

## ISSUE BRIEF

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

The year 2022 marks a turning point for India as the country emerges from the economic and social impacts of COVID-19 and progresses on its climate goals. In the international arena, Prime Minister Modi made bold, new climate announcements at COP26 in November 2021; following up on those commitments, India formally updated its Nationally Determined Contributions (NDC) in August 2022. The record-breaking 2022 heat wave emphasized the importance of accelerating the clean energy transition, even as the global increase in fossil fuel prices impacted India's energy import bill.<sup>1</sup> India continues to push hard on energy efficiency and renewable energy, expanding wind and solar capacity and launching landmark hydrogen projects. In addition to clean energy, the country plans to expand efforts to get on track to meeting its goal of increasing forest cover to create additional carbon sinks.

## National Climate and Energy Policy

In August 2022, India formally submitted its updated NDC to the United Nations, ten months after Prime Minister Narendra Modi's announcement of India's five-pronged goals to achieve full decarbonization by 2070.<sup>2</sup> These goals—dubbed *Panchamrit*, or 'five nectars'—set India's timeline for a net-zero economy as well as scaled India's commitments for renewable energy deployment and emissions reductions by 2030 (Figure 1).<sup>3</sup> In addition to the *Panchamrit*, PM Modi also announced the LiFE, or Lifestyle for the Environment, movement, formally launched on June 5, 2022. The LiFE movement focuses on encouraging sustainable, zero-carbon lifestyles and promote citizen action for climate change.<sup>4</sup>

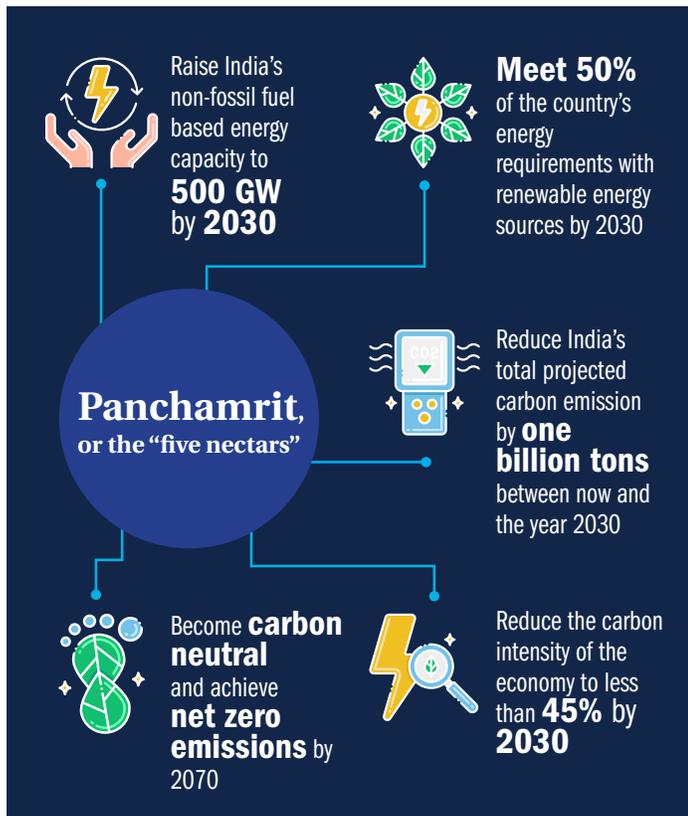
The updated NDC incorporate two of the five *Panchamrit* elements, combining PM Modi's announcement at COP26 into percentage-based commitments for renewables and emissions reductions, instead of net targets.<sup>5</sup> India's Union Cabinet approved a more flexible target of meeting 50 percent of overall power capacity by 2030 with non-fossil fuel energy.<sup>6</sup> In addition, the NDC increased the goal to reduce Gross Domestic Product (GDP) emissions intensity from 35 percent to 45 percent by 2030, a percentage-based goal that allows for parallel growth of national GDP.<sup>7</sup>



Farm workers cleaning the solar panels of a solar-powered water pump on the 80-acre farm of Gurinder Singh in Jagadhri village, Karnal, India

Credit: Prashanth Vishwanathan/IWMI, CC BY-NC-ND 4.0

Figure 1: India's panchamrit - a five-fold strategy to fight climate change, announced at COP26.



In 2022, India also announced domestic policy measures to help support the zero-carbon transition. These policies have the potential to achieve even more significant emissions reductions than the NDC indicates.<sup>8</sup>

The recent Electricity Amendment Act draft mandates power distribution companies in India meet Renewable Purchase Obligations and work to overcome the debt barriers that have limited renewable energy deployment in India.<sup>9</sup> Other important policies in the pipeline include the Green Hydrogen Consumption Obligations, which will provide a long-awaited framework for green hydrogen usage in the country, as well as a national policy on battery-swapping for electric vehicles.<sup>10</sup>

One of the biggest steps forward in climate policy for India is the Energy Conservation (Amendment) Act of 2022.<sup>11</sup> The Energy Conservation (Amendment) Act, passed by lawmakers in August 2022, mandates minimum renewable energy usage for industries, transportation, and commercial buildings. It also sets a minimum energy efficiency standard for all residential buildings, the first time such a standard has been enacted in India.<sup>12</sup>

The Energy Conservation (Amendment) Act also establishes the framework for India's first domestic voluntary carbon credit market.<sup>13</sup> The carbon credit market would function like a tax on polluting industries and require them to

purchase carbon credits to cover their emissions.<sup>14</sup> In the final phase the carbon market will focus on moving to a cap-and-trade system, with sectors and specific companies given emissions quotas.<sup>15</sup>

India's national policy efforts lay a strong foundation for not only meeting but potentially exceeding its international NDCs. The 2022 policy amendments set the nation on the path to a more sustainable and resilient future.

