Run Up to the Mid-Century

Guiding Framework for India’s Long-Term Strategy

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The Energy and Resources Institute
New Delhi
India’s Long-Term Strategy
A Guiding Framework

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Executive Summary
(To be drafted later)

1. Introduction
In 2015 under Paris Agreement, Parties committed to developing their long-term low-emissions development strategies by 2020 (Long-Term Strategy or LTS, for short). In line with the long-term goals of the Paris Agreement, the LTS must build on India’s development priorities, taking into account the principle of “common but differentiated responsibilities and respective capabilities in the light of national circumstances”. The purpose of the LTS is to develop a nation-wide multisectoral strategy, on the basis of extensive stakeholder consultation and provide guidance for subsequent policy development at multiple levels, including the private sector.

In light of this, we present a framing document to guide the process of developing a holistic Long-Term Strategy, both in terms of process and substance. It is based on TERI’s extensive, multisectoral analysis, policy and modelling work, coupled with thorough engagements with relevant experts across the domain.

2. Purpose
Article 4.19 of the Paris Agreement requires all countries to formulate and communicate Long-Term Strategies. Paragraph 35 of Decision 1/CP.21 accompanying the Paris Agreement further invites countries to communicate these strategies by 2020. The invitation to develop and submit a long-term strategy to the UNFCCC is thus not legally binding in the strict sense.

In addition to international engagements, there are numerous compelling domestic and geopolitical reasons for developing an LTS.

- **Coherence**: At the domestic level, India’s economic development process needs to be guided by a long-term vision of the desired outcome for sustainable lifestyles, society, the overall macroeconomy, and key sectors. Only then can mid-term policies and investments, at all levels including subnational, align behind a coherent vision. The long-term policy involves developing an indicative blueprint for development which can help to align all actors in a coherent thrust towards India’s development process.

- **Aligning Policy and Action Economy-wide**: LTS can encourage an effective alignment of policies in diverse areas, integrating environmental, societal and economic objectives; provide a market signal and lower financing costs; and so on. Even intra-governmental institutions - ministries especially, interaction between MOEFCC and Ministry of Finance, sectoral policies - can align better once an overarching long-term strategy is in place to guide the longer scheme of actions.

- **Allocating Resources**: An LTS will offer a longer view of the trajectory that India’s development will follow. This will in effect help in planning the allocation of resources-
financial, technological and human resources- to address climate and development goals simultaneously. Such clarity is also useful in achieving benefits of multiple policies operating simultaneously.

- **Undertaking Just Transition**
  The long term strategy gives an opportunity to look at means of achieving a ‘just transition’ while undertaking a green transition. Broadly, a just transition would include a package of policies and actions aimed at, first, anticipating the impacts of climate policies on employment; second, protecting and improving workers’ livelihoods (including health and skills); and third, supporting their communities. Just transition when embedded in the long term strategy will successfully contribute to a virtuous circle of social and economic progress. In India’s case, when policies are developed to move out of coal based economy, an important consideration must be that of jobs- both new and old. Adequate skills development training is a necessary prerequisite for ensuring that jobs lost in coal are reinstated in other low-emission sectors. A Long-term strategy will help smoothen the transition of workers both formal and informal.

- **Support and Assistance from the International Community:** At the international level, there may be some concern that producing an LTS would involve making untenable long-term commitments. It should be recalled that the LTS is an indicative document, unrelated to NDCs, and without any legal force. Indeed, the reverse should be considered: the LTS may be the most convincing and coherent way of articulating to the international community India’s ongoing development needs (which are unlikely to be exhausted by 2050). In doing so, India could also articulate in a clear way what it expects from the international community, in terms of technology learning, diffusion and transfer; financing; capacity building; and so on.

**Linking LTS with Nationally Determined Contributions**

In addition to commitment of Parties commitment to ‘formulate and communicate long-term low greenhouse gas emission development strategies’ (Article 4.19), Article 4 of the Paris Agreement also requires Parties to communicate and successively update their Nationally Determined Contributions (NDCs) on how they intend to tackle climate change via mitigation and adaptation activities keeping in view their common but differentiated responsibilities (Article 4.9).

While the NDCs come with a mandate to be reported and updated every five years starting 2020, LTS are only required to be communicated by 2020. India’s NDCs are committed for the period 2021 to 2030. It therefore, does not make it necessary for it to revise it in 2020. The three key commitments made by India are:

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To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.

To achieve ~40 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030

To create an additional carbon sink of 2.5 to 3 billion tonnes of CO$_2$e through additional forest and tree cover by 2030$^2$

India’s current NDCs and the path to achieve it will highlight the hurdles faced, future potential for enhancement and the next steps forward. This will in effect guide India’s long term strategy. Similarly, a clear formulation of India’s LTS will guide its short term milestones within its NDCs. An LTS will have sight of both climate and development goals of a country while providing a framework within which short to medium term decisions could be anchored and adjusted when necessary. Two key benefits that will arise out of a synergised NDC and LTS are briefly discussed below:

- **Market Signalling**
  
  LTS will signal increased inclination towards low emitting- high efficiency practices and technologies. Such clarity will provide the necessary market signal to spur increased R&D, and uptake of newer technologies domestically. As a result, in subsequent NDCs, favourable technologies and initiatives will benefit from economies of scale and be available to be widely used.

- **Forward and Backward Linkages**
  
  Since 2015, India’s commitment to reduce emissions intensity has resulted in creation of necessary forward and backward linkages. These help enhance the investment and sustainability ecosystem of respective sectors. In India’s case especially- enhanced energy efficiency across ranging from appliances used by households to industrial production processes- has helped reduce emissions intensity.

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$^2$ India is on a favorable trajectory to meet and even exceed some of its committed NDCs. India has reduced the emission intensity of its economy by 21 percent till 2014, as per its Second BUR to UNFCCC (December 2018). India’s non-fossil sources had accounted for about 37% of India’s power capacity as of 2019. Central Electricity Authority (CEA) projections yield an installed non-fossil capacity equivalent to 65% of the total capacity before or by 2030 (as of September 2019).
India’s Commitment and the Pandemic

The pandemic- COVID-19 that currently engulfs the world has given rise to uncertainty around climate action, amidst rising worries of the state of global economies. The Indian economy is faced with similar challenges, with specific concerns arising if this would lead to a slow-down in the pace of climate action that India has undertaken in the recent years.

While ensuring public health and safety remains of utmost importance as of now, the recovery of the economy post the Pandemic holds significant potential to follow a greener growth trajectory. As this immediate crisis begins to dissipate and attention moves to reflating economies, having a long term strategy in place can offer a green stimulus to the revival process. It is imperative then, to ensure that clean energy, transport and smart infrastructure is at the heart of this longer-term green stimulus.

India has been resilient in its commitment towards climate action and is likely to revert to the same path as the current global crises subsides. This shock to global economy and in turn to India’s is likely to tweak its fervent action towards climate change in the short run, only to be enhanced in the long run.
3. Boundary and Scope of the Framing Paper

A robust LTS will guide the sustainable growth pathway that India should follow, making use of the resources that it has and those that it may need from other countries. The LTS must in effect fulfil two crucial criteria: domestic developmental priorities, and enhancing resilience of local communities. The LTS would remain incomplete without equal focus on building resilience, adaptive and mitigative capacity. For this purpose, we have segregated the two components and will develop a separate framing document on enabling adaptation actions in the LTS, while this one focusses on mitigation action.

4. Pillars of the Framework

In the sections that follow, we build on the larger steps should be undertaken in order to arrive at a long term strategy. Figure 1 shows the key determinants of a successful long-term strategy.

![Figure 1: Pillars of the Long-Term Strategy](image)

As a starting point, it is imperative to take stock of the existing state of key sectors of the Indian economy. A quick but thorough assessment such as that is built in Section 5 ‘Macroeconomic Context’, is essential for the policy maker to review the past growth trajectory. In India’s case, economic growth was driven by steep service sector growth. While planning the LTS, such background analysis for each sector- identifying drivers and hurdles- will be useful to determine the pathway for the future. On the basis of this information, the section further identifies potential structural changes depending on the nature of growth pathway- medium or high- that India plans to target.

