but also how the world collectively responds to one of the biggest challenges facing humanity.



(Source: [https://www.g20.org/content/dam/gtwenty/gtwenty_new/gallery/september-23/g20-summit/session-of-g20/13.\)adega.jpg](https://www.g20.org/content/dam/gtwenty/gtwenty_new/gallery/september-23/g20-summit/session-of-g20/13.)adega.jpg)

Endnotes

- 1 “The hottest 12-month stretch in recorded history,” Climate Central November 2023, <https://www.climatecentral.org/report/the-hottest-12-month-stretch-in-recorded-history-2023>
- 2 US GST “Submission of the United States on the Elements for the Consideration of Outputs Component of the First Global Stocktake,” September 2023, https://www4.unfccc.int/sites/SubmissionsStaging/Documents/202309160945-US%20GST%20Submission_September%202023.pdf; International Energy Agency, 2022. “World Energy Outlook 2022.” Available at: <https://www.iea.org/reports/worldenergy-outlook-2022>.
- 3 S. Acharya and N. Ohri, “India’s economy grows at fastest pace in a year in June quarter, monsoon risk seen, Reuters, August 31, 2023, <https://www.reuters.com/world/india/indias-economic-growth-set-accelerate-its-fastest-year-2023-08-31/>
- 4 IEA (2020), India 2020, IEA, Paris <https://www.iea.org/reports/india-2020>
- 5 G20 New Delhi Leaders’ Declaration, September 2023, https://www.g20.org/content/dam/gtwenty/gtwenty_new/document/G20-New-Delhi-Leaders-Declaration.pdf
- 6 “Country Rankings,” IRENA <https://www.irena.org/Data/View-data-by-topic/Capacity-and-Generation/Country-Rankings>
- 7 “2022 Q4 and Annual Solar Market Update – 13 GW Installed in 2022,” Mercom India Research, <https://www.mercomindia.com/product/q4-2022-india-solar-market-update>
- 8 Sarita Chaganti Singh, “India succeeds in reducing emissions rate by 33% over 14 years – sources,” Reuters, August 2023, [https://www.reuters.com/world/india/india-succeeds-reducing-emissions-rate-by-33-over-14-years-sources-2023-08-09/#:~:text=India's%20rate%20of%20emissions%20intensity,Communication%20\(TNC\)%20report%20said.](https://www.reuters.com/world/india/india-succeeds-reducing-emissions-rate-by-33-over-14-years-sources-2023-08-09/#:~:text=India's%20rate%20of%20emissions%20intensity,Communication%20(TNC)%20report%20said.)
- 9 “The Energy Conservation (Amendment) Bill, 2022,” Ministry of Power, 2022, <https://prsindia.org/billtrack/the-energy-conservation-amendment-bill-2022>
- 10 S. Takker, “India’s Carbon Credit Trading Scheme 2023 - How is the industry reacting to it,” ETEnergyWorld, June 2023, <https://energy.economictimes.indiatimes.com/news/renewable/indias-carbon-credit-trading-scheme-2023-how-is-the-industry-reacting-to-it/101662053>; R. Singh and A. Ghosh, “India’s national carbon market to seek links with international registries,” SP Global Commodity Insights, <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/063023-indias-national-carbon-market-to-seek-links-with-international-registries>
- 11 S. Takker, “India’s Carbon Credit Trading Scheme 2023 - How is the industry reacting to it,” ETEnergyWorld, June 2023, <https://energy.economictimes.indiatimes.com/news/renewable/indias-carbon-credit-trading-scheme-2023-how-is-the-industry-reacting-to-it/101662053>; R. Singh and A. Ghosh, “India’s national carbon market to seek links with international registries,” SP Global Commodity Insights, <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/063023-indias-national-carbon-market-to-seek-links-with-international-registries>
- 12 “India tops globally in LEED Zero certifications of green building projects,” Press Trust of India, Business Standard, June 2023, https://www.business-standard.com/india-news/india-tops-globally-in-leed-zero-certifications-of-green-building-projects-123061501200_1.html <https://timesofindia.indiatimes.com/india-tops-globally-in-leed-zero-certifications-of-green-building-projects-dlf-ranks-1st/articleshow/101026117.cms?from=mdr>
- 13 M. Beha, “Maha in top 5 states with comprehensive EV policies,” Times of India, February 2023, <https://timesofindia.indiatimes.com/city/nagpur/maha-in-top-5-states-with-comprehensive-ev-policies/articleshow/97991827.cms>
- 14 M. Zachariah, A. T. K. Rao , F. Saeed, et al, “Climate Change made devastating early heat in India and Pakistan 30 times more likely,” World Weather Attribution, 2022 https://www.worldweatherattribution.org/wp-content/uploads/India_Pak-Heatwave-scientific-report.pdf
- 15 R. Raghavan , A. Laskar, “India’s Green Energy Sector expected to attract \$800 bn investment,” Livemint, June 2023, <https://www.livemint.com/news/india/800-billion-investment-expected-in-indian-green-energy-sector-over-next-decade-bank-of-america-11685897190627.html#:~:text=%E2%80%9CThe%20energy%20transition%20theme%20will,hydrogen%2C%20storage%20and%20component%20manufacturing.>
- 16 N. Khanna, D. Purkayastha and S. Jain, “Landscape of Green Finance in India 2022,” August 2022, <https://www.climatepolicyinitiative.org/publication/landscape-of-green-finance-in-india-2022/>
- 17 N. Khanna, D. Purkayastha and S. Jain, “Landscape of Green Finance in India 2022,” August 2022, <https://www.climatepolicyinitiative.org/publication/landscape-of-green-finance-in-india-2022/>
- 18 “India will soon overtake China as the world’s most populous country,” Jan 2023, The Economist, <https://www.economist.com/graphic-detail/2023/01/05/india-will-soon-overtake-china-as-the-worlds-most-populous-country>
- 19 World Bank, “GDP Growth Annual Percent – India,” <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?end=2010&locations=IN&start=2010&view=bar> (August 19, 2020); New York Times, “India’s Economy Shrank Nearly 24% Last Quarter,” August 21, 2020, <https://www.nytimes.com/2020/08/31/world/asia/india-economy-gdp.html>; International Monetary Fund, “World Economic Outlook: Near-Term Resilience, Persistent Challenges,” July 2023, <https://www.imf.org/en/Publications/WEO/Issues/2023/07/10/world-economic-outlook-update-july-2023>
- 20 “Fossil Fuel emissions,” Global Carbon Atlas, <https://globalcarbonatlas.org/emissions/carbon-emissions/>; IEA (2021), Global Energy Review 2021, IEA, Paris <https://www.iea.org/reports/global-energy-review-2021>
- 21 Carbon Monitor, 2023, <https://carbonmonitor.org/variation>
- 22 Central Electricity Authority, “All India Installed Power Capacity (in MW) of Power Stations (As on 31.10.2023),” https://cea.nic.in/wp-content/uploads/installed/2023/10/IC_OCT_2023-1.pdf; “India Has One Of The Fastest Rates Of Growth Of Renewable Energy Capacity In The World: Union Power Minister,” July 16, 2021, https://www.business-standard.com/article/news-cm/india-has-one-of-the-fastest-rates-of-growth-of-renewable-energy-capacity-in-the-world-union-power-minister-121071600225_1.html#:~:text=The%20Morning%20Show-,India%20Has%20One%20of%20The%20Fastest%20Rates%20of%20Growth%20of,The%20World%3A%20Union%20Power%20Minister&text=The%20Minister%20said%20that%20India,Renewable%20