## Renewable Energy

Annual electricity demand growth in India is expected to remain above pre-pandemic levels at around 6.5 percent per year between 2022 to 2024.<sup>16</sup> To meet the ballooning demand, India is expected to double its total power capacity from 403 GW in July 2022 to over 800 GW by 2030.<sup>17</sup> Record-breaking heat-related increases in power demand in 2021 and 2022 prompted India to expand coal production and delay the scheduled closures of several coal plants.<sup>18</sup> However, with India's climate goals of reducing emissions intensity and achieving 50 percent cumulative electric power installed capacity from non-fossil fuel based resources by 2030, renewables are expected to account for most new installations.<sup>19</sup>

In the short term, India is committed to achieving 175 GW of renewable energy by 2022, including 100 GW of solar, 60 GW of wind, 10 GW from biomass, and 5 GW from small hydropower. As of July 2022, India's total installed renewable energy capacity, excluding large hydropower, stands at 114 GW.<sup>20</sup> Though installed capacity continues to increase, growth slowed this year as a result of continued disruptions from COVID-19, compounded by the global supply chain crisis and financial uncertainties. Given these challenges, it appears that the target of 175 GW renewable energy will be reached in mid-2023 rather than at the end of 2022.<sup>21</sup>

The 2019 projections from the Central Electricity Authority (CEA) indicated India could meet 50 percent of its electricity demand with wind and solar by 2030. Updated 2021 CEA projections anticipate slightly lower wind and solar capacity and include large hydropower in meeting India's non-fossil fuel power target.<sup>22</sup> The growth of solar-wind hybrid projects provides a solution for providing round-the-clock renewable supply and managing peak power loads.<sup>23</sup>

The newly enacted Energy Conservation Act 2022 makes the use of clean energy mandatory, and the Green Open Access Rules 2022 smooth the process to allow small consumers to choose renewables based power options.<sup>24</sup> Another critical policy shift this year is 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.<sup>25</sup> 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.<sup>26</sup> Such national policy redesign lays a strong foundation for accelerating renewable energy growth to get back on track for India's long-term capacity targets.

## Green Hydrogen

India showcased the first part of its Green Hydrogen Policy as a step toward accomplishing the National Hydrogen Mission, which was announced in 2021. This marks a significant step toward cementing the place of green hydrogen, hydrogen fuel produced by splitting water with renewable electricity, in India's renewable energy story.<sup>27</sup> 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.<sup>28</sup> Though green hydrogen is not yet commercially viable, India aims to reduce the cost to a fifth of current rates and transform it from an emerging technology into fossil fuel competitor.<sup>29</sup> Projections predict green hydrogen production will grow by a factor of four by 2050, when India's production is expected to account for a tenth of global demand.<sup>30</sup> However, scaling green hydrogen to India's goals will require 115 GW of installed renewable capacity solely to support hydrogen plants—equivalent to the cumulative installed capacity of renewable energy in India today.<sup>31</sup>

In February 2022, India's power ministry announced their plan to make India a global center for green hydrogen production and export.<sup>32</sup> Several commitments from the private sector to green hydrogen expansion accompanied the national announcement, including a \$75 billion commitment from Reliance Industries to develop renewable energy infrastructure in order to support green hydrogen.<sup>33</sup> As the first green hydrogen plants emerge—including the first commissioned plant in Assam, and another announced in Tamil Nadu—and with 25 more in the pipeline by 2025, both private and public institutions have committed to green hydrogen as a critical part of India's future renewables mix.<sup>34</sup>

## Solar Energy

India has an estimated 750 GW of solar energy potential.<sup>35</sup> The National Solar Mission aims to install 100 GW of solar energy (60 GW utility-scale and 40 GW rooftop) by the end of 2022 and scale it to 280 GW by 2030.<sup>36</sup> Solar expansion forms the bedrock of India's net-zero and climate goals. In April

2022, India surpassed Italy to become the fourth largest solar power generator in the world, despite a number of financial and procedural hurdles.<sup>37</sup>

India's solar energy capacity is approximately 58 GW as of July 2022, a little more than 50 percent of its total installed renewable energy capacity.<sup>38</sup> Due to India's strong long-term policy goals and rapidly declining technology costs, solar energy is expected to continue to grow quickly.<sup>39</sup> Recent solar growth has been driven mostly by utility-scale solar, propelled by private investors and long-term leases. As India has focused on developing large-scale renewable energy parks, including some of the largest utility scale and floating solar projects in the world, utility-scale solar is on track to meet its targeted 60 GW by the end of 2022.<sup>40</sup>

Growth in rooftop solar sector has slowed and may fall 25 GW short of the domestic 40 GW allocated to solar rooftop in India's former 175 GW target.<sup>41</sup> Though installation rates have increased by 34 percent from last year, rooftop solar still accounts for the majority of the gap between the present and expected installed renewables capacity.<sup>42</sup> The government has shifted focus, as a result, to focus on overall solar capacity, rather than utility and rooftop specific goals, moving forward.<sup>43</sup>

Solar energy growth has occurred at different rates across India's states as each state pursues its own policy framework.<sup>44</sup> Global supply chain challenges and India's import tax introduced in April 2022 have had an impact on solar prices.<sup>45</sup> This import tax as well as other policies are



Workers cleaning the solar panels on a rooftop.

Credit: Wikimedia

intended to spur domestic solar manufacturing ecosystem; however, the pace of domestic manufacturing facilities has not yet matched the rate of new installations needed.<sup>46</sup>

India's solar industry is also experiencing headwinds with land availability, the uncertainty of compliance with power purchase agreements, decreased subsidies, and outstanding dues from distribution companies that purchase solar energy.<sup>47</sup> New legislations, however, promise relief for companies as bills like the Energy Conservation Act 2022 boost solar demand.<sup>48</sup> The proposed Electricity Amendment Rules 2022, now open for stakeholder comment, could formalize solar procurement procedures nationwide, set uniform tariffs, increase interstate transmission and cooperation, and improve recovery of costs. 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.<sup>49</sup>

## Wind Energy

India is the fourth largest in the world by wind-installed capacity, with a net capacity of 40.9 GW as of July 2022.<sup>50</sup> Wind makes up over 35 percent of total installed renewable energy capacity.<sup>51</sup> With substantial onshore and offshore resources, India has enormous capacity for wind energy production. Onshore, India could produce up to 300 GW from wind energy at 100-meter hub height, and more than 700 GW at 120 meters.<sup>52</sup>

The COVID-19 pandemic delayed and postponed completion of several projects. Additions up to June 2022 exceeded 2021 rates, with an 80 percent year-on-year increase.<sup>53</sup> However, with a cumulative 0.71 GW installed in 2022, wind energy will fall short of the 2022 renewable energy goal, which would require an additional 14 GW of capacity additions.<sup>54</sup> Wind expansion has faced difficulties in land acquisition.<sup>55</sup> The e-reverse auction system has posed a major barrier to the wind industry in particular and disincentivized involvement for many industry players due to artificially lowered tariffs in a quest to win the auctions by the bidders.