The next pillar is a strong analytical framework (Section 6) to build on inferences from the sectoral analysis. This section forms the backbone of the LTS. It incorporates modelling,
demand projections, multiples growth scenarios and simultaneous engagement with key
stakeholders. One of the most essential aspects at this stage is the growth narrative proposed
to be taken. The choice of growth narrative will drive the scenarios on which projections and
modelling will be built in the LTS. Another essential aspect at this stage is the interpretation
of results from the analytical assessment. Effectively presenting the results from respective
narratives is an essential communication tool for the LTS, both to communicate reforms to
citizens and increase public buy-in.

‘Sectoral Transitional Mapping’ (Section 7), the third pillar, is arguably one of the most
dynamic components of the LTS. Classifying sectors according to the ease of abatement and
the current stage of transition, this section maps out further path of transition for these
categories. Over the process of implementation of the LTS, the sectors in each of these
classifications are likely to modify several times- those in the initial stage of transition will
move to advanced, as new sectors get added to the list; and ease of abatement of a sector
will change as it undergoes more transition. This section will rely not only on the modelling
and forecasting capacities built in earlier stages of the LTS, but also the global scenario on
availability of technology and knowledge sharing for the respective sectors.

The fourth pillar, ‘technological and financial mapping’ (Section 8) is vital for three reasons.
First, to understand the technological and financial requirements for meeting the proposed
LTS; second, to take stock of available technological and financial resources and allocating
them effectively. And lastly, to assess the technological and financial support needed from
the international community and thereby building coalitions for knowledge and technology
sharing.

Lastly, effective ‘Institutional Arrangements’ (Section 9), are a must in designing a strong LTS.
This includes two main components- first, effective and holistic stakeholder consultation.
Stakeholders must be diverse, ranging across multiple sectors, industry experts, policy makers
and civil society. And second, a strong review mechanism to ensure staying on track with the
planned trajectory.

Readers will observe in the following sections that some sectors have been discussed in
relatively more detail than the others. Through India’s initial years of strong climate action,
these few sectors, power and electricity being a prime example, have been the forebearers
of robust mitigative action. In offering our analysis of how the LTS could be framed,
experiences from these sectors further enriches the process of framing as significant a
document as this.

A. Macroeconomic Context
a. Economic Growth, Economic Structure, and Service Demand
i. Introduction

Economic growth is the crucial driver of energy services and materials demands in long-term scenarios. In turn, it is the satisfaction of these demands which drives emissions. Thus, when considering the design of the long-term strategy (LTS), it is necessary to give substantial thought to the design of the macroeconomic scenarios underpinning the growth of energy service and material demands. While this holds true for all countries, it is particularly true for India. India is still at a relatively early stage in its development pathway with large structural transformations ahead. These transformations include:

Sectoral transition of employment and production out of agriculture and into industry and services. This raises productivity and incomes as workers transitioned into more productive sectors.\(^3\) According to data from the World Bank, agriculture is still responsible for slightly less than 50% of employment and about 17% of value added in India. By 2050, agriculture’s share in employment and output would fall into single digits. However, it is still not clear whether India would follow a path more typical of the East Asian (China, South Korea, Japan, Taiwan) ‘late industrializers’, whose development trajectory was driven by high rates of industrialization. On the other hand, India appears to be following a more services driven development pathway.

This does not mean that services take up a larger share of GDP in India than we would expect for a country of India’s level of GDP per capita: indeed, a cross country comparison shows that India is pretty close to the mean as regards the share of services as a share of GDP, at its current level of GDP per capita (see figure 1 below). Rather, India has seen a precocious development of highly productive, export-oriented services like Business Services and Financial Services. These two sectors made up 11% of India’s GDP in 2010, compared to 5% of China’s in the same year.\(^4\)

This service driven pathway has been facilitated by the increasing globalization of not just goods but also services, as well as – and this is a less positive development – India’s lack of international manufacturing competitiveness in international markets as well as the increasing automation and skill intensity of manufacturing. This phenomenon of so-called “premature de-industrialization” has also occurred in other developing countries, and is not specific to India.\(^5\) Indeed, there is evidence that structural technological trends, such as automation and decreased cost of communications, will lead to a future in which, to quote economists Richard Baldwin and Rikard Forslid, “manufacturing is jobless and services are

\(^4\) India data from the India KLEMS Database available at: https://www.rbi.org.in/Scripts/BS_PressReleaseDisplay.aspx?prid=43504
Indeed India is a harbinger perhaps of this: manufacturing employment grew just 1.6% per year between 2000-15, and its trade surplus in services of 44 billion USD went some way to compensating its deficit in goods trade of 184 billion USD.

Whether India follows a more service or industry driven pathway will have huge implications for its energy and material demands, and must be a very explicit choice in scenario frameworks for long-term emissions pathways for India. These frameworks should include different scenarios for India’s economic structure out to 2050, in order to explore the uncertainty India still faces in this regard.

Given India’s current pathway and political economy, it would seem more likely that India will continue to follow a more services-based and hence less energy and material intensive pathway, and this should be the central scenario.

The figure below shows the nature of the transition still facing India. It plots the sectoral share of agriculture, industry and services (vertical axis), compared to GDP per capita (horizontal axis). It shows all countries in the World Bank’s World Development Indicators Database from 1960-2018 (3324 data observations in total, see the grey semi-transparent dots). It also shows the data from India, China and South Korea.

As can be seen: structural change is an inevitable part of the development process, and India’s structural transformation still has a long way to go. It can also be seen how different the path followed by India is compared to China and South Korea. India’s industry share in GDP only approached that of its East Asian compeers during the brief boom prior to the Global Financial Crisis in 2008-9. Making choices about the future of India’s economic structure is a crucial choice for scenario design.

Figure 2: Structural Change with Increasing GDP Per Capita: Which Path for India?

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6 See Richard Baldwin and Rikard Forslid (2019), ‘Globotics and development: when manufacturing is jobless and services are tradable’.
7 From the India KLEMS Database
Transition from an essentially rural to an urbanised society: The sectoral transition of output and employment out of agriculture and into industry and services is associated with a spatial transition from a rural to an urban pattern of spatial development. This is one of the most significant drivers of economic development as it facilitates so-called “agglomeration economies”: that is to say, economies of scale in larger, and more tightly-knit, networks of production and exchange.

India’s official urbanisation rate is relatively lower than may be expected typically for a country of India’s GDP per capita. However, other measures of India’s urbanization process come up with higher estimates, reflective of the fact that much of India’s urbanization has been, in the words of the World Bank, “messy and hidden”. The suboptimal nature of India’s urbanization process has increased congestion costs, and lower the agglomeration benefits from urbanization. It also slows India’s structural transformation out of agriculture, because suboptimal “messy and hidden” urbanization raises the costs of and lowers the economic opportunities associated with the rural urban shift. For example, between 2013 and 2018 the residential price index, consisting of data from 8 tier one cities, increased three times faster than rural wages. This puts urban life out of the reach for many. We can contrast this with the affordability of housing in the growing cities of the United States in the early 20th Century, which could be constructed at costs as low as one dollar per square foot. A detached house in the manufacturing hub of Chicago could be bought for between 1-2 years’ worth of manufacturing labour wages in the early 20th Century. The house price to annual city-wise income in India (not rural income, i.e. those coming to India) on average in India was about 5.1 years, and would be much higher for rural migrants.

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10 Data from the RBI.
11 Wage data from [https://www.measuringworth.com/](https://www.measuringworth.com/) and, house price data from
There is also increasing evidence that structural, technology-driven changes within the global economy appear to be increasing the benefits of urbanization. As economist Paul Collier puts it:

“The removal of barriers to international commerce has geared up the benefits of clustering highly specialized people together by enlarging the potential market from national to global ... In consequence, their earnings are spectacular. In turn, a large population of very high earners creates a market for services to entertain them. Proximity matters: restaurants, theatres, shops crowd in to satisfy every whim of people flush with money but short on time”.  

This is exactly the dynamic that has driven the rise of Bangalore and Hyderabad. In the era of manufacturing driven development, the dialectic of agglomeration economies and congestion costs used to favour a more even spatial geography of development within countries, because manufacturing requires space, resources, large-scale transport infrastructure, and produces wastes that are best kept away from cities. Now, in the age of the globalization of services the balance between agglomeration economies and congestion costs falls in favour of the former.

The problem, however, is that an economic geography of a few booming cities and an economically backward hinterland (what Jean Dreze and Amartya Sen memorably called in the case of India “islands of California in a sea of sub-Saharan Africa”) is that it is deeply exclusionary for those without the skills or means to enter into the new economy. It is doubly exclusionary if urbanization is done poorly: by restricting the supply of housing and transport, suboptimal urbanization raises agglomeration costs (housing, transport, congestion, pollution, etc) and excludes those that would move into cities as part of the transitions described above (see the above data point about the residential price index).