- Energy%20capacity%20by%202030.; PIB Delhi, "India achieves 100 GW Milestone of Installed Renewable Energy Capacity" August 12, 2021 <https://pib.gov.in/PressReleaseDetailm.aspx?PRID=1745254>
- 23 Central Electricity Authority, "All India Installed Power Capacity (in MW) of Power Stations (As on 31.10.2023)," https://cea.nic.in/wp-content/uploads/installed/2023/10/IC_OCT_2023-1.pdf
- 24 IEA, Coal Market Update 2023, <https://www.iea.org/reports/coal-market-update-july-2023/supply#abstract> (August 2023).
- 25 IEA (2021), Global Energy Review 2021, IEA, Paris <https://www.iea.org/reports/global-energy-review-2021>
- 26 Central Electricity Authority, "All India Installed Power Capacity (in MW) of Power Stations (As on 31.10.2023)," https://cea.nic.in/wp-content/uploads/installed/2023/10/IC_OCT_2023-1.pdf
- 27 International Energy Agency, Electricity Market Report, January 2023, <https://iea.blob.core.windows.net/assets/255e9cba-da84-4681-8c1f-458ca1a3d9ca/ElectricityMarketReport2023.pdf> ; <https://economictimes.indiatimes.com/news/economy/indicators/indias-power-consumption-grows-by-8-4-pc-to-139-billion-units-in-july/articleshow/102310419.cms?from=mdr>
- 28 Ministry of Power, Power Sector at a Glance, <https://powermin.gov.in/en/content/power-sector-glance-all-india> (July 20, 2022); India News, "Govt mandates renewables mix in output of generation companies," Hindustan Times, April 29, 2022, <https://www.hindustantimes.com/india-news/govt-mandates-renewables-mix-in-output-of-generation-companies-101651171821298.html> (September 30, 2022).
- 29 Central Electricity Authority, "All India Installed Power Capacity (in MW) of Power Stations (As on 31.10.2023)," https://cea.nic.in/wp-content/uploads/installed/2023/10/IC_OCT_2023-1.pdf; MNRE, "Programme/Scheme wise Cumulative Physical Progress as on July 2022," <https://mnre.gov.in/the-ministry/physical-progress>, last accessed on September 1, 2022.
- 30 "India missed 175 GW renewable energy capacity target by 30 per cent: Bridge to India, ET Energy World, January 2023, <https://energy.economictimes.indiatimes.com/news/renewable/india-missed-175-gw-renewable-energy-capacity-target-by-30-per-cent-bridge-to-india/96740844>
- 31 "Renewables 2022 Global Status Report," Ren21, 2022, https://www.ren21.net/wp-content/uploads/2019/05/GSR2022_Full_Report.pdf
- 32 Central Electricity Authority, "All India Installed Power Capacity (in MW) of Power Stations (As on 31.10.2023)," https://cea.nic.in/wp-content/uploads/installed/2023/10/IC_OCT_2023-1.pdf; "Report on Optimal Generation Mix 2029-2030," CEA, 2023, https://cea.nic.in/wp-content/uploads/irp/2023/05/Optimal_mix_report_2029_30_Version_2.0_For_Upload.pdf
- 33 U. Gupta, "TATA Power builds 300 MW hybrid wind-solar project in India," PV Magazine, <https://www.pv-magazine.com/2021/12/20/tata-power-builds-300-mw-hybrid-wind-solar-project-in-india/> (December 20, 2021).
- 34 U. Bhaskar, "Bill likely to make use of clean energy compulsory," Mint, <https://www.livemint.com/industry/energy/mandatory-green-energy-use-carbon-trading-rules-soon-11658081150590.html> (July 18, 2022); "Government notifies Green Open Access Rules 2022," The Economic Times, <https://economictimes.indiatimes.com/industry/renewables/government-notifies-green-open-access-rules-2022/articleshow/92063132.cms> (June 7, 2022).
- 35 Sarita C Singh, "E-reverse auctions for wind projects to go: MNRE secretary," The Economic Times, <https://economictimes.indiatimes.com/industry/renewables/e-reverse-auctions-for-wind-projects-to-go-mnre-secretary/articleshow/92870616.cms?from=mdr> (July 14, 2022), last accessed on September 1, 2022.
- 36 R. Baruah, "Government to pull plug on e-reverse auction for renewable energy," Mint, <https://www.livemint.com/industry/energy/ereverse-auction-for-renewable-energy-to-end-soon-11657804719007.html> (July 15, 2022).
- 37 India Environment Portal, State Wise Estimated Solar Power Potential in the Country, 2014, <http://www.indiaenvironmentportal.org.in/content/403483/state-wise-estimated-solar-power-potential-in-the-country/>; CleanTechnica, India's Solar Power Potential Estimated at 750 GW, 2014, <https://cleantechnica.com/2014/11/29/indias-solar-power-potential-estimated-750-gw/> (August 14, 2020). Ministry of New and Renewable Energy, "Solar Energy Overview," <https://mnre.gov.in/solar/current-status/#:~:text=National%20Institute%20of%20Solar%20Energy,one%20of%20the%20key%20Missions> (August 14, 2020).
- 38 Central Electricity Authority, "All India Installed Power Capacity (in MW) of Power Stations (As on 31.07.2023) https://cea.nic.in/wp-content/uploads/installed/2023/07/IC_July_2023.pdf
- 39 U. Gupta, "India installed third most solar capacity in the world in 2022," PV Magazine, June 2023, <https://www.pv-magazine-india.com/2023/06/13/india-installed-third-most-solar-capacity-in-the-world-in-2022/#:~:text=India%20retained%20its%20third%20spot,of%20annual%20installations%20in%202022>.
- 40 Ministry of Power Central Electricity Authority, "Report on Optimal Generation Capacity Mix for 2029-30," January 2020, https://cea.nic.in/old/reports/others/planning/irp/Optimal_mix_report_2029-30_FINAL.pdf
- 41 U. Gupta, "India needs more PV capacity to reach 2027 target of 186 GW," PV Magazine, October 2023, <https://www.pv-magazine.com/2023/10/04/india-needs-more-pv-capacity-to-reach-2027-target-of-186-gw/>
- 42 U. Gupta, "India needs more PV capacity to reach 2027 target of 186 GW," PV Magazine, October 2023, <https://www.pv-magazine.com/2023/10/04/india-needs-more-pv-capacity-to-reach-2027-target-of-186-gw/>
- 43 "Solar and wind set to drive two-thirds of India's power generation growth by 2032, says Ember analysis," Times of India.com, October 2, 2023, <https://timesofindia.indiatimes.com/business/india-business/solar-and-wind-set-to-drive-two-thirds-of-indias-power-generation-growth-by-2032-says-ember-analysis/articleshow/104108408.cms?from=mdr>
- 44 A. Joshi, "India Installs a Record 13 GW of Solar Capacity in 2022, Up 27% YoY," Mercom Research Focus, February 2023, <https://www.mercomindia.com/india-installs-record-13-gw-solar-in-2022>
- 45 A. Joshi, "India Installs a Record 13 GW of Solar Capacity in 2022, Up 27% YoY," Mercom Research Focus, February 2023, <https://www.mercomindia.com/india-installs-record-13-gw-solar-in-2022>

- 46 "Record-high 4GW of rooftop solar capacity set to come in India in fiscal year 2024," IEEFA, September 2023, <https://ieefa.org/articles/record-high-4gw-rooftop-solar-capacity-set-come-india-fiscal-year-2024>
- 47 S. Arasu, "As India's electrical grid strains, rural hospitals and clinics find reliable power in rooftop solar," AP News, May 2023, <https://apnews.com/article/india-solar-hospitals-renewable-energy-climate-change-5469ad61650403fb4024911456daf06a> ; Record-high 4GW of rooftop solar capacity set to come in India in fiscal year 2024," IEEFA, September 2023, <https://ieefa.org/articles/record-high-4gw-rooftop-solar-capacity-set-come-india-fiscal-year-2024> ; A Koundal, "What is driving the historic growth in India's rooftop solar power sector?" ET Energy World, May 2023, <https://energy.economictimes.indiatimes.com/news/renewable/what-is-driving-the-historic-growth-in-indias-rooftop-solar-power-sector/99891707>; CEA records 3.7GW solar additions in Q1, but higher risks loom ahead," Saur Energy, <https://www.saurenergy.com/solar-energy-news/cea-records-3-7-gw-solar-additions-in-q1-but-higher-risks-loom-ahead> (July 18, 2022).
- 48 Kiran S, "Solar Shift: How India is silently becoming the next major PV player," ET Energy World, July 26, 2023, <https://energy.economictimes.indiatimes.com/news/renewable/solar-shift-how-india-is-silently-becoming-the-next-major-pv-player/102137650>
- 49 J. Ramnani, "Indian cities need policy reforms and more to achieve solar rooftop targets," Citizen Matters, <https://citizenmatters.in/rooftop-solar-in-indian-cities-policy-reforms-diy-guide-30427> (May 10, 2022).
- 50 A. Lolla, "India's race to 175 GW," Ember, <https://ember-climate.org/insights/research/indias-race-to-175-gw/> (April 28, 2022); K. Misbrenner, "Global solar industry sees 95% increase in downtime days due to pandemic, supply chain," Solar Power World, <https://www.solarpowerworldonline.com/2022/05/global-solar-industry-95-percent-increase-average-downtime-days/> (May 25, 2022).
- 51 "The long read: India's solar manufacturing wave," PV Magazine, <https://www.pv-magazine-india.com/2022/03/26/the-long-read-indias-solar-manufacturing-wave/> (March 26, 2022).
- 52 M. Aggarwal and K. Panday, "Policy flip-flop over solar contracts could eclipse India's sunshine sector," June 11, 2021 <https://india.mongabay.com/2021/06/flip-flop-in-policy-can-derail-indias-long-term-renewable-journey/>; T. Spencer, et al., "Execution challenges may limit renewable energy growth at 8GW in 2020: Icrs," Live Mint, July 29, 2020, <https://www.livemint.com/industry/energy/execution-challenges-may-limit-renewable-energy-growth-at-8gw-this-year-icra-11596023739242.html> (accessed on August 21, 2020).
- 53 M. Kumar, "India set to build its own carbon credit market, set bylaws for energy efficiency," Mongabay India, <https://india.mongabay.com/2022/08/energy-conservation-amendment-bill/> (August 18, 2022).
- 54 A. Joshi, "Power ministry proposes renewable energy central pool with uniform tariffs," Mercom, <https://mercomindia.com/ministry-proposes-renewable-central-pool-uniform-tariffs/> (August 17, 2022).
- 55 <https://www.livemint.com/industry/energy/indias-wind-energy-sector-surges-installed-capacity-reaches-43-773-mw-generating-71-814-million-units-of-electricity-11690896613457.html>; MNRE, "Programme/Scheme wise Cumulative Physical Progress as on July, 2022 ", <https://mnre.gov.in/the-ministry/physical-progress>, last accessed on September 1, 2022
- 56 MNRE, "Programme/Scheme wise Cumulative Physical Progress as on August 23," <https://mnre.gov.in/the-ministry/physical-progress>, last accessed on September 1, 2022
- 57 S. Anand, "India's installed wind energy capacity to rise to 99.9GW by 2029-30," Mint, August 2023, <https://www.livemint.com/industry/energy/indias-wind-energy-sector-surges-installed-capacity-reaches-43-773-mw-generating-71-814-million-units-of-electricity-11690896613457.html>
- 58 S. Jain, H. Arekar, R. Renade, "Revitalizing Wind Growth to Power the Energy Transition: India Wind Energy Outlook 2022-2026," Global Wind Energy Council, June 2022, <https://gwec.net/wp-content/uploads/2022/08/India-Outlook-2026.pdf>
- 59 "GWEC: Global Wind Energy Market Outlook 2023-2027," GWEC, MEC+, 2023, <https://gwec.net/india-wind-energy-market-outlook-2023-2027-report/>
- 60 I. Bhambra, "Bidding Adieu: Terminating reverse auctions to fully realize India's wind energy potential," Powerline, March 2023, [https://powerline.net.in/2023/03/15/bidding-adieu-terminating-reverse-auctions-to-fully-realise-indias-wind-energy-potential/#:~:text=Bidding%20Adieu%3A%20Terminating%20reverse%20auctions%20to%20fully%20realise%20India's%20wind%20energy%20potential,-March%2015%2C%202023&text=In%20January%202023%2C%20the%20Government,bidding%20for%20wind%20energy%20projects](https://powerline.net.in/2023/03/15/bidding-adieu-terminating-reverse-auctions-to-fully-realise-indias-wind-energy-potential/#:~:text=Bidding%20Adieu%3A%20Terminating%20reverse%20auctions%20to%20fully%20realise%20India's%20wind%20energy%20potential,-March%2015%2C%202023&text=In%20January%202023%2C%20the%20Government,bidding%20for%20wind%20energy%20projects;); M. Ramesh, "Wind power capacity addition to cross 5 GW this year, new auction method kicks-off," The Hindu Business Line, June 2023, <https://www.thehindubusinessline.com/markets/commodities/wind-power-capacity-addition-to-cross-5-gw-this-year-new-auction-method-kicks-off/article66923940.ece>
- 61 "GWEC: Global Wind Report 2022," 2022, <https://gwec.net/wp-content/uploads/2022/03/GWEC-GLOBAL-WIND-REPORT-2022.pdf>
- 62 "India's first offshore wind energy to come up off Tamil Nadu Coast," Times of India, June 2023, http://timesofindia.indiatimes.com/articleshow/100716920.cms?from=mdr&utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst . "Center to invite international bids to install offshore wind turbines in TN, Gujarat," The New Indian Express, <https://www.newindianexpress.com/states/tamil-nadu/2022/jun/30/centre-to-invite-international-bids-to-install-offshore-wind-turbines-in-tn-gujarat-2471227.html> (June 30, 2022).
- 63 K. Shah, "Another boost for India's offshore wind development," Institute for Energy Economics and Financial Analysis, <https://ieefa.org/resources/another-boost-indias-offshore-wind-development> (August 19, 2022).
- 64 Ministry of Power, Government of India, https://powermin.gov.in/sites/default/files/Green_Hydrogen_Policy.pdf (September 1, 2022).
- 65 "Hydrogen Overview," MNRE, <https://mnre.gov.in/hydrogen-overview/>; S. Sarkar, "India's initiatives on green hydrogen could help global decarbonization," Mongabay, Nov 2022, <https://india.mongabay.com/2022/11/indias-initiatives-on-green-hydrogen-could-help-global-decarbonisation/>
- 66 A. Chaudary, "India eyes lower green hydrogen costs to spur clean energy use," The Economic Times, <https://economictimes.indiatimes.com/industry/renewables/india-eyes-lower-green-hydrogen-costs-to-spur-clean-energy-use/articleshow/92033424.cms> (June 6, 2022).
- 67 "India announces definition of Green Hydrogen," PIB Delhi, August 2023, <https://pib.gov.in/PressReleasePage.aspx?PRID=1950421>
- 68 R. Kumar, "Green hydrogen policy and way ahead," New Indian Express, <https://www.newindianexpress.com/business/2022/feb/27/green-hydrogen-policy-andway-ahead-2424148.html> (February 27, 2022); P. Jestin, "India eyes large-scale green hydrogen production by 2030," ICIS, July 2023, <https://www.icis.com/explore/resources/news/2023/07/06/10902945/india-eyes-large-scale-green-hydrogen-production-by-2030/>

