EXECUTIVE SUMMARY

Highlights

- Over the past decade, India has taken several key steps to address climate change while supporting long-term development objectives. Strong and clear policy signals in sectors such as clean energy underline India’s commitment and continue to fuel optimism on sustained climate action.

- This paper analyzes the climate change mitigation goals that have been set and the key policies that have been and are being implemented. The objective is threefold: to enhance understanding of India’s goals, to evaluate implementation progress, and to identify opportunities for going further.

- Our analysis finds that India is making progress toward its 2030 mitigation goal, but further transparency is needed to support robust greenhouse gas (GHG) accounting.

- The 2030 mitigation goal is within reach through the full and effective implementation of the five key policies and actions we analyzed: Perform, Achieve, and Trade (PAT) scheme; Dedicated Freight Corridor (DFC); clean environment cess; renewable power by 2022; and Energy Conservation Building Code (ECBC; energy efficiency in the services sector). Moreover, India can meet its goal while maintaining gross domestic product (GDP) growth and delivering significant development benefits.

- India can reduce its GHG emissions intensity even further through a set of targeted interventions that address existing policy, institutional, financial, and technological barriers.
Context

In recent years, India has developed a range of policies, plans, and targets to address climate change while supporting the country’s long-term development agenda. In June 2008, India launched the National Action Plan on Climate Change (NAPCC), outlining measures to promote sustainable development, while also providing cobenefits to address climate change. Under the NAPCC, various policies, programs, and initiatives have been initiated at the national and sectoral level that have seen varying levels of implementation success. India also has two overarching climate mitigation goals: In 2009, India voluntarily pledged to reduce its emissions intensity per unit of GDP by 20 to 25 percent by 2020 relative to 2005 levels. Then, in 2015, India built on this goal in its Nationally Determined Contribution (NDC), setting a new target to reduce its emissions intensity per unit GDP by 33 to 35 percent below 2005 by 2030.

Hereafter, all policies, actions, programs, missions, plans, and initiatives in the paper are referred to as “policies” in short.

About This Paper

This paper reviews India’s mitigation goals, analyzes the progress of key mitigation policies, and assesses the potential contribution of these policies in reaching the NDC. In addition, this paper reviews India’s national GHG emissions intensity goals with the aim of providing inputs to enhance transparency around what these goals imply for future emissions. The paper also presents an analysis of the status of the implementation of the policies that have significant potential to reduce GHG emissions.

We followed a three-pronged research approach:

- The Greenhouse Gas Protocol’s Mitigation Goal Standard was applied to analyze progress toward mitigation goals.
- The World Resources Institute’s Climate Policy Implementation Tracking Framework was applied to assess the implementation status of key policies/actions.
- A model was developed by KPMG India Private Limited to project the GHG emissions for India until 2030 under different policy scenarios, which simulated the interactions among the economy, the energy systems, and the environment. The results of the model were used to assess the potential impact of policies in achieving GHG emission reductions as well as their impacts on GDP growth. Five policies/actions were modeled: the PAT scheme; DFC projects; clean environment cess; renewable power by 2022; and the ECBC.

Key Findings

Key finding #1: India is showing progress toward reducing its GHG emissions intensity in line with its mitigation goals, but further transparency is needed to support robust GHG accounting.

Available information indicates that India's GHG emissions per unit of GHG are declining towards its targets. This is supported by our study as well as other related analyses (UNDP 2017). To support more robust GHG accounting, further clarity is needed on emissions intensity in the base year (2005) and the allowable emissions in the target year (2030), as well as in the scope and coverage of the intensity target and the methodologies for measuring it.

Key finding #2: Financial incentives and a diverse set of instruments have supported successful policy implementation, but some hurdles still need to be overcome.

- The Jawaharlal Nehru National Solar Mission has been instrumental in the decline of solar power prices in India and has assisted in accelerated deployment of solar power in the country. The success of the solar mission in its first phase resulted in the exceptional ramp up of targets to 100,000 MW of solar power installed capacity by 2022. However, notwithstanding the decline in the cost of solar photovoltaic systems, barriers to large-scale adoption of solar power in the country still exist, including the scarcity of available land, low-cost finance, domestic manufacturing capacity, supporting grid infrastructure as well as the slow uptake of rooftop solar.

- The Electricity for All campaign has received considerable investment by the government. The Grameen Vidyutikaran dashboard could be a useful tool to track the campaign’s progress if maintained and updated on a real-time basis.

- The PAT scheme is progressing well and resulting in energy savings; however, it may not be able to support an efficient Energy Saving Certificates market in the first phase, given that most sectors (barring
thermal power generation) have met their targets, with obligated entities combined exceeding the target significantly.

- The ECBC has faced barriers, which are in the process of being addressed by the Bureau of Energy Efficiency (BEE). The BEE has prepared a new draft of the ECBC along with rules that were recently opened for public comments.

- The Unnat Jyoti by Affordable LEDs for All scheme has been running successfully and has already proved to be effective in driving down the price of light-emitting diodes (LEDs), transferring the savings to the customer, and reducing energy consumption and GHG emissions.

- The DFC projects, which are expected to significantly enhance efficiency in freight movement, have faced implementation delays due to factors such as unavailability of finance, land acquisition, and so on.

- The Renewable Energy Certificate mechanism has faced challenges for a variety of reasons, including the lack of enforcement of Renewable Purchase Obligations.

- The National Clean Environment Fund (NCEF), which has been expanded to other environmental initiatives apart from clean energy, has witnessed underutilization in the past, preventing it from creating the impact that was envisaged in its inception.

**Key finding #3: India can meet its 2030 GHG target through effective implementation of existing policies, while maintaining GDP growth and delivering development benefits.** The modeling and scenario development analyses yielded the following results:

- **Meeting targets while growing GDP:** Our analysis shows that India can meet its 2030 GHG target through the effective implementation of the five key existing policies and actions that we analyzed: PAT scheme; DFC projects; clean environment cess; renewable power by 2022; and ECBC. Even with meeting this target by reducing GHG emissions, India can still maintain its annual GDP growth rate of 6 to 7 percent. India’s economy will tend to decarbonize due to the increasing share of renewables in the total energy mix. The scenarios we have modeled are optimistic that India will be able to meet and exceed the NDC mitigation target through the full and effective implementation of key national policies.

- **Development benefits:** The implementation of these policies will deliver significant development benefits, supporting India’s overall approach to tackling climate change within the context of sustainable development. Our research shows that the overall income of both rural and urban households could increase in the range of 3 to 5 percent by 2030. Other benefits include a reduction in local air pollutants, a modest increase in jobs, and new investments in environmental projects (such as the Namami Gange Programme to reduce pollution of the Ganga River, which is set to improve the health and living conditions for the more than 150 million people that reside in the Ganga basin).

- **The possibility of further reductions:** By further enhancing these five existing policies, our results show that India can reduce the emissions intensity of its economy even beyond its current goals—by around 43 percent by 2030, relative to 2005 levels. This is promising in light of the need for enhanced action in line with the Paris Agreement goals. However, the institutional, financial and technological barriers to the enhanced implementation of these policies need to be addressed before these policies can fully contribute, as in this scenario, to meeting and exceeding the NDC target. Capacity building—coupled with technology transfer and low-cost international finance—will be equally important for scaling up India’s efforts to address climate change.

**Looking Ahead**

**Targeted interventions can address the policy, institutional, financial, and technological barriers to enhance their implementation:**

- The PAT scheme would benefit from improving design and target setting for encouraging the trading of certificates, creating an enabling environment, strengthening State Designated Agencies, developing process- and activity-specific targets for designated consumers, and deepening and widening of the scheme.

- The renewable sector could benefit from fostering an enabling environment, supporting the development
of the REC market, improving grid integration for renewable energy, reducing the cost of financing, and increasing domestic manufacturing capacity.

- The NCEF could benefit from defining the fund vision and strategy more clearly, improving governance structure, using NCEF support to leverage other sources of finance, improving communication strategy, and improving monitoring and evaluation.

- The services sector could benefit from ensuring enforcement of and compliance with the ECBC, raising awareness, building capacity, enabling technology transfer, and creating innovative financial schemes and fiscal incentives.

- The DFC project could benefit from improving project planning with regular monitoring and evaluation, using modern technologies, expanding the project, and paying attention to environmental considerations.

List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AFOLU</td>
<td>Agriculture, Forestry and Other Land Use</td>
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<tr>
<td>BEE</td>
<td>Bureau of Energy Efficiency</td>
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<tr>
<td>BUR</td>
<td>Biennial Update Report</td>
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<td>CERC</td>
<td>Central Electricity Regulatory Commission</td>
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<td>DDUJY</td>
<td>Deendayal Upadhyaya Gram Jyoti Yojana</td>
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<td>Delp</td>
<td>Domestic Efficient Lighting Programme</td>
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<td>DFC</td>
<td>Dedicated Freight Corridor</td>
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<td>DFCCIL</td>
<td>Dedicated Freight Corridor Corporation of India Limited</td>
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<tr>
<td>DISCOM</td>
<td>state electricity retailer</td>
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<td>ECBC</td>
<td>Energy Conservation Building Code</td>
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<td>EDFC</td>
<td>Eastern Dedicated Freight Corridor</td>
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<td>EESL</td>
<td>Energy Efficiency Services Limited</td>
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<tr>
<td>ESCerts</td>
<td>Energy Saving Certificates</td>
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<tr>
<td>FAME</td>
<td>Faster Adoption and Manufacturing of (Hybrid) and Electric vehicles</td>
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<td>GARV</td>
<td>Grameen Vidyutikaran</td>
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<tr>
<td>HFCs</td>
<td>Hydrofluorocarbons</td>
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<td>IMG</td>
<td>Inter-ministerial group</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<td>IPDS</td>
<td>Integrated Power Development Scheme</td>
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<tr>
<td>JNNSM</td>
<td>Jawaharlal Nehru National Solar Mission</td>
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<tr>
<td>MNRE</td>
<td>Ministry of New and Renewable Energy</td>
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<tr>
<td>MoEFCC</td>
<td>Ministry of Environment, Forest, and Climate Change</td>
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<td>MoP</td>
<td>Ministry of Power</td>
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<tr>
<td>NAPCC</td>
<td>National Action Plan on Climate Change</td>
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<td>NCEF</td>
<td>National Clean Environment Fund</td>
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<tr>
<td>NDC</td>
<td>Nationally Determined Contribution</td>
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<td>NEMMP</td>
<td>National Electric Mobility Mission Plan</td>
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<td>NMEEE</td>
<td>National Mission on Enhanced Energy Efficiency</td>
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<tr>
<td>NTDPC</td>
<td>National Transport Development Policy Committee</td>
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<td>PAT</td>
<td>Perform, Achieve, and Trade</td>
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<tr>
<td>REC</td>
<td>Renewable Energy Certificate</td>
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<td>RPO</td>
<td>Renewable Purchase Obligation</td>
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<td>SDA</td>
<td>State Designated Agency</td>
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<td>UIJALA</td>
<td>Unnat Jyoti by Affordable LEDs for All</td>
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<tr>
<td>WDFC</td>
<td>Western Dedicated Freight Corridor</td>
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1. INTRODUCTION

1.1 Objectives and Scope of the Study

In this study, we offer an independent analysis of the climate change mitigation goals that have been established by the Government of India and an analysis of the policies that have been implemented, or are in the process of being implemented, with a view to assessing their contribution to reaching these goals. To evaluate the impacts of policies until 2030, we have developed a model to estimate future changes in national gross domestic product (GDP) and greenhouse gas (GHG) emissions from three sectors; namely, energy (including transportation), industrial process and product use, and waste, as identified in the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. The timing is opportune, and as India turns its attention to implementing its Nationally Determined Contribution (NDC), we hope that the report helps policymakers, civil society, and other stakeholders to understand opportunities to strengthen India's policy portfolio as it relates to climate and developmental benefits.

The study has the following specific objectives:

- To enhance understanding regarding India’s GHG mitigation commitment and progress achieved to date
- To evaluate implementation progress and identify opportunities for enhancing implementation of key policies to accelerate their impact
- To provide insights into the projected future emission trends in India under a set of scenarios

The study is based on credible, transparent, and robust data and methodologies and is grounded in national circumstances and expert judgment.

1.2 Research Methodology

The study is built on five distinct research components:

1. Analysis of Mitigation Goals

In this component, we reviewed India’s national emissions intensity goals. The goals were analyzed to enhance understanding about what they imply and to provide clarity on the information that is required for monitoring progress toward the targets.

Transparency around a range of goal parameters is a prerequisite to understanding the implications of the goals and to monitoring progress against them. To facilitate this exercise, we used the GHG Protocol Mitigation Goal Standard, a robust, independent, and transparent methodology that has been developed through extensive international consultation.

2. Analysis of Mitigation Policies

We analyzed the status of implementation of the policies, programs, missions, and plans that have been established under the National Action Plan on Climate Change (NAPCC). In addition, we analyzed in greater depth announcements made in the country's budgets that have a direct impact on the emissions and environment of the country. Select key policies were then analyzed using the Climate Policy Implementation Tracking Framework developed by the Open Climate Network (OCN) (Barua et al. 2014). This framework presents a comprehensive approach to monitoring policy adoption and implementation and identifying indicators essential for evaluating effectiveness of policy implementation. Using the OCN framework, we looked specifically at indicators relating to policy implementation milestones, financing, compliance and enforcement, and impact.

To validate the policy analysis, we systematically identified and consulted with sectoral experts and policymakers to gain insights into implementation challenges, perceived and real policy impacts, and likely future developments. We conducted interviews with officials and scientists from the Ministry of New and Renewable Energy (MNRE), the Ministry of Power (MoP), the Bureau of Energy Efficiency (BEE), Energy Efficiency Services Limited (EESL), and the Dedicated Freight Corridor Corporation of India Limited (DFCCIL).

3. Development of the Model

To project GHG emissions for India until 2030 under different policy scenarios, we developed a model that simulates the interactions among the economy, energy systems, and the environment. The entities of the economy represented in the model include households; government; institutions, including public and private enterprises; and the rest of the world, which represents entities outside India.

KPMG, the India partner of the World Resources Institute (WRI), led the model development with inputs from the WRI and national and international experts. KPMG
consulted extensively with expert modelers from the Institute of Management Technology, Purdue University, and officials from the former Planning Commission, Government of India. These experts provided valuable advice on addressing challenges pertaining to model development such as unavailability of data, inconsistency in data, methods of representing the economy and its sectors in the model, and other technical challenges.