Thus, a key choice for scenario design going forward is what to assume about the extent and nature of India’s urbanization, and – perhaps as importantly – what it means for the country’s development going forward. Suboptimal urbanization is likely to retard the structural change that has to occur, raise inequality and negatively affect the aggregate growth rate, perhaps to a substantial degree.

A further question relates to the issue around the definition of urbanization in a country like India. According to official forecasts by UN DESA, India’s urbanization rate would be only 50% by 2050. At the same time, long-term energy scenarios like the India Energy Security Scenarios (IESS) assume a similar level of urbanization in 2050, and a GDP per capita in the order of >30,000 USD PPP. However, as can be seen on in the figure below, this would be completely

unprecedented in the history of economic development: no country has reached such high levels of GDP per capita while still having an urbanization rate of only 50%.

It is possible that this is merely a definitional issue, and that *de facto* urbanization – defined for example in terms of habitation proximity to economically relevant cities - in a country as densely populated as India need not reflect typical definitions, like habitation in a city above 5000 people. Alternative metrics, like the agglomeration index or nightlight density, already place India as much more urbanized than official definitions. But the key question is whether, from an economic perspective, this ‘messy and hidden’ urbanization can have the same benefits as urbanization according to typical definitions. If it is matched with inadequate infrastructure, housing and access to urban jobs, *then de facto urbanization may not entail economically functional urbanization, so to speak.*

The figure below plots the urbanization rate of all countries in the World Development Indicators Database and India, China and South Korea. India’s unusual pathway, on official definitions, is clear. The key question for long-term scenarios is not what will India’s urbanization rate be *per official definitions* but rather what will be the occupations, incomes and consumption of the half of the population still classified as “rural” by 2050 as per the official definitions and projections. It is simply impossible that India could achieve the kind of incomes per capita targeted in long-term scenarios like the IESS (>30,000 USD at PPP), while still having effectively 50% of its population as rural, *from an economic perspective.* By economic perspective, we mean rural types of employment, rural levels of income and consumption expenditure. Whatever the formal classification of ‘urbanization’, either India much have achieved an effectively ‘economic urbanization’, or it will not achieve the desired levels of GDP growth by 2050.

*Figure 3: India’s Unusual Urbanization Pathway*

*Source: TERI based on data from World Bank, World Development Indicators Database*
High rates of investment in productive human and physical capital: By definition the process of economic growth is driven by the increase in the supply and quality of productive capital, both human and physical. Increasing this supply requires sustained high rates of investment, funded largely out of national savings. The figure below shows the relationship between investment, industrialization, urbanization and GDP growth. Clearly there is a strong and interlinked relationship between all of these drivers. India’s investment rate and industrialization rate have risen since the early 2000s. However, both the rate of investment and the rate of industrialization have declined since the global financial crisis and the economic challenges of 2012-13. In its history, India is thus yet to maintain for a decadal to multi-decadal period, the rates of physical infrastructure investment and industrialization that have driven multi-decadal growth rates of close to 6%.

Figure 4: The Relationship Between Industrialization, Investment, Urbanization, and Growth

Source: TERI based on data from World Bank, World Development Indicators Database

Regarding education, the picture is also mixed. Currently, India invests about 4.6% of its GDP in education, which compares favourably with the investment level of its competitors like China, South Korea or Japan. However, India lags on the quality of its educational outcomes. In metrics like research output, citations, or the position of its universities in top global ranks, India lags behind countries that have achieved sustained fast growth, like China. On measures of the basic outcomes of primary and secondary education, like literacy, India also does not perform as well as the countries whose development pathway it seeks to emulate. East Asian countries like China and Vietnam have achieved much higher rates of total literacy, at lower levels of GDP per capita. Even Bangladesh, although poorer than India in GDP per capita, have achieved higher rates of total literacy and higher rates of female youth literacy.

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Having a workforce with a basic level of education has clearly helped these countries achieve growth in manufacturing, which while unskilled, does require basic levels of worker education.

*Figure 5: India’s Performance in Basic Educational Outcomes*

**Literacy Rate Versus GDP Per Capita**

Source: authors based on data from the World Development Indicators Database

Role of trade in the Indian Economic Growth: One of the widely debated factors of India’s economic growth remains whether it was an export-led growth (ELG). Some of the most evident high export periods were between 2003 and 2008. During this period, growth in export values were about 18% per year on an average (in constant INR), whereas imports grew at about 20%. However, the global financial crises slowed down India’s export growth only to not be revived to the same pace again. In the years between 2011 and 2018, the expansion of India’s export volume remained low at about 5-7%\(^{16}\). Import growth also slowed down during this period at about 6%.

The debate on whether India’s export was led by exports does have mixed conclusions but one of the consistent factors that has been observed across studies is that while export growth was an important driver of GDP growth prior to the global financial crisis, and


specifically during the pre-crisis boom years, and still contributed positively in 2010-11 and in 2011-12, its role in growth has diminished.

India’s export basket is broad, but the service sector takes up a large share. The share of service exports in 2016 was approximately 36% of total exports\(^{18}\). India’s services export baskets is largely occupied by technology-oriented business exporting in particular, computer service exports (accounting for almost 70% of total service exports). Other services such as financial services, travel, sea transport (freight), and several business services such as legal, accounting, management, public relations, architecture, engineering and technical services account for the remaining chunk of India’s service export basket. India’s core merchandise exports (i.e. non-oil and non-gold exports) accounted for about half of all exports in 2016; whereas oil exports accounted for 10% and gold exports accounted for 4%.

Indian imports which have remained higher than the total share of exports by an average of 32% between 2012 and 2018\(^{19}\) have witnessed a shift in its commodity basket. A drastic shift has been from the imports of raw materials (including mineral fuels and oils, natural or cultured pearls especially diamonds, plastic and articles and iron and steel), which declined from 41.59% in 2012 to 30.98% in 2016, towards intermediate and capital goods which increased from 15.88% in 2012 to 22.72% in 2016. This implies that India’s imports have been more centric towards that of machinery, mechanical appliances and nuclear reactor products over the last few years. The larger proportion of imports however adds to the wide current account deficit that India faces.

India is dependent on oil imports for about 2/3rd of its consumption and that is projected to rise to more than 90% over the course of the next few decades. India’s economy is exposed to shocks on the oil price which can adversely affect the balance of payments, exchange rate, inflation rate, and ultimately the growth rate of GDP. The adverse exposure to oil price rises can be mitigated in a scenario of global action on climate change. Even if a peak and rapid decline in oil consumption remains elusive, the progressive transition to non-oil forms of energy can help to cap oil prices at a low level, reducing the exposure of importers like India to this risk factor.

b. Bringing It All Together

India’s future is bright, and it has a lot of advantages going forward. However, strong and inclusive growth is not a given, and will require consistent reforms and improvements in governance. There is also evidence that structural trends like the increasing knowledge intensity of the global economy, technological change and changes in globalization are


\(^{19}\) https://www.tpci.in/research_report/indias-trade-basket/
altering the development pathways available to countries like India. Long-term strategies need to give these aspects careful consideration.

The discussion above shows the tight relationship between several drivers of economic growth, from education, to investment, to industrialization, to urbanization. This relationship implies that there is a need for considering the logical consistency between different scenario elements when considering different long-term scenarios. For example, it is difficult to see how a scenario with low rates of investment and industrialization could be consistent with high rates of long-term economic growth. In the same vein, a service driven development pathway, but with poor investments in urbanization and human capital formation would likely have ultimately poorer outcomes in terms of aggregate growth and inequality within the population. In the table below, we try and give some logically consistent scenario storylines along different parameters, and draw out their implications for energy and materials demand.