- 69 "India govt sets emission limit for hydrogen to qualify as 'green'," Reuters, August 2023, <https://www.reuters.com/sustainability/climate-energy/india-govt-sets-emission-limit-hydrogen-qualify-green-2023-08-19/#:~:text=India%20wants%20to%20become%20a,billion%20on%20fossil%20fuel%20imports>.
- 70 K. Raj, P. Lakhina, C. Stranger, "Harnessing Green Hydrogen," NITI Aayog, https://www.niti.gov.in/sites/default/files/2022-06/Harnessing_Green_Hydrogen_V21_DIGITAL_29062022.pdf (June 2022).
- 71 PTI, "India needs 115 GW RE generation capacity, 50 bn litre demineralised water to meet green hydrogen target: Report," The Economic Times, <https://economictimes.indiatimes.com/industry/renewables/india-needs-115-gw-re-generation-capacity-50-bn-litre-demineralised-water-to-meet-green-hydrogen-target-report/articleshow/92520923.cms> (June 28, 2022).
- 72 P. Jestin, "India eyes large-scale green hydrogen production by 2030," ICIS, July 2023, <https://www.icis.com/explore/resources/news/2023/07/06/10902945/india-eyes-large-scale-green-hydrogen-production-by-2030/>
- 73 R. K. Singh, D. Chakraborty, "Ambani's \$75 Billion Plan Aims to Make India a Green Hydrogen Hub," Bloomberg, <https://www.bloomberg.com/news/articles/2022-01-30/ambani-s-75-billion-plan-aims-to-make-india-a-hydrogen-hub> (January 30, 2022).
- 74 The Hindu Bureau, "OIL commissions India's first pure green hydrogen plant in Assam," The Hindu, <https://www.thehindu.com/news/national/other-states/oil-commissions-indias-first-pure-green-hydrogen-plant-in-assam/article65339440.ece> (April 20, 2022); S. Jai, S. Jacob, "Green hydrogen: India Inc's next big thing even as policies take shape," https://www.business-standard.com/article/economy-policy/green-hydrogen-india-inc-s-next-big-thing-despite-absence-of-policy-122082500977_1.html (August 26, 2022); G. Mishra, "India Hydrogen Alliance Seeks \$360 Million from Government to Deploy 25 Green Hubs," Mercom India, <https://mercomindia.com/india-hydrogen-alliance-360-million-deploy-green-hubs/> (July 1, 2022).
- 75 "India's Expanding Clean Energy Workforce," NRDC, January 2022, <https://www.nrdc.org/sites/default/files/indias-clean-energy-workforce-450-gw-target-report.pdf>
- 76 "India's Expanding Clean Energy Workforce," NRDC, January 2022, <https://www.nrdc.org/sites/default/files/indias-clean-energy-workforce-450-gw-target-report.pdf>
- 77 "Renewable Energy and Jobs Annual Review 2023," IRENA, 2023, <https://www.irena.org/Publications/2023/Sep/Renewable-energy-and-jobs-Annual-review-2023>; S. Anand, "Solar dominates as India adds nearly 1 million renewable jobs in 2022: Report," ET Energy World, October 2023, <https://energy.economictimes.indiatimes.com/news/renewable/solar-dominates-as-india-adds-nearly-1-million-renewable-jobs-in-2022-report/104171980>
- 78 Discussion with Skills Council for Green Jobs on August 4, 2021.
- 79 "Over 50,000 'Suryamitras' trained under skill development programme: RK Singh," The New Indian Express, <https://www.newindianexpress.com/business/2022/jul/20/over-50000-suryamitras-trained-under-skill-development-programme-rk-singh-2478613.html> (July 20, 2022).; PIB India, "Steps by the Government of India to boost employment opportunities in the green energy sector," Ministry of New and Renewable Energy, <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1842741> (July 19, 2022).
- 80 K. Mehrotra, "In India, desolate solar parks show the dark side of renewable energy," Scroll.in, <https://scroll.in/article/1017015/in-india-desolate-solar-parks-reveal-the-dark-side-of-renewable-energy> (February 11, 2022).
- 81 World Energy Employment Report, IEA, <https://iea.blob.core.windows.net/assets/a0432c97-14af-4fc7-b3bf-c409fb7e4ab8/WorldEnergyEmployment.pdf>.
- 82 A. Chowdhury, "Opportunities to innovate and collaborate for rural development using decentralized renewable energy," Times of India, <https://www.livemint.com/news/india/india-may-see-150-bn-investment-in-hydrogen-sector-in-a-decade-reliance-11655914234536.html> (December 13, 2021); "India may see \$150 bn investment in hydrogen sector in a decade: RIL," Mint, <https://www.livemint.com/news/india/india-may-see-150-bn-investment-in-hydrogen-sector-in-a-decade-reliance-11655914234536.html> (June 22, 2022).
- 83 REC India, "Saubhagya", accessed September 2, 2022, <https://recindia.nic.in/saubhagya>.
- 84 A. Sharma, "Electrification still a challenge in rural India," The Hindu, February 2023, <https://frontline.thehindu.com/the-nation/electrification-still-remains-a-challenge-in-rural-india/article66493576.ece>
- 85 S. Gupta, E. Gupta, G. K. Sarangi, "Household Energy Poverty Index for India: An analysis of inter-state differences," Energy Policy, <https://www.sciencedirect.com/standalone/article/pii/S0301421520303311> (September 2020).
- 86 The Economic Times, "Rural average electricity supply at 22.17 hours a day, 23.36 hours in cities in June 2021: Power Ministry," accessed September 2, 2022, <https://m.economictimes.com/industry/energy/power/rural-average-electricity-supply-at-22-17-hours-a-day-23-36-hours-in-cities-in-june-2021-power-ministry/articleshow/85066305.cms>.
- 87 The Hindu Business Line, "24x7 rural power supply eludes most States," <https://www.thehindubusinessline.com/data-stories/data-focus/24x7-rural-power-supply-eludes-most-states/article37105116.ece> (September 2, 2022).
- 88 Council on Energy, Environment and Water, State of Electricity Access in India: Insights from the India Residential Energy Consumption Survey (IRES) 2020, September 2021, <https://www.ceew.in/sites/default/files/ceew-research-on-state-of-electricity-access-and-coverage-in-india.pdf>.
- 89 J. Mistry, "Unleashing change: The new electricity act and India's power sector," June 2023, https://economictimes.indiatimes.com/markets/stocks/news/unleashing-change-the-new-electricity-act-and-indias-powersector/articleshow/100419526.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=
- 90 N. Taneja, "The clock is ticking on the issue of energy poverty," Indian Express, <https://indianexpress.com/article/opinion/columns/the-clock-is-ticking-on-the-issue-of-energy-poverty-8018081/> (July 9, 2022).
- 91 Ministry of Power, Press Information Bureau, "Union Government for the first time lays down Rights to the Electricity Consumers through "Electricity (Rights of Consumers) Rules, 2020", December 2021, <https://pib.gov.in/PressReleasePage.aspx?PRID=1682384>.
- 92 International Institute for Sustainable Development, "Implementing Solar Irrigation Sustainably: A guidebook for state policymakers on maximizing the social and environmental benefits from solar pump schemes," December 2021, <https://www.iisd.org/system/files/2021-12/implementing-solar-irrigation-sustainably.pdf>.