In years to come, however, many of these hurdles limiting wind growth to date may be surmounted. The long-awaited roll-back of e-reverse auctions may provide a boost for the Indian wind industry. In addition, India has emerged as a major turbine manufacturer—responsible for 8.5 percent of worldwide turbine supply. 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. Finally, this year heralds a milestone in Indian wind energy as after years of planning, the first offshore wind facilities begin to

take shape. The first tenders are expected by September in Tamil Nadu and Gujarat.<sup>56</sup> Given the immense offshore capacity available in India and India's goal to develop 30 GW of offshore capacity by 2030, these mark a turning point in the 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.<sup>57</sup>

## Renewable Energy Job Growth

Even as employment growth slowed in India due to the pandemic, employment across the renewable energy sector remained one of the few areas of consistent growth. The wind and solar sectors alone employed 114,000 people by the end of 2021. This number is expected to grow ten times 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.<sup>58</sup> The COVID-19 pandemic resulted in 48 percent fewer renewable energy jobs over 2020-21, but renewable energy jobs have grown significantly even as COVID-19 challenges linger elsewhere, indicating the strength of this sector.<sup>59</sup>

As India becomes a global leader in renewable energy, a commitment to national skilling programs have also strengthened renewable energy employment. The Government of India established the Skills Council for Green Jobs (SCGJ) under the National Skill Development Mission in 2015. Since its inception, SCGJ has developed skills standards across renewable energy sectors (solar, wind, bioenergy, clean cookstoves) along with waste and wastewater management domain. It has cumulatively affiliated 423 training partners, 4879 certified trainers, 761 certified assessors along with 28 assessment agencies across India.<sup>60</sup> SCGJ has trained more than half a million candidates, with 1 lakh (100,000) in solar and other renewable energy domains, and the rest in waste and wastewater management across the country.<sup>61</sup> 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. Run by the National Institute of Solar Energy under the skill development initiative of MNRE, the Suryamitra Skill Development Programme has trained over 50,000 people to date, with more than 60 percent finding employment in clean energy after the trainings.<sup>62</sup> This July, the government also announced the Vayumitra Skill Development Programme, a counterpart to Suryamitra, to focus on wind energy skilling and supporting the growing wind energy industry in India.<sup>63</sup> In addition, MNRE is providing support for postgraduate research in renewable energy.



Credit: Nicholas Doherty on Unsplash

Rampion Offshore Wind Farm in United Kingdom.

While jobs scale further, questions have arisen about the gap between permanent and temporary jobs. Many current renewable energy jobs are contractual with a focus on construction and installation activities.<sup>64</sup> To compete with and replace other traditional sectors of energy employment, renewable energy jobs also need to offer better benefits and labor protections.<sup>65</sup> With increasing numbers of potential jobs, the renewable energy job market seems set to transform dramatically over the next years.<sup>66</sup> As jobs emerge in new areas of renewable energy in India—including distributed renewable energy efforts as well as green hydrogen—renewable energy employment appears poised to provide an avenue for millions of people in India to find skilled and unskilled opportunities for employment.<sup>67</sup>

## Energy Access and the Power Sector

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, 26.3 million households have been electrified since September 2017.<sup>68</sup> 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.<sup>69</sup>

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.<sup>70</sup> Urban areas receive, on average, one hour more of electricity than rural areas.<sup>71</sup> In many rural areas, for anywhere from four to nine hours of the day, no electricity is available.<sup>72</sup> Many households also deal with frequent daily outages.<sup>73</sup> During the pandemic, the debts of distribution

economies ballooned further to six lakh crores—equivalent to almost US\$7.5 billion—and further restricted energy quality for consumers.<sup>74</sup>

PM Modi brought these issues of energy poverty to the spotlight at the 2022 G20 Summit.<sup>75</sup> New national policy and regulations have been directed to help distribution companies improve functionality and the Electricity (Rights of Consumers) Rules have mandated service standards that ensure reliable supply.<sup>76</sup> In addition, energy subsidies continue to work 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.<sup>77</sup>

To address last-mile connectivity and technology accessibility issues, distributed renewable energy (DRE) solutions have gained increasing popularity to improve energy access, especially in rural areas. DRE solutions, if deployed in a timely and strategic manner, can not only contribute to meeting India’s climate commitments but also become the fulcrum of economic development across India.