Table 1: Storylines for India’s Long-Term Scenarios

<table>
<thead>
<tr>
<th>Title</th>
<th>Structural Change</th>
<th>Urbanization</th>
<th>Investment</th>
<th>Growth and Inequality</th>
<th>Energy and Materials Demands</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td>Services, but still excessively large population in agriculture</td>
<td>Muddled</td>
<td>Moderate in both physical and human capital</td>
<td>Growth: moderate</td>
<td>Moderate to low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inequality: high</td>
<td></td>
</tr>
<tr>
<td><strong>High Growth</strong></td>
<td>Industry</td>
<td>Improved</td>
<td>High notably in physical capital</td>
<td>Growth: High</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inequality: moderate</td>
<td></td>
</tr>
<tr>
<td><strong>Clean and equal growth</strong></td>
<td>Services</td>
<td>Improved, allowing more equal structural change</td>
<td>High, notably in human capital allowing more equal structural change</td>
<td>Growth: higher</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inequality: moderate</td>
<td></td>
</tr>
</tbody>
</table>

Source: authors

ii. Long-Term Economic Growth

Any long-term strategy will need to make assumptions about India’s long-term growth rate to 2050. For example, the India Energy Security Scenarios (IESS) assume that India’s GDP grows 6.4% between 2012-2047, implying that India’s GDP per capita would reach about 34
000 USD PPP by 2047, roughly the level of Eastern Europe today.\textsuperscript{20} Such a rapid economic growth rate would be historically extremely unusual. India has already achieved a couple of decades of per capita economic growth well above 4\% (see Figure 6).

\textit{Figure 6: India’s Long Run Growth Performance}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{India_growth.png}
\caption{India’s Decadal Growth Performance}
\end{figure}

\textbf{Source: authors based on data from the Penn World Tables 9.1}

Only a few countries have maintained multi-decade per capita growth rates of above 5\%.\textsuperscript{21} The figure below shows the frequency of occurrences of different thirty-year growth rates across 62 countries since 1950 to 2018. The dataset contains 199 observations, i.e. measurements of annualized growth rate over a thirty-year period. This includes multiple overlapping observations: for example, 1950-1980 for the United States, and 1960 to 1990 for the United States, and so on. In a sense, this is double counting, because we count the growth performance of the years 1960-1980, in this instance, twice. But nonetheless, for the latter period of 1960-1990 to count as a growth episode above 5\%, then the aggregate growth per capita in the latter period has to also have per capita growth above 5\%. Thus, it is possible for one contiguous forty-year period to register as two growth episodes above 5\%, if for both periods (in our example 1950-1970 and 1960-1990) registered growth above 5\%.

Despite this double counting, episodes of sustained high growth are rare. Only 2\% of observations entailed a thirty-year growth performance above 7\% per year, namely Singapore (thirty years ending 1990), Taiwan (thirty years ending 1990), and Korea (twice, 1990 and 2000). Only 5\% of observations entailed a growth performance of above 6\% per year (all but

\textsuperscript{20} Assuming an INR / USD PPP conversion rate of 18.

\textsuperscript{21} See also, Lant Pritchett and Lawrence H. Summers (2014), “Asiaphoria Meets Regression to the Mean”, NBER Working Paper No. 20573
one of them was an East Asian country, which tells us the high performance of the East Asian model of development, which India is not currently following). And only 10% of observations reached above 5% per year. The median value was about 2.7% GDP per capita growth per 30-year period. A lot has to go right for a country to consistently achieve high rates of growth across a multi-decade period.

For India, a long-term (i.e. out to 2050) growth rate per capita of around 4 - 5% appears to be an ambitious target. It would be higher in the near term, and slow in later decades as India’s GDP per capita reached higher levels, and opportunities for easy catch up growth reduced. In other long-term forecasts, for example from the OECD, forecasts aggregate per capita growth at a rate of 4.2% between 2020 and 2050 (assuming population growth at a rate of 0.7% per year, this equates to an aggregate growth rate of 4.9%). Under this scenario, GDP per capita would grow from about 7000 USD2015 PPP to about 25 000 USD2015 PPP, placing India firmly within the ranks of the middle income countries and roughly in line with living standards in OECD parts of Latin America (Chile for example).

Given the discussion above, growth of 4-5% would seem to fall towards the upper end of the spectrum between the Baseline and High Growth scenario (see table 2). It seems pretty clear that unless India improves its performance on urbanization, human and physical capital development, achieving a long-term growth rate of 5% would be a stretch. A Baseline scenario might be more towards 4.0% (recall the OECD’s projection of 4.2%), and a High Growth scenario around 4.5%, and a Clean and Equal Growth Scenario around 5.0%.

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22 See OECD (2018), Economic Outlook No 103 - July 2018 - Long-term baseline projections
23 See for example, Vijay Joshi (2016), "India’s Long Road: The Search for Prosperity", Allan Lane.
B. Analytical Framework

This section will outline the analytical framework, which will be used to assess a number of scenarios for transition to inform the Long-Term Strategy. This framework is made up of a number of different activities, including the formation of narrative pathways, sectoral analysis, whole systems modelling, multi-criteria decision analysis and scenario interpretation and understanding. How these activities interplay is summarised in the below diagram.

1. Narrative Storylines and Quantitative Economic Scenarios

2. Material, Service and Energy Demand Scenarios

3. Sectoral Analysis

4. Whole System Modelling

5. Multi-Criteria Decision Analysis

6. Interpreting and Understanding Scenario Results

In the first instance, narrative pathways are drawn up, representing plausible futures. These will inform the later stages of analysis, including demand projections, which are then fed into three separate but inter-related analytical exercises: sectoral analysis, whole systems modelling and multi-criteria decision analysis. These will occur somewhat in parallel, using the findings of one to help corroborate and refine the others, appreciating that all have their relative strengths and weaknesses (some of which are discussed below). Finally, the outputs of these analytical exercises will need to be interpreted and understood, using the full range of evidence.

Extensive stakeholder engagement should be built in along all stages of the framework, ensuring relevant views are fed-in at the correct stage. Given the cross-economy coverage of the Long-Term Strategy and its intention as a blueprint for development, building consensus into its formation is vital.

a. Narrative pathways

Starting outside of the model with the qualitative and quantitative macroeconomic storyline is crucial for a country like India, which still has a huge and uncertain structural transition to undergo. There is a lot of evidence that energy system models do a poor job of reflecting
structural change of the type India faces, particularly if growth scenarios are an afterthought and not the first thought of the scenario exercise.24

These narrative pathways should focus around two or three scenarios for India’s future, borrowing heavily from existing literature, Government strategies and stakeholder views. It is important that these pathways represent plausible, internally consistent yet contrasting possibilities of a future India, accounting for changes in economic structure, urbanisation, investment, growth, inequality and energy and material demands.

b. Demand projections
From these macroeconomic scenarios and storylines, levels of demand for different sectors can be modelled, using simple econometric approaches, and combined with end-use analysis of equipment, material, and energy stocks and flows. These projections are done endogenously in many energy models, but it is useful to do demand modelling first as an exercise outside of the model, for example in a simple spreadsheet analysis. At this step, the focus must be kept on the physical realities of the system being analysed: the stock of buildings, kilometres of passenger and freight transport, and tons of steel, cement and other key industrial product demands. Simple econometric models can easily be built to understand these demands. These ‘out-of-model’ projections can be tested against simple heuristics and cross-country intertemporal comparisons. For example, if demand estimates show that per capita passenger kilometres reach in India by 2050 anywhere near the same level as the United States today (27,000 passenger kilometres in 2017), then this may be a cause for concern: India is an order of magnitude more densely populated than the USA, and India is highly unlikely to reach the US’s current level of income per capita by 2050 (see the section above). Transparent analysis of the physical realities of the system are more amenable to quick, common-sense benchmarking, than higher order abstractions of energy demand or emissions. It thus also provides a more appropriate starting point for stakeholder consultations.

c. Sectoral-level analysis and expert engagement
Once these ‘out-of-model’ demands have been estimated, the next step should be individual sectoral analyses. This will include working with sector experts to develop a comprehensive understanding of transition options in that sector, covering technologies, costs of abatement, different barriers (social, economic, political, etc.) and regional variations.

This will also involve sectoral modelling capabilities to enable a more detailed and nuanced understanding of the opportunities and constraints in different sectoral transitions. There is often a trade-off between a single model’s breadth of coverage and its representation of

sector specific, micro-scale realities. For example, there is fair amount of evidence that large
Integrated Assessment Models do a poor job of representing demand-side energy transition,
such as the shift to electric vehicles, alternative production processes in industry and so on.²⁵
Likewise, large-scale energy models may poorly represent the range of options for integrating
variable renewables in the power system, and therefore impose artificial or incorrect
constraints to the share of variable renewables.