4. Development of the Model Scenarios
As a starting point, the potential outcomes of each policy were mapped through policy causal diagrams using the GHG Protocol Policy and Action Standard. The policy causal diagrams link the direct, indirect, and induced impacts of the policies in the economy with the resultant change in GHG emissions. This helped us identify the types of effects a policy may have on GHG emissions in the future. Three scenarios were established: a reference scenario, a current policy scenario, and an enhanced policy scenario (more details about these scenarios are presented in Section 4).

We presented the modeling methodology and preliminary results from the model at a stakeholders’ workshop that comprised sectoral and modeling experts from academia, civil society, and the Indian government. The feedback we received during the workshop was instrumental in improving and refining the policy assumptions used in the model.

5. Development of Policy Implications and Recommendations
The results of the model were used to assess the potential impact of policies in achieving GHG emissions intensity reductions as well as their impact on GDP growth. Based on this analysis and using inputs from stakeholder interviews and literature review, we developed recommendations for policies to achieve enhanced implementation.

The research components are summarized in Figure 1.

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**Figure 1 | Research Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>Activities</th>
<th>Research methods used</th>
</tr>
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<tbody>
<tr>
<td>Analysis of goals and mitigation policies</td>
<td>Literature review</td>
<td>Open Climate Network Climate Policy Implementation Tracking Framework</td>
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<td></td>
<td>Developing top-down Computable General Equilibrium model</td>
<td>Key informant interviews with policymakers, subject matter experts, and government special purpose vehicles (SPV)</td>
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<td>Developing bottom-up electricity model</td>
<td>GHG Protocol Mitigation Goal Standard</td>
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<td>Development of the model</td>
<td>Developing policy causal links</td>
<td>World Resources Institute Policy and Action Standard</td>
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<td>Development of model</td>
<td>Developing reference scenario</td>
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<td>scenarios</td>
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<td>Data input and model calibration</td>
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<td>Policy implications from</td>
<td>Model results and limitations</td>
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<td>model output</td>
<td>Developing current policy scenario</td>
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<td></td>
<td>Developing enhanced policy scenario</td>
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1.3 Limitations of the Study

The model does not estimate emissions from the Agriculture, Forestry and Other Land Use (AFOLU) sector, given that the effort needed to undertake a detailed forecasting exercise for the sector warrants a separate study and set of expertise. Moreover, there is a lack of clarity as to whether agriculture emissions have been included in the NDC targets, given that emissions from agriculture were specifically excluded in India’s voluntary Copenhagen pledge for 2020 (Government of India, Ministry of Environment and Forests 2010). So, although the report indicates the extent to which different policies contribute to the emissions intensity target in percentage reduction terms, through the study results it is not possible to predict to what extent India would exceed the NDC target if the AFOLU sector were to be included. It may be noted that a similar approach was applied by the former Planning Commission of India in 2014, which excluded AFOLU sector emissions when estimating emissions intensity per unit of GDP for India.

The GHG emissions that have been modeled include methane, nitrous oxide, and carbon dioxide only because they are the three most dominant GHGs and together contributed to 98 percent of India’s GHG emissions inventory in 2010. Although emission of hydrofluorocarbons (HFCs) is also high, these were not considered due to constraints on data availability. The model does not consider technologies that are not yet available in the Indian market due to commercial nonviability; for instance, carbon capture and storage. Some policies could also not be modeled due to modeling constraints, such as policies aimed at increasing the penetration of electric vehicles in road transportation. However, if implemented, these policies are likely to contribute further to reducing the emissions intensity of the country in the short or long term.

Outside of the model, other limitations we faced while conducting the study included lack of data needed to fully understand the GHG emissions intensity targets (described in Section 3), complexity in determining the cobenefits of policies quantitatively, lack of data for quantifying many key indicators associated with selected policies, and lack of explicit review of consistency with respect to Paris goals (i.e., we did not assess whether India’s emissions trajectory is consistent with limiting the global warming to well below 2°C). Although we did not explore in detail the linkages and impacts on other developmental indicators, such as energy access, jobs, air quality, and so on, which are critical cobenefits of policies from a developing country standpoint, we hope to pursue the same as a follow-up to this report.

2. BACKGROUND ON THE CLIMATE POLICY FRAMEWORK IN INDIA

2.1 National Policy Framework

Although India continues to face daunting developmental challenges that override other priorities, it has also taken several key steps to address the challenge of climate change. The Prime Minister’s Council on Climate Change was set up in 2007. This high-level advisory group involving representatives from the government, industry, and civil society was formed to coordinate the national action plans for assessment, adaptation, and mitigation of climate change. In 2008, the council launched the NAPCC, which outlined eight national missions to promote sustainable development and simultaneously yield cobenefits for climate change. The government approved these missions between 2010 and 2014 (Shakti 2015). Under the NAPCC, various policies, programs, and initiatives have encouraged sector-specific climate change actions in the country.

Prior to the meeting of the Conference of the Parties (COP) in Copenhagen in 2009, the Government of India strengthened the nation’s commitment by announcing a voluntary goal to reduce the carbon emissions intensity of GDP by 20 to 25 percent by 2020, relative to 2005 levels. This was followed by the establishment of an expert group on low-carbon strategies for inclusive growth by the erstwhile Planning Commission of India to provide sector-specific recommendations for the formulation of the country’s five-year plan. The Government of India also introduced a clean energy cess, which is an earmarked tax on coal, lignite, and peat to be levied on both domestically produced and imported coal. The proceeds are to contribute to a non-lapsable National Clean Energy Fund (now renamed National Clean Environment Fund, or NCEF), established to finance research and development (R&D) and innovative projects that promote clean energy technologies.

The announcements in the Union Budget of 2015–2016 also provided impetus to India’s low-carbon growth efforts by strengthening renewable energy targets. The target for generation of electricity from solar energy was increased fivefold from 20 gigawatts (GW) to 100 GW by 2022, while the total renewable energy target was revised to 175 GW of installed capacity by 2022. Several other policies, such as the clean environment cess on coal, were also realigned to create an enabling environment for achieving
these targets. From 2018—2019 onward, the budget is also expected to have a climate-change budgetary supplement separately accounting for investment on climate change activities (Sethi 2017).

Prior to COP 21 in Paris in December 2015, India submitted its Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention on Climate Change (UNFCCC), outlining the country’s post-2020 climate actions. When India formally joined the Paris Agreement on October 2, 2010, the word Intended was dropped, and it became a Nationally Determined Contribution (NDC). India’s NDC builds on its goal of installing 175 GW of renewable power capacity by 2022 by setting a new target to increase the country’s share of non-fossil-based installed electric capacity to 40 percent by 2030 (with the help of international support). The NDC also commits to reduce India’s GHG emissions intensity per unit GDP by 33 to 35 percent below 2005 levels by 2030, and to create an additional carbon sink of 2.5 billion to 3 billion tonnes of carbon dioxide through additional tree cover (Government of India 2015a). The plan also prioritizes efforts to build resilience to climate change impacts and provides a broad indication of the amount of financing necessary to reach India’s goals.

The year 2015 also emerged as a pivotal year for the climate when the Parties at COP 21 reached an agreement to limit the average global temperature increase to well below 2°C above preindustrial levels and to pursue efforts to limit warming to 1.5°C (Box 1) (UNFCCC 2015). On April 22, 2016, Earth Day, 175 countries, including India, became signatories to the Paris Agreement (UN 2016). On October 2, 2016, the country formally joined the agreement by depositing its instrument of ratification.

The Paris Agreement establishes a mechanism to update NDCs every five years, informed by a global stocktaking of implementation and collective progress and an expectation of progression and ambition. Parties are asked to communicate or update their contributions by 2020 (Waskow and Morgan 2015).

The timeline in Figure 2 captures some of India’s key climate change milestones.

### 2.2 Sectoral Policy Framework

The Indian government has placed sustainable development and low-carbon growth as key priorities in its development planning (Government of India 2015a). The country’s GDP is expected to grow at approximately 7 percent annually (Government of India, Planning Commission 2014b), and there is a clear need to decouple economic growth from growth in carbon emissions. Some of the key initiatives taken by India across the energy, transportation, industry, and waste sectors are highlighted below.

**Energy:** With development, India’s energy demand has almost doubled since 2000 (IEA 2015). Because the energy sector (excluding transportation) contributes to almost 70 percent of India’s GHG emissions (including land use, land-use change, and forestry) (Government of India, Ministry of Environment, Forest and Climate Change 2015), the government has established aggressive targets to increase electricity generation from renewable sources as well as encourage demand-side energy-efficiency measures.

India’s renewable energy targets include installation of 100 GW solar, 60 GW wind, 10 GW biomass, and 5 GW small hydropower by 2022. In the Union Budget
Parties to the 2015 Paris Agreement, which India ratified in October 2016, agreed to hold the increase in global average temperature to well below 2°C, to pursue efforts to limit the increase to 1.5°C, and to achieve net zero emissions in the second half of this century (UNFCCC 2015). Current national commitments are not consistent with these goals; they would set warming on track for 2.6°C to 3.1°C (Rogelj, et al. 2016).

In this context, all countries will need to consider how to align their emission trajectories and national development pathways with the Paris Agreement goals. The agreement invites Parties to communicate or update their national commitments by 2020 and to strengthen them every five years thereafter. Additionally, by 2020, Parties are invited to communicate "mid-century long-term low GHG emissions development strategies," or "long-term strategies." In August 2016, India indicated its intent to develop such a strategy (UNFCCC 2016).

How countries implement their current commitments, which primarily target the period through 2030, will determine the cost and feasibility of bringing about the Paris goals. One consideration is the time it takes for infrastructure, such as power plants, buildings, and vehicle fleets, to reach the end of its life span and be replaced. If mitigation targets are met by making incremental improvements in the emissions intensity of fossil-fueled infrastructure, the infrastructure could lock in emissions for decades to come. Replacing such technologies with emissions-neutral alternatives before the end of their life spans would be expensive, but waiting until the end of their life spans could put the Paris goals at risk.

Long-term strategies provide an opportunity for countries to think through what the Paris goals mean for their own emissions trajectories and, in turn, what this implies for how to implement their mitigation targets. Developing such strategies can help countries prepare for more ambitious commitments by 2020, save money by avoiding investments that are inconsistent with achieving net zero emissions, and foster innovation by sending the right signals to the private sector (Morgan et al. 2015).

According to Levin et al. (2015), important factors to consider in developing such a strategy include:

- When to peak emissions: IPCC scenarios compatible with 430—530 and 530—630 ppm show all regions of the world peaking CO$_2$ emissions by 2020 (IPCC 2014).
- When to phase out net GHG emissions: To have a likely chance of limiting warming to 1.5°C, global carbon dioxide emissions must reach net zero by 2045—2050, and global total GHG emissions by 2060—2080 (UNEP 2015b). For a likely chance of limiting warming to 2°C, the same milestones must be met no more than 15 to 20 years later.
- How to achieve a realistic decarbonization rate: Countries would need to ensure that the annual rate of emissions decline is feasible and avoid relying on overly steep reductions in later years, which would be costly and may not be technologically and socially feasible.
- How to limit cumulative emissions: Temperature increase is directly related to total emissions over time, rather than emissions in a single target year such as 2030. Setting regular milestones can help ensure that long-term strategies consider the need to limit cumulative emissions.

Box 1  |  The Paris Agreement Temperature Goals: Context for India's GHG Emissions

Parties to the 2015 Paris Agreement, which India ratified in October 2016, agreed to hold the increase in global average temperature to well below 2°C, to pursue efforts to limit the increase to 1.5°C, and to achieve net zero emissions in the second half of this century (UNFCCC 2015). Current national commitments are not consistent with these goals; they would set warming on track for 2.6°C to 3.1°C (Rogelj, et al. 2016).

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- When to phase out net GHG emissions: To have a likely chance of limiting warming to 1.5°C, global carbon dioxide emissions must reach net zero by 2045—2050, and global total GHG emissions by 2060—2080 (UNEP 2015b). For a likely chance of limiting warming to 2°C, the same milestones must be met no more than 15 to 20 years later.
- How to achieve a realistic decarbonization rate: Countries would need to ensure that the annual rate of emissions decline is feasible and avoid relying on overly steep reductions in later years, which would be costly and may not be technologically and socially feasible.
- How to limit cumulative emissions: Temperature increase is directly related to total emissions over time, rather than emissions in a single target year such as 2030. Setting regular milestones can help ensure that long-term strategies consider the need to limit cumulative emissions.

of 2016—2017, the clean environment cess on domestic and imported coal was doubled, and the proceeds will be used to finance clean energy and environment initiatives. Trading of Renewable Energy Certificates (RECs) is another mechanism that was introduced to accelerate the installation of renewable energy at competitive prices.

Because coal will continue to account for a major share of India’s installed capacity in the near future, coal beneficiation, as well as use of supercritical technology, is being made mandatory for new plants. Renovation, modernization, and life extension of existing old power stations is being undertaken in a phased manner. In December 2015, more stringent emission standards on particulate matter, SO$_2$, NO$_x$, and mercury from coal-based thermal power plants have been introduced (Government of India 2015b).

The Energy Conservation Building Code (ECBC) was introduced in 2007 to encourage more energy-efficient building construction and design. For industry, the government has set up the domestic cap-and-trade mechanism Perform, Achieve, and Trade (PAT) scheme targeting energy-intensive industries. The Unnat Jyoti Affordable LEDs for All (UJALA) scheme, previously known as the Domestic Efficient Lighting Programme (DELP), is another demand-side measure promoted by the government that aims to replace all incandescent bulbs with energy-efficient light-emitting diodes (LEDs) by 2019.