Solar-based irrigation has received significant national attention as a DRE solution. In 2019, India launched Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM-KUSUM).<sup>78</sup> The scheme has three major component - components A and C of the KUSUM scheme focuses on feeder-level solarization whereas component B focuses on standalone or off-grid solar water pumps to usher adoption of clean energy in agriculture sector and enhance energy security for the farmers. With 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, the PM-KUSUM scheme could transform India's agriculture sector.<sup>79</sup> The scheme aims to increase farm productivity and reduce expenditure on fossil fuel to operate water pumps. Once fully implemented, the PM-KUSUM scheme can potentially reduce 32 million tons of CO<sub>2</sub> per annum and generate 0.755 million employment opportunities for skilled and unskilled workers.<sup>80</sup> However, diverse regulatory, financial, operational, and technical challenges have affected the scheme's progress, in addition to the COVID-19 pandemic.<sup>81</sup> The scheme needs a renewed push to accelerate the installation of solar-powered pumps. By improving coordination between different state departments, such as agriculture, irrigation, and power, steps can be taken to provide small and marginal farmers easy access to bank finance and create a level-playing field for distributed solar plants.<sup>82</sup>

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 (\$ 11.71 billion) in 2017 to the exchequer. 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 (\$ 1.67 billion) in 2022 from INR 25,500 crores (\$ 3.4 billion) in 2021.<sup>83</sup> 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.<sup>84</sup> Thus, better-designed subsidies could improve the affordability of clean cooking for poorer households. To supplement the clean cooking solutions, the Ministry of New and Renewable Energy is also making efforts to promote alternate clean cooking solutions.<sup>85</sup> However, issues of scaling up to reach all vulnerable households persist.<sup>86</sup>

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 villages, making villages central to the development objectives.<sup>87</sup> 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 fifteen villages in India. It is a unique and comprehensive 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 CO<sub>2</sub> every year and act as a model for sustainable economic development.<sup>88</sup>

### **BOX 1: The Russia-Ukraine Conflict Impact on India's Energy Landscape**

The Russia-Ukraine war has stressed global energy supply systems leading to a steep increase in oil and gas prices. For India, the energy market crisis resulted in rocketing fuel import prices.<sup>89</sup> The conflict's impact on energy prices highlighted the importance of energy independence which can be secured through moving away from fossil fuels.<sup>90</sup> The energy crisis spotlights many of the vulnerabilities of India's transition towards renewables, but also key chances for acceleration in years to come. India's largest gas supplier, GAIL Limited, sources 20 percent of its stock from Russian sources, but imports have dwindled over the last few months.<sup>91</sup> With supply cut short, gas prices grew to unprecedented heights across the country; more than power stations, these prices have impacted progress in rural and urban community health.<sup>92</sup> Many beneficiaries of India's Pradhan Mantri Ujjwala Yojana (PMUY) scheme, which aimed to improve indoor air quality by moving household cooking to gas-based rather than biomass-based stoves, have moved back to biomass with current LNG prices; how large-scale these transitions are or the consequences for long-term biomass usage remains unclear.<sup>93</sup>

More broadly, India's energy supply landscape is shifting. As the record-setting summer heatwave drove coal based power generation to a breaking point, Indian imports of the lower priced Russian light oil increased from two percent to 18 percent of overall supply over 2021, deepening the power supply's dependence on fossil fuels.<sup>94</sup> However, there is scope to use the substantial subsidy and expenditure on fossil fuels towards supporting a bigger push for renewables.<sup>95</sup> Several industry experts have noted that the growing unreliability of oil creates an opportunity for technologies like green hydrogen, where India has positioned itself as an emerging production hub.<sup>96</sup>

## **Energy Efficiency**

With skyrocketing urbanization rates, energy demand from buildings, appliances, and industry is rising. Buildings and industry already account for over 60 percent of India's annual energy usage.<sup>97</sup> With India's growing economy, advancing energy efficiency will be critical to saving energy, increasing energy access, and combating pollution.

## Buildings

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.<sup>98</sup> Buildings accounted for nearly 33 percent of the nation's energy use in July 2021.<sup>99</sup> 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.<sup>100</sup> Estimates from 2021 suggest that about 70 percent of India's 2030 urban infrastructure was yet to be built.<sup>101</sup> This represents more than 3.2 billion square meters of space, more than twice the area of New York City. Ensuring this construction occurs sustainably and these buildings are constructed to be energy-efficient and climate-resilient from the beginning, therefore, will have cascading, long-term impacts on India's emissions.

Several voluntary certification programs have encouraged efficient construction in India to date. India ranks third in the world for Leadership in Energy and Environmental Design (LEED) certification with 1,649 LEED-certified buildings and 3,369 LEED-certified projects.<sup>102</sup> 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.<sup>103</sup> The Green Rating for Integrated Habitat Assessment was adopted as a national tool for building assessment in 2007 and has assessed more than 50 million square meters of space. Several states have adopted it as a framework to create incentives for efficient construction.<sup>104</sup> Meanwhile, the Bureau of Energy Efficiency's star rating program has certified over 225 commercial buildings.<sup>105</sup> 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, equivalent to powering 358 million Indian homes annually between 2014 and 2030.<sup>106</sup>

Simultaneous state policy efforts have also increased the efficiency mandated by the minimum code. In 2017, the Bureau of Energy Efficiency (BEE) released an updated ECBC.<sup>107</sup> The ECBC sets minimum energy standards for commercial buildings and designates state agencies to certify and enforce ECBC by notifying the code. As of August 2022, 19 states and two Union Territories, including Andaman & 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 have notified ECBC. Five states have incorporated

the ECBC into their by laws: Andhra Pradesh, Haryana, Punjab, Telangana, and Uttar Pradesh. Four states, Andhra Pradesh, Karnataka, Telangana, and Uttar Pradesh have taken additional steps to add transparent compliance processes and enforcement mechanisms.<sup>108</sup> The potential impacts of ECBC implementation are high, even at state-levels. Projections predict Gujarat could save 83 TWh of energy and \$9 billion with basic building compliance.<sup>109</sup>

To further promote building energy efficiency, BEE announced a new initiative, the NEERMAN Awards, in July 2021.<sup>110</sup> The awards provide national-level recognition for exemplary building designs that comply with BEE's ECBC. BEE also released a revised and a complete version of residential building energy code—Eco Niwas Samhita 2021, which now includes all building systems in addition to the building envelope (from the earlier code).<sup>111</sup> This code will help drive energy savings in the residential buildings sector in the country, also expected to grow rapidly in the coming decades.

Finally, the 2022 Energy Conservation Act amendments also demonstrate a renewed commitment to energy efficiency. The act amends 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.<sup>112</sup> Critically, the act also expands the definition of efficiency under ECBC to also mandate a minimal amount of renewable energy for a sustainable building.<sup>113</sup>

## Green Appliances and Sustainable Cooling

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. However, this year also highlighted the vulnerability of households to global shifts as the Ukraine-Russia crisis prompted widespread shifts back towards biomass and heatwaves highlighted the need for sustainable cooling methods.