It is also the case that as models become increasingly complex, they become ever less
transparent and their use limited to a smaller group of expert users. This is incompatible with
the use of models to support transparent and accountable policymaking, as in the case of a
Long-Term Strategy.

As a result, sectoral analysis, supported by modelling can overcome some of these issues.
These sectoral models need not be very complicated: often, excel-based frameworks are
sufficient to get started and explore the key relationships. There is a wealth of open-source
options that can also be used.²⁶
d. Whole energy systems modelling
Whilst a detailed sectoral understanding of transition is a necessary starting point, bringing
these sectoral pictures together under a whole systems framework is also essential. In doing
so, we can understand cross-sectoral synergies, for example, different sectors can share the
same infrastructure, thereby reducing overall costs (known as ‘sector coupling’). This is
particularly relevant in the low carbon transition, where several of the main technology
options require network infrastructure, including electricity (electricity grid), hydrogen (gas
network) and carbon capture, use and storage (CO₂ network).

In bringing together the sectoral analyses, we can also better understand where these
sectoral transition options start to hit system-wide constraints on resource availability. This
includes the necessary electricity required for direct electrification or for the production of
hydrogen or for the use of biomass in different sectors.

In moving from a sectoral analysis to a whole systems approach, it is not practical to
incorporate all the detail from the sector work into a single model but rather to ensure that
any whole systems model is updated to reflect a set of rules or assumptions, informed by a
detailed sectoral understanding.

of Advanced Demand Side Technologies and Energy Demand Reduction in Achieving Ambitious Carbon Budgets’,
Applied Energy, pages 351-367. Available here:
https://www.sciencedirect.com/science/article/pii/S0306261919300339#s0085
²⁶ See for example www.deepdecarbonization.org
e. Multi-criteria decision analysis

To complement the quantitative, largely modelling-based exercises, it will be important to capture those elements of transition which are best assessed outside models. A way of doing so is to conduct a multi-criteria decision analysis based on a number of agreed metrics, particularly focusing in on those areas which are difficult to assess quantitatively. Such factors include political willingness, geopolitical concerns, behavioural complexities, energy security, pace of change and the logistical aspects of transition.

Undertaking this exercise will rely heavily on broad, yet expert, stakeholder engagement, feeding in the outputs of the other analytical exercises but also relying on expert judgement. This will require a broad range of experts beyond analysts involved in modelling exercises but also require industry experts, investors, policymakers, consumer experts, diplomats, logistics organisations, and politicians.

The outcome of such an exercise will be a broad understanding of the complexities of delivering different models of transition in India. Whilst this will take information from the other analytical exercises to inform discussion, the outputs of this exercise will also likely inform some of the constraints that are applied in the modelling.

f. Interpreting and understanding scenarios

Finally, the last step should be synthesis of the available evidence using human, not model, intelligence. Models can only give orders of magnitude, directions of travel, and broad trade-offs. Ultimately, it is up to human analysts, policy-makers and stakeholders to make sense of the models, and draw their own conclusions. This should be done in a transparent consultation process that can help to get stakeholder buy-in for the key conclusions drawn.

C. Sectoral Transitional Mapping

a. Remarks on Global Efforts and India’s Fair Share

Having made a few remarks of a methodological nature, we now turn to discussing, in broad strokes, the nature of action that the LTS should entail. This is accompanied with the financing and technology challenge in these respective sectors. The objective of the Paris Agreement is to limit warming to less than 2°C, and if possible to less than 1.5°C. It is clear that for India, as one of the most vulnerable countries in the world, a maximum of global mitigation would be in India’s interests. But what of the mitigation effort required of India?

Let us suppose that India’s GDP increases at an annual rate of 5.1% between 2014 and 2050, consisting of a per capita increase of 4.5% per year and a population growth of 0.6% per year. As discussed above, this would be a really ambitious and successful growth story for India, catapulting it into the ranks of the upper middle-income countries. Let us further examine the range of equity principles that one sees in the effort-sharing literature (for example Chapter 6 of Volume III of the 5th Assessment Report of the IPCC), and their implied emissions...
allocations to India by 2050 under a global scenario consistent with limiting warming to 2°C.
Combining the assumed economic size of India in 2050 with these different emissions allocations gives us the required GHG intensity of GDP consistent with the assumptions on emissions and economic growth. We can then calculate the required reduction in the GHG intensity of GDP by 2050 against the most recent historical year of 2014, as well as the annual compound growth rate necessary to reach this level in 2050. Essentially, India is capable of large and significant emissions reduction which can only be achieved via structural transitions in the economy. Substantial, continuous and accelerated efforts would be required in the reduction of GHG intensity of GDP by 2050, in order for India to be consistent with a 2°C.

b. Framing Priority Sectors and Analysing their Feasibility

When framing the mitigation challenge for India, and the kinds of conclusions that can be put in the LTS, it is useful to categorize these sectors in three different categories of mitigation challenge: Easier to Abate, Mitigation Pathways Opening Up with medium abatement potential, and Harder to Abate sectors.

As discussed further in this chapter, these sectors with key priorities have been classified depending on their ease of abatement and stage of transition. Some sectors which are in the early stage of transition, and also easy to abate (for example making infrastructure resilient), must be acted upon quickly. Others such as iron and steel industries- are in the early stage of transition but also are hard to abate. These sectors become more important to focus on in the longer term strategy. Table 3 shows the six categories in which India’s key sectors for mitigative action could be placed

<table>
<thead>
<tr>
<th>Stage of Transition</th>
<th>Ease of Abatement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Easy</td>
</tr>
<tr>
<td>Early</td>
<td>Resilient Infrastructure</td>
</tr>
<tr>
<td>Advanced</td>
<td>Power (Electricity), Energy Demand</td>
</tr>
</tbody>
</table>

Most of these sectors overlap with India’s eight core sector industries. This is expected considering these form the backbone of the fast growing economy. Apart from the power sector, which is advanced in its transition considering the significant measures have been taken under both-improving scale and uptake of renewable energy and simultaneously improving energy efficiency in India’s key emitting industries; the other sectors are in early
stages of transition. It is reassuring that each of these is already driven towards a foreseeable quick transition due to the well-established policy landscape in each of these sectors. The transition under each of these sectors implicitly highlights a move away from coal use and related emissions. In effect, the LTS instinctively moves towards higher emissions avoidance owing to the technological availability and favourable policy landscape. (Annexure 1 gives more detail on each of these sectors along with existing policy landscaping.)

In this section, we look to provide a framing of what is possible for India to achieve under a robust mitigation scenario, based on analysis of different economy-wise and sector-specific studies. To start with, let us look at India’s sectoral emissions breakdown in Figure 8 followed by the mitigation potential as per ease of abatement in Table 4.

![Figure 8: GHG Emissions Breakdown by Key Sector](https://unfccc.int/sites/default/files/resource/INDIA%20SECOND%20BUR%20High%20Res.pdf)

**Figure 8: GHG Emissions Breakdown by Key Sector**

**Source:** Authors based on BUR

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### India’s Emissions Classified According to Mitigation Challenge

<table>
<thead>
<tr>
<th>Category</th>
<th>Sectors</th>
<th>Emissions, 2014, Mt CO2e</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easier to Abate</td>
<td>Electricity, Buildings Energy Demand</td>
<td>1189.07</td>
<td>46%</td>
</tr>
<tr>
<td>Mitigation Pathways</td>
<td>Light Duty Road Transport, Light Industry</td>
<td>449.0</td>
<td>17%</td>
</tr>
<tr>
<td>Opening Up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard to Abate</td>
<td>Heavy Industry, Freight Transport, Agriculture</td>
<td>969.46</td>
<td>37%</td>
</tr>
<tr>
<td>Total, Ex LULUCF</td>
<td></td>
<td>2607.49</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: Authors

Table 3: India’s Emissions Classified According to Mitigation Challenge

Over the course of the LTS, the sectors in each of these categories are likely to interchange, while some new sectors will also be added. As and when the emissions contribution change in each of these sectors, so will the ease of abatement and stage of transition. Modelling and demand forecasting will play a vital role in deciphering which sectors fall in which categories over the course of the LTS.

c. Framing the Mitigation Challenge

In what follows, we discuss the nature of the mitigation challenge in each, and the kinds of conclusions that could be drawn here in terms of mitigation potential. Clearly the categorization here is broad and is open to different interpretations: the point is to provide a framework for thinking about the transition challenge, before even getting into any modelling work or numerical analysis. The categorization here is based on an extensive review of the literature regarding mitigation pathways in different sectors, but ultimately derives from the authors’ overall judgements regarding the state of the art in terms of climate mitigation.