Transportation: Demand for reliable transportation services for freight as well as passenger traffic is expected to increase in India, leading to higher energy consumption and corresponding GHG emissions, if no action is taken to decouple growth and emissions. The National Transport Development Policy Committee
projects total freight traffic to grow at 9.7 percent per annum to reach over 13,000 billion tonne-km in 2031–2032 and total passenger traffic to grow at about 15 percent per annum to reach 168,875 billion passenger-km in 2031–2032 (Government of India 2014a). The sector currently accounts for 10 percent of total GHG emissions in the country. To arrest this growth, the government has introduced a range of interventions in the passenger as well as freight transportation segments. Fuel consumption standards have been announced to improve vehicle efficiency, and an infrastructure cess is being implemented to discourage purchase of fossil fuel–based vehicles. The Faster Adoption and Manufacturing of (Hybrid) and Electric vehicles (FAME) program, under the National Electric Mobility Mission Plan (NEMMP) 2020, aims to encourage adoption of electric and hybrid vehicles through demand-side incentives and technology development. Mass Rapid Transit Systems and Dedicated Freight Corridors (DFCs) are also under development in many cities to induce modal shift within the passenger and freight segments respectively.

**Industrial Processes:** Industrial process emissions contribute to almost 9 percent of India’s total GHG emissions. The iron and steel and cement industries are the major contributors within the sector. Although cement production units in India are among the most efficient in the world, there is potential to reduce emissions further from iron and steel production. The government launched the “Make in India” program in 2014, to streamline the industrial sector through innovations, investments, intellectual property rights, infrastructure development, and increases in domestic manufacturing capacity. Subsequently, in 2015, the Zero Effect, Zero Defect program was launched as part of the Make in India campaign.

**Waste:** The waste sector in India accounts for 3.5 percent of the total GHG emissions (Government of India, Ministry of Environment, Forest and Climate Change 2015). The main sources of emissions in this sector are methane emissions from anaerobic decomposition of municipal solid waste and wastewater from the industrial and domestic sectors. In 2015, the government launched a major program called the Swachh Bharat Mission to eliminate open defecation, eradicate manual scavenging, practice modern and scientific solid waste management techniques, and bring about behavioral change in sanitation practices across rural and urban India. The Solid Waste Management Handling Rules of 2016 have also been revised to tackle waste disposal issues. The Ministry of Environment, Forest, and Climate Change (MoEFCC), in collaboration with the German Development Agency, is in the process of developing a sectoral Nationally Appropriate Mitigation Action for waste management, recycling, and energy production from waste.

As we can see, the sectoral coverage of India’s climate policies is diverse and covers each emission-intensive sector of the economy. Section 4 explores the efficacy of implementation of these policies. Section 5 explores the contribution of some of these key policies to the 2030 emissions intensity target described in Section 3.

**3. ANALYSIS OF NATIONAL MITIGATION GOALS**

**3.1 India’s Voluntary and NDC Emissions Intensity Pledge**

In 2009, India made a voluntary pledge to reduce the emissions intensity of its GDP by 20 to 25 percent from a 2005 base year by 2020. In its NDC submission in 2015, the country committed to reducing the emissions intensity of its GDP by 33 to 35 percent by 2030, relative to the same base year.

To assess the progress made toward achieving these GHG emissions intensity reduction targets, we followed the guidelines and provisions of the Greenhouse Gas Protocol’s Mitigation Goal Standard. This standard provides a standardized approach for assessing and reporting progress toward the achievement of national and subnational mitigation goals. The application of the standard is also useful as it provides valuable insights on the clarity and sufficiency of information available to understand mitigation goals, as well as the scope of metrics that must be tracked to credibly and reliably report progress toward the goal. Hence, the standard’s application enables understanding of where information and process gaps still exist, thus indicating areas for improvement.

The official indication of progress in terms of these goals is given in India’s first Biennial Update Report (BUR), which states that the emission intensity of GDP fell by 12 percent from 2005 to 2010 and India is on course to meeting the voluntary target of 20 to 25 percent reduction in emission intensity of GDP by 2020. However, no other background information is provided as to how this was calculated. Official inventory estimates are available only for 1994, 2000, 2007, and 2010:
In 2004, India submitted its initial national communication (for the 1994 emissions inventory).

In 2010, India brought out a GHG emissions report prepared by the Indian Network of Climate Change Assessment to present updated inventory estimates (for the 2007 emissions inventory).

In 2012, India submitted its second (for the 2000 emissions inventory).

In 2016, India submitted its first BUR (for the 2010 emissions inventory).

However, no inventory is available for the year 2005 or any of the other intermediate years. Hence, we have interpolated emissions between the years for which official inventories are available to estimate emissions for the intermediate years. According to official estimates for the years for which data are available, India’s total GHG emissions, including AFOLU, are shown in Figure 3. The trend in India’s GHG emissions intensity (per unit of GDP) is shown in Figure 4.

Although a summary of the GHG mitigation goals is presented in Table 1, the results of the application of the GHG Protocol Mitigation Goal Standard are presented in the Appendix. Our evaluation of the GHG emissions intensity goal revealed significant issues with transparency and accountability. Much of the information required for monitoring progress toward India’s target is not publicly available; there is a lack of clarity on emissions intensity in the base year (2005) and the allowable emissions in the target year (2030), as well as in the scope and coverage of the intensity target and the methodologies for measuring it. To improve transparency, the following specific gaps need to be addressed:

More clarity is needed in published reports from MoEFCC on India’s emissions in 2005. The BUR interpolates it based on emissions of 2000 and 2010, but the method used for this interpolation is not clear, whether linear or exponential.

The NDC does not clearly specify whether agriculture emissions are to be included within the goal boundary, as was clearly specified in the Copenhagen voluntary pledge.

The gases covered within the scope of the goal need to be clearly specified. The BUR includes CO₂, CH₄, N₂O, HFC-134a, HFC-23, CF₃C₂F₆, and SF₆ emissions, but it is unclear whether base year emissions include these gases.

The treatment of purchases and sales of transferable emissions units, such as offset credits generated from emission reduction projects or programs (for example, Clean Development Mechanism projects), needs to be clarified.

The treatment of emissions and removals from the land sector is not clear. How land sector emissions

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**Figure 3 | India’s National Greenhouse Gas Inventory, 1994–2010**

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Sources: India’s Initial National Communication to the UNFCCC; India’s Second National Communication to the UNFCCC; India: Greenhouse Gas Emissions 2007 prepared by MoEFCC; and India’s first BUR to the UNFCCC.
and removals are incorporated into the mitigation goal (treated as the goal boundary, treated as a separate sectoral goal, treated as an offset, or not accounted for) can have a significant impact on the overall reductions that would be achieved because of the goal.

Overall, India could improve the transparency of its mitigation goals by providing additional information that more closely follows the Lima Call for Climate Action (UNFCCC 2014) and the WRI’s Open Book framework (WRI 2015) (which is based on the Lima Call for Climate Action) and by detailing all relevant assumptions and methodologies. The next section presents an assessment of how India’s existing key mitigation policies could be improved to enhance effectiveness.

4. ANALYSIS OF KEY MITIGATION POLICIES

In this section, we explore the current policy environment to evaluate its potential for supporting an ambitious program of decarbonization and energy efficiency in the Indian economy. We assessed 10 key programs,
policies, and initiatives that have been launched under the NAPCC, India’s flagship program on climate change. They range from a sector-wide cap-and-trade program for the industry sector, to modal shifts in the transportation sector, to a targeted plan to introduce more efficient lighting. For each policy, we provide a brief overview of its aims and quantified goals where applicable, review the current state of implementation progress, and look ahead to assess the prospects for the policy in terms of meeting its planned objectives and contributing to India’s overall climate mitigation goals.

The 10 policies, and their organization under the national missions of the NAPCC, are shown in Figure 5. Our overall finding is that, while the government has established ambitious goals, especially related to renewable energy, its key climate policies have witnessed varying levels of implementation success. In the renewable energy space, while Jawaharlal Nehru National Solar Mission (JNNSM) has progressed well, the REC market has witnessed low participation due to various reasons, such as the financially distressed nature of distribution companies and lack of Renewable Purchase Obligation (RPO) enforcement. Similarly, in the energy-efficiency space, the UJALA scheme has done well to reduce prices of LED bulbs in the market, and the PAT Scheme has prompted industries to implement energy-efficiency measures. However, the ECBC has not yet achieved its full potential, because only a few states are mandating its enforcement.

The Government of India places great emphasis on

Figure 5 | Key Mitigation Policies under the NAPCC
transfer of technology and availability of low-cost international finance to meet its NDC. Some of clean technologies identified for transfer relate to clean coal, nuclear power, and renewable energy, including energy storage (Government of India 2015a). Storage technologies are particularly necessary in India for rapid scaling up of renewable energy. However, several barriers still exist to the transfer of technologies to developing countries, with the major one being intellectual property. Another barrier in use of new technologies is their costs of deployment, as those costs may be higher than available alternative technologies, thus requiring the availability of low-cost finance (Nanda and Srivastava 2011).

Table 2 presents an overview of the implementation status and progress of India’s 10 key climate policies. Each of India’s 10 key climate policies is reviewed in more detail below, based on the framework outlined in the WRI working paper “Climate Policy Implementation Tracking Framework” (Barua et al. 2014). Applying this framework allows us to monitor the progress of India’s policies over time against related milestones and identify barriers to policy implementation. Refer to Appendix 2 for the full application of this framework.

4.1 JNNSM

Overview:
In January 2010, the JNNSM was the first mission to be operationalized under the NAPCC. Using a three-phase approach, the mission’s objective is to establish India as a global leader in solar energy by creating the policy conditions for solar technology diffusion across the country as quickly as possible. The initial target of the mission was to install 20,000 megawatts (MW) of grid-connected solar power plants, including rooftop plants, by 2022. However, in early 2015, the government significantly enhanced the target to 100,000 MW to be achieved by the same target year (Government of India, Ministry of New and Renewable Energy 2015). However, it should be noted that the NDC target of 40 percent non-fossil-fuel-based power capacity by 2030 is a different type of target and hard to translate into terms comparable to the JNNSM target (Khosla and Dubash 2015).

State governments also have a crucial role to play in implementation of the mission through notification of solar energy policies that provide incentives to developers for installation of solar power projects. Implementation progress of the mission is monitored by the MNRE.

Progress to date:
A range of policy instruments has been adopted to implement this mission. First, an RPO was mandated for distribution utilities with a specific solar component. The recent revision to tariff policy requires all states to reach 8 percent solar RPO by 2022 (Government of India 2016a). Second, bundling schemes have been launched whereby cheap unallocated power from central power stations is bundled with more expensive solar power for sale to distribution utilities. The first phase of the mission opted for a reverse bidding mechanism. Reverse bids (discounts) on benchmark tariffs set by the Central Electricity Regulatory Commission (CERC) were invited from prospective project developers. Third, solar water heaters and rooftop systems have been promoted in certain commercial and residential areas through regulatory intervention, such as mandates under building bylaws and incorporation in the National Building Code. Fourth, off-grid and rooftop solar applications have been promoted through provision of subsidies from the central government. Finally, R&D is also being encouraged through approvals of R&D projects and the establishment of Centers of Excellence by the MNRE.
The decline in solar power prices in India has exceeded the expectations of most analysts and assisted in accelerated deployment of solar power through the mission. The minimum bid price for solar power began at INR 10.95/kWh (US$0.17/kWh) during the bidding of Phase 1, Batch 1, in December 2010; it fell as low as INR 4.351/kWh ($0.07/kWh) in January 2016 for the 420 MW bundling scheme in Rajasthan and INR 2.97/kWh in February 2017 for 750 MW Rewa Ultra Mega Power Limited (Mondal 2017). The prices fell further in this fiscal year to INR 2.62/kWh for the Bhadla Solar Park (Phelan Energy Group, Avaada Power) and INR 2.44/kWh for the 500 MW project in Rajasthan (Acme Solar Holdings, SBG Cleantech), which is lower than the average tariff of coal-based power. However, on average, the price of solar-based power generation is still higher than coal-based energy generation due to additional costs arising from grid integration as well as land acquisition.

Looking ahead:

Rapid developments are taking place in the field of solar energy, such as improvements in efficiency and concentrated solar power technology. These are likely to have positive spillover effects in countries like India as well. In April 2016, the MNRE announced year-on-year solar capacity targets, which chart a road map for achieving the country’s 2022 goal (Figure 6). The Draft National Electricity Plan, which has been prepared by the Central Electricity Authority, covers the electricity plan for 2017–2022 with details for renewable energy integration and a perspective for the period beyond 2022. India’s total installed renewable power capacity stands at 57 GW, so the country will need to significantly ramp up the pace of renewable capacity additions, from an average of 11 GW as envisaged originally to at least 24 GW per year to meet the 2022 target. With the rapidly falling solar tariffs, there is clear indication that solar energy is poised to attain grid parity and may heavily outplace thermal power in India, thereby helping overachieve the non-fossil-fuel installed capacity target by 2030.

However, there are barriers that still need to be overcome, including the scarcity of available land, challenges in grid integration and availability, high transmission losses, scarcity of low-cost finance and domestic manufacturing capacity, as well as the lack of supporting infrastructure and skilled manpower. Technological barriers and cost overruns faced by developers have also inhibited the uptake of solar thermal power plants in India. The government needs to focus on significant strengthening of the planning infrastructure, including planning policy, institutions, resources, and protocols, and invest judiciously in power grid infrastructure for transmission to enable smart supply-and-demand management. Greater R&D investments in commercially viable energy storage solutions could also help enhance grid stability in the future. Further, new conventional generation capacities should be incentivized to have flexibility in generation (in terms of ramp rates and minimum thresholds) and lower fixed costs with higher variable costs to be able to accommodate generation from solar power stations. Gas and hydro-based generators need to also be planned strategically to meet the needs of flexibility.
4.2 REC Mechanism

Overview:
The Electricity Act of 2003, the National Electricity Policy, and the Tariff Policy all promote the adoption of renewable sources of energy for electricity generation. The Electricity Act has mandated the respective State Electricity Regulatory Commissions (SERCs) to ensure a minimum percentage of renewable energy in the electricity mix in their states. This mandate, known as the RPO, is based on the potential for generation of renewable energy in each state, and the SERCs have prescribed these RPOs for distribution licensees in the states. To address the potential gap between the requirements placed on the distributers and the availability of renewable energy, the government has introduced the framework of RECs. Renewable energy generators that opt for participation under the REC mechanism must forgo any preferential tariffs or incentives. Instead, they receive RECs for their renewable electricity generation, which can be sold to any RPO entity and are then recognized toward their RPO compliance. Progress toward meeting of RPOs is tracked by the respective SERCs for each state.

