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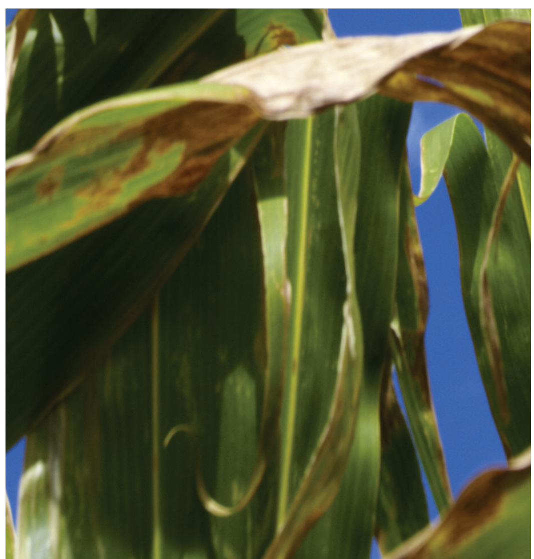
Reconciling India's Climate and Industrial Targets:

A Policy Roadmap



Annapurna Mitra
Editor

Reconciling India's Climate and Industrial Targets: A Policy Roadmap

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EDITOR'S NOTE

Industry in India has never grown to the levels the government has desired – either in contribution to GDP or to employment. Numerous targets have been set, particularly for the manufacturing sector, following the growth models of China and other countries in East Asia. However, India has come up short, largely due to lack of infrastructure, arbitrary regulations in land, labour and tax systems, and a poor business climate. Since 2014, despite the government's strong focus on manufacturing and ease of doing business, the sector remains at less than 15 percent of GDP, and unemployment is at its highest level in decades.

At the same time, India has performed remarkably well in terms of its climate trajectory over the past decade. As compared to 2005 levels, the country's GHG-emission intensity declined by 21 percent in 2014.[1] According to Climate Transparency, India is the only country among the G20 nations that is on track to achieve the targets set under the Paris Agreement.[2] One of the key, albeit unfortunate, reasons behind India's climate success is the underperformance of its manufacturing sector. Since industries comprise approximately one-fourth of the economy's total GHG emissions,[3] sluggish growth in the industrial sector has led to moderate increase in industrial power demand and emission-intensity of GDP.[4] The Indian government has set robust growth targets for its manufacturing sector. This includes the goal to ensure that manufacturing's contribution to GDP is increased to 25 percent by 2025 from the current 16 percent. As growth in the manufacturing sector ramps up, it is likely to come into conflict with India's climate ambitions. A comparison can be made of China: While manufacturing has powered the country's economy over the last two decades, the sector also accounts for 68 percent of nation-wide energy consumption and 84 percent of CO_2 emissions, as well as 24.1 percent of global emissions. The challenge for India is to achieve industrial growth on a low-carbon path.

1 https://www.ideasforindia.in/topics/environment/tracking-india-s-greenhouse-gas-emission-intensity-target.html
2 https://www.climate-transparency.org/wp-content/uploads/2020/11/Climate-Transparency-Report-2020.pdf
3 http://www.ghgplatform-india.org/industry-sector
4 https://www.thehindu.com/opinion/op-ed/why-make-in-india-has-failed/article30601269.ece

With the COVID-19 pandemic and parallel climate crises and geopolitical shifts, however, there arises an opportunity to rethink India's industrial sector and its place in the world economy. Globally, the COVID-19 crisis has brought into focus the fragility of vast, geographically spread out supply chains, which operate on 'just in time' principles. An additional fragility has been seen with China as the locus of too many supply chains. The tech industry, in particular, has started migrating rapidly out of China, with over 2,000 Japanese, Taiwanese and Korean companies announcing plans to diversify production. Their home governments have announced subsidies for the companies moving, with Japanese companies being incentivised to move to a number of countries, including India.

At the same time, the climate crisis has been used by a number of jurisdictions, most notably the countries in the EU, to accelerate their transition to a green economy. The UK announced a 10-point strategy for a 'Green Industrial Revolution' last year, aimed at simultaneously creating jobs and accelerating the shift to net-zero emissions[5]. These domestic shifts will be accompanied by regulations and restrictions on trade, flows of finance, and increasingly sophisticated measurement of Environment Social and Governance (ESG) implementation along supply chains. Huge amounts of emissions arise not just from production, but transport costs along the supply chain. The typical multinational's supply chain generates 5.5 times more emissions than its direct operations.[6] The world might soon be shifting to shorter, more geographically localised supply chains.

For India, these two shifts provide a huge opportunity, provided the country is able to act quickly to benefit from them. India's last industrial policy was published in 1991, in the throes of the license-quota-permit era, and was largely unsuccessful. A new one is due shortly, and this report attempts to make some recommendations for a policy regime that moves beyond the old model of government interference in business and markets, to one where the government actively works to address market failures, provide public goods and investment, and a regulatory architecture that supports green industrialisation.

5 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf

6 https://www.ft.com/content/936b4ab0-ac10-4860-a84f-02bfaa694b25 via CDP

The first section of this report examines three key elements of a shift to green industry: materials, technology and clean sources of energy. The shift from fossil-fuel to renewable sources of energy will change India's energy security calculus. While India has always been a net energy importer, it has managed to maintain a reasonably diversified supply chain so far. For renewable energy materials and machinery, however, supplies are geographically concentrated, which could lead to energy security concerns as the green transition progresses. The energy transition, therefore, will require an adequate supply of minerals, rapid technological innovation and the development of alternative sources of energy.

The pressing need to shift to clean energy and manufacturing has rapidly changed the types of inputs and raw materials required in industries. In Chapter 1, I examine the material needs of a shift to clean energy, which include a number of metals and minerals of which India lacks domestic endowments. Securing these supplies will require a number of measures. In the first instance, the government should conduct regular audits of the materials needed to meet clean energy targets. Global alliances and investments will be required to manage supplies of raw materials for which India lacks domestic endowments, as well as engagement with domestic industries to build up downstream supply chains. Finally, as the energy transition progresses, current infrastructure installations will rapidly start to become obsolete. Investment in technologies that enable recycling and reuse of the materials used could help in securing future supplies, as well as reduce the need for raw material extraction.

Secondly, a green transition for industry is necessarily a technological transition. In Chapter 2, *Sangeet Jain* highlights the importance of innovation-led growth in order to leverage the energy transition as an industrial opportunity. She identifies four major technological components for this transition, which include clean and wide-spread electrification, switching progressively to lower-carbon fuels and technology, resource efficiency, and finally, carbon capture and storage. She outlines specific policies that can support the development of these technologies.

Finally, ensuring a secure and reliable supply of clean energy to industries will now depend on creating a diversified supply chain for solar and wind energy infrastructure, as well as increased domestic manufacturing as described in Chapter 3. *Nandini Sarma* offers a series of policy recommendations that support the creation of a domestic clean energy industry. These include support to wind and solar manufacturing, creating and scaling up the use of hydrogen as a fuel, and finally, measures to incentivise technological development.

The next section looks at three sets of policies which can incentivise a shift to clean and sustainable modes of production. In chapter 4, *Tanushree Chandra* explores the viability of carbon pricing for Indian industry. She examines both government policies and private-sector initiatives for pricing carbon, in India and abroad, and suggests the need for a clear regulatory regime for pricing carbon. Remaining cognisant of both political economy challenges and the impact on industrial competitiveness, however, she suggests a policy pathway that looks to remove fossil-fuel subsidies in the short term. For the longer term, she suggests a carbon tax, with revenues redistributed back to households and firms, in order to mitigate the negative impact on consumption. This will require an immediate effort to strengthen India's digital infrastructure and social protection systems, to facilitate this revenue recycling.

In Chapter 5, *Ria Kasliwal* looks at mechanisms to encourage a shift towards clean energy in industry, as well as low-carbon manufacturing in three high-emissions sectors: iron and steel, cement and automobiles. She focuses on market-creating strategies, to foster demand for green products. She suggests re-evaluating fiscal incentives, phasing out harmful subsidies, incentivising consumers through price subsidies, concessions or rebates, and use of public procurement to create demand. In addition, she highlights the importance of certification in changing consumption habits, as well as clear mandates and targets to support production.

In Chapter 6, *Mihir Sharma* focuses on the role of finance in encouraging a low-carbon industrial sector. He provides an overview of current challenges in the Indian financial sector, focusing on the scarcity of investment finance and debt-related risks. His recommendations include using the priority sector lending framework to encourage the flow of finance to green industry, and the development of a comprehensive taxonomy for green finance. Complementary to these measures, he suggests enhanced disclosure rules coupled with stricter monitoring.

The last section assesses the potential for state government policies and corporate ambition to accelerate the green industrial transition. While India's industrial policy was last updated in 1991, the states publish industrial policies every five years. In their overview of these policies, *Manan Thakkar* and *Aakriti Rana*, evaluate states on their policies relating to renewable energy, pollution control, the availability of state-level industrial parks, waste-water management, and incentives for water and energy efficiency. While they find that a number of states have incorporated green elements into their policies, the implementation and efficacy of these is unclear. They recommend a clear demarcation of budgetary support to these sectors, monitoring and evaluation mechanisms to assess policy effectiveness and impact studies to analyse whether these policies affect decisions undertaken by business and industries.

Akarsh Bhutani, in his chapter, studies the climate commitments made by private-sector companies. He finds that a number of large, publicly-listed companies have already made ambitious climate commitments, and have progressed towards setting science-based net-zero emissions targets. Companies in the 'hard-to-abate' automotives, construction and chemical sectors account for almost 40 percent of those setting net-zero targets. However, the MSME sector, which accounts for 37 percent of Indian GDP will struggle to catch up without support. He recommends that large companies be encouraged to account for scope-3 emissions along their value chains, thus creating an incentive for suppliers to improve sustainability outcomes. The government, on the other hand, can support SMEs by setting up green industrial clusters and parks, which provide the infrastructure needed to operate sustainably.

These eight chapters provide a policy roadmap that can help reconcile India's attempt to generate economic growth and job creation through the manufacturing sector, and the country's climate ambitions. These policy suggestions are suited to India's economic, demographic and institutional conditions, as well as implementation capacity, that will support the creation of an internationally competitive industrial sector. The aim is to provide a blueprint that will address economic growth and job creation, while ensuring environmental sustainability, local production, and resilience to external shocks.

1

ELEMENTS OF THE CLEAN ENERGY TRANSITION

1.1

The Material Needs of the Green Transition

Annapurna Mitra

Introduction

A switch to low-carbon manufacturing will require adequate and reliable supply of renewable energy. As the costs of generating wind and solar energy fall, they are increasingly becoming more competitive sources of energy. The rapid deployment of renewables, however, poses two challenges for India.

First, India's energy security will now depend on creating a diversified supply chain for solar and wind energy infrastructure, as well as increased domestic manufacturing (as described in Chapter 4). Second, the pressing need to shift to clean energy and manufacturing has rapidly changed the types of inputs and raw materials required in industries. Rare earths, for instance, which were not used at all in the Indian manufacturing sector just a decade ago, will now be required for most green technologies. In solar components, for instance, India's import dependence has increased steadily, and is currently at over 92 percent.[a] A study by the Federation of Indian Chambers of Commerce and Industry (FICCI) shows that both the raw materials and the machinery required for producing solar modules are imported by Indian companies—this increases both production and inventory costs.[1] Lithium and cobalt will be required for battery storage, with the global demand set to increase by 488 percent and 460 percent, respectively, by 2050. Similarly, aluminium is used across most energy-generation and storage technologies, and achieving the 2-degree centigrade global climate target is estimated to require around 6 million tonnes of aluminium, annually, by 2050.[2]

This chapter looks at the risks to energy security that arise as the Indian economy shifts to clean sources. While Chapter 4 focuses on encouraging domestic manufacturing of solar and wind components, this looks at securing supplies of essential materials required for the energy transition. In the first instance, this will require regular audits of the materials needed to meet clean energy targets. Global alliances and investments will be required to manage supplies of raw materials for which India lacks domestic endowments, as well as engagement with domestic industries to build up downstream supply chains. Finally, as the energy transition progresses, current infrastructure

a Lok Sabha Unstarred Question No. 397, dated 19.07.2018 installations will rapidly start to become obsolete. Investment in technologies that enable recycling and reuse of the materials used could help secure future supplies, as well as reduce the need for raw material extraction.