- 93 “Easing the Norms: MoP issues draft Electricity (Amendment) Rules, 2023,” August 2023, <https://powerline.net.in/2023/08/02/easing-the-norms-mop-issues-draft-electricity-amendment-rules-2023/>
- 94 Cabinet Committee on Economic Affairs, Press Information Bureau, “Cabinet approves launch Kisan Urja Suraksha evam Utthaan Mahabhiyan,” February 2019, <https://pib.gov.in/Pressreleaseshare.aspx?PRID=1565274>.
- 95 Ministry of New and Renewable Energy, Press Information Bureau, “Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM),” November 2021, <https://pib.gov.in/FactsheetDetails.aspx?Id=148576>.
- 96 Ministry of New and Renewable Energy, PM KUSUM Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan – A New Green Revolution, <https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/may/doc202351191401.pdf>
- 97 “Government Extends PM-KUSUM Scheme Till March 2026 As Covid Affects Implementation,” Press Trust of India, Outlook India, February 2023, <https://www.outlookindia.com/business/government-extends-pm-kusum-scheme-till-march-2026-as-covid-affects-implementation-news-258895>; Council on Energy, Environment and Water, Powering Agriculture in India - Strategies to Boost Components A and C Under PM-KUSUM Scheme, August 2021, <https://www.ceew.in/sites/default/files/ceew-study-on-pm-kusum-scheme-for-solar-based-power-plants-and-grid-pumps-india.pdf>.
- 98 Institute for Energy Economics and Financial Analysis, Powering up solar irrigation effort will support India’s renewable energy targets, June 2021, https://ieefa.org/wp-content/uploads/2021/06/Solar-Powered-Irrigation-Would-Accelerate-Indias-Energy-Transition_June-2021.pdf; Council on Energy, Environment and Water, Powering Agriculture in India - Strategies to Boost Components A and C Under PM-KUSUM Scheme, August 2021, <https://www.ceew.in/sites/default/files/ceew-study-on-pm-kusum-scheme-for-solar-based-power-plants-and-grid-pumps-india.pdf>.
- 99 The Economic Times, “Deadly smoke set to return as India cuts outlays on cooking gas program,” accessed September 2, 2022, <https://economictimes.indiatimes.com/industry/energy/oil-gas/deadly-smoke-set-to-return-as-india-cuts-outlays-on-cooking-gas-program/articleshow/81404608.cms?from=mdr>.
- 100 The Conversation, “Gas prices: as cooking fuels become more expensive, people are turning to dirtier alternatives,” accessed September 6, 2022, <https://theconversation.com/gas-prices-as-cooking-fuels-become-more-expensive-people-are-turning-to-dirtier-alternatives-182201>.
- 101 Ministry of New and Renewable Energy, Press Information Bureau, “Government making efforts to reduce dependence on traditional biomass cooking,” March 2018, <https://pib.gov.in/Pressreleaseshare.aspx?PRID=1525934>.
- 102 The Conversation, “Why India’s urban poor struggle to transition to clean cooking despite grave health impacts,” accessed September 2, 2022, <https://theconversation.com/why-indias-urban-poor-struggle-to-transition-to-clean-cooking-despite-grave-health-impacts-153266>.
- 103 “MNRE notifies National Bio Energy Programme,” PIB Delhi, Nov 2022, <https://pib.gov.in/PressReleasePage.aspx?PRID=1874209>
- 104 The World Bank, “Rural Population (% of Total Population) – India, 2020,” accessed September 2, 2022, <https://data.worldbank.org/indicator/SPRUR.TOTL.ZS?locations=IN>.
- 105 NRDC-SEWA, It Takes a Village: Advancing Hariyali Clean Energy Solutions in Rural India, January 2021, <https://www.nrdc.org/sites/default/files/takes-a-village-clean-energy-solutions-202101.pdf>.
- 106 National Statistical Office Statistics and Programme Implementation Government of India, “Energy Statistics 2022,” <https://mospi.gov.in/documents/213904/1606151//Energy%20Statistics%20India%2020221644825594802.pdf/aed59aac-4d5a-995b-1232-bb68397cd873> (January 28, 2022).
- 107 Ministry of Environment, Forest and Climate Change, India Cooling Action Plan (ICAP), 2019, <http://ozonecell.nic.in/wp-content/uploads/2019/03/INDIA-COOLING-ACTION-PLAN-e-circulation-version080319.pdf>.
- 108 Bureau of Energy Efficiency. (2022). Impact of Energy Efficiency Measures for the Year 2021-22. https://beeindia.gov.in/sites/default/files/publications/files/Impact%20Assessment%202021-22_%20FINAL%20Report_June%202023.pdf
- 109 “G20 Energy Transitions Ministers’ Meeting Outcome Document and Chair’s Summary,” G20 Summit, July 2023, https://www.g20.org/content/dam/gtwenty/gtwenty_new/document/ETMM_ODCS.pdf
- 110 International Energy Association, “India Data Browser,” 2022, <https://www.iea.org/countries/india#data-browser>.
- 111 RMI, “India’s Buildings Sector Moonshot: Corporate Climate Commitments Can Forge the Path,” June 2021, <https://rmi.org/indias-buildings-sector-moonshot-corporate-climate-commitments-can-forge-the-path/>.
- 112 T. Spencer, A. Awasthy, “Analysing and Projecting Indian Electricity Demand till 2030,” TERI, <https://www.energy-transitions.org/publications/analysing-and-projecting-indian-electricity-demand-to-2030/> (February 2019); NITI Aayog, “India Energy Security Scenarios 2047,” <http://iess2047.gov.in/%20pathways//electricity> (August 20, 2020).
- 113 RMI, India’s Buildings Sector Moonshot: Corporate Climate Commitments Can Forge the Path, June 2021, <https://rmi.org/indias-buildings-sector-moonshot-corporate-climate-commitments-can-forge-the-path/>.
- 114 S. Nandgaonkar, “India outperforms US, China in LEED net zero certifications,” Hindustan Times, June 19, 2023, <https://www.hindustantimes.com/cities/mumbai-news/india-leads-in-leed-zero-green-building-projects-outperforming-us-and-china-usgbc-and-gbci-101687115927271.html> (August 2023)
- 115 Gujarat ECBC factsheet, <https://www.nrdc.org/sites/default/files/energy-saving-benefits-building-energy-code-gujarat-fs-20220830.pdf>
- 116 India Green Building Market Maturity Snapshot 2020, Edge, IFC, 2021, https://edgebuildings.com/wp-content/uploads/2022/04/IFC0077-2021-India-Green-Building-Market-Maturity-Sheet_R3.pdf
- 117 India Green Building Market Maturity Snapshot 2020, Edge, IFC, 2021, https://edgebuildings.com/wp-content/uploads/2022/04/IFC0077-2021-India-Green-Building-Market-Maturity-Sheet_R3.pdf; Gujarat ECBC factsheet, <https://www.nrdc.org/sites/default/files/energy-saving-benefits-building-energy-code-gujarat-fs-20220830.pdf>
- 118 Bureau of Energy Efficiency, “Commercial Buildings,” <https://beeindia.gov.in/en/programmesenergy-efficiency-in-buildings/star-rating-for-buildings#:~:text=Star%20Rating%20of%20Commercial%20Buildings,bldings%20being%20the%20most%20efficient> (August 2, 2023)