### Framing the ‘Easier to Abate’ Sectors

In the ‘Easier to Abate’ sectors we have placed in particular the electricity sector and buildings energy consumption (both residential and commercial buildings). These together account for about 46% of India’s emissions in 2014. Technology progress has dramatically opened up the realm of the possible for electricity sector abatement: it is now possible to imagine largely renewable based power systems, combined with a variety of flexibility options, in particular energy storage in the form of battery, pumped hydro or power-to-X systems (for example power-to-hydrogen). There is every reason to think that high renewables systems could be competitive with a fossil fuel-based system by 2050, based on observed technology learning in renewable power and energy storage.

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28 The terms easy or hard to abate may vary in different contexts however, can in general be understood in terms of abatement potential and cost of abatement along with policy support. Lower marginal cost of abatement, higher ease of implementation and complimentary policy framework, for a sector are likely to make the emissions easier-to abate in the sector. Similarly, for medium and hard to abate sectors.
This does not mean that the mitigation challenge will be ‘easy’, or that electricity sector emissions could be ‘easily’ driven down to zero by 2050. Certainly, abatement of the last 10-15% of electricity sector emissions may be challenging. Likewise, the rate at which zero carbon electricity supply would have to be increased is perhaps the greatest challenge. By 2050, electricity demand would be in the order of 5500-6000 TWh, potentially more. Meeting this largely from renewables and peaking and eventually declining the share of coal would require the addition of in the order of 80-100 TWh of zero carbon electricity per year, roughly 30 GW of new renewable generation capacity per year between now and 2050. To-date, the largest achieved capacity addition of wind and solar in India is about 12 GW in a calendar year. It should be noted, however, that the same calculation holds for fossil based systems: meeting demand growth in the order of 80-100 TWh per year from coal would require capacity additions in the order of 10-15 GW, with the accompanied infrastructure expansion for coal supply, a rate which has only been achieved in the period 2010-2015.

If electricity supply can be largely decarbonized by 2050, then buildings energy consumption, which is already largely electricity, can be likewise largely decarbonized. Here the major challenge is cooking, which will have to be electrified. This is not a financial or economic challenge, as electricity based cooking will be more cost effective than gas-based. Rather the challenge is organizational, behavioural and cultural.

In these sectors an appropriate target would be to peak emissions before 2040, and be on a pathway down thereafter. This would include peaking coal consumption and associated emissions in power generation before 2040.

Framing the ‘Mitigation Pathways Opening Up’ Sectors

In this category we have placed sectors like light duty road transport and light duty industry, these account for roughly 17% of total emissions as of 2014. Here the pathway is likely to be electrification for light-duty road transport and industrial low-grade process heat. In addition, given India’s extremely congested cities, in transport the priority must first and foremost be on the expansion of high quality public transport, before the expansion of – unsustainable-model of private road transport. City buses and rail can easily be electrified by 2050, and it is likely that the technology will be so advanced that medium to long distance intercity buses could also be electrified by that date. Likewise, we would expect that electrification of low-

30 There is still some considerable uncertainty in this figure, given the uncertainty in how key parts of the economy will decarbonize, such as heavy industry sectors, which may demand large amounts of low carbon electricity for hydrogen.
grade process heat requirements would be cost-effective and technologically feasible by 2050.

The way we see the challenge is not so much one of technological transition, but rather one of transition in the infrastructural paradigm of the country. In particular, for industry low grade process heat to electrify, the grid must become more reliable and cost-effective; this includes removing the cross-subsidy burden from industry. It is also the case that much of India’s light industry falls within the broader Micro, Small and Medium Enterprise (MSME) sector, where small business owners lack awareness and capital to invest in new electrification technologies. Likewise, the expansion of charging infrastructure to enable transport electrification will likely require substantial public investment, as well as urban planning consideration of how to integrate charging infrastructure into India’s congested and chaotic cities. The paradigm of private EV ownership is not likely to be the one India should follow, but electrified public transport, taxi fleets, three and two wheelers are likely to be the way forward.

➢ In these sectors, we feel it would be feasible and reasonable to aim for an emissions peak in the decade 2040-50.

Roles of MSMEs in India’s Long-Term Strategy

India’s manufacturing sector, comprises organised and unorganised establishments i.e. large industries and MSMEs, which build long and strong supply chains for the former. In India, MSMEs contribute to about 38% of the GDP and for about 40% of its total exports while providing employment to about 117 million people. MSMEs collectively are the second largest employers of the Indian workforce after agriculture. They span wide across sectors ranging from textiles and food processing to manufacturing metallurgy, glass and ceramics and chemicals. MSMEs are considered to be backbone of a developing economy and are likely to play a pivotal role in the LTS.

This significantly large and growing sector holds large potential to steer towards a low carbon economy in the short, medium and long run. Most of the MSMEs still use conventional technologies and practices that are inefficient and lead to pollution. Many energy-intensive MSME sectors such as have not witnessed innovation in energy efficient technology as have the larger counterparts. The MSMEs face two large challenges. First, emissions from MSMEs

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are yet not included in India’s inventory. This misses out on acting upon the large mitigation
topportunity that this sector offers.

Second, while this sector receives more policy support and regulatory ease than its larger
industrial counterparts, it remains devoid of enough financial resources to be able to finance
a greener transition, especially in the manufacturing MSMEs.

MSMEs face severe competition from international markets for both exports and cheap
imports. Initial, but significant measures, such as enhancing the energy efficiency can improve
cost effectiveness in the production process and also nudge a greener transition.

Currently, action in the MSMEs would be at the initial stage of transition, but mitigation in all
sectors of MSMEs may not necessarily present equal difficulty in abatement. The LTS would
require a thorough assessment of each type of MSME to include them in the abatement
classification and accordingly frame necessary action.

Framing the ‘Hard to Abate’ Sectors

In these sectors we find largely the agricultural sector and heavy industry, freight transport
and aviation. Agriculture is a very significant emitting sector for India, but has been left out
of India’s pledge under the Copenhagen Accord, given its social sensitivity and the absence of
technological solutions to agricultural emissions. By 2050, we would expect some inroads to
have been made in emissions free fertilizers, alternative proteins, and low carbon farming.
But it could still be expected that the agricultural sector would remain a gross emitter by
2050, and the goal of net zero emissions globally would require some degree of negative
emissions. We therefore don’t discuss agriculture further.

In the heavy industry and heavy transport sectors, we expect strong growth in India’s
emissions based on the currently very low level of material consumption and transport
demand. Opportunities for mitigation include, of course, substantial potential for demand
reduction through the circular and shared economy, as well as energy efficiency. This could
contribute to mitigating service demands and energy demand, but emissions can be expected
to still growth substantially. Thus, as the power sector transitions, and service demands grow
in industry and freight transport, it is expected that industry will become the largest share of
India’s emissions by 2050, while freight transport will grow from about 200 Mt to about 700
Mt by 2050.33

However, mitigation options are starting to open up, although they are still not commercially
ready. In industry, we would expect the proliferation of low-carbon hydrogen (H₂), carbon
capture, use and storage (CCUS), and advanced electrification to open up increasing

33 See for example: Stephane de la Rue du Cian et al (2019), “Modelling India’s energy future using a bottom-up
approach”, Applied Energy, 238, 1108-1125
mitigation options during the 2030s. However, the technology readiness level (TLR) of these options is still relatively low, with a number of key options still having a TLR of less than 5, i.e. full system level validation of technological and commercial feasibility in has not yet occurred.

- Hard to abate sectors are expected to account for a large share of India’s emissions growth, due to the low level of per capita material and transport consumption and the gradual abatement of ‘easier-to-abate’ sectors’ emissions.
- Here, what India can achieve depends on the global effort to prove and commercialize the relevant technologies, with leadership being taken by developed countries.
- In this context, we do not feel that it would prudent to speculate on a peaking date for these sectors in the LTS.