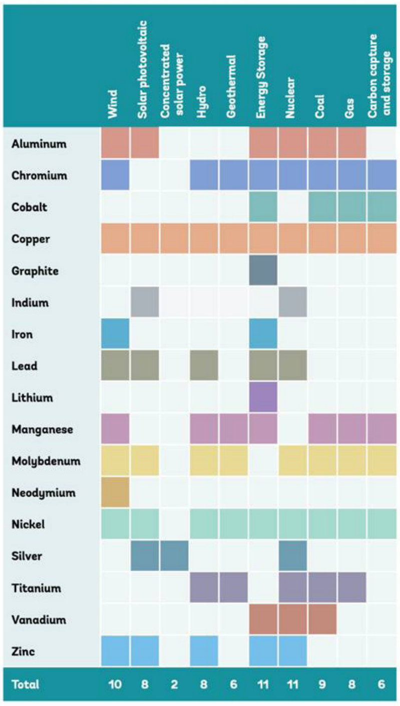
Materials Required for a Green Transition

Figure 1 shows the minerals used in different low-carbon technologies. Aluminium, copper and nickel, for example, are all widely used in generating solar power, and have a range of other uses. The demand for these, therefore, is likely to remain high over the next few decades, irrespective of the energy mix.[3] Major industrial economies, recognising this need, have declared aluminium a strategic sector (See Figure 2). Neodymium, in contrast, is used only in wind energy generation, but is a magnetic rare earth with a range of uses in electronic devices, including electric vehicles. Forecasts suggest that the market for magnetic rare-earths will increase five-fold by 2030, with a supply shortfall of 48,000 tonnes for neodymium.[4]

The International Energy Agency, in a 2020 study, highlighted that geopolitical risks to energy will intensify with the shift to clean energy, as the endowment of critical raw materials is more geographically concentrated.[5] Refining operations are also highly concentrated, with China controlling 50-70 percent of the lithium and cobalt value chains, as well as almost 90 percent of rare-earth processing. Therefore, regulatory and political changes can have a significant impact on energy security.

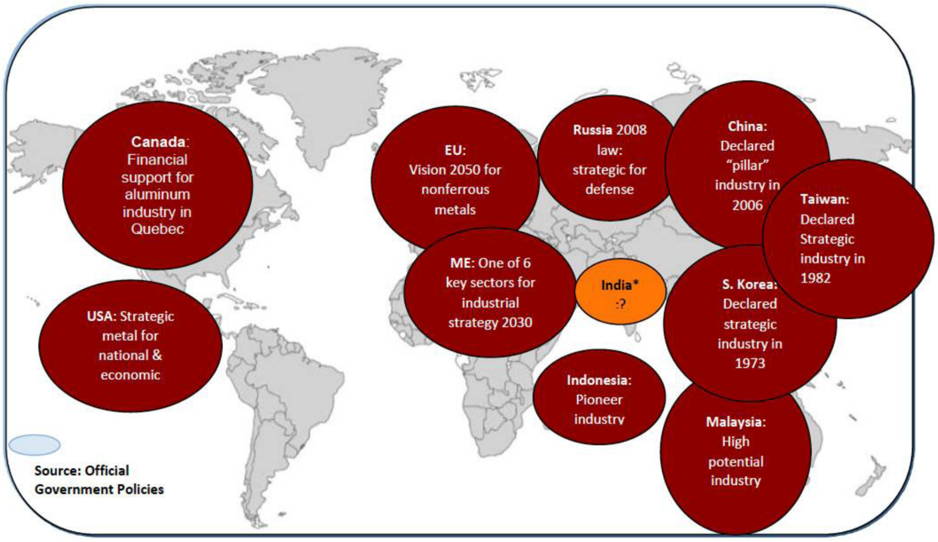
India, unfortunately, lacks domestic endowments of some of these raw materials. A Department of Science and Technology study estimates that risks to the supply of heavy rare earths, which are essential to most green technologies, will be at critical levels by 2030.[6] Moreover, India has not invested sufficiently in technology and refining capacity for a number of these sectors.

Figure 1. Mapping Minerals with Relevant Low-Carbon Technologies



Source: World Bank[7]

Figure 2. Industrial economies that have declared Aluminum a strategic industry

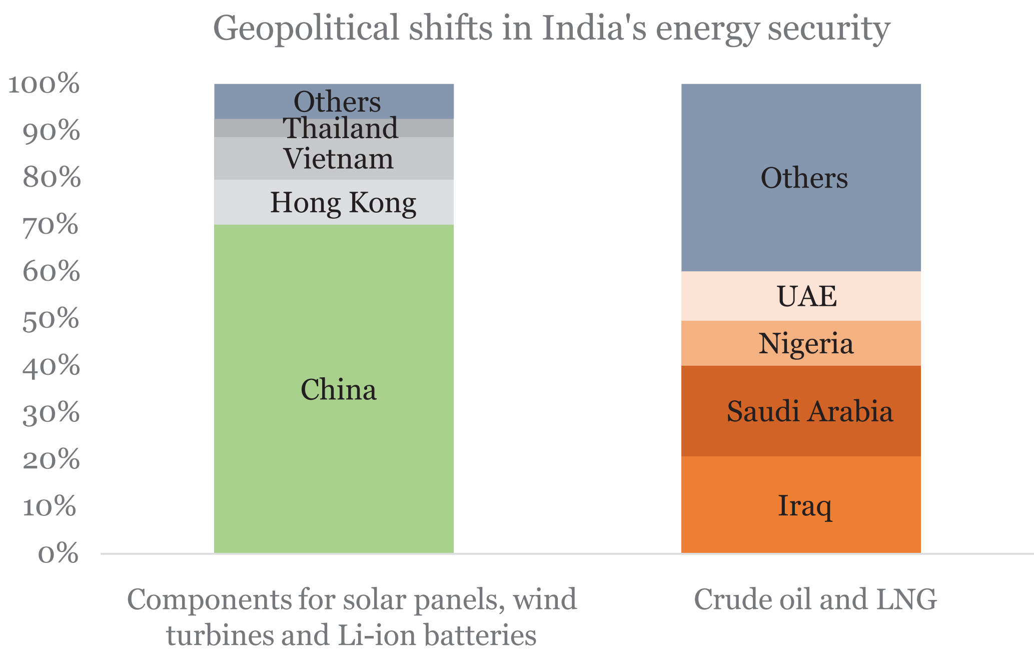


Source: NITI Aayog

Geopolitical Risks to India's Energy Security

While India has always been dependent on imports for its energy security—with more than 80 percent of crude oil and natural gas supplies coming from abroad—it has managed to maintain a reasonably diversified supply chain. However, the shift to green energy will lead to a concentration of import dependence on China, which in 2019 accounted for 70 percent of imports for critical sectors (See Figure 3).

Figure 3. India's energy imports by country of origin



Note: Country-wise imports of solar cells and modules, wind turbines, permanent magnets, rare earths, lithium-ion batteries, crude oil and liquefied natural gas from April-Dec 2019 in USD million. Calculations: Author's own. Data source: Tradestat database of the Department of Commerce, https://tradestat.commerce.gov.in/eidb/default.asp

While such a high dependence on a single country for a critical resource carries inherent risks, in this case the risk is intensified by China's control of global supplies of raw materials essential to green manufacturing. China has used export restrictions on these materials in the past as a leverage in its political conflicts, for instance in 2010 with Japan. In 2020, the Chinese government proposed new legislation that would allow the government to curb exports of strategic materials on grounds of national security.[8] Other countries, too, have put in place restrictive export policies. Indonesia, for example, banned the export of nickel in 2020,[9] and Congo put in place a new mining policy in 2018 which tripled royalties on cobalt—in turn increasing the price for the end-user.[10]

Supply chain disruptions in these materials can also impact the viability of industrial production. Companies are looking increasingly to the supply of clean energy and transport decisions, as they determine the locations of their factories. Furthermore, many upcoming manufacturing industries essential to reducing emissions—in particular, electric mobility and energy storage—will require large quantities of batteries, semiconductors and permanent magnets, which India does not produce domestically. Though the government is incentivising companies to set up battery manufacturing plants, 40-50 percent of the raw materials will still have to be imported.[11] Disruptions in international supplies often impact local industry. For instance, in January 2021, media reports said that auto manufacturers in China, Japan, the EU and the US would be forced to cut production of electric vehicles due to a shortage of semiconductors.[12] In order to maintain energy security, therefore, India will need to develop robust supply chains for the required components.

Managing Supply Risks

Conduct audits of critical minerals

The first step to managing supply risks is to conduct an audit of critical elements essential to India's green transition. While the Department of Science and Technology conducted such an analysis in 2016,[b] it was not mapped in any way to match India's requirements for the green transition. Given rapidly changing technology, it also needs to be updated regularly, in order to identify substitutes and changing intensity of use of different materials.

The European Union (EU), for example, conducts such an audit every three years, and the number of materials on its list has more than doubled in the last decade, from 14 in 2011 to 30 in 2020.[13] In addition, the European Commission estimates material needs for growing technologies based on the EU's 2050 climate-neutrality scenarios[14] and provides an outlook to 2030 and 2050 of material demand for these

b https://dst.gov.in/sites/default/files/CEEW_0.pdf sectors. Similarly, Australia identified 15 critical materials[15] for the defence and high-tech sectors in 2017, and is working on developing projects for each of these. The US, for its part, declared a "national emergency" in the supply of critical minerals in 2020, and the government is working on hastening the development of mines.[16]

Use international alliances and strategic investments

A number of countries are entering into alliances for the extraction of these raw materials, and to build processing and developing capacity, in order to create secure supply chains. The European Raw Materials Alliance works with member countries to ensure reliable and sustainable access to critical raw materials to support the industrial ecosystem.[17] They are currently focused on permanent magnets, essential for wind energy, as well as energy storage solutions. To direct investment to critical sectors, they are establishing a Raw Materials Investment Platform (RMIP) to bring investors and investees together, and use EU funding, both within and outside Europe, to develop these projects. Russia has offered reduced mining taxes and cheaper loans to investors to increase their share of global rare earths output to 10 percent by 2030 from the current 1.3 percent.[18]

The US and Australia entered into an alliance in 2018 for strategic minerals exploration, extraction, processing and research, and the development of rare earths and high performance metals.[19] In 2019, the US, Australia, Canada, Peru and Botswana founded the Energy Resource Governance Initiative to meet the demand for materials required for clean energy technologies. They intend to engage resource-rich countries in extracting these metals, directing investment to these projects and supporting the creation of sustainable supply chains.[20]

The US is also increasing the range and scope of strategic investments in these sectors. The US International Development Finance Corporation, set up in 2019 to provide an alternative to Chinese overseas investments, already has more than 800 projects across the globe.[21] One of the priority areas is the diversification of critical supply chains, and investments in this area include a Brazilian mining project for nickel and cobalt in partnership with a UK company.[22] The US-Australia partnership has identified projects worth AU$5.7 billion for investments.[23] To lower the cost of capital in this sector, the US Congress introduced bipartisan legislation in 2020 to provide tax incentives to companies involved in the mining, reclaiming and recycling of these minerals.[24]

The Indian government, for its part, has created a government monopoly in this sector and has not exploited its resources effectively. Domestic mining of rare earths is carried out by Indian Rare Earths Limited (IREL), a public sector company, and is largely focused on raw materials for nuclear energy generation.[25] While India has domestic deposits of light rare earths, the technology and infrastructure to extract and refine these has yet to be developed. For materials which are not domestically available, India in 2019 set up the Khanij Bidesh India Limited (KABIL), a public sector enterprise for the acquisition, exploration and processing of strategic minerals abroad; it has identified lithium and cobalt as priority sectors.[26] KABIL signed MoUs with Australia, Bolivia and Argentina in 2020.[27]

Recent policy announcements from the Indian government, in the 2021 budget speech as well as discussions around KABIL,[28] indicate a focus on import substitution and self-sufficiency in these sectors. Given the complexity of these supply chains, as well as rapidly changing technologies, India should focus instead on integrating its companies into global supply chains. Joining existing US and EU alliances, for example, could provide access to a diversified supply chain as well as new technologies and investment opportunities.