- 119 ASCI and NRDC, Building Efficient Cities: Strengthening the Indian Real Estate Market Through Codes and Incentives, 2017, <https://www.nrdc.org/sites/default/files/energy-saving-benefits-building-energy-code-gujarat-fs-20220830.pdf> (August 20, 2020).
- 120 Ministry of Power, "Energy Efficiency," <https://beeindia.gov.in/en/energy-conservation-building-code-ecbc> (August 20, 2020).
- 121 P. Madan, "More States Adopt Building Energy Codes in India," NRDC, April 2023, <https://www.nrdc.org/bio/prima-madan/more-states-adopt-building-energy-codes-india#:~:text=To%20date%2C%2023%20states%20have,Building%20Code%20for%20Commercial%20Buildings>.
- 122 ANGAN: Augmenting Nature by Green Affordable New-habitat, A Courtyard for Revolutionary Change in Building Energy Efficiency An International Conference & Exhibition on Building Energy Efficiency Presentation, September 2019; N. Bommala, "India's first green gov't building to come up in Hyderabad," Telangana Today, <https://telanganatoday.com/indias-first-green-govt-building-to-come-up-in-hyderabad> (July 9, 2022).
- 123 Gujarat ECBC factsheet, <https://www.nrdc.org/sites/default/files/energy-saving-benefits-building-energy-code-gujarat-fs-20220830.pdf>.
- 124 M. Karthik, "All you need to know about the energy conservation bill," Down to Earth, <https://www.downtoearth.org.in/news/energy/all-you-need-to-know-about-the-energy-conservation-bill-84362> (August 17, 2022).
- 125 U. Gupta, "Amended Energy Conservation Bill to drive renewables adoption," PV Magazine (August 17, 2022).
- 126 BEE Bureau of Energy Efficiency, Government of India, Mandatory Scheme, <https://beeindia.gov.in/en/standards-labeling> (August 2, 2023).
- 127 Ministry of Power, "National Ujala Dashboard," www.ujala.gov.in (August 2, 2023).
- 128 S. Agrawal, Sunil Mani, Dhruvak Aggarwal, Abhishek Jain, Chetna Hareesh Kumar and Karthik Ganesan. October 2020. "Awareness and Adoption of Energy Efficiency in Indian Homes: Insights from the India Residential Energy consumption Survey (IRES) 2020." New Delhi: Council on Energy, Environment and Water. <https://www.ceew.in/publications/awareness-and-adoption-energy-efficiency-indian-homes>
- 129 O. Basith, "How the humble ceiling fan may be the next big thing in green tech," The Times of India, <https://timesofindia.indiatimes.com/blogs/voices/how-the-modest-ceiling-fan-may-be-the-next-big-thing-in-green-tech/> (February 16, 2022).
- 130 "EESL targets deploying 10 million energy-efficient fans in India," June 4, 2023, ET Energy World, <https://energy.economictimes.indiatimes.com/news/power/eesl-targets-deploying-10-million-energy-efficient-fans-in-india/100736413>
- 131 Ministry of Power, "BEE Notifies New Energy Performance Standards for Air Conditioners," <https://pib.gov.in/PressReleasePage.aspx?PRID=1598508> (August 13, 2020).
- 132 Ministry of Power, "BEE Notifies New Energy Performance Standards for Air Conditioners," <https://pib.gov.in/PressReleasePage.aspx?PRID=1598508> (August 13, 2020).
- 133 FP Explainer, "Explained: Government's New Star Rating for ACs and What It Means for Manufacturers and Buyers," Tech 2, <https://www.firstpost.com/tech/news-analysis/explained-governments-new-star-rating-for-ac-and-what-it-means-for-manufacturers-and-buyers-10826991.html> (June 23, 2022).
- 134 PIB Delhi, "Government's Star Labelling Program results in energy efficiency improvement of split Acs," May 10 2023, <https://pib.gov.in/PressReleaseframePage.aspx?PRID=1923031>
- 135 Ministry of Power, "Government's Star Labelling Program results in energy efficiency improvement of split Acs," 2023, <https://pib.gov.in/PressReleaseframePage.aspx?PRID=1923031>
- 136 Ministry of Power, "BEE notifies new energy performance standards for air conditioners," November 5 2019, <https://beeindia.gov.in/sites/default/files/Press%20release-%20Amendment%20in%20Energy%20Conservation%20Act%202001.pdf>
- 137 P. Madan, S. Kwatra, "Discussing Climate Friendly Cooling in India," NRDC, July 2022, <https://www.nrdc.org/bio/prima-madan/discussing-climate-friendly-cooling-india>
- 138 NRDC Expanding Heat Resilience across India: Highlights from Heat Action Plans," May 2021 https://www.nrdc.org/sites/default/files/expanding-heat-resilience-india-fs-20210514_0.pdf.
- 139 J. Hess, S. Lm, K. Knowlton, et al., "Building Resilience to Climate Change: Pilot Evaluation of the Impact of India's First Heat Action Plan on All-Cause Mortality." Journal of environment and public health vol. 2018 7973519. 1 Nov. 2018, doi:10.1155/2018/7973519
- 140 State Energy Efficiency Index 2021-2022, Alliance for an Energy Efficient Economy, 2022, <https://stateenergyefficiencyindex.in/wp-content/uploads/2023/04/State-Energy-Efficiency-Index-2021-22-Report.pdf>
- 141 "NITI Aayog releases Analytical Tools for managing Climate Change and exploring Net Zero Pathways," PIB Delhi, July 2023, <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1941098>
- 142 Bureau of Energy Efficiency, "Impact of Energy Efficiency Measures For The Year 2021-22," June 2023, https://beeindia.gov.in/sites/default/files/publications/files/Impact%20Assessment%202021-22_%20FINAL%20Report_June%202023.pdf
- 143 "Impact of Energy Efficiency Measures," Bureau of Energy Efficiency, May 2023, https://beeindia.gov.in/sites/default/files/publications/files/Impact%20Assessment%202021-22_%20FINAL%20Report_June%202023.pdf ; The Ministry of Power, "PAT-Read more," <https://beeindia.gov.in/en/programmes/perform-achieve-and-trade-pat#:~:text=PAT%20Cycle%2D%20had%20completed,million%20tonne%20of%20CO2%20emissions>. (August 20, 2020).
- 144 "Impact of Energy Efficiency Measures," Bureau of Energy Efficiency, May 2023, https://beeindia.gov.in/sites/default/files/publications/files/Impact%20Assessment%202021-22_%20FINAL%20Report_June%202023.pdf; Perform Achieve and Trade (PAT) Scheme https://beeindia.gov.in/sites/default/files/press_releases/Brief%20Note%20on%20PAT%20Scheme.pdf
- 145 "Impact of Energy Efficiency Measures," Bureau of Energy Efficiency, May 2023, https://beeindia.gov.in/sites/default/files/publications/files/Impact%20Assessment%202021-22_%20FINAL%20Report_June%202023.pdf ; PIB Delhi, "Status of Implementation of National Mission for Enhanced Energy Efficiency (NMEEE): Three years of PAT Scheme constitutes of 7 cycles," March 29, 2022, <https://pib.gov.in/PressReleaseframePage.aspx?PRID=1811051>