Progress to date:
The Indian Energy Exchange launched trading for RECs in February 2011 through a double-sided closed auction. Initially, the floor and ceiling prices were set at INR 12,000/MWh ($185/MWh) and INR 17,000/MWh ($262/MWh) respectively for solar certificates and INR 1,500/MWh ($23/MWh) and INR 3,900/MWh ($60/MWh) respectively for non-solar certificates based on the Average Power Purchase Cost and minimum price for viability of renewable energy. Due to the decline in solar energy prices, the floor and ceiling prices for solar certificates were revised down to INR 9,300/MWh ($144/MWh) and INR 13,400/MWh ($207/MWh) respectively in August 2011 and further slashed to INR 3,500/MWh ($54/MWh) and INR 5,800/MWh ($90/MWh) respectively in December 2014. Older projects that were constructed prior to December 2014 were allowed a vintage multiplier to recover their higher capital costs.

The initial months of REC trading saw the sale bids exceeding the supply and certificates selling at prices closer to the ceiling level. However, as more renewable energy generators were accredited and certificates issued, supply began to exceed demand in the market, resulting in accumulation of a large volume of unsold RECs with
developers. The lack of enforcement of RPOs or a lack of stringent penalty structure for noncompliance has also resulted in state electricity retailers (DISCOMs) not complying with their RPO targets, leading to persistently low levels of demand for RECs. As an example, the average numbers of sell bids for solar and non-solar segments in the first five months of 2016 were 2,346,373 and 7,616,465 respectively, much higher than the buy bids during the same period of 46,343 and 264,960 respectively (Indian Energy Exchange 2016). Thus, all trades for solar and non-solar certificates have been taking place at the floor price since as far back as June 2013.

Looking ahead:
The REC mechanism, in principle, has significant potential to scale up its installation at competitive costs, using market mechanisms. However, it has not seen success to date, and it appears unlikely that the situation will improve soon unless the regulatory authorities intervene with more stringent enforcement of RPOs and penalties for noncompliance. RPO enforcement could be monitored periodically to ensure that all states are meeting their obligations. A proposal for this is under discussion wherein the CERC would monitor compliance with RPO targets by state-owned DISCOMs and present the results on a website (Upadhyay 2017).

Another proposal under discussion is to prepare a separate power-trading platform to help states buy, sell, and trade renewable-based power and meet their RPOs. This model would then subsume the REC mechanism (Jai 2016). It is also important to address accounting issues in the mechanism. For example, there is no agreed format for calculating or accounting for RPO compliance. While some states double count open access renewable energy, others do not apply such a practice.

Figure 7 shows the growth in installed renewable energy capacity since 2000 and the growth required to meet India’s target for 2022.

4.3 Clean Environment Cess

Overview:
A clean energy cess (renamed the clean environment cess in April 2016) was introduced on domestically produced and imported coal, lignite, and peat in the Union Budget for 2010–2011. Initially set at INR 50 per tonne ($0.77 per tonne), the cess has been doubled each year since April 2014; as of April 2016, it stands at INR 400 per tonne ($6.17 per tonne). The proceeds of the cess support the NCEF, established under the Ministry of Finance to fund R&D and innovative projects that promote clean energy technologies (Government of India, Ministry of Finance 2011). The NCEF’s mandate has recently been expanded to include other clean environment initiatives. Projects are appraised by an inter-ministerial group (IMG) consisting of representatives from the Ministry of Finance, the Principal Scientific Advisor, and line ministries concerned with the specific proposal. To monitor the progress of funded projects, the IMG identifies and appoints appropriate professional agencies.

Progress to date:
The NCEF’s functioning was initially criticized both for underutilization and for the way in which it is operated and administered. An assessment conducted by the National Institute of Public Finance and Policy noted that the allocations made by the fund, such as environmental pollution remediation projects and support for deployment of renewable energy, were not in line with the main objective, which was to stimulate R&D in clean energy. The institute’s assessment also noted several shortcomings in the structure and operation of the fund, such as lack of vision, lack of a dedicated team for administration, and no encouragement for leveraging other sources of finance (Pandey et al. 2013).

The total funds expected to be generated by the cess through March 2017 amount to INR 54,336.17 crores ($9 billion) (Government of India, Ministry of Finance 2017). As of April 2015, the IMG has approved projects requiring total funding support of INR 34,811.19 crores ($5.8 billion), and these are primarily from the MNRE, such as solar photovoltaic electricity generation (Government of India, Ministry of Coal 2016). Further, only 74 percent of this amount (INR 25,810.46 crores, or $4.3 billion) has been transferred to NCEF, and the amount disbursed is even lower at around 26 percent (INR 9,021.04 crores, or $1.5 billion).

Looking ahead:
In the future, the fund is likely to finance environmental initiatives such as the Namami Gange Programme to arrest pollution of the Ganga River and to revive it. Considering the
barriers, considering the barriers to effective use of the NCEF fund, a clear fund vision, better communication strategy, and a transparent institutional process to allocate funds to renewable energy projects, environment initiatives, and R&D projects should be established. The process should provide dedicated administrative support and establish checks and balances for funds collected, project selection, and fund disbursement. To ensure effective fund utilization, the funds can be released on project progress evidence, such as project progress reports. Focus on improved communication with other ministries, state government departments, and the private sector can be used to encourage participation.

4.4 PAT Scheme

Overview:
The National Mission on Enhanced Energy Efficiency (NMEEE), one of the eight missions under the NAPCC, envisaged a domestic cap-and-trade scheme called the PAT scheme to incentivize energy-efficiency initiatives among the energy-intensive sectors of the economy. After extensive baseline data collection, benchmarking, and stakeholder consultations, the MoP, in consultation with the BEE, rolled out the scheme on March 31, 2012. Plants were given a target for reduction of their specific energy consumption, that is, net energy consumed per unit of output generated. At the end of the three-year compliance cycle, plants that overachieve their target would be issued Energy Saving Certificates (ESCerts) that can be traded over a market exchange. Plants that do not meet their target can either purchase such ESCerts or pay the penalty imposed by regulatory authority. The BEE is the market regulator and administrator for the PAT Scheme.

Progress to date:
The first three-year cycle of the scheme (March 31, 2012
to March 31, 2015) set a target for 478 plants across eight energy-intensive sectors; namely, aluminum, cement, chlor-alkali, fertilizer, iron and steel, pulp and paper, textiles, and thermal power production. Collectively, these plants had a baseline energy consumption of 164.97 million tonnes of oil equivalent (mtoe), and they were required to reduce energy consumption by 6.686 mtoe, amounting to a reduction of about 4 percent. In the first phase, presentations from officials indicate that, among the assessed plants, all sectors with the exception of thermal power generation have met their target with an overachievement of the target by about 30 percent (Government of India, Ministry of Power 2016a). The trading of ESCerts is expected to start in 2017 with the announcement of the trading rules by the CERC in May 2016. It remains to be seen whether plants that have overachieved their targets choose to sell their ESCerts or hold them for use in the next cycle, given that the overachievement of targets by each sector overall may not be able to generate demand to support an efficient trading market in the first phase.

Looking ahead:
The second three-year cycle of the PAT Scheme was announced on March 31, 2016. In this phase, the number of sectors has been increased to 11 with the inclusion of electricity distribution companies, petroleum refineries, and railway companies. The number of plants subject to targets has been increased to a total of 621, with a baseline energy consumption of 227 mtoe. The new target energy savings are 8.869 mtoe, again amounting to a reduction of about 4 percent (Government of India 2016b). Interactions with BEE officials have also indicated that going forward, they would not wait for the three-year cycle to lapse before notifying new units. Such units would be notified of their targets at the beginning of the financial year and would need to comply with them over a period of three years from the time of being notified. Monitoring and verification procedures should be completed in a regular and timely manner, along with trading of ESCerts, to bring further clarity and visibility to industry participants on costs of meeting the notified targets.

4.5 Fuel Efficiency Standards

Overview:
In January 2014, the MoP, in consultation with the BEE, announced average fuel consumption standards for fossil fuel–based passenger cars with up to nine seats (including the driver’s seat) and a gross vehicle weight less than 35,000 kg (Government of India 2014b). These fuel consumption standards have been specified in terms of average fuel consumption (petrol-equivalent liters per 100 km) across the entire fleet of manufactured or imported vehicles of a manufacturer in a fiscal year. The calculation of the threshold vehicle value is dependent on the unladen mass of the vehicle and other constants announced from time to time by the MoP in consultation with the BEE. These standards will have a significant impact on India’s GHG emissions profile, as the country’s passenger vehicle market is expected to grow at a compound annual growth rate (CAGR) of 12 percent to 5 million units by 2020 (Thakkar 2014). The Ministry of Road Transport and Highways would be enforcing the standards under the Central Motor Vehicle Rules of 1989.

Progress to date:
While these standards were initially expected to come into effect in April 2016, they were delayed due to inter-ministerial conflicts and pressure from the automobile industry to allow manufacturers another year for implementation (Chauhan 2014).

Looking ahead:
Although the standards for passenger vehicles came into effect in April 2017, the standards for heavy-duty vehicles are still under development and are likely to come into effect in 2020 (although India’s road transportation ministry has yet to fix a timeline for the rollout of heavy-duty vehicle fuel economy standards). Passenger vehicles currently run at an average fuel consumption of about 16 km/liter, and following introduction of the new standard, the average is expected to improve to 18.2 km/liter by 2017–2018 and 22 km/liter by 2022–2023.
The BEE estimates that this improvement will result in an estimated saving of about 20 million tonnes of fuel by 2025 (Chauhan 2014). The BEE is also proposing to introduce a fuel economy star rating for passenger vehicles that will inform consumers about vehicle mileage. Manufacturers are gearing up for these standards and are likely to start venturing into electric and hybrid vehicles as well.

Eight countries—Japan, the United States, Canada, China, South Korea, Mexico, Brazil, and India—plus the European Union, have established or proposed fuel economy or GHG emission standards for passenger vehicles and light commercial vehicles/light trucks. Figure 8 shows how India’s target compares with standards in these other entities. While India’s current fuel economy standards lag behind other countries, it is poised to be a leader in light-duty vehicle fuel economy standards by 2024, just second to the European Union.

### 4.6 DFCs

**Overview:**

The Golden Quadrilateral network of Indian railways connects the cosmopolitan cities of Delhi, Mumbai, Kolkata, and Chennai. Although it represents only 16 percent of the country’s rail network, it carries nearly 58 percent of freight traffic. The Ministry of Railways is planning to meet high and growing demand by expanding the freight network, and it set up the DFCCIL in 2006 as a special-purpose vehicle to undertake planning, development, and mobilization of financial resources, as well as the construction, maintenance, and operation of DFCs. DFCs aim to meet higher demand at lower per-unit cost with reduced impact on the environment. The total cost of the DFC is estimated at INR 81,459 crore ($13.6 billion), covering a track length exceeding 3,300 km.

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**Figure 8 | Comparison of Vehicle Efficiency Standards for Light Vehicles**

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<tr>
<th>Country</th>
<th>Fuel Efficiency Standards (km/liter)</th>
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<td>India</td>
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Progress to date:
The DFCCIL was set up in 2006 and, according to original timelines, was supposed to be completed by 2011 at an estimated cost of INR 28,181 crores ($4.7 billion). However, due to various challenges, there has been a significant time overrun as well as cost escalation (Government of India 2015c). The DFCCIL is working to operationalize two DFC projects, namely, the Eastern DFC (EDFC) and Western DFC (WDFC). The EDFC project of 1,856 km connecting Ludhiana to Dankuni has secured a loan, from Japan’s International Cooperation Agency, and the WDFC project of 1,520 km connecting Mumbai to Delhi has secured a loan from the World Bank. The DFCCIL plans to execute both the projects in a phased manner, with each phase involving a traffic projection study, land acquisition, and construction. The intention is to complete 25 percent by March 2018, a further 35 percent by March 2019, and the remaining 40 percent by December 2019. Based on interviews with the DFCCIL, DFC trains will be electric locomotives of approximately 1.5 km length with double-stack containers that can carry about 13,000 tonnes running at a maximum speed of 100 km/h. In comparison, the existing freight trains have a length of 700 meters with single-stack containers of 5,000 tonnes carrying capacity and a maximum speed of 75 km/h. To reduce environmental impact during the construction and operation phases of these projects, trees have been planted on both sides of the tracks; and special measures have been taken in laying tracks in ecologically sensitive zones. For instance, in Aravalli hills, the corridors have been laid below ground, and barricade walls have been put up alongside the DFC near Sanjay Gandhi National Park in Mumbai.

Looking ahead:
Freight traffic projections for the EDFC and WDFC projects estimate that nearly 70 percent of Indian railway freight traffic will shift to DFCs after 2019. Three new freight corridors—i.e., north-south connecting Delhi to Chennai, east-west connecting Kharagpur to Mumbai, and east coast connecting Kharagpur to Vijayawada—are also proposed to be taken up and made high priority to ensure structuring, award, and implementation in a timely manner through innovative financing mechanisms, including public-private partnerships. The ability to address environmental considerations such as air, water, and noise pollution is also an important concern. Raising funds for these upcoming projects might be a challenge due to increased land acquisition costs. (Land acquisition for both the EDFC and WDFC is still under way.) As per the New Land Acquisition Act, the compensation that needs to be paid to land owners is four times the market cost of the land in rural areas and twice the market cost in urban areas. We recommend an increased focus on improved project planning and regular monitoring and evaluation, as DFC projects have been facing significant delays in the past due to their large-scale, complex nature and land acquisition challenges. Improved planning can also help arrest the escalation of project costs due to implementation delays.

4.7 NEMMP

Overview:
The NEMMP 2020 was launched in 2013 by the Department of Heavy Industries to achieve national fuel security through promotion of electric and hybrid vehicles. The plan aims to achieve sales of 15 million to 16 million hybrid/electric vehicles by 2020 (Press Trust of India 2017), which could result in liquid fuel savings of 2.2 million to 2.5 million tonnes and decrease CO₂ emissions by 1.3 to 1.5 percent (Government of India 2013). (At the end of 2015, India only had an electric vehicle stock of 6,000. This includes battery electric cars and plug-in hybrid electric cars; IEA 2016.)