Work with industry for supply chains and alternatives to scarce minerals

The industrial strategy should look at supporting the creation of manufacturing capacity along the supply chain. The Indian government is already planning to expand the production of electric vehicles (EVs) by building mega-scale manufacturing facilities, charging stations, solar photovoltaic (PV) cells, and lithium-ion batteries. It proposes financial incentives for EVs to increase demand and achieve the target of 30-percent EV penetration by 2030.[29]

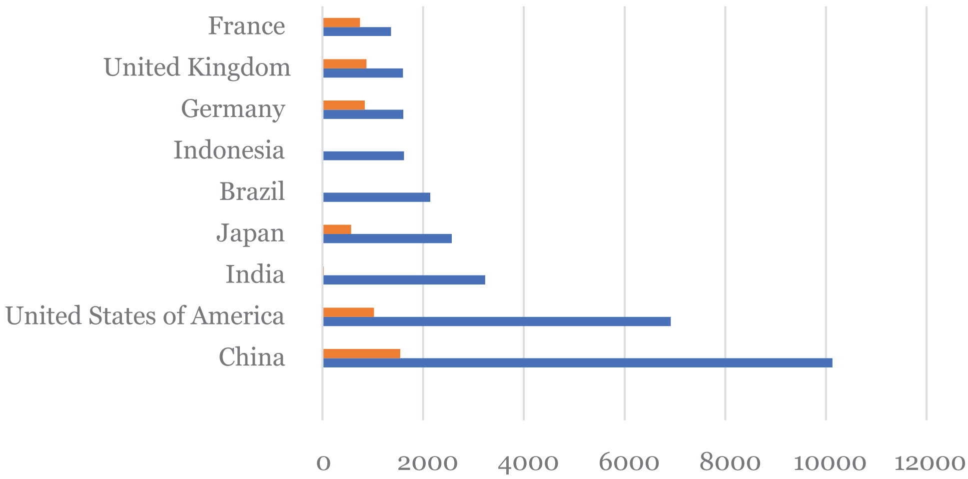
To be sure, continued interaction with industries will be required to ensure a well-coordinated industrial policy. Indonesia, for example, has embarked on a multi-year project to build an EV supply chain—from mine to final product.[30] The chain started with the acquisition of nickel mines in 2020. The government has inked agreements with the world's largest lithium-ion battery makers to start production in 2021. Finally, they are working with the South Korean multinational automaker, Hyundai, to start an EV manufacturing hub in the region. The EU Raw Materials Alliance works with companies to mitigate regulatory and financing bottlenecks.[31]

In India, Rare Earths Limited has an MoU with Japan's Toyota for the promotion of mining within the country, and for export to the US, EU and Japan.[32] Such agreements limit Indian companies to extraction processes, while the refining process—which creates greater value—is carried out abroad. To build capacity further up the value chain, these partnerships should be expanded to domestic manufacturing companies, with the government supporting the process of investment and technology acquisition.[33]

Recycling and Reuse as Investment Opportunities

In only a few years, existing green technologies and infrastructure will start becoming obsolete. The UN Innovation Network states that although e-waste generated by the solar sector represents less than 0.1 percent of current global e-waste streams,[34] this will rise to 78 million metric tonnes by 2050.[35] India is one of the worst of all producers in recycling e-waste, with only 1 percent collected and recycled each year.[36]

Figure 4. E-waste generated and recycled in major economies



Source: Global E-waste monitor 2020[37]

Similarly, renewable energy installations like solar panels usually last from 20 to 25 years, and early installations are likely to start being decommissioned within the current decade. As India is prioritising solar in its energy mix, having a headstart in recycling will ensure that the solar industry remains sustainable in the long run.

India, therefore, has potential to secure future supplies by investing in recycling industries, as well as creating a secondary market for recycled minerals. Recycling is also much less polluting than mining. For example, the World Bank estimates that depending on the source of aluminium, recycling could mitigate the global warming potential of aluminium use by anywhere between 8.7 – 30.5 percent.[38]

The Indian government has recognised the need to recycle e-waste; if effective, recycling could allow for the reuse of cobalt, nickel, lithium and neodymium. In February 2020 the Draft Battery Waste Management Rules were released,[39] making manufacturers responsible for collecting used batteries and sending them to registered recycling units, and filing an annual record of their sales and buyback to state pollution control boards. The rules are based on the principle of extended producer responsibility (EPR) and propose to cover 70 percent of waste generated within seven years of the rules being implemented (See Figure 5).

Figure 5. Targets for Extended Producer Responsibility

Year	Battery-Waste Collection Target (Number/Weight)
During first two year of implementation of rules	30% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.
During third and fourth years of implementation of rules	40% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.
During Fifth and Sixth years of implementation of rules	50% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.
Seventh year onward of implementation of rules	70% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.

Source: *GoI's Battery Waste Management Rules (2020)*

The experience with EPR in India, however, has been mixed. Gupt and Sahay (2019), analysing the effectiveness of four different waste management rules based on the principle of EPR, between 2001 and 2019, find that they have failed to achieve the desired results.[40] These legislations have been a driver for the setting up of formal recycling facilities, and there are 312 authorised recyclers in India, with the capacity for treating approximately 800 kilo tonnes (kt) annually. However, formal recycling capacity remains underutilised, as the large majority of the waste is still handled by the informal sector which has the capacity for collecting waste.[41,42] These laws have also been difficult to implement due to the high regulatory burden and inadequate time.[43]

Increasing recycling in these sectors will therefore need to integrate the informal sector with formal recycling units. Research by the Organisation for Economic Cooperation and Development (OECD) shows that the disposal of waste by the informal sector is usually hazardous and polluting.[44] A viable solution might be to rely on monetary incentives to the informal sector to collect waste, and then using formal facilities to undertake the recycling process.[45]

For metals, meanwhile, India does not have an organised recycling industry. Only about 25 percent of metal is recycled, and largely in the informal sector.[46] The NITI Aayog identifies a number of problems in metal recycling, particularly for aluminium: lack of collection infrastructure, primitive technology, poor quality control, and high levels of pollution.[47] A comprehensive policy will be required to establish the appropriate legislative, administrative and institutional framework for the recycling of metals and materials.

Conclusion

As India's industrial sector grows, creating a regular and stable supply of clean energy will be essential for meeting the country's climate targets. Companies are already looking to the supply of clean energy and transport options as they determine the locations of their factories. However, the shift to clean energy creates a new set of challenges to energy security, as the supply of materials required for clean energy installations is geographically concentrated. India will need to conduct a serious inventory of its material needs in line with clean energy targets, and expand both domestic capacity and international alliances to meet this demand.

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1.2

Enabling a Green Technological Transition in India: The Case for a Green Industrial Strategy

Sangeet Jain

Industrial emissions have been described as the "world's blind spot" in climate change mitigation efforts.[1] In India, industry has been the top source of energy demand since 2000,[2] and the country's share of industrial emissions is predicted to rise to 35 percent of overall Indian emissions by 2040.[3] As the country puts political capital behind its 'Make in India' initiative—fuelled further by the imperatives of supply chain security and resilience highlighted by the COVID-19 pandemic—Indian industry's energy and material intensity is expected to increase. Therefore, the decarbonisation of industry must be a crucial and urgent priority for Indian industrial policy to reconcile the country's environmental and industrial goals.

Even as developed economies have now embraced the need to formulate green industrial strategies (for instance, the UK recently released a first-of-its-kind industrial decarbonisation strategy[4]), the challenge for developing countries such as India is far more formidable. India's strategy must be two-pronged: to promote value-additive growth and industrial upgrading, while ensuring that such industrial transformation is green. Technological progress will be the game changer in making this green growth possible.[5] Analysis by the Council on Energy, Environment and Water suggests that if India was to rely only on currently available technologies, manufacturing emissions will need to peak before 2050 for the country to meet its environmental targets.[6] This will mean a loss of US$23 billion in industrial output and 19 million jobs. The green transition is, therefore, necessarily a technological transition.

Industries have so far treated the negative effects of old, polluting technologies as irrelevant "externalities". Fixing these market failures and harnessing the benefits of the world's latest "technological revolution"[7] will require deliberate policy support and investment to shape and co-create markets for green technologies,[a] and support their diffusion and absorption across geographies. The need for an engaged entrepreneurial-regulatory state to manage the green transition is acknowledged in other parts of this volume. This chapter has two broad aims: to provide an insight into the elements of a clean technological transition for Indian industry, and to make a case for designing an appropriate green industrial policy that can facilitate

a Green technology does not have a consistent definition. For the purpose of this chapter, green technologies shall refer to technologies that have a minimal negative impact on the environment throughout the course of their life cycle.

this transition. Currently, as evidenced by India's draft industrial policy,[8] there is considerable political momentum and willingness on the government's part to design and support the phase-in of green technologies. At the India Energy Forum 2020, NITI Aayog CEO Amitabh Kant suggested that India requires a "10 year roadmap" for green technologies.[9] This chapter aims to build clarity on the elements that must inform such a roadmap from a political economy perspective.

Formulating a green industrial strategy for India is particularly opportune as its energy future is yet to be determined. According to the International Energy Agency (IEA), most of India's future emissions depend on infrastructure and industrial capacity yet to be built.[10] In building it green, India could create a source of tremendous industrial competitiveness.[11] Additionally, decarbonising industry promises to be an innovation-intensive endeavour that will spur knowledge spillovers and industrial upgrading. Green technologies have been found to create over 40-percent more positive spillovers than those from conventional technology, creating higher value in the broader economy and higher-quality job growth.[12]

Elements of a Green Technological Transition for Industry

Based on a literature review, this analysis identifies four major components of a green technological transition for industry: clean electrification; resource efficiency; cleaner energy mix (switching to progressively lower-carbon fuels and technologies); and carbon capture, utilisation and storage.

1. Clean Electrification

According to the International Renewable Energy Agency, renewables-powered electricity as an energy source must meet at least 50 percent of global energy needs by 2050 (up from the present 20 percent) if the world is to achieve its environmental goals.[13]

The IEA *India Energy Outlook* finds that the country has made significant progress in access to electrification.[14] However, approximately 239 million people in the country remain without access to electricity.[15] This is a massive opportunity for clean electrification to make inroads into the country, as large parts of India are not yet locked into a dirty grid. Currently, electricity makes up just 20.3 percent of industrial energy use in India.[16]

Industrial processes are, at present, hard to fully electrify. Technological barriers exist in some cases. For example, the direct reduction of iron ore for steel production requires chemical feedstocks that electrification cannot provide (25 percent of industrial emissions occur due to these chemical reactions[17]). Some industrial processes are highly heat-intensive and require fossil fuels.[18]

Additionally, there are issues unique to the Indian political economy that pose challenges for the electrification of industrial processes. In purchasing power parity terms, electricity prices for Indian industry are among the highest in the world due to cross-subsidisation—a mechanism that subsidises electricity provision to poorer citizens and farmers while commercial and industrial consumers pay higher rates.[19] Industry is also hurt by unreliable, low-quality electricity supply. The IEA suggests that about 35 percent of rural enterprises depend on non-grid electricity sources such as diesel generators and solar home systems.[20] This is mainly due to an inefficient power sector—India has a surplus of generation capacity relative to demand but faces technical and revenue losses in distribution.[21] Reliable and cost-effective supply is crucial for industrial competitiveness, and the shoddy state of the power sector compelled Indian industries to set up their own power plants (captive power plants).