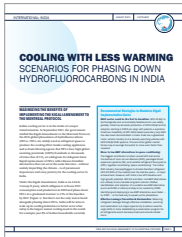
- 146 S. Tripathy, "As Carbon Trading Takes Off, Focus on Building a Robust Market," Outlook, <https://timesofindia.indiatimes.com/blogs/toi-editorials/still-using-firewood-pollution-update-puts-a-spotlight-on-how-india-cooks/> (July 13, 2022).
- 147 W. Hall, "Decarbonization of India industry: Transitioning to a cleaner economy," October 2019, <https://www.teriin.org/policy-brief/decarbonisation-indian-industry-transitioning-cleaner-economy>.
- 148 S. Motwani, "Adoption of EVs for a healthier world," May 2023, <https://timesofindia.indiatimes.com/blogs/voices/adoption-of-evs-for-a-healthier-world/>
- 149 Decarbonizing Road Transport: More Wheels Needed, April 2023, <https://www.orfonline.org/expert-speak/decarbonising-road-transport-in-india-more-wheels-needed/>
- 150 "Number of vehicles in operation across India from financial year 1951 to 2020," Statista, February 2023, <https://www.statista.com/statistics/664729/total-number-of-vehicles-india/#:~:text=In%20a%20country%20with%20the>
- 151 Decarbonizing Road Transport: More Wheels Needed, April 2023, <https://www.orfonline.org/expert-speak/decarbonising-road-transport-in-india-more-wheels-needed/>
- 152 A. Jain, "After China and US, India becomes world's 3rd largest auto market: Report," Jan 2023, <https://www.livemint.com/news/india/india-becomes-world-s-3rd-largest-auto-market-report-11673164107467.html>
- 153 Decarbonizing Road Transport: More Wheels Needed, April 2023, <https://www.orfonline.org/expert-speak/decarbonising-road-transport-in-india-more-wheels-needed/>
- 154 "Moving Forward Together: Enabling Shared Mobility in India," NITI Aayog, <https://e-amrit.niti.gov.in/assets/admin/dist/img/new-fronend-img/report-pdf/Shared-mobility.pdf>
- 155 PIB Delhi, "The Automobile Sector in India," February 2023, <https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/feb/doc2023217160601.pdf>
- 156 McKinsey Center for Future Mobility, "The unexpected trip: The future of mobility in India beyond COVID-19," July 2020, <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-unexpected-trip-the-future-of-mobility-in-india-beyond-covid-19>.
- 157 HT Auto Desk, "India auto component industry grows 23% in FY22, records highest ever turnover," HT Auto, <https://auto.hindustantimes.com/auto/news/indian-auto-component-industry-grows-23-in-fy22-clocks-highest-ever-turnover-41661228229830.html> (August 23, 2022).
- 158 A. Kumar, "Green road ahead for the automotive sector," The Times of India, October 5, 2022, <https://timesofindia.indiatimes.com/blogs/voices/green-road-ahead-for-the-automotive-sector/>
- 159 "Decarbonising Transport: Redefining Mobility Policies in India," NITI Aayog, June 2021, <https://www.niti.gov.in/decarbonising-transport-redefining-mobility-policies-india>
- 160 "Towards Decarbonising Transport 2023," GIZ, NITI Aayog, Agora, 2023, https://niti.gov.in/sites/default/files/2023-07/98_Towards_Decarbonising_Transport_2023_compressed.pdf
- 161 IANS, "Over 21.70 lakh EVs registered in India, UP tops list," Times of India, March 22, 2023, <https://timesofindia.indiatimes.com/auto/cars/over-21-70-lakh-evs-registered-in-india-up-tops-list/articleshow/98881804.cms?from=mdr>
- 162 "EV sales in India increases 174% YoY to 12,47,120 units in FY23," ETAuto, May 11, 2023, <https://auto.economictimes.indiatimes.com/news/industry/ev-sales-in-india-increases-174-yoy-to-1247120-units-in-fy23/100156256>
- 163 "EV sales in India increases 174% YoY to 12,47,120 units in FY23," ETAuto, May 11, 2023, <https://auto.economictimes.indiatimes.com/news/industry/ev-sales-in-india-increases-174-yoy-to-1247120-units-in-fy23/100156256>
- 164 Change to: "EV sales in India increases 174% YoY to 12,47,120 units in FY23," ETAuto, May 11, 2023, <https://auto.economictimes.indiatimes.com/news/industry/ev-sales-in-india-increases-174-yoy-to-1247120-units-in-fy23/100156256>
- 165 Government of India, Ministry of Heavy Industries & Public Enterprises, "National Electric Mobility Mission Plan 2020" <https://dhi.nic.in/writereaddata/content/nemmp2020.pdf> <https://pib.gov.in/PressReleaseFramePage.aspx?PRID=1942506#:~:text=Faster%20Adoption%20and%20Manufacturing%20of,10%2C000%20crore>.
- 166 "Fame India Scheme," PIB Delhi, July 2023, <https://pib.gov.in/PressReleaseFramePage.aspx?PRID=1942506>
- 167 "Centre to come up with a master app to check EV charging stations near you," Business Standard, June 2023, https://www.business-standard.com/economy/news/centre-to-come-up-with-a-master-app-to-check-ev-charging-stations-near-you-123061200208_1.html
- 168 L. Phillip, "Electric vehicle sales to cross 2 million in FY24: Experts," March 2023, https://economictimes.indiatimes.com/industry/renewables/electric-vehicle-sales-to-cross-2-million-in-fy24-experts/articleshow/99003468.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
- 169 Ministry of Heavy Industries and Public Enterprise, Government of India, Publication of notification in Gazette of India (Extraordinary) regarding Phase-II of FAME India Scheme, 2019, <https://dhi.nic.in/writereaddata/UploadFile/publicationNotificationFAME%20II%20March2019.pdf> (August 25, 2020); NRDC, Scaling Up Electric Charing Vehicle Infrastructure, July 2020, <https://www.nrdc.org/sites/default/files/charging-infrastructure-best-parctices-202007.pdf> (August 25, 2020).
- 170 D. Jain, M. Sampat, S. Keum, and S. Kumbakonam, "Electric Vehicles Are Poised to Create a \$100B+ Opportunity in India by 2030," Bain and Company, December 2022, [https://www.bain.com/insights/electric-vehicles-are-poised-to-create-a-\\$100-billion-opportunity-in-india-by-2030/](https://www.bain.com/insights/electric-vehicles-are-poised-to-create-a-$100-billion-opportunity-in-india-by-2030/)
- 171 PIB Delhi, "Year-End- Review of Ministry of Heavy Industries – 2022," Dec 2022, <https://pib.gov.in/PressReleasePage.aspx?PRID=1887129>
- 172 "India's electric vehicles industry revenue pool expected to hit \$100 billion by 2030, says report," Express Mobility Desk, December 2022, <https://www.financialexpress.com/business/express-mobility-indias-electric-vehicles-industry-revenue-pool-expected-to-hit-100-billion-by-2030-says-report-2914151/>

- 173 "Analysis of State Electric Vehicle Policies and their Impact," Climate Trends, February 2023, <https://climatetrends.in/wp-content/uploads/2023/02/full-report-digital-with-spreads.pdf>
- 174 HT Auto Desk, "Audi to focus only on electric cars in India from 2033," Hindustan Times, <https://auto.hindustantimes.com/auto/electric-vehicles/audi-to-focus-only-on-electric-cars-in-india-from-2033-41658832437175.html> (July 26, 2022).
- 175 S. Chakraborty, "Indian electric car makers charge up to head off overseas rivals," Nikkei Asia, <https://asia.nikkei.com/Business/Automobiles/Indian-electric-car-makers-charge-up-to-head-off-overseas-rivals> (July 25, 2022).
- 176 HT Auto Desk, "Passenger vehicles sales in India to see 75% EV penetration in 2050," HT Auto, <https://auto.hindustantimes.com/auto/electric-vehicles/passenger-vehicles-in-india-to-see-75-ev-penetration-by-2050-study-41658305229615.html> (July 20, 2022).
- 177 M. Baruch, "Spain's Fersa Group invests in India-based Delux Bearings," January 2023, Autocrat Professional <https://www.autocarpro.in/news/spains-fersa-group-invests-in-india-based-delux-bearings-113960>
- 178 Autocar Pro News Desk, "Nitin Gadkari discusses postponing CAFE Phase 2 norms with SIAM delegation," 02 Mar 2021 <https://www.autocarpro.in/news-national/nitin-gadkari-discusses-postponing-cafe-phase-2-norms-with-siam-delegation-78634>; ICCT, "Fuel consumption standards for heavy-duty vehicles in India," 2017, <https://theicct.org/publication/fuel-consumption-standards-for-heavy-duty-vehicles-in-india/> (August 30, 2020).
- 179 S. Sharma, "Fleet Modernization: solution to achieve better air quality," Teriin, <https://www.teriin.org/sites/default/files/2020-01/Fleet%20Modernization%20A%20solution%20to%20achieve%20better%20air%20quality.pdf> (August 20, 2020).
- 180 A Roychowdhury, "A milestone: India to regulate real driving emissions from new vehicles today onwards," Down to Earth, April 2023 <https://www.downtoearth.org.in/blog/air/a-milestone-india-to-regulate-real-driving-emissions-from-new-vehicles-today-onwards-88578>
- 181 "What is the real Driving Emissions (RDE) Test?" <https://www.caremissionstestingfacts.eu/rde-real-driving-emissions-test/>
- 182 P. Charan, "BS 6 Phase II and CAFE II Norms: All You Need to Know," Money Control, <https://www.moneycontrol.com/news/automobile/bs-6-phase-ii-and-cafe-ii-norms-all-you-need-to-know-8705371.html> (June 18, 2022).
- 183 A. Ahmed and A Shah, "India will not extend 2022 deadline for tighter fuel efficiency rules: Report" March 26, 2021, <https://www.livemint.com/companies/news/india-will-not-extend-2022-deadline-for-tighter-fuel-efficiency-rules-report-11616771219210.html>; "Nitin Gadkari discusses postponing CAFE Phase 2 norms with SIAM delegation," March 2, 2021, <https://www.autocarpro.in/news-national/nitin-gadkari-discusses-postponing-cafe-phase-2-norms-with-siam-delegation-78634>; Government of India, Ministry of Heavy Industries & Public Enterprises, "National Auto Policy (Draft)" February 2018. https://dhi.nic.in/writereaddata/UploadFile/DHI-NAB-Auto%20Policy%20Draft%20Document_vDRAFT.pdf.
- 184 TECH2 News Staff, "Maruti Suzuki Decides Against Reintroducing Electric Vehicles With An Eye on Upcoming Emissions Norms," TECH2, <https://www.firstpost.com/tech/auto-tech/maruti-suzuki-decides-against-reintroducing-diesel-vehicles-with-an-eye-on-upcoming-emission-norms-10155411.html> (November 22, 2021).
- 185 Livemint. "Over 950k vehicles to be impacted by new curbs to fight air pollution," Mint, <https://www.livemint.com/news/india/over-950k-diesel-vehicles-to-be-impacted-by-new-curbs-to-fight-air-pollution-11657853129566.html> (July 15, 2022).
- 186 R. Raghavan, A. Laskar, India's Green energy sector to attract \$800 bn," Livemint, June 2023, <https://www.livemint.com/news/india/800-billion-investment-expected-in-indian-green-energy-sector-over-next-decade-bank-of-america-11685897190627.html>
- 187 N. Khanna, D. Purkayastha and S. Jain, "Landscape of Green Finance in India 2022," August 2022, <https://www.climatepolicyinitiative.org/publication/landscape-of-green-finance-in-india-2022/>
- 188 S. Saha, "Green finance is gaining traction for net zero transition in India," June 2023, https://www.ey.com/en_in/climate-change-sustainability-services/green-finance-is-gaining-traction-for-net-zero-transition-in-india
- 189 R. Raghavan and A. Laskar, 'India's green energy sector to attract \$800 bn investment' June 2023, <https://www.livemint.com/news/india/800-billion-investment-expected-in-indian-green-energy-sector-over-next-decade-bank-of-america-11685897190627.html>
- 190 J. Shah, "Bridging the green finance gap in India: A status check," ET Energy World, August 2023, <https://energy.economictimes.indiatimes.com/news/renewable/bridging-the-green-finance-gap-in-india-a-status-check/103255890>; N. Khanna, D. Purkayastha, S. Jain, "Landscape of Green Finance in India 2022," Climate Policy Initiative, [https://www.climatepolicyinitiative.org/publication/landscape-of-green-finance-in-india-2022/#:~:text=It%20is%20estimated%20that%20to,USD%20170%20billion\)%20per%20year](https://www.climatepolicyinitiative.org/publication/landscape-of-green-finance-in-india-2022/#:~:text=It%20is%20estimated%20that%20to,USD%20170%20billion)%20per%20year) (August 10, 2022); S. Jaiswal, R. Gadre, "Financing India's 2030 Renewables Ambition," BloombergNEF, https://assets.bbhub.io/professional/sites/24/BNEF-Financing-India%E2%80%99s-2030-Renewables-Ambition_FINAL.pdf (June 22, 2022).
- 191 R. Whitlock, "\$223 billion investment needed if India is to meet is solar and wind goals," Renewable Energy Magazine, <https://www.renewableenergymagazine.com/panorama/223-billion-investment-needed-if-india-20220622>, (June 22, 2022).
- 192 S. Jaiswal and R. Gadre, "Financing India's 2030 Renewables Ambition," Bloomberg NEF, June 2022, https://assets.bbhub.io/professional/sites/24/BNEF-Financing-India%E2%80%99s-2030-Renewables-Ambition_FINAL.pdf
- 193 S. Jaiswal, R. Gadre, "Financing India's 2030 Renewables Ambition," BloombergNEF, https://assets.bbhub.io/professional/sites/24/BNEF-Financing-India%E2%80%99s-2030-Renewables-Ambition_FINAL.pdf (June 22, 2022).
- 194 "IREDA to Create a Green Window for Green Energy Finance," Ministry of New and Renewable Energy, <https://pib.gov.in/newsite/PrintRelease.aspx?relid=195728> (December 11, 2019).
- 195 A. Bercarra Cid, P. Bodnar, T. Grbusic, D. Sims, etc. "State of Green Banks 2020," Natural Resources Defense Council, 2020, <https://www.nrdc.org/sites/default/files/state-green-banks-2020-report.pdf>.
- 196 P. Renjen, "ESG reporting will build financial edge," Financial Express, <https://www.financialexpress.com/opinion/esg-reporting-will-build-competitive-edge/2601901/> (July 22, 2022).
- 197 S. Jaiswal, R. Gadre, "Financing India's 2030 Renewables Ambition," BloombergNEF, https://assets.bbhub.io/professional/sites/24/BNEF-Financing-India%E2%80%99s-2030-Renewables-Ambition_FINAL.pdf (June 22, 2022).