Established in 2006, BEE's Standards and Labeling Program consists of both mandatory and voluntary schemes for 29 major appliances, including refrigerators, air conditioners, tube lights, color televisions, and electric geysers, etc.<sup>114</sup> India has a specific program for addressing lighting and 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 367 million LED lights resulting in an annual emission reduction of 38.6 million tons of carbon dioxide equivalent.<sup>115</sup> According to BEE reports, its star-labelling program for room ACs kept

almost 38 million tons of CO<sub>2</sub> out of the atmosphere.<sup>116</sup> The UJALA program transformed the lighting sector in India: nearly two-third of the lighting stock in Indian homes now comprises LED bulbs and tube-lights.<sup>117</sup>

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, in 2019. ICAP is a comprehensive plan that prioritizes energy-efficient, climate-friendly, and affordable cooling for all. India is projected to account for one third of global emissions from space cooling, and as part of ICAP, the government of India has worked with civil society groups like NRDC to strategize implementation.

Increasing the climate-friendliness of appliances is a key part of these cooling efforts. 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.<sup>118</sup> 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 addition, after two years of delays due to COVID-19, the new standards for air-conditioners started on July 1, 2022.<sup>119</sup>

As of January 2020, India requires that all room air conditioners have a default temperature setpoint of 24°C

(75.2°F), potentially resulting in significant energy savings.<sup>120</sup> 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 effective January 2022.<sup>121</sup>

India's major inverter air conditioning market has been proactive in its efforts to reduce the high-global warming refrigerant HFCs that are used in air conditioning units while 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.

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. In April 2021, to expand sustainable cooling and enhance access to cooling, the National Disaster Management Authority (NDMA), working with partners NRDC and Indian Institute of Public Health-Gandhinagar (IIPH-G), released a "Heat Wave Season 2021: Cool Roofs Challenge." 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.<sup>122</sup> According to one study, mortality rates on days at or above 45°C (113°F) daily



Women and children in front of their house with solar panels and cool paint on the rooftop in Fangini Village, Gujarat, India.

Credit: Akanksha Golchha, NRDC

maximum temperature dropped by 27% after the HAP was implemented, relative to pre-HAP years.<sup>123</sup>

## Industrial Energy Efficiency

The National Mission for Enhanced Energy Efficiency (NMEEE) 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. Under PAT Cycle I from 2012-2015, over 31 million tons of carbon dioxide equivalent were avoided.<sup>124</sup> PAT Cycle II from 2016-2019, which included an expanded list of sectors, is estimated to have avoided an additional 66 million tons of CO<sub>2</sub>e emissions. PAT Cycle III seeks to cover six energy-intensive sectors: thermal power plants, cement, aluminum, pulp and paper, iron and steel, and textile. Under PAT Cycle III energy consumption is projected to be lowered by 3 percent annually for regulated industries. As of 2022, seven PAT cycles have been notified. PAT Cycles IV, V and VI aimed to reduce energy consumption by expanding 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 million tons of oil equivalent.<sup>125</sup> 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.<sup>126</sup> 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.<sup>127</sup>

## Transportation Sector

As India recovers from the COVID-19 pandemic, more people have started traveling again. Though walking remains a key mode of mobility in India, the transportation sector still accounts for upwards of 16 percent of total CO<sub>2</sub> emissions and over 33 percent of particulate matter pollution.<sup>128</sup> In 2022, India was the fourth largest global auto market, with approximately 3.7 million units sold in the passenger vehicles category alone.<sup>129</sup> India's auto sector is set to be third largest in the world by 2026.<sup>130</sup>

The automotive industry is a crucial part of the Indian economy, making up approximately half of India's manufacturing GDP.<sup>131</sup> COVID-19 has presented India's automotive sector with unprecedented challenges, as well as a liquidity crunch, higher acquisition costs, supply chain constraints and weaker customer demand, which have all contributed substantially to the downturn the industry has been grappling with since the third quarter of fiscal year 2018.<sup>132</sup> However, in Financial Year 2021, the automotive industry demonstrated strong resilience as further challenges like the Ukraine-Russia crisis and the China lockdowns delayed automotive supply further. Indeed, these international events spurred domestic production and the automotive components sector in India grew by 23 percent in 2022, while recording its highest ever turnover and a massive trade surplus.<sup>133</sup>

## 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

### BOX 2: India's Carbon Sink Goals

In India's 2015 NDC under the Paris Agreement, the government committed to creating additional carbon sinks that can hold up to three billion metric tons of CO<sub>2</sub>-equivalent GHG emissions by 2030. In India, these carbon sinks mainly take the form of the vast stretches of forests found across the country. India holds two percent of the world's forest cover. India's protection and restoration of these forests as carbon sinks has important implications for national and global emissions.<sup>232</sup> Reports from the Environment Ministry have all found yearly increases in forest cover, with an average 266,000 hectares of forest added every year from 2010 to 2020.

To be able to better track forest cover and the CO<sub>2</sub>-equivalent savings, several ecologists have recommended coming up with a clear and consistent definition for forest cover. For example, roadside plantations are not considered a part of the forest cover as per India's Forest Conservation Act, but are included in some official estimates.<sup>233</sup> Additionally, an amendment to India's Forest (Conservation) Act 1980, the 2022 Forest Conservation Rules, was notified on August 27, 2022.<sup>234</sup> While these rules create a mechanism for trading afforestation credits, they also remove requirements for compliance with the Forest Rights Act, which grants India's Indigenous groups land sovereignty.<sup>235</sup> India can consider joining the global pledge to reverse deforestation.<sup>236</sup> These carbon sequestration efforts are a critical partner to the clean energy transition to build a low-emission future.

stringent anti-pollution standards in countries to which they are exporting vehicles, and therefore can adhere to strict domestic standards as well.<sup>134</sup>

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 will result in up to 40 percent reduction in particulate matter (PM) emissions and 43 percent reduction in NOx compared to BS IV emission standards.<sup>135</sup> Real Driving Emission testing will be implemented in 2023 to prevent the use of cheating devices and regulate vehicle emissions. BS VI Phase II will also come into force in 2023 and mandate the use of automatic fuel injectors.<sup>136</sup>

Additionally, India introduced the second phase of Corporate Average Fuel Efficiency (CAFE) 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 CO<sub>2</sub> per kilometer, amounting for a reduction of about 13 percent over the earlier standard.<sup>137</sup> There is scope for these limits to tighten further to 108 or 104 g/km.<sup>138</sup>

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.<sup>139</sup> 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.<sup>140</sup> Such local mandates, especially in highly populous areas, could generate additional pressure to reduce vehicular emissions.