Captive power accounts for 14 percent of India's total electricity consumption.[22] This situation is now increasingly unsustainable and a source of energy inefficiency. Now that electricity distribution companies (discoms) have built excess capacity, they are facing heavy losses due to captive power. This puts pressure on power companies' plant load factors (PLF) as lower demand means lower PLF and higher use of coal, and consequently, energy inefficiency.[23] Additionally, an ill-thought-out policy in 2019 capped charges for captive power plants on renewable energy purchase obligations (RPOs).[24] About 64 percent of captive plants are already coal-based, 33 percent diesel and gas-based, and only 4 percent are wind and solar-based.[25] This has meant that discoms and states—already financially stressed—will need to increase their own RPOs to meet the country's climate obligations. This has served as a disincentive for industry to clean up their captive power plants and will hamper an increase in renewable capacity as discoms already have a poor track record of buying renewable power. [26]

Flexible storage technologies: A Spotlight on Batteries

Another key technical barrier for clean electrification is that renewable energy is variable, and demand needs to coincide with supply to ensure grid stability. Flexible storage technologies, such as batteries, can provide for delayed consumption. According to the IEA, India can become a "world leader" in battery storage. However, given India's limited experience in developing new battery technologies, a well thought out industrial strategy will be required to encourage the commercialisation and deployment of grid-scale battery storage.[27]

India has already announced the National Mission on Transformative Mobility and Battery Storage, which has approved a five-year plan for the phased manufacturing of large-scale battery and cells.[28] India may consider following a "bottom-up approach", beginning at the lower ends of the value chain to capture crucial market share immediately.[29] Infant industry protection will be crucial for India to develop economies of scale and build its productive capabilities in the sector, before encouraging foreign competition to boost the sector's capabilities. Market signalling through "time-of-day pricing" could help incentivise investment in this area.[30] Instruments such as capacity payments, feed-in tariffs, investment tax credits and accelerated depreciation can be deployed to encourage commercial viability.[31] The state's role will also extend to providing an enabling regulatory framework for grid-scale storage, to encourage commercialisation of the technology.[32] The government's efforts thus far have already led to a marked increase in the number of grid-scale storage tenders. [33]

Policy recommendations

The following policy recommendations may help encourage a shift to clean electrification for industry:

1 The rationalisation of industrial power tariffs is a long-overdue reform. It will boost industrial competitiveness and may promote a shift to grid-based electricity by making the particularly costly, energy-inefficient captive units financially unviable.[34] Steps must also be taken to incentivise rooftop solar as a captive power source (as costs of integrated solar plus battery continuously fall).[35]

2 There is a need to identify and encourage electrification through industrial policy in sectors where electrification is technologically possible. According to one

estimate, it is currently technologically feasible to electrify as much as half of global industrial fuel consumption.[36]

3 Technological solutions such as smart grids need industry buy-in and market creation initiatives by the government to encourage their deployment in promoting energy efficiency.[37]

4 A dedicated policy is required for micro, small and medium enterprises (MSMEs); only 48.2 percent of MSMEs use electricity as their primary energy source.[38]

2. Resource Efficiency

The use of technology in the promotion of material and energy efficiency in industry has multiple benefits—it lowers production costs and enhances industrial competitiveness, while also being more sustainable and less polluting in the long term. Here, the term resource efficiency encompasses energy-efficient processes and the development of sustainable materials that have a longer life cycle and are more environmentally friendly. The role of industrial policy stems from the fact that promoting energy efficiency is a collective action problem; there is a risk of industry efforts being undercut by free-riding competitors in the absence of adequate provision of carrots and sticks to prevent a race to the bottom. Industrial policy also needs to play a role in creating a market for sustainably produced products. [39]

Energy efficiency

India's Energy Conservation Act (2001) legally mandates the implementation of energy efficiency measures undertaken by the Bureau of Energy Efficiency and state-designated agencies. India also has a National Mission on Enhanced Energy Efficiency, which encompasses the PAT (perform, achieve and trade), a successful market-based mechanism that mandates energy consumption reduction targets for large energy-intensive industries.[40]

Energy efficiency measures that work for developed countries cannot always be replicated in developing ones, as retrofitting is investment-heavy and an innovation-intensive endeavour. State support could enable the adoption of new technologies requiring constant retrofitting and need more advanced production capabilities to be developed in the economy. [41] Industrial strategy can also boost awareness of energy-efficient technologies, especially to make smaller companies aware of potential cost savings.[42]

The MSME sector is the weak link for energy efficiency in India. The cash-strapped sector continues to rely on old, inefficient technologies and processes, and being largely informal, there is a lack of data on the sector's energy usage, limiting the scope of policy.[43] COVID-19 has hit the sector hardest, and the case for energy efficiency take-up is now even more compelling to reduce costs for the sector and promote competitiveness. MSMEs are outside the purview of the Energy Conservation Act and India needs a dedicated policy for energy efficiency in the sector.[44] Through an industrial strategy, the state can help support dedicated pilots and technology demonstration platforms,[45] and help provide access to expertise and technical advice for MSMEs.

Material efficiency

About 62 percent of worldwide emissions are released during the extraction, processing and production of goods, and only about 9 percent of used material is part of the circular economy.[46] Heavy industries that require extreme heat (such as steel, cement and petrochemicals) are among the next frontiers in the economy's decarbonisation. As an illustrative example, this section examines the prospects of cleaning up India's iron and steel industry since the sector is estimated to have the most significant potential for savings in material and energy intensity.[47]

The iron and steel sector is responsible for approximately 30 percent of India's industrial energy consumption.[48] Most Indian plants use old blast furnace technology, making their emissions intensity twice the global level. Additionally, the Indian steel industry is also heavily reliant on imports due to a scarcity of high-grade coking coal.[49] Energy efficiency improvements will not suffice for this sector, neither will recycling, as steel is already among the most-reused materials on earth. There is thus a global thrust towards developing technologies to produce low-carbon iron and steel.[50]

Most initiatives are still at the laboratory stages—coke is extremely hard to replace due to its heat-intensive properties—and are estimated to be ready for the market only by 2030. [51] Relying on hydrogen as fuel will most likely be part of the solution, but this will be a tremendously expensive proposition—ArcelorMittal, for instance, estimates that the decarbonisation of its facilities in the European Union (EU) will cost between €15-40 billion—and is expected to increase the cost of steel for consumers exponentially.[52] State support will be required for green steel to be able to compete with inferior and vastly cheaper steel in the market.

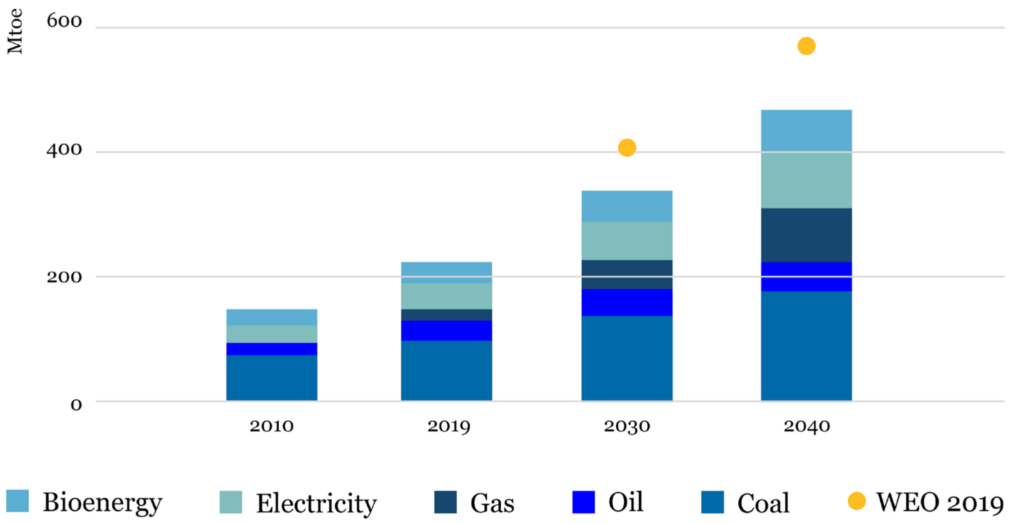
TATA Steel has piloted the 'Hlsarna process' for producing greener steel in Europe, and is likely to be a conduit for innovation diffusion in this area as it also plans to build a commercial-scale plant in India.[53] It is also collaborating with the Confederation of Indian Industry and multiple stakeholders to develop a 'GreenPro Ecolabel' as a regulatory standard for green steel in the country.[54] Much of the research and development (R&D) efforts for green steel are taking place in Europe and, therefore, support for international academic-industry linkages will be tremendously important for innovation diffusion. The iron and steel sector will also need a lot of financial support from the banking industry, coupled with investment in domestic R&D to encourage frugal innovation in this field. A systemic industrial policy will be needed as clean electricity and building the requisite hydrogen infrastructure will be crucial to produce green steel in the country.[55] The public procurement of green steel by the National Highways Authority of India, Central Public Works Department or the Railways could boost innovation in this sector considerably. Indian industry will get some relief this year as steel scrap has been exempted from customs duties for the 2021-22 financial year.[56] The government should consider extending the exemption further to encourage innovation, since scrap is required for the electric furnace steelmaking route.

3. Cleaner Energy Mix: Shifting to Progressively Lower-Carbon Fuels

The decarbonisation of industry will require switching over to cleaner, renewable fuels. India has set an ambitious target of 450 GW of electricity generation through renewable energy by 2030.[57] An industrial strategy must therefore support the development of new, low-carbon sectors in the economy.[58]

India requires a clean energy technology roadmap—short-term (10 years) and medium-term (20 years)—for policy clarity. This is crucial since the country is set to add energy capacity approximately the size of the EU to meet its growth in energy demand over the next two decades, and the choice of technologies it employs now will create path dependencies for the future.[59] This section explores a selection of key technologies that have tremendous potential in decarbonising India's industry and require a clear policy direction to boost innovation momentum.

Figure 1: Industrial final consumption by fuel (projected)



Source: IEA India Energy Outlook 2021[60]

Short-term outlook

	COAL	SOLAR POWER	BIOENERGY
Current Status	Makes up over 60 percent of India's industrial energy demand	Makes up less than 4 percent of India's electricity generation	Makes up around 7 percent to 10 percent of India's industrial energy demand
Transition status	Transition has begun, but coal is likely to remain dominant in the short and medium-term. Clean coal technologies have a large role to play in enabling coal growth to reconcile with India's green transition goals. The IEA has identified four types of clean coal technologies: coal upgrading, efficiency improvements, advanced technologies and near-zero emissions technologies.[61]	Dominates India's clean energy transition. Growing at an annual average rate of 60 percent over the past five years. By 2040, the IEA's Stated Policies Scenario (STEPS) expects solar to match coal's share in the Indian energy mix.**	Underutilised; tremendous potential in industrialisation—150 million tonnes of surplus biomass being produced every year in India. India can leverage the capacity and technological expertise developed for fossil fuel use in industry to leverage bioenergy's potential. Solid biofuels can technically substitute coal in many industrial heating processes, and biogas can meet industry demand for heat and chemical feedstock.

	COAL	SOLAR POWER	BIOENERGY
Policy interventions required	Stricter consumption-side regulation: coal power plants have been consistently delaying commitments to clean up emissions. Smaller users such as brick kilns are almost entirely unregulated With appropriate policy incentives, the Indian government's decision to allow private sector entry into coal mining could bring in the required technology and investment Flexible coal-fired plants to provide for grid variability requirements will need expensive retrofitting and appropriate regulation. A higher time-of-day price could help incentivise investment	Solar equipment manufacturing will require a concerted industrial policy push by the government for infant industry protection at first. Setting up solar manufacturing parks Leveraging institutes such as the National Institute of Solar Energy and the National Centre for Photovoltaic Research and Education for R&D support to local firms Industry-university linkages Government procurement programmes mandating local content requirements Providing policy clarity on grid infrastructure development to attract further capacity and investment Policy roadmap for rooftop solar technology deployment is currently below target due to high costs and regulatory barriers. Basic customs duty for solar inverters introduced in 2021 is expected to raise costs further for rooftop solar industry	Scaling-up use of biomass gasifiers will contribute to meeting thermal power requirements of MSME clusters in India Addressing supply chain uncertainties and information asymmetry for bioenergy should be scaled. There is significant uncertainty at present about the availability and quality of waste streams across the country. This affects financing prospects of bioenergy by banks.