- 198 R. Kundu, S. Narayan, "India to hold off on green bonds sale," Livemint, August 2023, <https://www.livemint.com/news/india/india-to-hold-off-on-green-bonds-sale-11692899991291.html>
- 199 K. Azizuddin, "India proposes national blue bond standards, COP-aligned green bonds," <https://www.responsible-investor.com/india-proposes-national-blue-bond-standard-cop-aligned-green-bonds/> (August 8, 2022).
- 200 "Centre asks state firms to explore plans amid LNG supply crisis," Business Standard, https://www.business-standard.com/article/economy-policy/centre-asks-state-run-firms-to-explore-plans-amid-lng-supply-crisis-report-122081600367_1.html (August 16, 2022).
- 201 The Economic Times, "Discoms' dues down by a third to Rs 93,000 crore in less than a year of enforcing Late Payment Surcharge Rule", https://economictimes.indiatimes.com/industry/energy/power/discoms-dues-down-by-a-third-to-rs-93000-crore-in-less-than-a-year-of-enforcing-late-payment-surcharge-rule/articleshow/100392220.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
- 202 OECD, "Clean energy finance and investment roadmap," <https://www.oecd.org/cefi/india/roadmap/> (September 30, 2022).
- 203 S. K. Dash, R. K. Jenamani, M. Mohapatra, "India's prolonged heatwave linked to poor summer rains," Nature, <https://www-nature-com.stanford.idm.oclc.org/articles/d44151-022-00054-0> (May 21, 2022).
- 204 M. Zachariah et al., Climate Change Made Devastating Early Heat In India And Pakistan 30 Times More Likely, May 2022, https://www.worldweatherattribution.org/wp-content/uploads/India_Pak-Heatwave-scientific-report.pdf.
- 205 M. Romanello, C. Di Napoli, P. Drummond, "The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels," The Lancet, October, 2022, DOI: [https://doi.org/10.1016/S0140-6736\(22\)01540-9](https://doi.org/10.1016/S0140-6736(22)01540-9)
- 206 "Extreme Heat: Preparing for the Heatwaves of the Future," IFRC, OCHA, Red Cross Red Crescent Climate Centre, October 2022, <https://www.ifrc.org/sites/default/files/2022-10/Extreme-Heat-Report-IFRC-OCHA-2022.pdf>
- 207 H. Regan, "Climate change is fueling deadly heat waves in India. It's putting the country's development at risk, study says," CNN, April 20, 2023, <https://www.cnn.com/2023/04/20/asia/india-heat-wave-development-climate-intl-hnk/index.html>;
- 208 S. Varadhan, "India sweats over worst power cuts in six years due to extreme heat," Reuters, <https://www.reuters.com/world/india/indian-heat-wave-disrupts-industrial-activity-power-demand-soars-2022-04-28/> (April 28, 2022).
- 209 E. M. L. Southard, H. Randell, "Intensifying heatwaves threaten South Asia's struggling farmers—increasingly, it's women who are at risk," The Conversation, <https://theconversation.com/intensifying-heat-waves-threaten-south-asias-struggling-farmers-increasingly-its-women-who-are-at-risk-184378> (June 28, 2022).
- 210 Knowlton, K., Suhas Kulkarni, Gulrez Azhar, Dileep Mavalankar, Anjali Jaiswal, Meredith Connolly, Amruta Nori-Sarma, et al. 2014. "Development and Implementation of South Asia's First Heat-Health Action Plan in Ahmedabad (Gujarat, India)." International Journal of Environmental Research and Public Health 11 (4): 3473–92. <https://doi.org/10.3390/ijerph110403473>.
- 211 NRDC, "Expanding Heat Resilience Across India: Heat action Plan Highlights," May 2020 <https://www.nrdc.org/sites/default/files/india-heat-resilient-cities-ib.pdf> (August 25, 2020);
- 212 NRDC, "Expanding Heat Resilience Across India: Heat action Plan Highlights," May 2020 <https://www.nrdc.org/sites/default/files/india-heat-resilient-cities-ib.pdf> (August 25, 2020); CodeBlue, "How an Indian city saved 1000 lives a year," CodeBlue, <https://codeblue.galencentre.org/2022/08/01/how-an-indian-city-saved-1000-lives-a-year/> (August 1, 2022).
- 213 A. Harigovind, "Delhi sees 13 heatwave days so far, but heat action plans has yet to be implemented," The Indian Express, <https://indianexpress.com/article/cities/delhi/delhi-sees-13-heatwave-days-so-far-but-heat-action-plan-yet-to-be-implemented-7941513/> (May 30, 2022).
- 214 Vellingiri, Selvakumar, Priya Dutta, Srishti Singh, LM Sathish, Shyam Pingle, and Bijal Brahmabhatt. 2020. "Combating Climate Change-Induced Heat Stress: Assessing Cool Roofs and Its Impact on the Indoor Ambient Temperature of the Households in the Urban Slums of Ahmedabad." Indian Journal of Occupational and Environmental Medicine 24 (1): 25–29. https://doi.org/10.4103/ijoem.IJOEM_120_19; NRDC, Keeping it cool: Cool Roofs Programs Protect People, Save Energy and Fight Climate change, July, 2019, <https://www.nrdc.org/sites/default/files/keeping-it-cool-roofs-india-fs.pdf> (August, 20, 2020); NRDC, ASCI, IIPHG, and Mahila Housing SEWA Trust, Cool Roofs – Protecting Local Communities and Saving energy, 2018, https://www.nrdc.org/sites/default/files/ib_-_cool_roofs_-_hyd_workshop.pdf (August 19, 2020); Joshi, Jaykumar, Akhilesh Magal, Vijay S. Limaye, Prima Madan, Anjali Jaiswal, Dileep Mavalankar, and Kim Knowlton. "Climate Change and 2030 Cooling Demand in Ahmedabad, India: Opportunities for Expansion of Renewable Energy and Cool Roofs." Mitigation and Adaptation Strategies for Global Change, July 2022. <https://doi.org/10.1007/s11027-022-10019-4>.
- 215 R. Prasad "Implementing climate change adaptation: lessons from India's national adaptation fund on climate change" August 2018, <https://www.tandfonline.com/doi/abs/10.1080/14693062.2018.1515061?journalCode=tcpo20>.
- 216 NRDC, "Expanding Heat Resilience Across India: Heat Action Plan Highlights 2022," NRDC, https://www.business-standard.com/article/current-affairs/climate-change-making-it-difficult-to-predict-weather-says-imd-dg-122080700297_1.html (April 2022).
- 217 NRDC, "Expanding Heat Resilience Across India: Heat Action Plan Highlights 2022," NRDC, https://www.business-standard.com/article/current-affairs/climate-change-making-it-difficult-to-predict-weather-says-imd-dg-122080700297_1.html (April 2022).
- 218 NRDC, "Expanding Heat Resilience Across India: Heat Action Plan Highlights 2022," NRDC, https://www.business-standard.com/article/current-affairs/climate-change-making-it-difficult-to-predict-weather-says-imd-dg-122080700297_1.html (April 2022).
- 219 Press Trust of India, "Climate change making weather prediction difficulty across the world: IMD DG," Business Standard (August 7, 2022).
- 220 India Today Web Desk, "Delhi's air quality in May in 2022 poorest in last 3 years: Central Pollution Control Board," India Today, <https://www.indiatoday.in/cities/delhi/story/delhi-air-quality-may-poorest-last-three-years-central-pollution-control-board-1956927-2022-06-01> (June 1, 2022).
- 221 Health Effects Institute, Air Quality and Health in Cities: A State of Global Air Report 2022, <https://www.stateofglobalair.org/sites/default/files/documents/2022-08/2022-soga-cities-report.pdf>.