## Electric Vehicles

India's electric vehicle journey started in 2013, with the government putting out the National Electric Mobility Mission Plan 2020 with the aim to subsidize the cost and facilitate the sale of six to seven million hybrid and electric vehicles (EVs) by 2020.<sup>141</sup> There are about 1.3 million EVs drivers in India and approximately 1,700 charging stations across the country.<sup>142</sup> Ninety percent of these EVs are two- and three-wheelers.<sup>143</sup> While EVs made up only two percent of total automobile sales in India in 2021, close to a third of all vehicles sold in India in 2030 are expected to be electric, mostly electric two- and three-wheelers.<sup>144</sup> Encouraged by India's investments in electric mobility with government policy funding, the penetration of EVs continues to grow at exponential rates, almost doubling every year.

India's FAME-II policy forms a key pillar of support for electric mobility.<sup>145</sup> The program aims to support electric mobility through substantive research funding for battery technologies and development and provides 10,000 crore (\$1.4 billion) for demand incentives and charging infrastructure subsidies. These apply across market types including electric public buses, commercial vehicles, three-wheelers, and privately owned two-wheelers.<sup>146</sup> In 2021, the Government of India extended FAME-II until 2024 and increased the demand incentives for electric two wheelers from 10,000 per kWh to 15,000 per kWh.<sup>147</sup>

However, 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.<sup>148</sup> As such, parallel schemes have encouraged the Make in India initiative, and the Government has used its Productive Linked Incentive scheme under the Global Champion plan to attract applications and investments from more than 115 companies.<sup>149</sup> In order to strengthen battery storage, the National Mission on Transformative Mobility and Battery Storage is designed to support the battery and EV component manufacturing in India.<sup>150</sup> To promote the Make in India initiative, the Government of India also approved the Production Linked Incentive (PLI) scheme for manufacturing advanced chemistry cell battery with an estimated outlay of 18,100 crore (\$16 billion).<sup>151</sup> The proposal aims to achieve manufacturing of 50 GW of battery storage, which is critical to India's renewable energy and EV mission.

The Ministry of Power further amended the charging infrastructure guidelines, making them technology agnostic and encouraging both private and public sector entities to set up charging/swapping stations.<sup>152</sup> As of March 2022, the Ministry of Power has approved the establishment of 2,877 publicly funded vehicle charging stations in 68 cities across 25 states and union territories, 1,576 charging stations across nine expressways and 16 highways.<sup>153</sup> The 2022-2023 budget speech included the announcement of a landmark battery swapping policy, a critical step towards making vehicles charging affordable and accessible.<sup>154</sup> As of June 2022, NITI Aayog has published a draft of this policy and received public comment.<sup>155</sup> The government is also setting up charging stations at approximately 22,000 fuel pumps across India, making a charging station available at one in every three existing petrol pumps.<sup>156</sup> In 2022, CESL plans to launch an EV 'super' app and create a reliable framework to help consumers find charging stations.<sup>157</sup> State and municipalities have also begun to lead the way on electric vehicle incentives and policies. Starting with the notification



Credit: Pradeep Gaurs/Shutterstock

Drivers charging their electric cars at charging stations in New Delhi, India.

of the Karnataka Electric Vehicle and Energy Storage Policy in 2017, a total of 20 Indian states and territories have notified or have draft EV policies as of February 2022.<sup>158</sup>

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 and several other companies are expected to follow suit.<sup>159</sup> As India builds up its domestic capabilities, local manufacturing of EVs is expected to scale rapidly and become competitive with overseas companies.<sup>160</sup> By 2050, 75 percent of the passenger vehicles sales in India are expected to be EVs.<sup>161</sup> In order to support this growth, however, policies must continue to support advancements in the battery technology ecosystem and charging infrastructure.

## Public Transit

States and cities across India are working to electrify the substantial public transport system that links the country. India's rail network has become a focus point for electrification. With a network stretching over 68,155 km, India has the third largest rail system in the world and transports more than 1.3 billion passengers every year.<sup>162</sup> India's railways help reduce energy consumption and optimize space occupancy across the country and are now moving towards emissions reductions. In 2020, the

country has set a target of full electrification of this system by December 2023 and has made rapid progress toward this goal.<sup>163</sup> More than 30,000 kilometers of electrification occurred in the last five years alone.<sup>164</sup> Eighty percent of Indian Railways' broad-gauge tracks were electrified as of March 2022, comprising 52,247 kilometers of railway line. The railways are also examining other alternative low-emission options, and the first hydrogen powered train is likely to be launched in 2023.<sup>165</sup>

India's metro stations continue to grow from year to year. India has 750 km of metro lines, distributed across 15 Indian cities – Ahmedabad, Bengaluru, Chennai, Delhi, Gurgaon, Hyderabad, Jaipur, Kanpur, Kochi, Kolkata, Lucknow, Mumbai, Nagpur, and Noida and Greater Noida.<sup>166</sup> Though many metros remain under construction or with limited coverage, India's goals for metro expansion are ambitious. The Metro Policy 2017 mandates a metro system in every city with over 1 million residents.<sup>167</sup> By the end of 2022, a total of 900 km of metro is expected to be available for passenger usage.<sup>168</sup>