Source: Author's own

** Solar PV has witnessed rapid diffusion in India due to falling costs globally. However, the lack of a production-centric approach has constrained India's potential for leveraging the meteoric growth of the technology in the country. Low-cost installations were prioritised over production, and the demand for solar installations in India has largely been met by foreign (especially Chinese) manufacturers—in 2017-18, over 90 percent of solar cells used in India were imported. Once a competitive industry, Indian solar manufacturing began to lag behind due to a failure to invest in R&D and expand capacity.[62] These supply chain risks were highlighted during the COVID-19 pandemic, prompting the government to announce a large manufacturing thrust in solar equipment under the "Atmanirbhar Bharat" programme. A production linked incentive scheme has now been announced for the domestic production of solar PV modules and advanced chemistry cell storage batteries.[63]

Medium-term outlook

Green hydrogen

An emerging technology, green hydrogen, is a tiny industry—99 percent of industrial hydrogen is produced from fossil fuels and is "gray".[64] However, it has infinite potential. Hydrogen can contribute immensely to industrial decarbonisation by providing steel and cement industries with zero-carbon heat for heat-intensive industrial processes that currently rely on coal.[65] Hydrogen may also provide an excellent storage technology option compared to other alternatives like batteries, as it is less expensive to add hydrogen capacity.[66]

Electrolytic hydrogen production, once prohibitively expensive due to its reliance on large amounts of electricity, is now appearing to be more feasible due to the rise of renewable power.[67] However, it is still expensive—solar-powered electrolysers can cost as much as six times as those powered by natural gas.[68] However, given a robust industrial policy, India has the potential to enter the electrolyser manufacturing sector. Manufacturing costs are projected to fall steeply with new technologies entering the market ,also since electrolysers are modular and relatively easy to manufacture.[69] The use of this technology at an industrial scale may become competitive within the next ten years. India can become an electrolyser manufacturing hub[70]—it has the requisite cost-competitive skilled labour, and manufacturing will reduce equipment costs drastically, making hydrogen competitive faster.[71] India needs to encourage international collaboration in this area as electrolyser technology needs scale economies for it to viable.[72]

Hydrogen has been delineated here as a medium-term technology for India's industrial strategy, as it will require a whole new ecosystem to be built around it. Its safe storage and transportation are difficult propositions and require building out expensive infrastructure. However, in the short term, hydrogen can be combined with carbon monoxide to produce synthetic fuels, a replacement for diesel/gasoline.[73] The hydrogen supply chain provides many options; green hydrogen is also being combined with nitrogen captured from the air to make zero-carbon ammonia at the laboratory stage.[74]

There is much scope for international knowledge exchange and collaboration in this space—Europe is already planning an electrolysis capacity of 40 GW by 2030. Europe also sees "hydrogen valleys," electrolysis plants co-located with industrial clusters.[75]

Germany has exempted hydrogen producers from surcharges on electricity. European governments have also mandated blending, i.e. enabling natural gas pipelines to carry hydrogen.[76] In India's case, ramping up natural gas production will have the twin benefit of making the hydrogen distribution network more viable. Capacity needs must also be assessed—India will need pipelines to transport the hydrogen from renewables-rich sites, where the cost of producing hydrogen is nearly zero, to industrial demand sites.[77] Hydrogen diffusion will also need a robust, flexible grid.

India now has a National Hydrogen Mission, with INR 25 crore allocated for R&D. Currently, the country's hydrogen demand is primarily located in the chemical and petrochemicals sector.[78] The Ministry of New and Renewable Energy first produced a hydrogen roadmap in 2006,[79] but there has recently been a significant public sector foray into green hydrogen—Indian Oil, GAIL, Hindustan Petroleum and Bharat Petroleum have plans for pilot projects in 2021-22.[80] There is tremendous potential to encourage greater public-private partnerships in this space.

The government must also make efforts to map storage sites for hydrogen.[81] India needs a regulatory framework for the safe deployment of this technology. Demonstration projects in the steel sector and other such promising sectors, and the provision of guaranteed markets initially for the technology can go a long way towards inspiring investor confidence.[82]

Natural gas

Natural gas is not exactly a "clean" technology—it is a fossil fuel and emits carbon dioxide. However, it emits half as much carbon dioxide as coal, has lower capital costs and is a much more operationally flexible fuel than coal. Its share in Indian industry has increased by ten times since 2010 [83]. It currently makes up about 6 percent of India's energy mix, the lowest globally,[84] with plans to increase this to 15 percent by 2030.[85] Given the high dominance of coal in Indian industry and the need to decarbonise quickly, natural gas should find a place in the country's medium-term clean energy transition plan.[86]

India's natural gas supply chain needs to be liberalised. Supply and distribution networks are largely state-owned and highly regulated and cannot cater to decentralised industrial demand.[87] Production is unable to meet demand, with India importing 50 percent of its LNG demand.[88] Natural gas prices are relatively high in the country, and the supply infrastructure is not well developed. The development of new technologies for reducing methane leaks in industrial use can significantly reduce industrial emissions.[89] There is strong incentive for the Indian government to address these challenges in its industrial decarbonisation strategy—the IEA suggests that the natural gas industry can provide key knowledge spillovers for clean energy technologies, such as carbon capture and storage (CCS), hydrogen, biofuels and offshore wind, and has the potential to help in scaling these clean technologies. Moreover, the oil and gas sector currently provides one-third of the total investment in CCS projects. An industrial policy push can open pathways for the oil and gas sector to collaborate with CCS technology developers to deploy large-scale investments.[90]

4. Carbon Capture and Storage

A "negative emissions technology," CCS refers to the capture of waste carbon dioxide from large point sources, and its storage and deposit where it cannot enter the atmosphere.[91] CCS constitutes the "last 10%" of the climate mitigation challenge, the final element.[92]

According to the Intergovernmental Panel on Climate Change, CCS can reduce the costs of reaching climate commitments by a whopping 140 percent.[93] More than 6000 km of carbon dioxide quality pipelines are operational globally, and around 11 CCS facilities in Asia are under development, with costs falling fast. Even though the technology is currently commercially unviable in India, there appears to be growing policy interest. At present, India has one CCS project, the Carbon Clean Solutions in Chennai, running without subsidies.[94] Several companies seem keen to leverage this technology; for instance, Dalmia Cement has announced its intent to become carbon negative by 2040, mainly through CCS.[95]

India's muted interest in CCS is due to technical and political economy concerns, such as land acquisition challenges, fears of groundwater contamination, lack of geological carbon dioxide storage data, high costs, and technological uncertainties. A dedicated policy is required to create awareness around the industry, create civil society coalitions and develop public understanding,[96] and create the conditions for technology diffusion by encouraging industry-academic collaboration and the sharing of know-how.[97] The state could also support commercial opportunities in transport fuel and chemical production from coal to help develop the CCS ecosystem.[98]

The development and deployment of the CCS technology, and the creation of an attendant carbon dioxide transport infrastructure, will require heavy investment.[99]

International finance could play a larger role (the Clean Technology Fund's classification of CCS as a "pre-commercial" technology has limited funding for the technology[100]). On the domestic front, policy instruments such as mandatory price supports, market creation efforts and public R&D funding could help. The public sector in India has taken the first step—the National Aluminium Company, Oil and Natural Gas Corporation, Bharat Heavy Electricals Limited are in the early stages of setting up CCS facilities.[101] Additionally, a clear regulatory framework and government support for CCS pilot demonstration projects at an industrial scale will help inspire confidence in the technology.[102]

Enabling the Technological Transition: Recommendations for Designing a Green Industrial Strategy

Need for an Innovation-Oriented Systems Approach to Green Industrial Policy

A policy to address industrial decarbonisation and the technological transition involve thinking about multiple systems together. This translates to thinking about issues such as jobs, energy security, and pollution in tandem in developing countries. There will inevitably be trade-offs between these multiple aims, and their management will be a particularly "wicked problem", one that has no optimal solution and defies a technocratic answer.[103] A systems approach can make the task easier by enabling us to view these trade-offs more clearly and holistically.

A systems transition management perspective can also address key issues such as the life cycles of clean technologies. This includes securing the supply of critical minerals needed for the technological transition and policies for disposal and waste management of these technologies. India's current 31 GW solar installed capacity will result in 107,000 tons of waste by 2022, and the country does not have a solar PV waste management policy. This kind of perspective also opens new industrial opportunities; for instance, India can develop a battery recycling and reuse sector in light of its upgraded battery waste management rules.[104]

Need for a Policy Mix

The technological transition will throw up a set of techno-economic challenges, which will need a suite of varied policy instruments—a mix of supply- and demand-side policies. The role of a whole suite of industrial policy instruments in enabling India's solar technology diffusion and in enabling the technology to become competitive has often been underestimated. Ambitious targets set at the highest political levels, a conducive political economy due to effective management of risks such as land acquisition,[105] renewable purchase obligations mandating a minimum public procurement for renewable energy,[106] and innovative regulation that encouraged combining solar power with other technologies and storage for 24 hour-supply[107] all determined the success of solar technology diffusion in India. Therefore, a wide range of policy instruments will need to be considered and wielded by the state for an effective technological transition for industry.

Cluster-Based Approach

India's green industrial policy could take an industrial cluster-based approach, with state industrial policies taking the lead. If the Centre were to have a broader "green mission" framed, it could create a competitive-collaborative framework to incentivise states to develop low-carbon industrial clusters. Incentives for firms in special economic zones/clusters could be based on performance indicators such as the use of green technology upgradation and energy efficiency indicators, especially as India's export-linked incentives have been ruled to be in violation of global trade rules.[108] These will also make Indian exports more competitive, as key geographies such as the EU and the US set high standards for international trade not to undermine their own industries' move towards sustainability.

Technology Transfer

Clean technology diffusion will require an international push to enable technology transfer through all available multilateral and bilateral initiatives and combat the shrinking policy space for developing countries at the World Trade Organization (WTO). Between 2000 and 2010, India solar cell and module manufacturing performed well in terms of exports and was globally competitive. However, when India came up with a domestic content requirement policy to protect its sector from intense Chinese competition following the 2008 global financial crisis, the WTO ruled against India. Thus, first movers in India in manufacturing had to shut down and suffered a great setback.[109] In recognition of this barrier to innovation, South-South cooperation mechanisms must now be strengthened to push for a renewed focus on innovation diffusion.

India must also now look at partnering with other developing countries through coalitions such as the International Solar Alliance to export clean energy and technology transfer. South-South innovation diffusion is often much more adapted to developing country contexts,[110] and can provide avenues for economies of scale to develop these critical technologies.

Technology Advancement

India currently spends a low 0.02 percent of its GDP on public energy R&D.[111] A policy roadmap or mission at the national level identifying key priority R&D projects, can inspire confidence in the government's policy direction. Technology advancement will also require a production-oriented approach. India missed the bus on solar manufacturing before but must now learn from its experience and develop a robust industrial strategy to capture emerging opportunities in battery, electrolyser and solar manufacturing, among other areas. Electrolyser technology has key commonalities with and positive spillovers for battery and fuel cell production. Therefore, the co-location of research and manufacturing clusters for these technologies could help accelerate innovation in this space.[112] A production-oriented approach can enable India to build comparative advantage in these emerging technologies if industrial policy is geared towards creating productive capabilities through learning-by-doing, technological upgrading, exposure to international firms, and encouragement of industry-academic linkages.