- 222 Ministry of Environment, Forests and Climate Change, "Government Launches National Clean Air Programme (NCAP)," Press Information Bureau, January 10, 2019, <https://pib.gov.in/newsite/PrintRelease.aspx?relid=187400> (August 19, 2020).
- 223 Non-Attainment_Cities.pdf (cpcb.nic.in), 1st August 2023;.
- 224 IAS Parliament, "Graded Response Act – New Delhi," October 2019, <https://www.iasparliament.com/current-affairs/graded-response-action-plan-delhi> (August 25, 2020).
- 225 E. Roy, "Tracking NCAP: Marginal dip in pollution levels, states not spending enough funds," The Indian Express, <https://indianexpress.com/article/india/tracking-ncap-marginal-dip-in-pollution-levels-states-not-spending-enough-funds-7750459/> (February 1, 2022).
- 226 E. Roy, "Tracking NCAP: Marginal dip in pollution levels, states not spending enough funds," The Indian Express, <https://indianexpress.com/article/india/tracking-ncap-marginal-dip-in-pollution-levels-states-not-spending-enough-funds-7750459/> (February 1, 2022).
- 227 "Commissions Reports," Finance Commission of India, <https://fincomindia.nic.in/ShowContent.aspx?uid1=3&uid2=0&uid3=0&uid4=0&uid5=0&uid6=0&uid7=0>.
- 228 E. Roy, "Explained: What the commission for air quality management in NCR aims to achieve and why are some opposing it?" August 8, 2021. <https://indianexpress.com/article/explained/delhi-air-quality-commission-explained-7444052/>
- 229 Commission For Air Quality Management In National Capital Region And Adjoining Areas, Revised Graded Response Action Plan (GRAP) For NCR, August 2022, <https://caqm.nic.in/WriteReadData/LINKS/GRAP%20Document%20Newc57e7cc0-6165-4c40-8e8e-cc09227dc06c6e0cd339-eeef-4753-955c-3fb410de616c.pdf>; Express News Service, "Revised graded pollution plan to be in place from October 1," The Indian Express, <https://indianexpress.com/article/cities/delhi/revised-graded-pollution-plan-to-be-in-place-from-october-1-8075558/> (August 7, 2022).
- 230 A. Usmani, "India's Heatwaves Turn Deadlier with Unusually High Air Pollution," Bloomberg Quarterly, <https://www.bqprime.com/nation/indias-heatwaves-turn-deadlier-with-unusually-high-air-pollution> (August 26, 2022).
- 231 Delhi sees cleanest July air in 4 yrs: Air quality panel, "Indian Express", <https://indianexpress.com/article/cities/delhi/delhi-sees-cleanest-july-air-in-4-yrs-air-quality-panel-8870138/>, (1st August 2023)
- 232 "Member Countries," International Solar Alliance, <https://isolaralliance.org/membership/countries> (2022).
- 233 "OSOWOG Initiative," ISA, <https://isolaralliance.org/work/osowog/>
- 234 "One Sun Declaration," Green Grids Initiative, Nov 2021, https://isolaralliance.org/uploads/3_One_Sun_Declaration.pdf; S. Jai, "India launches Green Grids, OSOWOG and IRIS at COP26 on Day-2 of parleys," Business Standard, November 2021, https://www.business-standard.com/article/current-affairs/india-launches-green-grids-osowog-and-iris-at-cop26-on-day-2-of-parleys-121110201622_1.html
- 235 "COP27 Reaches Breakthrough Agreement on New "Loss and Damage" Fund for Vulnerable Countries," UN Climate Change News, November 2022, <https://unfccc.int/news/cop27-reaches-breakthrough-agreement-on-new-loss-and-damage-fund-for-vulnerable-countries>
- 236 J. Nandi and S. El Sheikh, "COP27 strikes deal over damage fund," Hindustan Times, <https://www.hindustantimes.com/india-news/cop27-strikes-deal-over-damage-fund-101668967192354.html>
- 237 "G20 Logo & Theme," <https://www.g20.org/en/g20-india-2023/logo-theme/>
- 238 "G20 New Delhi Leaders' Declaration," September 2023, https://www.g20.org/content/dam/gtwenty/gtwenty_new/document/G20-New-Delhi-Leaders-Declaration.pdf
- 239 A. Bhatia, "Indo-Japan climate action ready to be rolled out in 10 states," The Statesman, <https://www.thestatesman.com/india/indo-japan-climate-1503099379.html> (August 11, 2022); PTI, "Germany pledges 10 billion euros for India's climate action targets," The Hindu, <https://www.thehindu.com/news/national/germany-pledges-10-billion-euros-for-indias-climate-action-targets/article65376622.ece> (May 2, 2022).
- 240 CNBCTV18.com, "Climate cooperation: India seeks strong ties with EU for transition to clean energy," CNBC, <https://www.cnbctv18.com/environment/climate-cooperation-india-seeks-strong-ties-with-eu-for-transition-to-clean-energy-11679292.htm> (December 2, 2021).
- 241 K. Mehrotra, "Climate summit: PM Modi, Joe Biden launch India-US clean energy initiative," The Indian Express, <https://indianexpress.com/article/india/narendra-modi-joe-biden-india-us-clean-energy-initiative-7284833/> (April 23, 2021); Briefing Room, "Readout of President Biden's Meeting with Prime Minister Modi of India," The White House, <https://indianexpress.com/article/india/narendra-modi-joe-biden-india-us-clean-energy-initiative-7284833/> (May 24, 2022).
- 242 "Joint Statement from the United States and India," Whitehouse.gov, June 2023, <https://www.whitehouse.gov/briefing-room/statements-releases/2023/06/22/joint-statement-from-the-united-states-and-india/>
- 243 "All Ratifications," United Nations Environmental Programme, <https://ozone.unep.org/all-ratifications> (August 1, 2023)
- 244 IISD, "India Launches Global Coalition for Disaster Resilient Infrastructure," October 2019, <https://sdg.iisd.org/news/india-launches-global-coalition-for-disaster-resilient-infrastructure/>.
- 245 "Infrastructure for Resilient Island States (Iris)," <https://iris.cdri.world/>
- 246 Government of Sweden Ministry of Energy, "Sweden launches global leadership group to reduce industry emissions," September 2019, <https://www.government.se/press-releases/2019/09/sweden-launches-global-leadership-group-to-reduce-industry-emissions/> (August, 20, 2020).
- 247 Press Information Bureau, "Sweden and India announce co-funding for multimillion-dollar program on Smart Grids," March 2020, <https://pib.gov.in/PressReleaseDetail.aspx?PRID=1605428> (August 28, 2020).
- 248 "Statement by H.E. Xi Jinping President of the People's Republic of China At the General Debate of the 75th Session of The United Nations General Assembly," Ministry of Foreign Affairs of the People's Republic of China, September 2020, https://www.fmprc.gov.cn/mfa_eng/zxxx_662805/t1817098.shtml; "By the Numbers: The Inflation Reduction Act," The White House, <https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/15/by-the-numbers-the-inflation-reduction-act/>

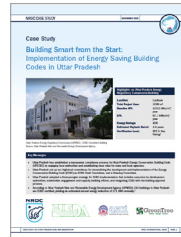
Highlighted Reports



Cooling With Less Warming
Scenarios for Phasing Down
Hydrofluorocarbons
in India



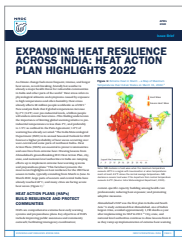
How to Manual
Siting Electric Vehicle
Charging Stations in
Indian Cities



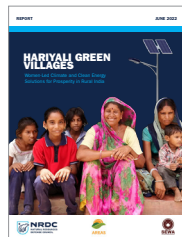
Building Smart from the Start:
Implementation
of Energy Saving
Building
Codes in Uttar
Pradesh



Energizing Freight:
Policy Toolkit
for Medium and
Heavy-Duty truck
Electrification in India



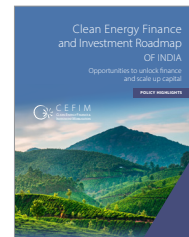
**Expanding Heat
Resilience Across
India: Heat Action
Plan Highlights
2022**



**Hariyali Green
Villages: Women-Led
Climate and Clean
Energy Solutions for
Prosperity in Rural
India**



**India's Expanding
Clean Energy
Workforce:**
Opportunities in
the Solar and Wind
Energy Sectors



**Clean Energy
Finance and
Investment
Roadmap of India**

Copyright © 2023 Natural Resources Defense Council

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without prior permission.