D. Technological and Financial Mapping

Technological and Financial needs require thorough assessment, for three key reasons mentioned earlier - understanding and mapping the need for both technology and finance, landscaping available resources and allocating them efficiently and lastly, for assessing the need for technological sharing across international communities via coalitions or bilateral and multilateral agreements. In this section we discuss these in more detail. Another important consideration here is that the technology and finance needs may vary for different sectors during different stages of their transition. For instance, transition in electricity may be far ahead from that in transport. It therefore requires more finance for better/advanced technologies to further its efficiency. Therefore, building on the classification done earlier, we also view the financial and technological necessities as per mitigation ease and potential in this section.

a. Need Assessment

On a broader scale, the pathway that the LTS proposes will in effect route investments. This in turn will drive where further action is taken and where more finance is mobilised. A starting point for this exercise will involve assessing cost, availability and access to the technology which is required for the proposed long term pathway.

Analysing the best available technologies in each of the targeted sectors and how they can be accessed will be helpful in mapping the needs for technology and corresponding finance. A step further at this stage may be estimating financial costs over and above that of acquiring the best technology. That is the cost of implementation and roll out of the proposed plan. This too, will vary across sectors but will give a holistic view of the resources required.

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b. Existing resource mapping and allocation

As a next step it will be beneficial to develop a thorough landscaping of existing resources. In case of India it is likely to imply taking stock of public funds dedicated towards climate action via policy measures. It will also be useful to track the flow of international climate finance for the different types of climate projects. Similarly, assessing the existing means of technological and knowledge sharing; scope and potential of incentivising R&D within the country for the nature of technology required.

At this stage, it must be kept in mind that the climate goals under LTS will be heavily intertwined with the development pathway the country chooses to undertake. Therefore, finance earmarked for conventional economic development—such as infrastructure or job creation—will also have to be carefully taken into consideration of the larger landscaping and allocation exercise.

c. Mobilising increased resources

The effectiveness of any strategy, including LTS will largely depend on availability of necessary technological and financial resources. After a thorough needs assessment and allocation of existing resources, there is likely to be need for additional support and knowledge sharing. In this case, a few alternatives may be useful for the policy makers to explore. First, bilateral or multilateral engagements including coalitions among Parties could serve as the first step towards mobilising knowledge sharing (further explored in Section 9 (b)). Second, what may also be essential on a national level, is evolution of an appropriate carbon market. Article 6 of the Paris Agreement necessitates the creation of market-based mechanisms which can mobilise finance and incentivise large scaled action. While that is still underway, India could explore the possibility of voluntary carbon markets. This could start with sectors which have high abatement potential but are in early stages of transition, such as energy efficiency in MSMEs in the India. This could facilitate movement of cleaner technology while also making the transitions financially viable.

In what follows, we discuss specific technological and financial need for the three broad categories under transition easy, medium and hard to abate sectors.

- In easy to abate sectors, there are still financial and technology needs. In particular, this relates to the build out of requisite infrastructure, which while it may have a positive social return, may have such long payback periods that commercial funding would not be available. Rather than have this compete for scarce public returns, some

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36 This could be particularly useful as we rebuild our economies post the Pandemic. A voluntary carbon market is likely to boost the flow of resources towards mitigative action, complementing and even boosting the flow of public funds directed towards this.
international capital could be provided. Likewise, in terms of technology the need of the hour is no longer with regard to solar PV or onshore wind, but rather with more cutting edge technologies like offshore wind, battery storage and power-to-X. Here there is a need for international capital for demonstration and commercialization. Private international capital is already funding the domestic renewables sector to a large degree, but will not be willing to move yet into projects where policy, technological and commercial readiness is lower.

- For those sectors which have mitigation pathway opening up, what is required is not so much public international costs to bridge an irreducible cost gap (the paradigm of the “agreed full costs” set out in Article 4.3 of the UNFCCC, because in the long-term transition in these sectors is likely to be socially beneficial, particularly if we take into account pollution externalities from transport and industry). Rather the paradigm needs to be of international public funding for transition costs, in particular the upfront investment cost in infrastructure and capital equipment. In terms of technology need, access to the latest in battery storage and fuel-cell technology will be crucial but unlikely to be prohibitive to the transition.

- In harder to abate sectors, the key is that technologies for abating these sectors are proven and commercialized at the global level, and made available in the countries where demand in these sectors is likely to grow, notably India. A global collaborative effort is required to prove technologies, diffuse them, and ensure that countries can undertake policies in these sectors without damaging trade competitiveness. There is likely to be substantial investment requirements, particularly for demonstration plants in India, and it is reasonable to expect large international public financing for them. There is a need to transition public financing away from sectors where progress has now become ‘autonomous’ and into sectors where there is a real need for risk-taking capital and mitigation of substantial upfront costs.^[37]

E. Institutional Arrangements
a. Institutional Set Up
Structured engagement and oversight, driven by the central ministries, involving both sectoral line ministries and state governments, is essential for consistently implementing a low-carbon mid-century strategy. Through its National Action Plan for Climate Change (NAPCC), while includes eight relevant National Missions focussed on addressing the various critical aspects of climate action, and State Action Plans for Climate Change (SAPCC) from all of its 28 States and 8 Union Territories, India has

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already created the basic framework for a comprehensive and multi-level institutional framework for fighting against climate change.

To understand the effectiveness of the existing institutional framework for delivering effective implementation of the LTS, the MoEFCC, under the aegis of the PM’s Council on Climate Change, should conduct the following exercise:

1. As a first step, the **efficacy of the existing institutional framework** should be assessed and the gaps and barriers to implementation of climate actions identified.

2. A **landscaping of the existing legal and policies framework** should also be conducted, with the aim of connecting this with the institutional framework, to ensure that the key nodal ministries and departments are properly engaged and made accountable.

3. An **assessment of the resource allocation** to these institutions should then be conducted, to identify if they have sufficient resources to achieve their goals and understand the feasibility and requirements for enhancing the national climate strategy.

4. Finally, a **reformulation of the responsibilities, with accountability**, of the key institutions should be formalized.

The design of the institutional framework, while assigning the responsibilities and accountabilities, should allow for the required degree of flexibility, such that it is able to respond to the changing economic, political and technological environments. The following chart depicts a broad framework, which builds on the existing system, is depicted in the figure below.
To ensure that the key nodal bodies are empowered and capable of undertaking the responsibilities assigned to them, regarding the LTS, it is important to address the following fundamental requirements for the implementation of the LTS:

b. Stakeholder Engagement

For the LTS formulation and implementation, regular stakeholder consultations, both vertical and cross-functional, will need to be adopted for effective implementation of the strategy. This will also be important to help assess and understand the technology solutions required, programmes and business models needed to support the emerging solutions, and capacity requirements at all levels.

Leveraging the Stages Model of policy formulation process to guide the framing of the mid-century strategy (LTS), the stakeholder engagement process could have the following three aims through the initial stages:
1. **Identification of Issues:** A comprehensive understanding of the key issues and priorities concerning climate action should be done. This entails appropriate inclusion of work done in the past on these areas, as well as the on-going work. Further, the stakeholders involved in the previous planned and implemented initiatives need to be identified and included as lead discussants, to avoid duplication and allow meaningful insights to emerge. It is also necessary to have representation from different stakeholder groups, including the government, industry, finance sector, sub-national actors and civil society.

2. **Agenda Setting:** The national priorities and key focus areas of the LTS should be decided through a focused series of stakeholder engagements with key relevant Ministries and nodal bodies at the States. This can be driven by the PM’s Council on Climate Change.

3. **Formulation of Processes:** In parallel to the agenda setting, an assessment of the requirements and capacities for implementation, financing and monitoring processes need to be done to design an implementation framework. This can be led by the MoEFCC as the national nodal body, which can then align these to the emerging requirements from the UNFCCC rulebook for implementing the Paris Agreement.

With the aim of fostering a collaborative approach to the development and implementation of the LTS, some vital objectives of the stakeholder engagement process and roles of the different groups for implementing the mid-century strategy can be as follows:

- **High-level leadership:** To drive a successful LTS development and its effective implementation, clear support from the political leadership, at the Centre and also the States, in the form of mandates and policy direction is required. To achieve this, initial momentum needs to be built and kept up with the help of research organizations, civil society and development institutions.

- **Sectoral coalitions:** Engaging the key Indian industrial sectors is crucial to enable achieving climate goals in a feasible manner. Through the sectoral line ministries, industry associations and industry leaders should be engaged in forming viable sectoral coalitions developing plans and strategies, to address the challenges to these.