Finance

Investment in clean energy technologies will require state financial support, particularly in the initial stages, as these technologies are subject to high uncertainty and information asymmetry regarding the nature of the products, their scope of commercialisation and amortisation periods.[113] Only the state has the wherewithal to provide the "patient, long term and committed finance"[114] required for this purpose. The market cannot provide accurate cost incentives for these technologies as market prices cannot reflect the externalities that come with polluting technologies.[115] Additionally, financial market volatility may hit green technologies particularly hard, and so cyclical finance cannot be relied on to support this long-gestation, high-risk projects.[116]

These technologies also face political headwinds, as powerful groups are lobbying for the survival of polluting technologies.[117] India's public sector bank capital is locked into coal plants[118] and public sector units are expected to account for approximately 30 percent of new energy capital in the next decade. Private companies will need to meet 70 percent of investment in clean technologies in India, according to the IEA, but they lack scale and diversified access to financing. India's financial system must develop towards this end.[119] In addition to providing high-risk public capital, it is important also to consider risk management for private capital. Efforts to promote system-level risk reduction—managing currency risks, encouraging regulatory and contract certainty, and working towards a healthy banking and financially robust power sector—will attract capital and enable India to leverage the market, currently flush with liquidity and excessive enthusiasm for environmental, social and governance (ESG) investing.[120]

Conflict Management and State Capacity Constraints

State capacity is a critical prerequisite for an effective industrial policy. States need to invest in building public sector capabilities and strong institutions as transition management requires adaptive policymaking that can respond to uncertainties and evolving information flows.[121]

Formulating and aligning a green mission at the country level with clearly defined sectoral and state policies in a large heterogeneous developing country is a formidable task. India has currently not committed to a net-zero target. While the country does not have a climate mitigation-focused institutional architecture, its "thin" institutional framework has made it possible for India to navigate difficult policy terrain to leverage opportunities as and when they arise. It is important to remember that very few countries globally have institutional architectures equal to the task at hand.[122] Institution-building for the technological transition is, therefore, an area ripe for international collaboration and knowledge-sharing.

To avoid state capture and for subsidies and government support to not become giveaways, they must be limited to a well-defined transition period, monitored consistently, and the recipients of state support must be subject to "reciprocal control mechanisms" (incentives and "rents" must be linked to learning and performance, contingent on achieving specific performance standards)[123]. Technologies also create distinct political economies, and an industrial technology transition will create winners and losers. For instance, Indian states dependent on coal revenue, such as Odisha and Jharkhand, will be hit disproportionately hard.[124] Even as there is tremendous employment potential in green industries—they are more labour intensive, and retrofitting is likely to create jobs as well—green jobs will be more geographically dispersed than those in fossil fuels. This implies a politically contentious transition as job losses will be concentrated,[125] and those laid off will have to be re-skilled and re-employed. India must adopt a new industrial policy framework that accounts for the importance of conflict management and the critical role of the state in ensuring a just transition. [126]

Dedicated Policy for MSMEs

India's MSMEs—the backbone of its industrial transition, a significant source of emissions and the weak regulatory link—need a dedicated policy to address their transition management. The policy could focus on the following elements:

- MSMEs need access to capital, customised financial products, and a larger market for energy efficiency and investments in technology.
- Identify sectors that can be electrified.
- Mobilise industry associations to make them aware of emerging clean technologies and their potential and arrange demonstrations for this purpose.
- MSMEs could benefit from technical institutions for skill development and training. A cluster service approach—with a local service provider/manufacturer in place to offer fuel and tech supply, maintenance, awareness of new skills and the like—could spur MSMEs' uptake of new technologies. [127]
- Innovation diffusion literature suggests that MSMEs particularly benefit from the technological learning that takes place from co-location of large and small industries within innovation clusters.[128]

Conclusion

A green transition for Indian industry can contribute not just to the country's environmental goals but also to its industrial competitiveness. Decarbonising industry will combine fiscal and technology policy, market creation, supply chain security, and finance.

The technological transition for industry will require progress on clean electrification, resource efficiency, a cleaner fuel mix and negative emission technologies such as CCS. For India, this shift will require overcoming barriers not only in technology but also in political economy—which will be far more formidable. An entrepreneurial-regulatory state with strong public sector capabilities and a comprehensive understanding of the task can collaborate with the private sector to leverage the opportunities of the new technological revolution to build back better. Designing a green industrial policy will have to be an exercise in transition management and in embracing uncertainty. India has already demonstrated its willingness to be at the forefront of the move towards industrial decarbonisation. Academia must now play a seminal role in highlighting the trade-offs and pathways that will be encountered along the way, and this chapter is a contribution towards that end.

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1.3

Developing Clean Energy Alternatives for Industries

Nandini Sarma

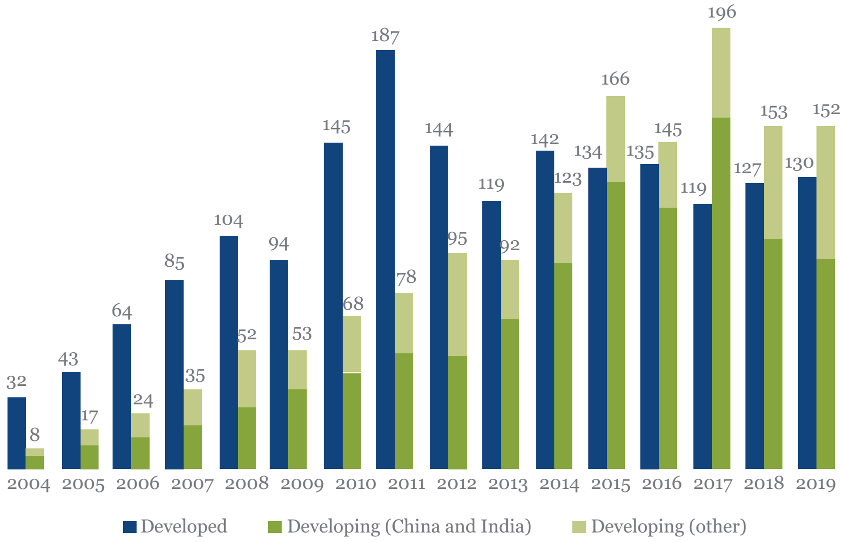
Introduction

Efforts towards a transition to low-carbon energy are gaining pace across the world. India, for example, has been making significant progress in increasing the share of renewable energy in its total energy mix. Among the drivers of the ongoing transition is the commitment of the business sector to step up on its shift to clean energy. After all, the corporate sector makes up about 25 percent of total energy demand in the country and their policies are key to building a low-carbon economy. Certain companies have voluntarily adopted a target of 100-percent renewable energy within a specific period, also known as the RE100 initiative.[1] Globally, there was a 40-percent rise in clean electricity purchases in 2019.[2]

The rise in demand for renewable energy also provides benefits in increasing the manufacturing base, creating job opportunities, and diversifying the export market. In turn, opportunities in manufacturing can help the export sector through greater integration into global value chains and by enhancing India's trade potential in the wind and solar energy sectors. India has had limited success so far in developing indigenous capacity in the solar sector. It is possible to attain security in these sectors by identifying the obstacles and having a more focused policy approach. India also needs to identify manufacturing opportunities in new technology areas such as hydrogen fuels, and devise long-term strategies accordingly.

Developing the renewable manufacturing base will help attract investments. Globally, investments in renewable energy in developing countries reached US$ 152.2 billion in 2019. Since 2010, investments in the developing world, which constitutes 54 percent of the global total, have exceeded investments in developed economies (See Figure 1).[3]

Figure 1. Investments in renewable energy sector (US$ billion)



Source: UNEP-Bloomberg report, 2020[4]

The rest of this chapter identifies current issues in the domestic production supply chain of clean energy sources and suggests possible policy initiatives. The analysis also delves into the issue of transfer of technology at the global level, and the leading role that India can play to facilitate technology transfer and development of green technology.

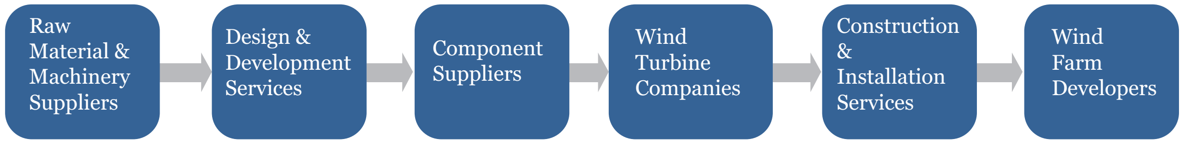
State of Clean Energy Sectors in India: An Overview

Wind energy

India's wind energy industry is relatively self-sufficient, with 80 percent of equipment produced domestically. India today is the world's fourth largest producer of wind energy, with installed capacity at 37 GW.[5] The industry is wholly private owned.[6]

Figure 2 shows the supply chain for the wind energy sector. There are fewer players in certain segments of the supply chain—the gearbox, bearings, and blades—as they require high investments and have considerable barriers to entry. Other segments such as generators and tower segments have lower barriers to entry, and thus have more players. There are enormous opportunities for manufacturing at the various stages of the supply chain—from raw material to component suppliers. There is also opportunity for service providers in operations and maintenance, feasibility studies, and geotechnical services.

Figure 2. Supply chain in the wind energy sector



Source: Author's own

India's wind energy sector currently caters to small turbines with capacity between 250kW to 1.8MW. The larger equipment are supplied by wholly Indian-owned Suzlon,[7] which is one of the largest companies in the world in wind turbine manufacturing. It supplies about 50 percent of wind turbines in India and has 8 percent of the global share.[8]

Favourable national-level policies have helped create a stable regulatory environment for the wind energy sector. The government has encouraged domestic production with suitable domestic pricing policies and by adjusting customs duties. It has launched initiatives such as Generation Based Incentive (GBI) schemes, the accelerated depreciation scheme, as well as feed-in tariffs.[9] The latter provides a guaranteed purchase price, lowering the risk for suppliers.

In 2017, the government replaced the system of feed-in tariffs with tariff-based competitive auctions on account of growing capacity and fall in the prices of renewable energy.[10] This model has also been adopted at the state level. While competition from auctions has led to a fall in tariffs, it is likely to affect revenue as well, making manufacturers wary about the system.[11]

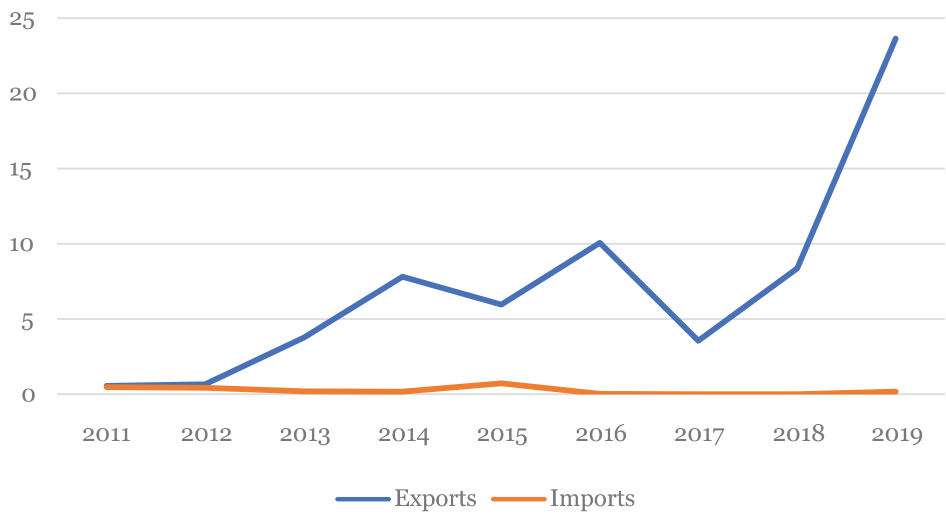
What helped Suzlon attain the global status that it has reached? Suzlon initially acquired basic technology through technical collaborations with German companies and through licensing, before developing its own research centres. Local manufacturing allowed the company to produce at competitive prices due to lower costs of labour and other inputs.[a] The strategy of Suzlon to have an integrated supply chain meant

a Production cost for Suzlon is the lowest in its Indian plant as compared to all the other centres of manufacturing.

that it had more control over cost across the entire supply chain, and the flexibility to respond to demand. Other factors that contributed to the initial success of Suzlon include R&D, and effective supply chain management.

Figure 3 shows that in the trade of wind turbines, exports— which reached US$ 23.6 million in 2019—far exceed imports, at less than 0.2 million the same year. This shows that India has the potential to become an export hub in the wind energy export sector.