The plan has four focus areas (Puri 2013):

- Demand creation through incentives (cash subsidy) for various electric vehicles and mandates for some segments such as public transportation vehicles
- Domestic manufacturing through various tax rebates such as excise duties or corporate taxes
- Research, development, and demonstration through the creation of center of excellence for accelerated development and tangible outcomes of research work at the component level and pilot projects to test and assess the impact of electric vehicles and spread awareness
- Infrastructure creation through public-private partnerships or private players for power infrastructure and charging infrastructure

Progress to date:
As a complement to this plan, the FAME program was launched in 2015, with a financial outlay of INR 75 crore ($12 million). Phase 1 of FAME, to be implemented by 2017, is under way with funds allocated to technology platform, charging infrastructure, development of pilot projects, and
effective demand incentives. The central government has also formed an IMG to develop a self-financing plan for the complete transition to electric vehicles by 2030 (Press Trust of India 2016a). Prior to the NEMMP, the MNRE had also supported 47,000 new battery-operated vehicles (four-wheelers and two-wheelers) through a subsidy in the form of central financial assistance (Government of India, Ministry of New and Renewable Energy 2013). However, the demand for electric vehicles in India has been sluggish thus far. This may be due to the high initial investment requirement and lack of charging and maintenance infrastructure. Battery technology is still improving, and performance standards (range and speed) for electric vehicles are not yet able to compete with conventional vehicles. Limited domestic manufacturing capabilities and a nonexistent supply chain are also substantial barriers that need to be addressed if uptake of electric vehicles in the country is to be improved.

Looking ahead:

The government recently announced the target to eliminate the sale of petrol or diesel cars by 2030, and through FAME is attempting to make the purchase of electric vehicles an attractive option for consumers. A market for greater consumer acceptance of these vehicles needs to be developed through awareness activities, exchange schemes, and subsidies or incentives. To reduce the high cost of electric vehicles, the government needs to spur localized manufacturing and increase investments in R&D and technology acquisition from other countries. The government is developing pilot projects in select cities, with the intent of replication across the country. Some state governments, such as that of Maharashtra, have committed to waive off-road and registration taxes on electric vehicles to make them more cost-effective (Press Trust of India 2016b).

4.8 ECBC

Overview:

Under the Energy Conservation Act of 2001, the BEE, with support from the MoP, launched the ECBC in May 2007. The ECBC provides voluntary guidelines for minimum energy standards in new commercial buildings with a connected load of 100 kW or contract demand of 120 kilovolt-ampere and above (Government of India, Ministry of Power 2017a). The code aims to encourage adoption of energy-efficient practices in the commercial sector in India and has been harmonized with the National Building Code and building bylaws. Furthermore, respective state governments have the flexibility to modify the code to regional or local needs before notifying the ECBC. The urban local bodies are responsible for code enforcement in their regions.

A voluntary quantified target was introduced in the 12th Five-Year Plan (2012–2017) to make 75 percent of all new commercial buildings ECBC-compliant and to reduce the energy consumption of existing commercial buildings by 20 percent by 2017, which is estimated to result in energy savings of 5.07 billion kWh (Seth 2017). It is also estimated that energy savings of nearly 30 percent can be achieved through technology retrofits alone (Government of India, Ministry of Power 2017b), and mandatory enforcement of the ECBC could reduce energy use by 30 to 40 percent, to 120–160 kWh/m²/year.

Progress to date:

Till December 2016, 10 states have made the ECBC mandatory for commercial buildings through notification in their state gazettes and another 10 states are in the process of notification (UNDP-GEF-BEE). Further, EESL and the Central Public Works Department have launched several projects in states, including New Delhi, Maharashtra, Rajasthan, and West Bengal. The ECBC has been integrated into other rating and compliance systems, such as Green Rating for Integrated Habitat Assessment and Leadership in Energy and Environmental Design.

The implementation of the ECBC faces several barriers (UNDP 2015):

- Policy and institutional: The code is not a mandatory requirement, and in the absence of its notification within the building bylaws, it is unlikely to be implemented to its full potential.
- Technical and managerial capacity: The lack of technical expertise and awareness of energy-saving opportunities discourages builders from implementing this code.
- Materials and technology: The unavailability of energy-efficient equipment and materials with certification in the local marketplace presents a significant barrier to developers, forcing them to import this equipment at higher costs.
- Finances: The higher initial cost of energy-efficient measures is a disincentive to developers, and commercial banks are often unwilling to make loans for projects with uncertain returns and long payback periods for the borrower. This requires development of innovative financing schemes.
Although the government has taken initiatives to encourage the adoption of the ECBC, there is currently no concrete plan for implementation of the code or monitoring and verification of the code once implemented. Moreover, the creation of ECBC cells, which will ensure coordination among all relevant state departments on integration of ECBC provisions within the building regulations, is still in progress. The United Nations Development Programme (UNDP) is currently supporting the BEE in implementation of the ECBC.

Looking ahead:

The BEE prepared a new draft of the ECBC, along with rules that were opened for public comments, that attempted to address some of the existing barriers to implementation (Government of India, Ministry of Power 2016b). This refreshed version of the code (ECBC 2017) was launched in June 2017. Furthermore, the recently launched portal on net zero energy buildings in India, which has been developed jointly by the MoP and the U.S. Agency for International Development, updates and reflects the market changes and technological advancements in the buildings sector (Government of India, Ministry of Power 2016c). This portal has been developed as a knowledge center for the building sector on energy-efficiency standards, practices, technologies, and case studies.

For an effective takeoff of the ECBC across the nation, mandatory ECBC notification in remaining states within the building bylaws, accompanied by their effective enforcement by urban local bodies, is necessary. The high initial cost and concerns related to return on investment for ECBC-compliant buildings can also be addressed through encouragement of technology transfer with developed countries and design of innovative financial schemes between the government and private financial institutions. An effective awareness-generation and capacity-building program should be initiated to develop technical and managerial capacity for implementation of and compliance with the code.

4.9 UJALA Scheme

Overview:

The government launched the UJALA scheme in 2016 to promote energy-efficient lighting in India; the scheme runs alongside the earlier DELP. Through this scheme, the government aims to replace 77 crore (770 million) inefficient lamps with LED lamps by March 2019 (Government of India, Ministry of Power 2016d). The scheme aligns with the NMEEE under the NAPCC and Energy Conservation Act of 2001. EESL, a joint venture between the MoP and distribution Public Sector Undertakings, is the monitoring and implementing agency. Prior to UJALA, the Bachat Lamp Yojana, also managed by EESL, had successfully replaced 30 million incandescent lamps with compact fluorescent lamps. As per estimates of EESL, the implementation of UJALA could result in an annual GHG emissions savings of 80 million tCO₂e (Government of India, Ministry of Power 2016e). State governments can also tie up with EESL to distribute LED bulbs under the UJALA scheme.

Progress to date:

The business model followed by EESL involves a company making a 100 percent up-front investment to procure high-quality 9-watt LED bulbs in bulk at a reduced price and distributing them to customers designated by the state governments at a concessional rate. Each bulb gives the same luminosity as a 9-watt incandescent bulb while consuming less than one-tenth of the power (Government of India, Ministry of Power 2016f). The investment is recovered either through monetization of energy savings or through monthly installments over a seven- to eight-month period. Normally, an LED bulb with a market price of INR 300 ($4.63) is sold at a discounted rate of INR 75 ($1.16). EESL has partnered with distribution utilities to set up outlets and kiosks. EESL has also set up an online dashboard, which captures the number of LEDs distributed in real time (Government of India, Ministry of Power 2017c) as well as the notional energy saved, cost savings, carbon dioxide emissions reduced, and peak demand avoidance.

By March 2016, under UJALA, 8 crore (80 million, or 10 percent of the goal) LED bulbs have been distributed in states, including Maharashtra, Gujarat, and Madhya Pradesh, thereby meeting the MoP’s goal for FY 2016 (Government of India, Ministry of Power 2016g). Moreover, the scheme is progressing so well that its model is already being extended to other energy-efficient appliances, such as fans, air conditioners, and agricultural pumps, among others. The UJALA scheme has already proven to be effective in driving down the price of LEDs, transferring the savings to the customer, and reducing energy consumption and GHG emissions.
Looking ahead:

The UJALA scheme was developed to overcome the barrier of the high cost of LEDs in the market. Through this scheme, the government has ensured that LEDs are available to all households at a reduced cost and has additionally provided innovative repayment schemes such as PAYS, or Pay as You Save.

This model can be developed as a case study or example for the launch of other energy-efficient appliances throughout the nation. With the current rate of market transformation for the UJALA scheme, the market can be ready in the space of a few months, and support from EESL may no longer be required.

4.10 Electricity for All

Overview:

Of the 17 crore (170 million) rural households in India, about 73 percent are electrified (Government of India 2017). The MoP has taken several initiatives in collaboration with state governments with the target of providing 24/7 power supply across India by 2019. Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) and the Integrated Power Development Scheme (IPDS) (Government of India, Ministry of Power 2014a) are two of the major schemes developed to meet this target. DDUGJY is being implemented by the Rural Electrification Corporation Ltd. in rural areas to provide reliable and adequate power supply to farmers by separation of agriculture and nonagriculture feeders and strengthening of subtransmission and distribution infrastructure in rural areas. Separation of feeders leads to better load management and increased power supply for rural households and small industries (World Bank 2013). On independence day on August 15, 2015, the Government announced that the 18,500 electrified villages in the country would be electrified within the next 1,000 days, by May 1, 2018 (Government of India, Ministry of Power 2015). As of August 2016, 98.6 percent of villages have been electrified.

The IPDS, on the other hand, is being implemented by Power Finance Corporation Ltd. and targets urban electrification through reduction of aggregate technical and commercial losses, and strengthening of subtransmission and distribution networks. These schemes have subsumed the previously operational Rajiv Gandhi Gramin Vidyutikaran Yojana scheme for rural electrification and the Restructured Accelerated Power Development and Completion of the Reforms Program for urban electrification respectively. The campaign is monitored by a committee led by the MoP to ensure that the sanctioned projects are completed on schedule.

Between 2014 and 2022, the central government will provide budgetary support of INR 68,900 crore ($11 billion) (Government of India, Ministry of Power 2014b) for implementation of the DDUGJY scheme, and INR 48,081 crore ($7.7 billion) for implementation of the IPDS scheme. The Rural Electrification Corporation Ltd. and Power Finance Corporation Ltd., as the nodal agencies, will execute a tripartite agreement among the MoP, the state government, and the distribution utilities to ensure that the projects are implemented according to the scheme’s guidelines. All distribution companies, including private companies that undertake projects defined under this scheme, can access government funding up to 60 percent of their costs (Government of India, Ministry of Power 2013).

Progress to date:

By March 2016, the government had released INR 144.92 crore ($24 million) (Government of India, Ministry of Power 2014c) under DDUGJY and INR 5,697 crore ($949 million) under the IPDS scheme (Government of India, Ministry of Power 2013). Following the example of the Digital India campaign, Rural Electrification Corporation has developed a Grameen Vidyutikaran, or GARV, dashboard that captures real-time data of electrified and unelectrified villages under the DDUGJY scheme. In April 2016, the data captured showed that 7,292 villages have been connected to the grid, and 678 villages have been connected to off-grid power under this scheme (Government of India 2017). The GARV dashboard has proved to be a useful tool in providing transparent, real-time data on the electrification of villages and the progress toward achievement of the campaign’s goals. The GARV dashboard also includes information about when project milestones have been missed. Other important success indicators of this campaign that are not not being tracked currently include the quality and reliability of power delivery, the efficiency of the electricity distribution (relating to aggregate technical and commercial losses, etc.), and the repair and maintenance of the grid infrastructure. These indicators should be measured, verified, and reported monthly to garner a true sense of the status of electrification in the country.
Looking ahead:
The power sector has immense potential for growth, and the goal of providing electricity to all households can be achieved through proactive involvement of all stakeholders, such as central and state governments, district and village administration, and transmission and distribution companies. The government is focusing on key issues, such as availability of fuel and support to state governments to control transmission and distribution losses. Considering the debt-ridden nature of most distribution companies, a complete financial restructuring may be required.

Under MoP definitions, a village is considered electrified if basic infrastructure such as a distribution transformer and distribution lines are available, electricity is provided to public places, and the number of electrified households is at least 10 percent of the total number of households in the village (Government of India, Ministry of Power 2017d). With this definition, even after achieving 100 percent rural electrification, there may be several households without access to electricity. Thus, it is important for state governments to further consider mini-grids, micro-grids, and home systems in areas the grid has not yet reached or where adequate power is not available in the grid. Currently, in the absence of any specific policy incentives or government prioritization, such systems are at risk of becoming costly and unviable in case the electricity grid also reaches the area before the completion of the project’s life. Thus, state governments should consider having frameworks in place to mitigate such risks and for incentivizing investment in micro-grids. These grids can provide rural communities with additional livelihood opportunities as well.

4.11 Summary of Implementation Progress

Some of the key factors contributing to the success of these 10 climate policies include financial incentives that support the implementation of climate policies (for example, the bundling scheme under the JNNSM, in which cheap unallocated power from central power stations is bundled with the more expensive solar power for sale, or the reduction in LED prices for the consumer under the ULALA scheme); a diverse set of policy instruments that support policy implementation (for example, the JNNSM has at least six instruments that range from R&D stimulus and manufacturing support, to financial incentives and subsidies); and real-time monitoring of the implementation of policies (such as the GARV dashboard under the Electricity for All policy, or the national UJALA dashboard, which tracks the distribution of LEDs).

Some of the shortcomings of these climate policies include unexpected and unforeseen costs (such as increased land acquisition fees for DFCs); lack of enforcement of policy instruments (for example, the lack of enforcement of RPOs or a stringent penalty structure for noncompliance under the REC mechanism); inadequate tracking of disbursement funds (as in the case of the NCEF); and unclear policy implementation plan (as in the case of the ECBC, which lacked a concrete plan to implement, monitor, and verify the code).
5. THREE POSSIBLE FUTURES: THE SCENARIOS AND THEIR UNDERLYING ASSUMPTIONS

To provide a clearer picture of how India’s climate policies could shape the country’s energy future, the study developed three scenarios presenting alternative growth trajectories. The study analyzes the impact of these policies on key variables like economic growth, energy consumption, associated GHG emissions, and energy intensity. Of the 10 policies evaluated in the previous section, the study models 5 selected policies, namely, the cap-and-trade PAT scheme, DFCs, the clean environment cess, the renewable power by 2022 goal, and energy efficiency in the services sector. The modeling scenarios were built assuming 100 percent implementation of these five policies that is, each policy achieving its intended target in a given time. To test the sensitivity of the models, the policy targets were also enhanced, as described in the following section.