Finally, buses help provide last-mile connectivity in India and make up an important focus of vehicular electrification. In 2019, there were 1.9 million privately owned buses and over 100,000 public buses.<sup>169</sup> The central government has

allocated 35.45 billion (US \$486 million) in incentives to support the adoption of 7,090 e-buses. As of January 2021, 6,315 e-buses have been sanctioned to 65 cities and State Transport Undertakings.<sup>170</sup> Major Indian states and cities, including Gujarat, Maharashtra, New Delhi, Telangana, Uttar Pradesh, Rajasthan, and Kerala, also have their own programs for the expansion of electric bus fleets.<sup>171</sup> The 2020 establishment of Convergent Electricity Services Limited (CESL), a state-controlled company to manage solar and electric vehicles leasing has helped drive bus fleet electrification.<sup>172</sup> In a milestone move, CESL committed \$10 billion to launch more than 50,000 electric vehicles across the country.<sup>173</sup>

## Mobilizing Green Investment

India has received more than \$40 billion in green investment since 2019. However, according to some estimates more than \$1 trillion in investment is needed to achieve India's latest NDC by 2030.<sup>174</sup> Though COVID-19 caused significant declines in climate funding in 2020, green investment recovered in the 2021 financial year. Investments grew exponentially, more than doubling from investment rates seen in 2015, with debt financing increasing by a factor of more than six times in 2022.<sup>175</sup> However, these investments remain only about a quarter of the annual amount required to meet India's 2030 climate goals and 2070 net zero target.<sup>176</sup> Investments needed in renewable energy (RE) generation alone come to approximately \$223 billion over the next eight years.<sup>177</sup> Concurrently, \$175 billion must be invested in strengthening and preparing the national electricity grid to support the massive increase in RE capacity.<sup>178</sup>

Funding acquisitions by private companies drove India's strong recovery from 2020, bolstered by the rise in post-pandemic electricity demand that has helped grow the domestic RE sector.<sup>179</sup> India is working to provide funding for clean energy through government programs, private investments, and international climate finance. As public funds alone will not produce the capital required, institutions have focused on catalytic finance to expand the clean energy market. Catalytic finance leverages limited public funds to attract private investment. Catalytic financial mechanisms and institutional facilities such as "green windows" can be effective in transforming the India clean energy market. 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.<sup>180</sup> India's support for the green window could attract more concessional funding and open up the Indian clean energy market 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.<sup>181</sup>

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.<sup>182</sup> However, few standardized frameworks for ESG metric reporting exist to date, particularly for independent power producers.<sup>183</sup>

Continuing to attract green investment in India will require the continued development of novel financial instruments. The sustainable debt market, in particular, represents a significant and growing portion of green investment, with the market more than doubling over the last two years as average deal size continues to increase in debt finance portfolios. Sustainable debt financing is a key pathway for foreign investors in India, with 50 percent of sustainable debt financing comes from offshore sources.<sup>184</sup> Green bonds form the majority of sustainable debt financing. Though a relatively new instrument in India, with the first Indian green bonds issued in 2015, they have become a critical way to refinance projects after initial investment stages. Apart from IREDA and NTPC, Greenko, ReNew Power, Azure Power, TCCL and Adani Green Energy have been integral to issuing green bonds.<sup>185</sup> Greenko and ReNew Power have accounted for nearly 70 percent of all issuances by value.<sup>186</sup> 2021 marked a record year for the green bond market with more than \$7.0 billion worth in bonds issued over the financial year, compared to US \$11 billion from 2014-2021.<sup>187</sup> 2022 is likely to set another record as national policy decisions facilitate domestic sustainable debt investment. To date, green bonds in domestic markets have accounted for only US \$0.5 billion of cumulative investment.<sup>188</sup> However, with SEBI's July 2022 update of India's national green bond framework to reflect international standards and the expected announcement of a sovereign green bond in the second half of 2022, domestic green bonds are projected to grow exponentially.<sup>189</sup>

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 the Russia-Ukraine conflict, investing in clean energy solutions for energy independence has only become more important.<sup>190</sup>

The next years represent an opportunity to build on the strong recovery from COVID-19 and continue to scale clean energy and other climate investments. 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.

Compounded by the power deficits in March and April 2022, DISCOM debt to generation companies grew 23 percent to reach a 5-year high of \$15 billion (INR 1 lakh crore); about 20 percent of the debt was overdue towards renewable energy generators.<sup>191</sup> Though the government extended a 1,35,000 crore (\$13 billion) liquidity line to DISCOMs, with the goal of assisting DISCOMs with paying outstanding dues to generation companies, DISCOM dues continued to rise through April, May, and June 2022.<sup>192</sup> However, the new Electricity Amendment bill may help strengthen payment security and address the recurrent defaults by DISCOMs while also increasing the ability of regulators to enforce

### BOX 3: Focus on Large Hydropower

Large-scale hydropower forms a bedrock of non-fossil fuel power generation in India. It makes up the largest non-fossil fuel generator right now, making up 11.6 percent of India's overall capacity with 46.85 GW of power.<sup>237</sup> Though its share in the overall mix is projected to decrease to 8.8 percent by Central Electricity Authority predictions, its capacity will nevertheless almost double to 73.45 GW over the next decades as India pushes for more hydropower projects.<sup>238</sup> India's updated goal to meet 50 percent of power requirements with non-fossil fuel power involves including hydropower in addition to wind, solar, and green hydrogen to meet these targets.<sup>239</sup>

The government has capitalized on hydropower's flexibility in scaling power production, the long-term savings, and its ability to stabilize grid power. Large hydropower's status as a renewable energy, formalized by the Government of India's March 2019 categorization of hydropower larger than 25 MW as renewable power, has been leveraged to meet India's NDCs.<sup>240</sup> Research has shown that refocusing energy and funding towards small hydropower projects—producing under 25 MW—could avoid many of the effects of large hydropower and help alleviate rural poverty.<sup>241</sup> As small hydropower does not require damming rivers, it avoids many of the environmental and social impacts of large hydropower and has large potential, with a projected capacity of 21 GW of power generation nationwide.<sup>242</sup>

debt repayment.<sup>193</sup> The Electricity Amendment Bill can help improve RE returns and investor confidence.