Figure 3. Imports and Exports of Wind Turbine (HS Code 84128030) (US$ million)



Source: Ministry of Commerce and Industry[12]

Table 1. India's exports of wind turbine (by Country, in US$ million)

Country	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020
U S A	0.09	0.09	0.05	2.04	8.86
CHINA P RP	0	0	0	2	5.7
DENMARK	0.02	0	0	1.11	3.28
SPAIN	0.07	1.23	2.97	2.01	3.21
GERMANY	0	1.76	0	0.62	1.4
BRAZIL	0	0	0	0	0.67
ARGENTINA	0	0	0	0.17	0.2
RUSSIA	0	0.02	0.03	0.05	0.09
AUSTRALIA	0.04	0.02	0	0.01	0.06
TURKEY	0.45	0.02	0	0.01	0.05
ANGOLA	0	0	0	0	0.03
LITHUANIA	0.01	0.02	0.01	0.01	0.02
NIGERIA	0		0.01	0.01	0.02

Source: Ministry of commerce and industry[13]

As Table 1 shows, exports to Latin American countries such as Brazil and Argentina have increased, along with those to African countries. In 2011, officials from Uruguay conducted visits to India to explore collaboration in the wind energy sector.[14] Industry experts agree that India can become a key supplier to the growing markets of Africa and Latin America. This will give India the opportunity to diversify its export basket and expand their reach. Another opportunity is in exporting older and lower-capacity turbines, refurbished at competitive prices, to countries looking to expand their renewable energy base. Increasing exports from the sector would also help reduce the current account deficit and balance the huge import bills on oil imports.

Indeed, the wind energy sector is fairly well established. Indian companies have acquired licenses from foreign companies for technology and have also shown the ability for research and adapting technology to domestic conditions. However, India needs more investments in design and research comparable to those of companies abroad. New renewable energy technologies require huge investments, and the role of government facilitation is important. China, for example, has specific funds for expenditure on R&D in wind turbine systems.[15] The capacity of Chinese wind turbines has increased from 600 kW in 1997 to 6 MW by 2011. Research for designed 10-MW wind turbines is being undertaken by many Chinese companies. In its 13th five-year plan, China identifies technology between 8-10 MW as the next step in the country's technological upgrade.[16] Globally, turbine sizes have reached the size of 14 MW.[17] India requires long-term strategic planning to develop technologies and identify specific ones that will increase and diversify the export basket.

The next step would be to move into offshore wind production, which is well developed in Europe. India has a draft policy as of 2013. The off-shore wind sector has higher costs for logistics, and greater technology challenges than on-shore. Especially with respect to infrastructure, the sector faces challenges in the transportation of components. India's logistics cost, which is at 14 percent of GDP, needs to be brought down to below-10 percent of GDP, which is comparable to that of developed countries.[18] The high cost of export credit is a significant cost concern, with foreign and rupee export credit interest rates at more than 4 percent and 8 percent, respectively. Globally, the rates are at 0.25-2 percent.[19] Given the level of development of the wind energy sector, India's EXIM bank should extend long-term credit to the sector for periods of 10-15 years.

Solar Energy

The solar sector industry is dominated by Chinese and western companies, but Indian companies such as Adani, Jupiter, and Tata, are also making a mark.[20] Eighty percent of solar cells and modules in India are imported from China. Indian modules are 33 percent more expensive than the Chinese ones.[21] The solar industry has been dependent on imports of critical raw materials such as EVA, back-sheet, reflective glass, balance of system for solar thermal, and PV. In addition to higher costs, the Indian solar energy sector suffers from underutilisation of current production capacity, due to cheaper Chinese products.

The development of indigenous capacity for manufacturing solar energy can create jobs in engineering, construction, maintenance, finance, design, and wholesale distribution. A study by Shakti Foundation on India shows that a 3-GW integrated manufacturing plant (polysilicon to solar module) can generate some 5,500 jobs.[22] The current domestic manufacturing capacities of solar cells and modules is about 3 GW and 10 GW, respectively, as of 2019, whereas the demand is 20-30 GW per year. The difference is filled by imports.[23]

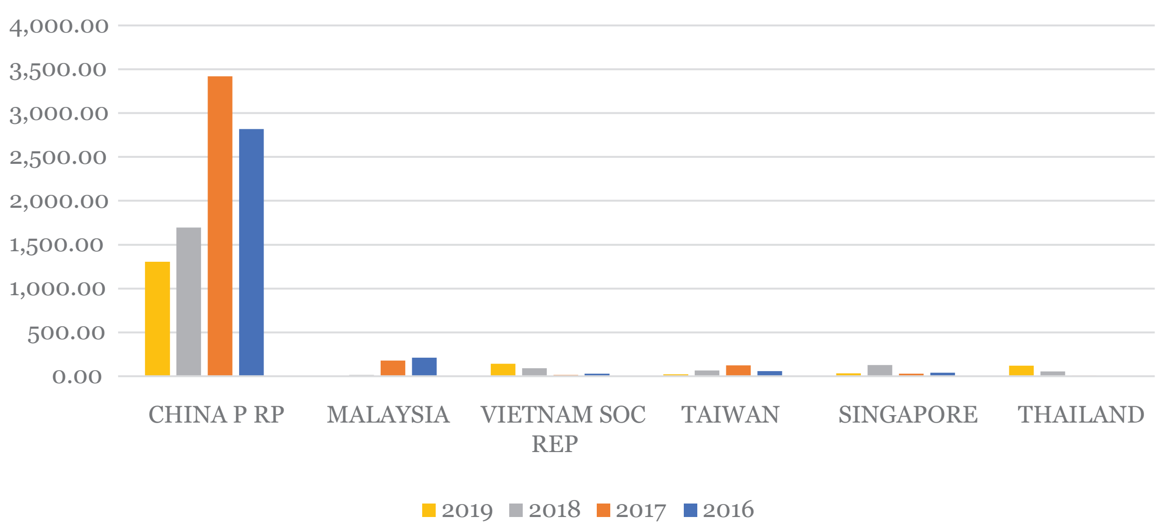
Table 2 shows the top sources from where India imports. India mainly imports from China but imports from other Southeast Asian countries such as Vietnam and Thailand have increased over the years. India had imposed increased tariffs on imports of solar cells and modules from China and Malaysia in 2018, which helped control imports (See Table 2 and Figure 4.)[24] However, the tariffs did not apply to other countries. India is a growing market, and the domestic industry faces competition not just from China but many other countries that view India as a key market destination.

Table 2. India's Top import sources of solar cells (in US$ million)

	2019	2018	2017	2016
China	1,307.03	1694.04	3418.96	2817.34
Malaysia	3.91	15.31	179.55	210.35
Vietnam	140.63	91.97	13.47	27.81
Taiwan	20.97	65.58	122.44	58.86
Singapore	31.32	126.3	28.11	39.6
Thailand	120.47	55.05	7.6	4.18

Data Source: *Ministry of Commerce and Industry*[25]

Figure 4. India's Imports of Solar cells/modules (by country; other than China)



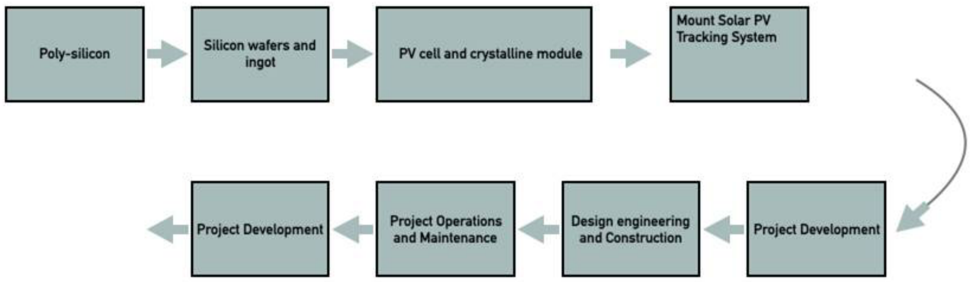
Data from Ministry of Commerce and Industry[26]

In 2018, the government increased import tariffs on renewable products to help domestic manufacturers and extended the validity of the rates till July 2021.[27] This is a necessary step given the competition facing the sector. However, an imposition for only a year would not provide sufficient protection to expand manufacturing to the level that is required. For investment decisions to be made, a longer time period would ensure certainty and protection. Further, this order included China, Thailand and Vietnam, but excluded Malaysia—this means the imports from the country will likely increase. The government, in its 2021 Budget, has announced higher tariffs on solar lanterns and inverters. However, given that domestic manufacturing is inadequate, this measure may not serve the intended purpose of providing protection to the industry at this stage. Tariffs may become useful in a few years, when manufacturing picks up.

Indeed, in the past, uneven protection has hurt the solar industry. In the domestic content requirement (DCR) scheme, the exclusion of thin films led to a contraction of the domestic supply of crystalline silicon production in India. It led to a situation where India is dominated by thin film in PV installations, as compared to the global market where crystalline silicon holds the majority share. There is a need to bring thin films under DCR.

Figure 5 shows the various components of the supply chain, from manufacturing to operation and maintenance. At present, the majority of manufacturing in India is centred around cell and module assembly, which is mainly downstream manufacturing. Upstream manufacturing of polysilicon, wafer and ingots is technology- and capital-intensive, and globally, only a few companies constitute a majority of the manufacturing. Module and PV cell manufacturing is almost completely dependent on imports for raw materials.

Figure 5. Supply Chain of the solar energy industry



Source: Author's own, using various sources

The industry needs financial support to scale up production. India would need to provide low-cost financing to manufacturers to be able to compete with Chinese goods. India's PV production has shifted from mainly public production in the 1970s to private production by the late 1980s. Access to finance at competitive costs is one of the most difficult challenges to investment in the solar energy sector. Further, the industry is highly capital-intensive, and developers require capital throughout the lifespan of the technology. Indian companies in Rajasthan and Gujarat have financed their projects under the first phase of the National Solar Mission (NSM) through loans from the US Exim Bank. But this has also meant sourcing components from the US' manufacturing base.[28,29] Thus, these loans cannot be the main source of funding for domestic manufacturing, as they carry a foreign currency risk.

India has taken various measures to support manufacturing in the renewable sector through the Jawaharlal Nehru National Solar Mission (JNNSM), Modified Special Incentive Package Scheme (MSIPS),[30] and 'Make in India' which provides incentives and subsidies. However, as imports remain more cost-effective, higher-capacity domestic production remains difficult. Many companies have also filed for debt restructuring on account of lack of demand.

In November 2020, the Cabinet approved a scheme to introduce production-linked incentive (PLI) to the solar industry for an amount of INR 45 billion.[31] The policy aims to incentivise domestic production. The incentive should be linked to output as well as standard quality specifications. The second phase of JNNSM introduced viability gap funding (VGF) and Generation Based Incentive (GBI) as funding mechanisms. The VGF does not incentivise production but compels suppliers to go for low-quality components to keep prices low. This has led to low power tariffs, which in turn have put into question the viability of projects. For example, banks such as SBI are no longer lending to projects that sell below a certain tariff level due to questions on their viability.[32] The lower participation by scheduled banks is worrisome, as countries like Brazil and China have shown that public banks play an important role in supplying credit to the renewable sector. Therefore, more innovative financing methods to increase long-term low-cost funding from banks need to be explored. Credit enhancements for developers can be explored, which will enable them to attain higher credit rating and raise funds from the bond market.[33]

India has high cost of capital. It can learn from Brazil which has similar cost of debt and has done well in adding capacity in renewable energy in recent years. Brazil has been successful in providing low-cost long-term finance through the National Social Economic Development Bank (BNDES) that provides majority of the financing for renewable infrastructure.[34] It has partnered with development banks in other countries to set up credit lines to support projects in Brazil, and has mandated local content as a prerequisite for access to credit. This model may be studied by Indian policymakers to enable a similar financing pattern in the country.