Policies like fuel-efficiency standards, the NEMMP, and Electricity for All were analyzed using the OCN implementation analysis tool but were not included in the model due to constraints on availability of input data as well as detailed disaggregation of the Social Accounting Matrix (SAM) that is used as the base for the model. Under the Electricity for All policy, the government aims to ensure around-the-clock power for rural households; however, the impact of this electrification on actual rural consumption of electricity by rural households, such as in terms of affordability, is still unclear. In addition, SAM does not have disaggregation in the use of biomass for cooking and lighting, thus making it difficult to model the impact of rural electrification in terms of increase in expenditure on electricity and decrease in consumption of biomass. Further, the fuel-efficiency standards and the NEMMP are still in the early stages of implementation, making them difficult to model. So it would be fair to assume that the policies not included in the model will still have a marked impact on India’s ability to meet or exceed the NDC targets.

This section introduces the model scenarios developed and the policy assumptions underlying them. We focus on defining each of the three scenarios and briefly explain the methodology that was used in their development.

5.1 The Three Scenarios

Reference Scenario

This scenario represents a reference wherein all future trends are an extrapolation of the performance of the economy from 2007 until 2015, the latest year for which reliable data on macroeconomic parameters were available for input into the Computable General Equilibrium model (implicitly covering all policies that existed before 2014). Although some of the selected five policies, like PAT, came into effect before 2014, their impact is not modeled explicitly in the reference scenario, as these policies were in the very initial stages of execution with almost negligible impact on the economy before 2014. Thus, projections for this scenario were run to 2030, assuming no change in the policy environment and macroeconomic trends existing till 2015.

This scenario is validated through calibration for the period 2007 to 2014 on the major macroeconomic variables of the model, such as GDP at factor cost, total investment in the economy, fossil fuel consumption, electricity demand, and GHG emissions from combustion of fossil fuels. The validation exercise demonstrated that the model reproduced the actual performance of the Indian economy over the period with reasonable accuracy.

Please note that this is not a scenario with any particular policy significance, and neither should it be viewed as a business-as-usual scenario. It is only included for analysis purposes to compare the emission reductions that could be delivered by further implementation of policies as planned.

Current Policy Scenario

This scenario presents the combined impacts of five key policy options over the time frame 2014 to 2030 (i.e., PAT, DFC, clean environment cess, renewable power by 2022, and energy efficiency in the services sector), and the policy parameters reflect the current state of implementation and projected growth rates as specified in official policy documents or anticipated by sectoral experts. Each of the policy options was modeled explicitly with the existing rate of implementation for the years 2014 to 2016, and the rate of policy execution was then accelerated gradually for future years, assuming full (100 percent) implementation of each policy over time that is, each policy realizing its intended target according to the announced timelines. Since these policies were laid out with specific targets in mind, assuming any partial implementation (less
than 100 percent) would not help discover India’s true potential of reducing its emissions intensity if policies were implemented as planned. If any of the five policies fails to achieve its target, this would affect the results quantitatively.

Enhanced Policy Scenario

This scenario presents the combined impacts of the five selected policies in which the policy parameters (implementation targets) for each policy are enhanced to a practical limit that is based on expert judgment (assumptions derived from interviews with experts and government officials), and our policy analysis. Our aim was to develop a scenario that is ambitious and yet remains within the bounds of economic and political feasibility and test the sensitivity of the results to the policy targets. Thus, this scenario assumes even more stringent policy settings than in the reference scenario and current policy scenario (see Table 3).

5.2 Key Assumptions Underlying the Three Scenarios

In the reference scenario of the model, all policies that came into effect before 2014 are implicitly covered. Historical validation of the model, based on a comparison of key macroeconomic variables from 2007 to 2015, establishes that the model reliably simulates the Indian economy. The existing status of these policies has been extrapolated from 2014 onward, assuming no further change in the policy variables. Table 3 presents the assumptions for the reference scenario.

Table 3 | Key Assumptions Underlying the Reference Scenario

<table>
<thead>
<tr>
<th>Variable</th>
<th>Annual average growth rate, 2016-2017</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total investment</td>
<td>2.5%</td>
<td>Investment rate subject to change as per policies considered under reference policies; labour force participation rate as per census (2006) projections. Foreign savings (sum of current account deficit and net transfers to and from abroad) as a percentage of GDP is negative in 2007 as gross domestic savings exceeded gross capital formation in the economy. Thus, a negative growth to these values implies higher inflow (fewer outflows) of income in the economy in the future.</td>
</tr>
<tr>
<td>Foreign savings as a percentage of GDP</td>
<td>(−) 6%</td>
<td></td>
</tr>
<tr>
<td>Total factor productivity growth rate</td>
<td>1.8%</td>
<td></td>
</tr>
<tr>
<td>Energy-efficiency growth rate</td>
<td>1.35%</td>
<td></td>
</tr>
<tr>
<td>Labour wage growth rate</td>
<td>3.8%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reserve Type</th>
<th>Annual growth rate in reserve extracted over base year (2007-2008), assumed to 2030-2031 (averaged over 24 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>10%</td>
</tr>
<tr>
<td>Oil</td>
<td>1%</td>
</tr>
<tr>
<td>Natural gas</td>
<td>14%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Coal cess</th>
<th>Carbon tax equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010–2012</td>
<td>INR 50/tonne</td>
<td>INR 30/tonne</td>
</tr>
<tr>
<td>2013–2014</td>
<td>INR 100/tonne</td>
<td>INR 60/tonne</td>
</tr>
<tr>
<td>2015 onward</td>
<td>INR 200/tonne</td>
<td>INR 120/tonne</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Emission factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal (Central Electricity Authority database)</td>
<td>1.42tCO₂ per tonne of Indian coal</td>
</tr>
<tr>
<td>Crude oil (Planning Commission, 2014)</td>
<td>0.175tCO₂ per tonne of crude oil refined</td>
</tr>
<tr>
<td>Petroleum products (IPCC, 2006)</td>
<td>3.102tCO₂ per tonne of product</td>
</tr>
<tr>
<td>Natural gas (IPCC, 2006)</td>
<td>0.002tCO₂ per cubic meter</td>
</tr>
<tr>
<td>Policies</td>
<td>Reference Scenario</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Perform, Achieve, and Trade</td>
<td>No trading of energy-efficiency certificates prior to 2014; no new distribution companies; no explicit modeling of energy efficiency.</td>
</tr>
<tr>
<td>Dedicated Freight Corridor</td>
<td>No targeted investment towards DFC; no new investment flows to rail; electricity intensity in railways stay at current levels (2014—2015); diesel consumption in road freight transportation stays at current projections (2014—2015); 1.5% energy-efficiency growth rate for railways from 2015 to 2030.</td>
</tr>
<tr>
<td>Renewable power by 2022</td>
<td>No targeted investment toward the objective of achieving the 175 GW target.</td>
</tr>
<tr>
<td>Coal cess (carbon tax equivalent)</td>
<td>Level of cess (carbon tax equivalent): 2010–2013 Rs 50/tonne (Rs 30/tonne), 2014 Rs 100/tonne (Rs 60/tonne), 2015 and onward Rs 200/tonne (Rs 120/tonne); tax redistributed as investment with 40% into solar, 10% into wind, 30% into services, and 20% into the health sector.</td>
</tr>
<tr>
<td>Energy efficiency in the services sector</td>
<td>No improvements in energy-saving potential.</td>
</tr>
</tbody>
</table>
A carbon tax equivalent to the past and existing clean environment cess rates is levied on coal consumption. The rate of this tax is considered the same for all years after 2015. The revenue from the carbon tax is redistributed to renewable electricity sectors, mainly solar.

The total factor productivity growth rate has been assumed to be approximately 3 percent for all major sectors. However, this growth rate becomes approximately 7 percent for solar and nuclear power, keeping in view the targets set by the MNRE.

The energy-efficiency growth rate has been assumed to be 0.3 percent for the electricity sector and 1.5 percent for the remaining sectors of the economy. The government consumption growth rate considered in the baseline scenario is in line with the tenets under the 12th Five-Year Plan.

Table 3 presents other key assumptions in the reference scenario.

The key assumptions and characteristics for the policies modeled in the three scenarios are illustrated in Table 4.

6. SCENARIO OUTPUTS AND DISCUSSION

This section discusses the key findings of the study, based on the modeled outputs and the goals and policy analysis presented in Section 2. The section is structured as follows:

- Summary of results, presenting the highlights of each of the three model scenarios, in terms of key macroeconomic and environmental outcomes.
- Detailed presentation of the results of the current and enhanced policy scenarios and the impacts of changes in specific policy parameters; for example, raising the level of the clean environment cess, or increasing efficiency targets under the PAT Scheme.

6.1 Summary of Model Results

The study finds that India can make significant long-term emission intensity reductions, effectively implementing existing policies and those newly initiated. However, this would require concerted action by state and other relevant stakeholders to overcome existing policy barriers/challenges. The country can reduce its GHG emissions intensity by 33 percent below 2005 levels in 2030 and achieve a reduction of up to 43 percent in 2030 if the targets are further enhanced for the given five policies (Figure 9). Moreover, a low-carbon transition will not require sacrificing the health of the economy significantly. In fact, it is found that these scenarios could be pursued in parallel with robust economic growth. In all scenarios, the economy’s growth rates are around 6 to 7 percent (Table 5). This is because most of these policies involve targeted additional investments either from the government (like in the case of renewable power by 2020) or new technological investment by the sectors or firms (like in the PAT scheme), leading to higher economic activity. Although at the onset, GDP is adversely affected in the initial years (2015–2019) with these policies, the GDP growth rate increases in the later years in the current policy scenario. However, in case of the enhanced policy scenario, the negative impact persists throughout the study horizon (2015–2030).

We find also that India’s NDC targets can be met (in the current policy scenario) and can be overshot in the case of the enhanced policy scenario. The intended emissions intensity reduction to reach the targets come primarily from decarbonizing the electricity sector (the share of coal-based electricity drops by 25 percent with respect to the reference scenario) and uptake of renewable sources for electricity generation (a 34 percent increase in share from the reference scenario). These trends are more evident in the enhanced policy scenario, in which the share of coal in electricity generation decreases by 46 percent and renewables participation increases by 70 percent with respect to reference scenario levels.

In Table 5, we present a summary of the main results from our analysis.

6.2 Reference Scenario Results

A summary of the findings for the reference scenario is provided below, and the detailed findings can be found in the Appendix.

Energy and Electricity Profile

India’s primary energy demand is projected to grow at 4.7 percent per year from 2007 to 2030. Coal continues to be the dominant fuel, although its share in the energy mix declines slightly, from 54 to 50 percent, because of the coal cess levied in the model. The share of renewables in the energy mix rises only slightly, from 3.4 to 5.1 percent (see Figure 11).
### Table 5 | Summary of Main Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Reference Scenario</th>
<th>Current Policy Scenario</th>
<th>Enhanced Policy Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>From 2007 to 2030 %</strong></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>GDP growth</td>
<td>6.8</td>
<td>6.9</td>
<td>6.7</td>
</tr>
<tr>
<td>Primary energy demand growth</td>
<td>4.7</td>
<td>4.6</td>
<td>3.1</td>
</tr>
<tr>
<td>Electricity demand growth</td>
<td>5.0</td>
<td>4.0</td>
<td>2.9</td>
</tr>
<tr>
<td><strong>In 2030</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrease in emissions intensity*</td>
<td>29.0</td>
<td>33.0</td>
<td>43.0</td>
</tr>
<tr>
<td>Share of coal in energy mix</td>
<td>50.0</td>
<td>48.6</td>
<td>31.6</td>
</tr>
<tr>
<td>Share of renewable energy in energy mix</td>
<td>5.1</td>
<td>5.8</td>
<td>7.8</td>
</tr>
<tr>
<td>Share of coal in electricity generation</td>
<td>52.5</td>
<td>39.6</td>
<td>28.3</td>
</tr>
<tr>
<td>Share of renewable energy in electricity generation</td>
<td>28.9</td>
<td>38.6</td>
<td>49.1</td>
</tr>
</tbody>
</table>

*Note: *Compared to 2005 levels.

### Figure 9 | Emissions Intensity Levels

![Emissions Intensity Levels](image-url)
National demand for electricity is expected to grow at nearly 5 percent per year over the same period. Coal continues to be the dominant fuel for electricity generation, but its share in the electricity-fuel mix declines significantly, from 67 percent in 2007 to 52 percent in 2030. The share of renewable energy sources in the electricity sector rises from 20 to 29 percent (Figure 12).
The major driver of the demand for coal is the thermal power sector, which increases its coal demand by a compounded annual growth rate of roughly 5 percent from 2007 to 2030, followed by the service and manufacturing sectors. The demand for oil (refined) is mainly driven by the transportation, agriculture, and manufacturing sectors, with all these sectors experiencing an annual growth rate from 6 to 7 percent over the same period. Lastly, the demand for gas in the economy is primarily driven by electricity generation from gas, with a growth of slightly over 5 percent from 2007 to 2030. This seems reasonable, given that the share of gas in electricity generation is expected to increase to 18 percent in 2030, with an overall growth of 7 percent in gas-based power generation over the same period, while there is energy-efficiency improvement in gas-based plants.

In the electricity segment, the industry sector remains by far the largest consumer. Due to energy-intensive sectors like manufacturing, industry restrains its demand growth to a compounded annual growth rate of 7 percent from 2007 to 2030, although its share of total electricity demand still grows slightly from 40 to 42 percent. The transportation, agriculture, and services sectors all grow at compound average annual rates of from 7 to 9 percent. Notably, electricity demand in the agriculture sector increases more than nonelectric energy inputs. This is due to the replacement of diesel pumps with electric water pumps, as the government of India plans to install 26 million solar water pumps, according to Bloomberg. While the transportation sector continues to be a dominant consumer of refined oil, its electricity demand is also likely to grow by an annual rate of 9.4 percent from 2015 to 2030, which seems in line with the electrification of transportation under the NEMMP. Although the NEMMP is not explicitly covered in the reference scenario, this is happening because of a natural shift from nonelectric energy inputs to electricity in the economy. The same is also reflected in the energy-electricity profile of the services sector.