- **Sub-national action:** A centralized decision-making and implementation of the strategy will be limited in its effectiveness. For a truly ambitious and effective strategy, it is important to engage with the key sub-national actors, especially the States. This process has already been kick-started in the form of the on-going revision of the State Action Plans for Climate Change (SAPCC). Using these, the Centre should work more closely with the States, using support from developmental and research organizations, to help States realize their potential for climate actions and better inform the national level mid-century strategy.

With these goals in mind, it is important to design an institutional framework for implementation, which should ensure that these stakeholder groups are involved at the
appropriate points of the process and are empowered with the required capacity and authority to effectively drive the national strategy.

c. Effective Institutional Mechanisms for Review

An effective stakeholder engagement process and institutional implementation can be spurred through a well-designed monitoring system, aimed at providing access to timely and relevant credible information to help key actors in their decision-making.

In order to effectively ensure implementation of LTS, monitoring should imbibe the following principles:

- **Enhanced transparency** through periodic communication of an assessment of progress by various line and state nodal bodies and the central nodal;
- **Strengthened data** availability by using standardized methodologies which are internationally accepted and establishing uniform standards and procedures where possible;
- **Access to updated information** through regular reporting from all key stakeholders, with them clearly being assigned the responsibility to do so.

An assessment of the existing processes and capacities should be done to enable effective monitoring that would primarily focus on the following aspects:

I. Measuring progress in the processes and implementation of concrete actions

II. Measuring emissions and their reduction across various sectors and regions of the country

III. Identifying co-benefits and measuring the impact of LTS on these through select indicators

IV. Tracking the various means of supporting implementation, including finance, technology, technical assistance, etc. at the national and sub-national levels.

There is scope for the country to further modernize and digitalize its institutional platforms and the specific nodal bodies and their databases, keeping these abreast of international requirements from the UNFCCC as well as making these effective in managing the various climate actions and initiatives being undertaken in the country. India will continue to do this by taking an iterative approach and learning from best practices, at the sub-national, national and global levels.
5. Key Messages
We draw a few broad conclusions from the above discussions.

1. **LTS will bring about coherence**
   India requires a long-term strategy for better coherence in guiding its economic growth and climate action, aligning its existing and upcoming policies, institutional mechanisms and resource allocation. An effective LTS will improve the planning and commitment in subsequent NDCs as they are likely to be subsets of the LTS.

2. **India is likely to still have a development gap by 2050.**
   India should aspire to the highest rate of high-quality GDP growth possible between now and 2050, where quality refers to social inclusion and environmental sustainability. However, projections for urbanisation, structural change and income growth suggest that India will still have a development gap by 2050, and large material growth still ahead of it. This is a challenge: by 2050, the world will have to be on a path to zero emissions and India must play a part in that. India’s ongoing development need and a global paradigm of net zero emissions must be made compatible. This can be done by promoting a rapid transition in the energy and industrial paradigm of development.

3. **In other sectors, solutions are emerging but cannot yet be relied on to peak emissions, here global learning is required.** India is faced with a paradox: it will be the source of energy demand growth in industry and heavy transport going forward, and these sectors are likely to be the largest emitting sectors by 2050 for India. On the other hand, demonstrating, commercializing and making competitive the technologies to drive forward solutions in these sectors depends on global action, particularly in the developed countries at the technology frontier. Here India can and should make its position contingent on global efforts to drive technology learning and diffusion and financing.

4. **The LTS is the best vehicle to articulate the vision for a development strategy cognizant of these points and the conditions for India’s strengthened participation in global action.**
   Putting together a vision that articulates the points above has a number of benefits for India. Firstly, it can signal its commitment to participating as strongly as possible in global action. Secondly, it can articulate what and why it can achieve in terms of emissions abatement. Thirdly, it can provide a vehicle to articulate the conditions for stronger action, particularly in terms of global technology learning, commercialization and diffusion, and the financing needs of India’s transition.

5. **An LTS would be as strong as its institutional mechanisms.** Strong policy landscaping and resource allocation mechanisms, sound legislative backing, capacity building and effective review mechanisms are the most essential groundwork to be laid for the LTS to be thoroughly implemented.

6. **Technological and Financial mapping and support** is crucial in designing an effective LTS. Assessing needs, taking stock and building international cooperation (via coalitions or bilateral and multilateral agreements) to further technological sharing and financial mobilisation. Global carbon markets complimented by innovative market based
mechanisms at a domestic level are likely to boost mobilisation of both finance and technology.

7. **A thoroughly designed LTS is likely to help chart out NDCs for the subsequent periods.** Developed with careful consultations with respective stakeholders, the likelihood of implementation of the respective NDCs leading up to the long term goal is higher.
Annexure 1: Key Priority Sectors in India

<table>
<thead>
<tr>
<th>Sector</th>
<th>Contribution to GDP (2018-19)</th>
<th>Stage of Transition and Ease of Abatement</th>
<th>Reasons</th>
<th>Mitigation options</th>
<th>Existing Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (electricity production)</td>
<td>2.03</td>
<td>Easy to Abate but Advanced stage of transition</td>
<td>Renewable electricity technologies being deployed at scale, at costs competitive with fossil fuel alternatives.</td>
<td>Wind, solar, hydro, nuclear, batteries, hydrogen</td>
<td>a. The energy sector contributes 73% to India’s total emissions inventory and is well regulated with various polices to guide the transition in the sector.</td>
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<td>b. Policy and action under the power sector is segregated into action under renewables and action on enhancing energy efficiency.</td>
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<td>c. National Solar Mission</td>
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<td>d. RPO</td>
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<td>e. National Clean Energy and Environment Fund 2010</td>
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<td>f. PAT Scheme</td>
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<td>g. Star rated appliances</td>
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<td>h. Energy Efficient Buildings Programme</td>
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<td>Transport</td>
<td>17.56</td>
<td>Medium to abate but early stage of transition</td>
<td>Whilst BEV technology is starting to become cost-effective with fossil fuel alternatives on a TCO basis, upfront casts are still significant. Levels of adoption are still relatively low.</td>
<td>Battery electric vehicles, fuel cell electric vehicles, public transport, ride sharing, walking, cycling</td>
<td>a. Emission standards and Auto Fuel Policy 2003</td>
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<td>b. Alternative fuels</td>
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<td>i. Ethanol Blended Petrol Programme (EBP)</td>
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<td>ii. National Policy on Biofuels 2018</td>
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<td>c. National Electric Mobility Mission Plan 2020</td>
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<tr>
<td>Industry</td>
<td>Stage</td>
<td>Description</td>
<td>Solutions</td>
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<td>Iron &amp; steel (mining</td>
<td>Hard to abate and early stage of transition</td>
<td>Commercial scale plants won’t be established until the mid-2020s and additional costs of ‘green’ steel will need to be managed.</td>
<td>Hydrogen direct reduction, increasing scrap use, resource efficiency, Hilsarna + CCUS, electrowinning</td>
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<td>quarrying, manufacturing</td>
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<td>a. PAT Scheme [ National Mission on Enhanced Energy Efficiency (NMEEE)]</td>
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<td>and construction)</td>
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<td>b. ZED Scheme for MSMEs</td>
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<td>Petro-chemicals</td>
<td>Hard to abate and early stage of transition</td>
<td>Requires scaling up of cost-effective hydrogen and biomass use, as well as CCUS, all of which are at an early stage.</td>
<td>Hydrogen and electrification for energy use, fossil fuels + CCUS and biomass for feed stocks</td>
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<td>Cement</td>
<td>Easy to abate and early stage of transition</td>
<td>Alternative materials and requisite CCUS technology are at an early stage of development.</td>
<td>a. National Building Code of India (NBC) 2016</td>
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<td>Buildings (cooling)</td>
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<td>b. Energy Conservation Building Code (ECBC)</td>
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<td>Resilient Infrastructure</td>
<td>Early Stage of Transition</td>
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<td>c. Building retrofitting project</td>
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<td>d. Star rating system for buildings</td>
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<td>e. Smart cities mission</td>
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| Forestry | 4. Forestry  
|---|---|
| a. Forest (Conservation) Act, 1980  
b. Compensatory Afforestation Fund Act 2016  
c. National Afforestation Programme  
d. Green Highways (Plantation, Transplantation, Beautification and Maintenance) Policy, 2015  
e. National Agroforestry Policy, 2014  
f. National Mission for a Green India  
g. The Indian Forest (Amendment) Act, 2017  
h. Twenty Point Programme  
i. Clean Development Mechanism  
j. Reducing Emissions from Deforestation and Forest Degradation in developing countries (REDD+) |