Policy measures and solutions like the Electricity Amendment Bill 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 are jointly developing 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.<sup>194</sup> The Roadmap brings government and private sector stakeholders together to agree upon a clear action plan that identifies and addresses 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.

## Strengthening Resilience to Extreme Heat and Air Pollution

### Extreme Heat

In 2022 extreme heat was once again in the spotlight as India experienced months of record-setting temperatures, beginning with the hottest March in recorded history since 1901 and the hottest April and May recorded over the last 20 years of available data.<sup>195</sup> A 2022 analysis found that because of climate change, the probability of an event such as the early extreme heat in India and Pakistan in early 2022 has increased by a factor of about 30.<sup>196</sup> The arrival of the monsoon also failed to prove the expected respite, as the beginning of the rains brought temperatures that exceeded pre-monsoon weather amid the increased humidity.<sup>197</sup> The unprecedented temperatures shone harsh light on the effects of heat in India and current adaptation measures. India's wheat production plummeted 5.7 percent from predictions as businesses, schools, and people nationwide were forced to transform their operations to keep people inside.<sup>198</sup>

The 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.<sup>199</sup> 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, are the ones left outside in many places continuing with the backbreaking manual labor through sweltering afternoons.<sup>200</sup>



Credit: Ahmedabad Municipal Corporation

Safe drinking water vans deployed by the Municipal Corporation under Ahmedabad Heat Action Plan as a part of adaptation measures to deal with heat stress.

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 (HAPs) 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. 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.<sup>201</sup> Since the launch of Ahmedabad's HAP, more than 23 states and over 100 cities in India have followed suit.<sup>202</sup> However, several key cities still lack HAPs, including Delhi, India's capital.<sup>203</sup>

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 (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.<sup>204</sup> India also implemented the National Adaptation Fund for Climate Change, which was established in 2015 to help states become more resilient to the adverse effects of climate change. States can submit project proposals to the NAFCC program and will then receive subsequent program funding.<sup>205</sup>

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.<sup>206</sup> Several emerging studies also address and map where and how heat impacts people across India.<sup>207</sup> 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."<sup>208</sup> 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 for longer.<sup>209</sup>

## Air Quality

After the temporary improvements in air quality experienced in India during the COVID-19 lockdown, air quality worsened in 2022 as economic activity resumed.<sup>210</sup> 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<sub>2.5</sub> concentrations over the last decade.<sup>211</sup> 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.<sup>212</sup> Under the program, 124 cities have prepared city-level action plans by the Central Pollution Control Board to meet the specified NCAP targets. The city-specific plans are primarily standalone measures without an airshed component.<sup>213</sup> Several cities, such as Ahmedabad, Pune, and New Delhi, have developed city clean air plans, including a focus 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 odd and even license plate programs, shutting down thermal power plants, limiting construction and industrial activities, and other measures.<sup>214</sup>

The NCAP is the first of its kind national level policy formulated to address air quality in Indian cities. It is a significant intervention to address air quality; however, 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.<sup>215</sup> In several cities, such as Mumbai, pollution has increased over the last three years despite NCAP efforts.<sup>216</sup>

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 ₹4,440 crore (US \$604 million) per grant used for air quality improvement measures, monitoring, and local body capacity building. In a subsequent Finance Commission Report for 2021-26 released in February 2021, this grant program has been deepened and renewed, with the total allocation of ₹12,139 crore (US \$1.65 billion) over a period of 5 years.<sup>217</sup> 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). CAQM has major implications for setting a roadmap for regional airshed level air quality management and can potentially be replicated in other air quality hotspots across the country.<sup>218</sup> So far, the CAQM has convened an expert group that recommended updating Delhi's Graded Response Action Plan, and its revisions are set to come into effect from

October 1, 2022.<sup>219</sup> Overall average pollution of the summer of 2022 was higher than last summer.<sup>220</sup> Summer 2022 saw uncharacteristically high levels of particulate pollution, especially in north India. Small towns experienced poor air quality over the summer of 2022, representing the expansion of air pollution beyond megacities.

High summer pollution was a result of 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.<sup>221</sup>

## International Engagements

India has over the years emerged as a global leader in climate action, advocating for low-carbon transitions for Global South countries 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 in 2015, India and France jointly launched the International Solar Alliance, an important multilateral partnership aiming to mobilize \$100 billion by 2030 to promote solar power globally. As of August 2022, 88 countries have signed and ratified the framework agreement.<sup>222</sup> The International Solar Alliance recently launched the "One Solar, One World, and One Grid" plan that aims to support greater renewables penetration through interconnected grid systems and continues work on capacity building efforts in developing countries.

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 \$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 \$10 billion euros to energy innovation, hydrogen development, and more.<sup>223</sup> 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.<sup>224</sup> Finally, a May 2022 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.<sup>225</sup> The US committed to joining India in technology innovation research at six out of 25 research hubs in India.

Beyond clean energy, India has also worked towards helping phase down 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 August 2022, 137 countries have ratified the Kigali amendment, including China and India.<sup>226</sup> The United States Senate is to vote on ratifying the Kigali amendment after approval by a Senate committee in May 2022, though no date is scheduled yet.<sup>227</sup> 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.<sup>228</sup> 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.<sup>229</sup> 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.<sup>230</sup>

At the UNFCCC COP27 in November 2022, countries are expected to submit progressively stronger NDCs and work towards intensifying efforts on securing climate finance and enhance adaptation action. India's updated NDCs set a positive example 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 carbon neutrality by 2060, and peak carbon emissions by 2030, the three major economies of the world have begun to chart a low carbon future.<sup>231</sup>

India is a critical international stakeholder in combatting climate change. The country has set ambitious goals and taken the first 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 millions of people within the country, but also how the world responds to one of the biggest challenges facing humanity.

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# Highlighted Reports



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