Economy and Emissions Profile

Under the reference scenario, India’s GDP rises at an annual growth rate of 6.8 percent from 2007 to 2030. Growth is driven primarily by an increase in consumption by 7.6 percent, investment by 3.6 percent, and overall exports by 6.3 percent. However, growth is hindered by a compounded annual growth rate of 6 percent in imports over the same period. The projected rise in GDP from 2007 to 2030 is shown in Figure 13.

This economic growth is accompanied by a steady increase in GHG emissions. The total GHG emissions in the economy (excluding AFOLU emissions) is expected to rise to 5,292 Mt by 2030. GHG emissions from the energy sector is expected to rise to 4,505 Mt CO₂e by 2030,
emissions from IPPU is expected to rise to 668 Mt CO$_2$e with emissions from waste expected to account for the remaining balance.

Clearly, GHG emissions (excluding AFOLU) rise more slowly compared to economic output, indicating the start of a decoupling of energy demand and GDP. Both the energy and electricity intensity of GDP fall over the time frame of the reference scenario. Assuming an annual energy-efficiency growth rate of 1.5 percent for most of the sectors, the energy intensity and electricity intensity falls by 37 percent and 32 percent respectively from 2007 to 2030.
The decline in emissions intensity forecast by the reference scenario is 29 percent by 2030 with reference to 2005 levels (Figure 14). This is achieved with no additional policy action after 2014.

6.3 Current Policy Scenario Results

While a summary of the findings for the current policy scenario are provided below, the detailed findings can be found in the Appendix.
Energy and Electricity Profile
Under this scenario, India’s primary energy demand is projected to grow at 4.6 percent per year from 2007 to 2030, compared to 4.7 percent under the reference scenario. Coal continues to be the dominant fuel. However, its share in the energy mix declines from 54 percent in 2007 to 49 percent in 2030, compared to the single percentage point decrease for the reference scenario over the same period. The share of renewable energy in the energy mix rises from 3.4 to 5.8 percent (Figure 15).

National demand for electricity is projected to increase at an average of 4 percent per year over the same period. Coal continues to be the dominant fuel for electricity generation, but its share in the electricity-fuel mix declines significantly, from 67 percent in 2007 to 40 percent in 2030. In the reference scenario, coal made up more than half of the fuel mix in 2030. While the coal share of the fuel mix decreases, the share of renewable energy sources in the electricity sector rises from 20 percent in 2007 to almost 39 percent by 2030 (Figure 16).

Economy and Emissions Profile
Like the reference scenario, economic growth is still accompanied with an increase in GHG emissions of 6 percent per year. Total GHG emissions are expected to increase to 5,158 Mt CO₂e by 2030, compared to the 5,292 Mt CO₂e rise under the reference scenario. Emissions from the energy sector are expected to rise to 4,350 Mt CO₂e by 2030, compared to the 4,505 Mt CO₂e rise under the reference scenario.

GHG emissions rise more slowly than economic output. Emissions intensity decreases from 0.04 Mt CO₂e/Rs billions in 2007 to 0.03 Mt CO₂e/Rs billions in 2030, at an average rate of 0.9 percent per year. It is a slight improvement from the reference scenario’s average rate of 0.7 percent per year.

6.4 Enhanced Policy Scenario Results
Although a summary of the findings for the enhanced current policy scenario has been provided below, the detailed findings can be found in the Appendix.

Energy and Electricity Profile
Under this scenario, India’s primary energy demand is projected to grow at 3.2 percent per year from 2007 to 2030, compared to 4.7 percent under the reference scenario and 4.6 percent under the current policy scenario. Unlike the previous two scenarios, coal is surpassed by oil to become the dominant fuel from 2022. The share of renewables in the energy mix rises from 3.4 to 7.8 percent from 2007 to 2030 (Figure 19).
National demand for electricity is projected to increase, on average, at 3 percent per year, over the same period. Unlike the previous two scenarios, coal stops being the dominant fuel for electricity generation. Its share in the electricity-fuel mix declines significantly, from 66 percent in 2007 to 28 percent in 2030. At the same time, the share of renewable energy sources in the electricity sector rises from 20 to 49 percent (Figure 20).

Economy and Emissions Profile

Economic growth is accompanied by an increase in GHG emissions of 5 percent per year, compared to 6 percent per year for both the reference and current policy scenarios. Total GHG emissions are expected to increase to 4,123 Mt CO$_2$e, compared to 5,158 Mt CO$_2$e under the current policy scenario by 2030. Emissions from the energy sector are
expected to rise to 3,348 Mt CO\textsubscript{2}e, compared to 4,350 Mt CO\textsubscript{2}e under the current policy scenario by 2030.

In all three scenarios, GHG emissions (excluding AFOLU emissions) rise more slowly than economic output. Emissions intensity decreases from 0.04 in 2007 to 0.02 Mt CO\textsubscript{2}e/Rs billions in 2030, with an average decrease in intensity of 1.6 percent per year, compared to 0.9 percent per year for the combination policy scenario (Figure 22).

6.5 Modeling Study Insights

Through the study, we discovered that the examined five-policy package has the potential to meet and exceed
the emissions intensity target put forward in India’s NDC, irrespective of the scenario analyzed (current or enhanced). Moreover, we find that in either scenario, the associated emissions reductions do not have a significant impact on the overall health of the Indian economy; the annual growth rate of the economy is around 6 to 7 percent in all three scenarios. The factors driving this growth are essentially improvements in total factor productivity, energy-efficiency improvements, and new investment in the economy.

In the current policy scenario, India’s GDP grows at a CAGR of 6.98 percent as against 6.68 percent in the reference scenario during 2015 to 2030. Collectively, these policies help boost economic growth. GDP increases by approximately 3 percent in 2030 over the growth rate in the reference scenario. It is interesting to note that the impact of restrictive policies like PAT, which affected GDP adversely, is completely nullified when other policies are brought into force.

In the enhanced policy scenario, the CAGR of GDP for 2015 to 2030 is 6.597 percent, which is lower than the GDP growth rate of 6.98 percent in the current policy scenario. As the policies become stringent, based on the assumptions of policy enhancements, the overall GDP of the economy faces an adverse situation, an outcome suggesting that the enhanced combined scope of these policies may directionally change the future trajectory of the economy.

The household consumption of agriculture and consumer goods decreases roughly from 0.34 percent to 2.21 percent in 2015 in the current policy scenario as compared to the reference scenario. The consumption of these goods goes up from 2.02 percent to 6.41 percent in 2030 as compared to the reference scenario.

The household consumption of agriculture and consumer goods decreases roughly from 0.32 percent to 1.92 percent in 2015 in the enhanced policy scenario as compared to the reference scenario. Consumption increases for some goods while decreasing for others in 2030. The consumption pattern of different households is different across consumption goods, and hence the range of deviation is higher.

Net exports in the current policy scenario decrease by 0.08 percent as compared to the reference scenario in 2015; however, in 2030 net exports increase by 1.15 percent. This explains the increase in GDP over the reference scenario in the current policy scenario. Net exports in the enhanced policy scenario decrease by 0.06 percent as compared to the reference scenario in 2015, and a reduction of 0.08 percent is predicted for 2030. Therefore, the level of economic activity (or GDP) is lower in 2030 in the enhanced policy scenario. Although the increase in energy demand is similar in the reference scenario, the current policy scenario, and
the enhanced policy scenario through 2030, there is a marked difference in the electricity sector composition across the scenarios. The transformation of the electricity sector is key for reaching India’s climate objective and we find that certain policies induce a shift from coal or other fossil fuels to electricity (such as the DFC policy), whereas others provide disincentives for the use of fossil fuels by making them more expensive (such as the clean environment cess and the PAT scheme). Certain policies explicitly target a higher use of renewables (such as renewable energy by 2022) and set goals for improving energy efficiency (such as the ECBC). The combination of these policies provides incentives to start decarbonizing the electricity sector—the share of coal drops by 25 percent and 46 percent with respect to the reference scenario in the current and enhanced scenarios respectively. The share of coal increases to 34 percent and 70 percent with respect to the reference scenario in the current and enhanced scenarios respectively.

6.6 Sustainable Development Benefits

As emphasized in India’s NAPCC and NDC, although these policies have the potential to deliver significant emission reductions, it is equally important that they deliver sustainable development benefits.

The five policies will also yield significant cobenefits. Results from the modeling exercise indicate that the overall income of both rural and urban households will increase in the range of 3 to 5 percent by 2030 in the current policy scenarios, in comparison to the reference scenario. This is because in policies like DFC and renewable power by 2022, there is additional public spending that results in increased economic activity. Because households are the owners of capital and labor, increased economic activity results in higher household income. In the enhanced policy scenario, household incomes are lower than in comparison to the reference scenario even in 2030. This highlights that when the policies are used together in conjunction, each policy needs to be implemented up to a certain tipping point, after which the marginal benefits of the policy become lower than the marginal costs to the economy. Thus, there is always an optimal level of implementation of each policy for the maximum cobenefits to be realized.

However, if the policy targets are chosen wisely, these policies could in fact reduce poverty in future generations. Moreover, the policy scenarios do not decelerate current growth rates, meaning that poverty reduction, economic growth, and enhanced climate action can be mutually supportive objectives. Further, policies such as the ECBC may drive demand for more efficient appliances due to lower operational costs, also potentially making these options more affordable for the poor. There may be a mild growth in jobs too, in keeping with increased demand. Funding generated by the clean environment cess (tax on coal, lignite, and peat) has been earmarked to finance initiatives such as the Namami Gange Programme to reduce pollution of the Ganga River. This program is set to improve the health and living conditions for the more than 150 million people who reside in the Ganga basin while providing new jobs (National Mission for Clean Ganga 2016). The DFC, in addition to moving freight off the current rail network, will also move freight off India’s roads, thereby reducing local air pollutants associated with the tailpipe emissions of heavy-duty vehicles.

Another interesting observation is the nonlinearity aspect of various policies, which is to say that the combined impact of all policies may not be the aggregation of the individual impacts. For example, we see that the emissions reduction in the case of the renewable power in 2022 policy scenario itself is in similar range as the emissions reduction in the overall enhanced policy scenario. This may pose a natural question: Isn’t this policy (alone) sufficient to meet NDC targets? However, to answer this, one needs to consider various other socioeconomic effects. For example, this policy triggers losses in government savings by 5 percent in 2030. Thus, to mitigate the increase in fiscal deficits, other counter-balancing policies need to be brought in.

Lastly, because this study only focuses on the five examined policies, it should be kept in mind that other planned policies or programs (such as transportation sector policies) may have the potential to reduce emissions further and generate additional cobenefits than identified in the study. Moreover, our study also does not account for every possible technology (for example, carbon capture and storage and electric vehicles), and hence it should be kept in mind that the introduction of new clean technologies in the future may also have a significant potential for further bringing down emissions.
7. RECOMMENDATIONS

This section presents recommendations for enhancing the effectiveness and transparency of India’s action on climate change.

7.1 Goal and Strategy Recommendations

Developing a more transparent mitigation goal

Our analysis shows that there is a need for enhanced transparency in India’s mitigation goals. (This includes the country’s Cancun pledge for 2020 and its NDC for 2030.) For example, regarding the 2030 GHG target, the scope and coverage of the goal is not clear, and the treatment of transferable emission units and the land sector accounting is not specified. Moreover, it is difficult to track progress toward goal achievement, as the emission intensity in the base year is not specified, nor are the allowable emissions in the target years. India could improve the transparency of its mitigation goals by providing additional information that more closely follows the Lima Call for Climate Action (UNFCCC 2014) and the WRI’s Open Book framework (WRI 2015), which is based on the Lima Call for Climate Action, and details all relevant assumptions and methodologies.

DEVELOPING A LONG-TERM STRATEGY

Although our analysis shows that strengthening the mitigation policies (enhanced policy scenario) that India is already pursuing could deliver significant results (reducing 2030 emissions by over 20 percent relative to the reference scenario with minimal impact on GDP), even under this scenario, 2030 emissions would double from today’s levels, without peaking. The temperature goals reflected in the Paris Agreement suggest the need to achieve net zero GHG emissions in the second half of the century. From emissions in the range of 4,000 to 5,300 Mt CO₂e in 2030, India would face a very steep rate of decline, potentially incurring significant costs associated with retiring carbon-emitting infrastructure before the end of its useful life.

Deepening understanding of the long-term emissions pathways that could be compatible with India’s development goals and with the global goals outlined in the Paris Agreement could help optimize the path forward. Mathur et al. (2014) characterize a deep decarbonization pathway for India predicated on transformation across a range of sectors: rapid deployment of zero-carbon power generation and an improved grid in the power sector, significant efficiency improvements and reductions in process emissions across industrial sectors, improved efficiency and electrification of agriculture, strengthened public transit infrastructure, more compact development patterns and electrification in transportation, and improved efficiency in residential and commercial sectors. Many of these changes could result from addressing failures in markets and institutions, which in turn would unlock improvement in development and human well-being (Brahmbhatt and Kathuria 2015). For example, correcting the current model of sprawling urban development offers the opportunity to avoid an estimated cost of $330 billion to $1.8 trillion by midcentury (Tewari and Godfrey 2016).

Developing a long-term strategy offers India the opportunity to maximize synergies between near-term and long-term goals and avoid costly missteps that would prevent the country from achieving long-term ambitions.

7.2 Finance and Capacity-Building Recommendations

Our research suggests that there are significant finance and capacity-building needs associated with current and further action on policies. Although the majority of the share of India’s current climate finance comes from domestic budgetary sources, the NDC suggests that a substantial scaling up of the climate action plans would require greater resources. The 2030 renewable energy quantitative target, as mentioned in the NDC, is intended to be met with the help of technology transfer and low-cost international finance, including from the Green Climate Fund. Capacity building is equally important to plan for future strategies, access finance, implement policies and programs, deliver results, and monitor and report progress. The MoEFCC, the nodal agency for climate change in India, needs to play a pivotal role in building readiness for finance as well as capacity building for being able to fulfill future requirements for accessing finance. To be able to access international funds, there is also a need to develop and adopt more robust methods to assess the potential mitigation impacts of efforts being undertaken, building on internationally accepted GHG accounting guidelines such as the GHG Protocol Policy and Action Standard. For several existing policies, the government provides estimates of potential impact but there is limited clarity on how they have been calculated.
7.3 Policy Recommendations

For the examined policy package to deliver the intended results, there is a need to address barriers to the effective implementation of the policies considered (as highlighted in Section 2). Recommendations for strengthening implementation of each of the five key policies are provided below, broadly organized corresponding to policy, institutional, finance, and technological barriers faced. The nodal agencies responsible for the implementation of the various policies—the BEE, the MNRE, the Ministry of Finance, the Ministry of Urban Development, and the Ministry of Railways—need to play a critical role in facilitating an enabling environment and in ensuring the enforcement and success of these policies.

1. PAT Scheme

CREATION OF ENABLING ENVIRONMENT
The success of the PAT scheme largely depends on active participation from designated consumers notified under the scheme. Target setting needs to be done judiciously across sectors to ensure that the optimum environment for trading is created with healthy supply-and-demand dynamics. An enabling environment also needs to be created for consumers through easy access to energy-efficient technologies, along with business models to deploy them quickly. Facilitative exchange of ideas and experiences among designated consumers of a sector can encourage them to adopt such technologies.

STRENGTHENING OF SDAS
The institutional mechanism of PAT can be further strengthened to enable its effective enforcement by the regulatory authorities as well as compliance by the designated consumers. Under the current PAT rules, SDAs have several important responsibilities with regard to monitoring, reporting, and verification and can even initiate penalty proceedings in case of noncompliance. However, for SDAs to be able to take up these responsibilities effectively, an adequate number of inspecting officers and extensive training and capacity building of SDA personnel is required.

PROCESS AND ACTIVITY-SPECIFIC TARGETS FOR DESIGNATED CONSUMERS
The current gate-to-gate approach adopted in the PAT scheme is not the most appropriate for facilities manufacturing multiple products, due to difficulties in normalization. For example, the normalization in cement plants needs to convert various product mixes such as Ordinary Portland Cement, Portland Pozolona, Portland Slag Cement, and imported or exported clinker into equivalent major grades of cement product. Thus, the scheme may benefit from elaborating further targets for specific processes and activities within a facility that can promote adoption of energy-efficiency alternatives in each process.

INCLUSION OF OTHER SECTORS
The Energy Conservation Act of 2001 identifies 15 energy-intensive industries as designated consumers. Although 8 of these industries were notified in the first cycle and 3 more in the second cycle, there are 4 more sectors that are yet to be included under the scheme. These are sugar, the port trust, the transportation sector (industries and services), and commercial buildings or establishments. Studies to examine the baseline energy consumption and energy-efficiency potential in such sectors will need to be commissioned well in advance of their inclusion under the scheme.

ENCOURAGING TRADING OF CERTIFICATES
Mandatory disclosures of energy consumption by designated consumers at regular frequency (such as quarterly disclosures) can help provide early price signals to market participants and promote more frequent trading activity. An annual position paper issued by the BEE on the status of achievement of targets by various players can also be helpful for speculation. Provisions related to banking of energy-saving certificates would also need to be designed appropriately so that they encourage higher energy savings but do not result in overflooding of certificates from one cycle to the other.

2. Renewable Energy by 2022

CREATION OF ENABLING ENVIRONMENT
Renewable energy project developers face various challenges in implementation of projects, such as land availability and land transfer, lack of reliable resource assessment studies, grid substation capacity constraints, issues with road connectivity to project sites, and late payment of dues by grid utilities. Accordingly, an enabling environment is one of the key requirements for rapid uptake of renewable energy. This could be achieved through initiatives such as single-window clearance systems, the establishment of dedicated transmission infrastructure for renewable energy systems, and dedicated support to renewable energy developers from state government authorities.
ENCOURAGEMENT OF MINI- AND MICRO-GRIDS
To further the goal of providing electricity to all households, state governments need to encourage mini-grids, micro-grids, and home systems in areas where the grid has not reached or where adequate power is not available in the grid. Specific policy incentives, incentivizing of investment, and prioritization by government is required to ensure that these systems remain viable and are not in direct competition with expansion plans of the national electricity grid.

SUPPORTING THE DEVELOPMENT OF THE REC MARKET
The REC market has significant potential to accelerate deployment of renewable energy at competitive prices through efficiency of the markets. However, it has not performed well, with most of the trading happening at floor price so far. The market could be further supported through measures such as strict enforcement of RPOs by SERCs with imposition of penalties on defaulting distribution companies and notifying long-term RPO targets that help provide clarity to market participants. Uptake of off-grid renewable energy systems has also been increasing in recent times and could be included under the gamut of the REC mechanism.

GRID INTEGRATION FOR RENEWABLE ENERGY
The targeted increase in renewable electricity capacity by 2022 is likely to pose a significant technical challenge for grid managers in ensuring smooth operation of the grid, given the variability in generation from renewable energy sources. This can be addressed through measures such as focus on renewable energy-generation forecasting, investments in grid-balancing power systems such as gas-fired power plants and reservoir-based hydro power stations, and R&D on renewable energy-storage technologies.

REDUCTION IN COST OF FINANCING
The high cost of capital and its short tenure are major barriers for renewable energy generation projects in India. Further, access to foreign debt is also difficult due to volatile exchange rates and high cost of foreign exchange hedging. These barriers can be addressed through use of financial instruments such as infrastructure debt funds and partial credit guarantees that reduce risks for investors, thus lowering the cost of finance.

INCREASE IN DOMESTIC MANUFACTURING CAPACITY
India’s limited domestic manufacturing capacity for renewable energy, especially solar cells and modules, can affect its ability to meet the renewable electricity capacity target by 2022. China and Taiwan account for the major share of global solar module supplies, and a hard landing of the Chinese economy could influence the global supplies and solar panel prices. Thus, the government needs to provide incentives for the private sector to undertake R&D and set up manufacturing facilities in the country. One of the reasons for poor manufacturing capacity is the current Import–Export Code that is allowed in the Indian market. Because of this coding ban, the same companies provide better modules to international markets but provide inferior-quality products to the Indian market. This drawback needs to be addressed.

ENABLING TECHNOLOGY TRANSFER
As the share of renewable energy in India’s electricity grid increases, the ability to store and regulate energy supply will play an important role in which transfer of energy-storage technologies is required. However, several barriers still exist, with the major one being intellectual property. Although the government has proposed that patent costs be borne through the Green Climate Fund in cases of technology transfer, there could be other approaches as well through international cooperation, such as technology pooling through a collective global approach, international cooperation to regulate restrictive practices in licensing agreements and anticompetitive uses of intellectual property, financing R&D, and promoting access to climate-friendly technologies or having an international declaration on intellectual property and climate technologies (Third World Network 2011).

3. Clean Environment Cess and the NCEF
DEFINING FUND VISION AND STRATEGY
The guidelines for selection of projects for support from the NCEF are quite broad, which can lead to drifting away from the focus of the fund, which is financing R&D and innovative projects that promote clean energy and environment initiatives. The NCEF can form a short-term and long-term vision regarding allocation of funds to projects, and this vision can be routinely updated to incorporate changes such as changes in technology. This will help communicate the fund’s vision to prospective fund seekers and ensure balanced resource distribution with the fund’s intended impact.

IMPROVEMENT IN GOVERNANCE STRUCTURE
Housed in the Ministry of Finance, the NCEF does not have a dedicated team of its own. Decision making primarily lies with the IMG that operates based on the
recommendations of the line ministries. A dedicated NCEF team can be formed, with clearly defined roles and responsibilities. This will streamline the operational processes and induce efficient disbursement of the fund. A dedicated team will also be able to predetermine the eligibility and appropriateness of projects, thus ensuring that the correct projects are selected for financing.

USING NCEF SUPPORT TO LEVERAGE OTHER SOURCES OF FINANCE
The current NCEF guidelines do not encourage applicants to leverage other sources of finance, such as private investment or international finance. The guidelines require organizations to put in a minimum financial commitment of 40 percent, and NCEF assistance cannot exceed 40 percent of the total project cost. These commitments can be revised to allow assistance of up to 100 percent of the project cost for proposals from academic institutions, government, nonprofit research organizations, and nongovernmental organizations and can consider any cofinancing from other sources as a part of the minimum 40 percent commitment required from organizations.

BETTER COMMUNICATION STRATEGY
The NCEF corpus is primarily accessed by the MNRE with very little interest from other ministries and none by the private sector. The fund’s objectives and vision need to be aggressively communicated to all stakeholders so as to encourage voluntary participation from all parties involved, including the private sector. This will encourage collaboration between industry and government, thus increasing the magnitude, efficacy, and scale of impact.

IMPROVEMENT IN MONITORING AND EVALUATION
The NCEF guidelines currently do not include a comprehensive monitoring and evaluation framework. Despite significant collections of clean environment cess, the disbursement of funds to projects has remained low thus far. A periodic monitoring and evaluation framework can be developed at project or fund disbursement or institutional level, with an independent external monitoring agency conducting assurance of the already disbursed fund. A set of key performance indicators can be developed to monitor impacts due to use of disbursed funds.

4. Energy Efficiency in the Services Sector

ENSURING ENFORCEMENT AND COMPLIANCE OF THE ECBC
The impact of the ECBC depends on the effectiveness of its enforcement and compliance for all new and existing buildings in India. At present, majority buildings in India are not ECBC-compliant. Thus, the code can be made mandatory for all buildings throughout India and its enforcement ensured by the state-level regulatory authorities and the BEE. This will help fully achieve the targeted energy savings and reduce emissions associated with buildings. Evaluation of the level of enforcement can also be taken up to ensure that confidence is instilled in the market and trust built among the stakeholders.

AWARENESS RAISING AND CAPACITY BUILDING
Currently, there is a lack of awareness among builders and consumers related to energy efficiency in buildings, creating a void in technical and managerial capacity. Awareness-building workshops and technical capacity-building workshops can be conducted among the stakeholders to develop the managerial and technical capacity for implementation of and compliance with the code.

ENABLING TECHNOLOGY TRANSFER
There is a high cost associated with adopting energy-efficient technologies that deters stakeholders from adopting the same. The government can facilitate technology and material transfers with countries, such as the United States and China, that are involved in robust enforcement of similar building codes. This will help reduce the initial cost of implementation of the code.

INNOVATIVE FINANCIAL SCHEMES AND FISCAL INCENTIVES
The high initial cost of implementation for energy-efficient technologies can also be addressed through innovative financial schemes formulated between the government and private financial institutions. With a better return on investment, the stakeholders can be convinced to implement such technologies in both existing and new infrastructures. In addition, builders and construction material producers operating in India can be provided with fiscal incentives, such as tax exemptions, to encourage development of indigenous low-cost technology and materials for buildings.

5. DFCs

IMPROVED PROJECT PLANNING WITH REGULAR MONITORING AND EVALUATION
The DFC project has faced significant delays due to various challenges, such as land acquisition, achieving consensus on project design, and securing funding for the various rail sections. Since the inception of these projects, the cost of materials has also increased manifold. Thus, proper planning for construction and implementation
phases is essential to complete such large-scale projects in a reasonable time frame. It is also essential to have a strong monitoring and evaluation framework in place that tracks the progress of activities closely and identifies bottlenecks in advance to meet the project timelines.

**USE OF MODERN TECHNOLOGIES**
Modern technologies and global best practices for freight corridors can be leveraged in the design of India’s freight corridors. New technologies in the areas of locomotive design, capacity utilization, or signaling technology can go a long way toward increasing the efficiency of freight corridors, having benefits in terms of operational cost savings as well as reduction in environmental impacts.

**OTHER ENVIRONMENTAL CONSIDERATIONS**
Given the large-scale nature of DFC projects, they may have a negative impact on the environment during the construction as well as operation stages. Environmental well-being can be ensured through planting and maintenance of trees along DFCs to ensure greenbelt development. Air, water, and noise quality monitoring stations can also be installed at all junction station sites. To reduce the noise and vibrations generated due to these projects, modern noise-free technologies can be adopted during the construction phases, along with construction of temporary noise barriers in urban and forested areas to reduce the effects of noise production. The NCEF could be used for this purpose.

**PROJECT EXPANSION**
Considering that after initial delays, the construction of the EDFC and WDFC are now back on track, further expansion of DFC corridors to the north and south sections can be considered. These will significantly strengthen the land transportation network in India and improve connectivity between the hinterland and the trading ports, thereby increasing trade in India and further inducing modal shifts from road to rail.
REFERENCES


Government of India. 2015a. "Intended Nationally Determined Contribution." http://www4.unfccc.int/submissions/INDC/Published%20Documents/India/1/INDIA%20INDC%2020%20UNFCCC.pdf.


ENDNOTES


2. Now Niti Aayog.

3. After signing the Paris Agreement, the signatory country's INDC document is referred to as a Nationally Determined Contribution (NDC).

4. All currency conversions in this paper are calculated based on the USD/INR exchange rate on March 30, 2017, sourced from Bloomberg.

5. Phase 1 of the JNNSM set targets for 200 MW of off-grid solar, 1,000–2,000 MW of grid connected solar, and 7 million m² of solar collectors.

6. A double-sided auction differs from a conventional auction process due to the presence of many sellers and many buyers, as opposed to one auctioneer and many bidders. These auctions solicit bids from both the sellers and the buyers of the RECs.

7 A formal process for mandating the ECBC.
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ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity and human well-being.

Our Challenge
Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth’s resources at rates that are not sustainable, endangering economies and people’s lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision
We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach
COUNT IT
We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT
We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT
We don’t think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people’s lives and sustain a healthy environment.
ABOUT OCN

Open Climate Network (OCN) brings together independent research institutes and stakeholder groups to monitor countries’ progress on climate change. We seek to accelerate the transition to a low-emission, climate-resilient future by providing consistent, credible information that enhances accountability both among and within countries. www.openclimatenetwork.org.

ABOUT KPMG INDIA

KPMG is a global network of professional firms providing audit, tax, and advisory services. We operate in 152 countries and have 189,000 people working in member firms around the world. The independent member firms of the KPMG network are affiliated with KPMG International Cooperative ("KPMG International"), a Swiss entity.

KPMG’s member firm professionals work to turn our knowledge into value for the benefit of our clients, our people, and our communities. We provide an integrated suite of service offerings ranging from strategy and policy advisory to facilitating project execution, project funding and asset operations, project management governance, public services transformation, technology transformation services, and climate change and sustainability services, among others, to help meet the specific requirements of our private sector and government clients.