Moreover, technological advancements are taking place at a rapid pace in this sector. R&D is essential to keep in touch with the fast-changing market and produce at more competitive prices. The solar sector has seen disruptive innovations in the past few decades. The sizes of solar cells and modules are also continuously increasing. This means there is a need for additional capital investments by cell and module manufacturers to adapt to the larger sizes and install new production systems. For example, there is an emerging technology called the Cells of Passivated Emitter Real Cell (PERC), which requires the current cell and module production processes to be retrofitted. Thus, in addition to high upfront cost of capital equipment, there is a need for continuous capital expenditure to keep up with the changing technology. To be sure, India is conducting R&D at the national level.[35] This has to be strengthened by exploring relevant opportunities for international collaborations. A clear road map to develop the next generation of technology is required, outlining specific targets and timelines.

The industry needs long-term strategic planning to nurture domestic manufacturers that can effectively take on the imports from abroad. In the long run, it will be feasible to indigenise the entire supply chain. At present, a more focused approach to indigenise certain segments of the supply chain, coupled with lower import duties or import tax exemptions for those components that need to be imported, can help the government arrive at an optimal combination of policy options. There is a need to provide an entire ecosystem to give a boost to manufacturing: land, cheap credit, funds for research, cash incentives, and tax rebates. The concept note on manufacturing solar PV scheme was shared with stakeholders in 2017.[36] India should create a road map and vision on how to localise the manufacturing for the entire country with coordinated efforts with state governments.

Renewable purchase obligation (RPO) is also an important component for the development of manufacturing in renewable energy. It provides the necessary demand pull. It requires distribution companies (discoms) to mandatorily purchase a certain percentage of their total power from renewable sources. But it is often not implemented as expected and there are delays in imposing penalty for non-compliance. This issue is even more acute for the solar industry due to falling solar tariffs and lower average power procurement[37] by discoms that has led to uncertainly about the revenues for solar power projects. These issues are recognised and steps are being taken to address them.[38]

Policy Recommendation for Solar and Wind Energy Sectors

1. **Protection and support to domestic industry** – While protection may be needed to help the industry face competition from cheaper imports, they should be with the aim of helping the industry grow more competitive. These should come with a specific timeline so as not to make the industry dependent on them and make them inefficient in the long run. The government's decision to stop the system of feed-in tariffs in 2017 for the wind industry led to losses for the wind turbine industry. Suzlon, for example, has incurred huge losses as a result of the shift to auction-based system.[39] Thus, it is important to implement protection with properly defined sunset clause.

    a. <u>Import duties on solar cells and modules</u> – The time period for this should be announced beforehand with a minimum of 5 years so as to allow manufacturing to respond. However, given the dependence on imports, this could increase the cost of production for the sector as well. In 2013, the Finance Ministry decided to not implement the anti-dumping duties recommendation submitted by the Directorate General of Anti-Dumping and Allied Duties (DGAD) following lobbying efforts by the power ministry. Thus, other measures to provide subsidy on production will have to balance the initial increase in cost on inputs for domestic producers.

b Production subsidy can be provided for small manufacturers or larger firms up till a certain production limit. It should be introduced with a clear timeline and a sunset clause. The government has recently announced a PLI scheme in the budget.

c Domestic Content Requirement (DCR) for solar energy procurement – This will help increase the capacity utilisation to 100 percent and bring down the cost of BOMs as compared to China. This works if there is some level of sunset clause. It should not become a clutch.

2 **Manufacturing parks for both wind and solar companies.** This could be based on the Gujarat solar manufacturing that has been set up. It should be with plug and play model with land availability, low-cost power and other incentives.

3 **R&D –** The example of how the wind industry (as explained in the case of Suzlon) developed in terms of technological progress should be used to aid the solar industry. Technological progress with foreign collaborations and joint ventures should be encouraged. The government should also initiate programs with counterparts in the US and Europe to learn from experience and expertise. It should be a central focus area when negotiating India's trade deals.

4 **Standardised quality criteria at various stage of the supply chain** - As different segments of the supply chain develop, there is a need for harmonising the market by setting standards for quality at the various stages and to create a system of auditors who can regularly evaluate and certify. The standards need to be aligned with international ones.

Hydrogen Energy

Hydrogen energy is becoming an important new low-carbon technology. Its adoption in transportation, production and storage for renewable power energy can help make significant contributions to the future of cleaner energy. To balance the variable renewable sector, hydrogen can provide cost-effective storage option, as compared to batteries, that can store energy for several day or weeks. The current global demand is at 70 Mt but is expected to multiply many times by 2050.

Almost all of the hydrogen produced today is from fossil fuels. The cost of producing it from renewable source remains higher than from other sources. India would require coordinated policy initiatives to identify potential demand sites so as to scale up production, carry out research nationally as well as through international cooperation, and identify low-cost storage options for hydrogen. As per a study by CEEW, only aggressive price reduction in the cost of electrolyser and storage technologies would make the price of hydrogen competitive by the next decade.[40] Hydrogen produced from green sources will help curb carbon emissions. R&D to help reduce cost will be critical. Currently, hydrogen is used in refinery to remove sulphur from fuels. Countries such as Japan have been at the forefront but other countries such as the US and China are also outlining ambitious plans to scale up hydrogen production in the coming years.

This is an opportunity for India to be a maker of technology and lead in this sector rather than perpetually playing catch-up. The government has decided to launch a plan to build hydrogen plants that will be produced from renewable power sources.[41] The budget presented recently also announced a National Hydrogen Mission as well as the setting up of a National Research Foundation with an outlay of INR 50,000 crores to strengthen research in new technology. Long-term vision for the development of future technologies will be essential.

Transfer of Technology

Access to new technology is crucial to the ability of developing countries to transition to cleaner energy. It is also key to mitigating the adverse effects of climate change. In turn, technology transfer—and consequently, bridging the technological gap between developed and developing countries—is dependent on trade. This takes place through different channels – international trade in goods and services, FDI, licensing, joint ventures, agreements between governments, and non-market channels such as imitation.

The need is for transfer of technology at a reasonable cost to developing countries. Despite the importance of transfer of technology, it remains a contentious issue, and developed and developing countries have yet to find common ground. Indeed, transfer of technology is costly. Over the years, however, technological and finance advancements have led to falling costs in energy transition, especially owing to the technology changes that have led to improved efficiency.

India recognises the need for technology transfer, and over the years has liberalised foreign direct investment (FDI) rules in almost all sectors. In the renewable energy sector, FDI is permitted up to 100 percent under the automatic route. The investment in the sector surpassed US$1 billion for the first time in 2017-18.[42] The government has undertaken measures to attract investments for manufacturing solar cell, electric vehicles, and battery storage systems. Globally, India is the biggest market: in 2019, it attracted venture capital or private equity investments in renewables worth US$ 1.4 billion.[43]

Technology transfer through FDI can happen through reverse engineering, movement of labour, and integration into the global supply chain. Another form of technology transfer is internalisation of R&D by large firms such as multinational companies (MNCs). Larger Indian firms have also been able to tap into the global R&D systems. For example, Suzlon has set up R&D centres in Germany, Netherlands and Denmark, apart from the one in India. Companies in India and China have also facilitated transfer of technology through acquisition of firms abroad, as well as cooperation with research institutions in developed countries and local R&D centres. A combination of different channels and interactions for transfer of technology has been undertaken. However, with India becoming a primary market, foreign companies see domestic manufacturers as competitors, leading to a disincentive to transfer technology. Companies such as Suzlon have acquired technology from smaller companies in the developed countries that had little to lose from international competition.

Leading companies have the resources to pool together local and international knowledge flows to acquire technology, but small and medium enterprises do not enjoy the same leverage. After all, transfer of technology involves significant investments in experimentations and organisational structures. Further, much of current innovation still happens in the US and Europe and there is a need to facilitate their transfer. Therefore, there is possibility of active policy interventions. What is needed is international collaboration with an aim to achieve development goals. Government can help establish links between local and international firms to facilitate such transfers with an emphasis on green technology. The next steps would be to attract FDI that will help deliver long-term benefits through indigenisation of technology, which in turn can lead to further innovations. India is already preparing to study FDI trends to analyse how policy can be effectively reviewed to ensure greater transfer of technology.[44]

India, through the International Solar Alliance (ISA), can help foster greater collaborations. There is a gap at the international level for collaboration that is purely for meeting development or poverty alleviation issues. Through ISA, countries can help identify specific needs and pool resources – both financial and human– to achieve specific targets. Network of collaborations between scientists and researchers from top universities across nations needs to be strengthened. A fund dedicated to advancements in specific renewable technologies should be set up. There is a need to set specific targets and deliverables to be achieved in a given period with industry-university research cooperation.

The innovations thus achieved can be given the status of public goods. The COVID-19 pandemic has led to the development of vaccines. There is international cooperation in transferring technology so as to allow medicines to be produced at affordable prices. There is a need to build a similar narrative for green technologies and build mechanisms that would facilitate technology transfer and cooperation.

Conclusion

Demand for renewable sources of energy will only grow manyfold in the future as more countries transition to cleaner sources of energy and cost of renewable energy continues to fall. India would need to implement policies that will push the renewable sector to grow and meet this demand. The demand for renewable sources such as wind and energy, for instance, is subject to fluctuations and therefore the prerequisite is technological progress that can provide a steady source of energy.

India will have to formulate policies to stay ahead in terms of technology upgrades in the solar and wind sector, as well as newer sources of energy such as green hydrogen. India can also play an important global role by forging partnerships with both developing and developed countries to enable further research in newer technologies and facilitate technology transfer.

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2

TILTING THE PLAYING FIELD: SUPPORTING GREEN INDUSTRY

2.1

Pricing Carbon: Trade-offs and Opportunities for India

Tanushree Chandra

Introduction

India has performed remarkably well in terms of its climate trajectory over the past decade. From 2005 to 2014, the country's GHG-emission intensity declined by 21 percent.[1] According to Climate Transparency, India is the only G20 nation on-track to achieve the targets under the Paris Agreement.[2] One of the key, albeit unfortunate, reasons behind India's climate success is the underperformance of its manufacturing sector. Since industries constitute approximately one-fourth of the economy's total GHG emissions,[3] the sector's sluggish growth has led to only a moderate increase in industrial power demand and emission-intensity of the gross domestic product (GDP).[4]

The current government has set robust growth targets for the country's manufacturing sector, which includes increasing its contribution to GDP from the current 16 percent to 25 percent by 2025. However, experience indicates that growth in the manufacturing sector is likely to place it in conflict with India's climate goals. For instance, in China, the manufacturing sector is the engine of growth and has powered unprecedented economic development over the last two decades. However, the sector also accounts for 68 percent of the national energy consumption, 84 percent of the national CO_2 emissions, and 24.1 percent of global emissions. The challenge for India is to achieve similar industrial growth on a low-carbon path.

To navigate this (false) trade-off,[a] it will be crucial to identify key drivers that could catalyse Indian industry's green transition. Some of these drivers—renewable energy, technology, energy security and market creation—have been explored in other chapters in this volume. This chapter examines carbon pricing as a tool that can achieve deep carbon cuts and effectively integrate the climate calculus into India's developmental goals. It has four sections: section one examines the rationale behind carbon pricing and gives an overview of the global and country landscape; section 2 explores the key challenges to pricing carbon; section three discusses the possible policy pathways for pricing carbon in India; and section four concludes the chapter and outlines a plausible way forward.

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a Sustained and rapid economic growth in India offers an opportunity to lift millions out of poverty. However, this may come at a steep cost to the nation's environment and natural resources and deepen the climate crisis. It is important to point out that the economy versus environment trade-off is an inaccurate presentation of policy options. Sound economic management and good environmental governance are fundamentally about achieving the same end—putting scarce resources to their best use.

Carbon Pricing: The Rationale

The core of the climate conundrum is often framed as a problem of market failure. The rationale behind this is appealing in its simplicity—the primary driver of climate change is the unabated flow of emissions from industries (and households). These emissions are a negative externality for the environment and the economy, since their true social cost is not reflected by the market price of carbon-intensive goods and services. Thus, instituting a price that reflects the true cost of these emissions seems like an intuitive solution to address this market failure. Indeed, this proposition has received widespread support from multilateral organisations (IMF and World Bank), industry stalwarts (Larry Fink and Anand Mahindra), and religious leaders (Pope Francis).

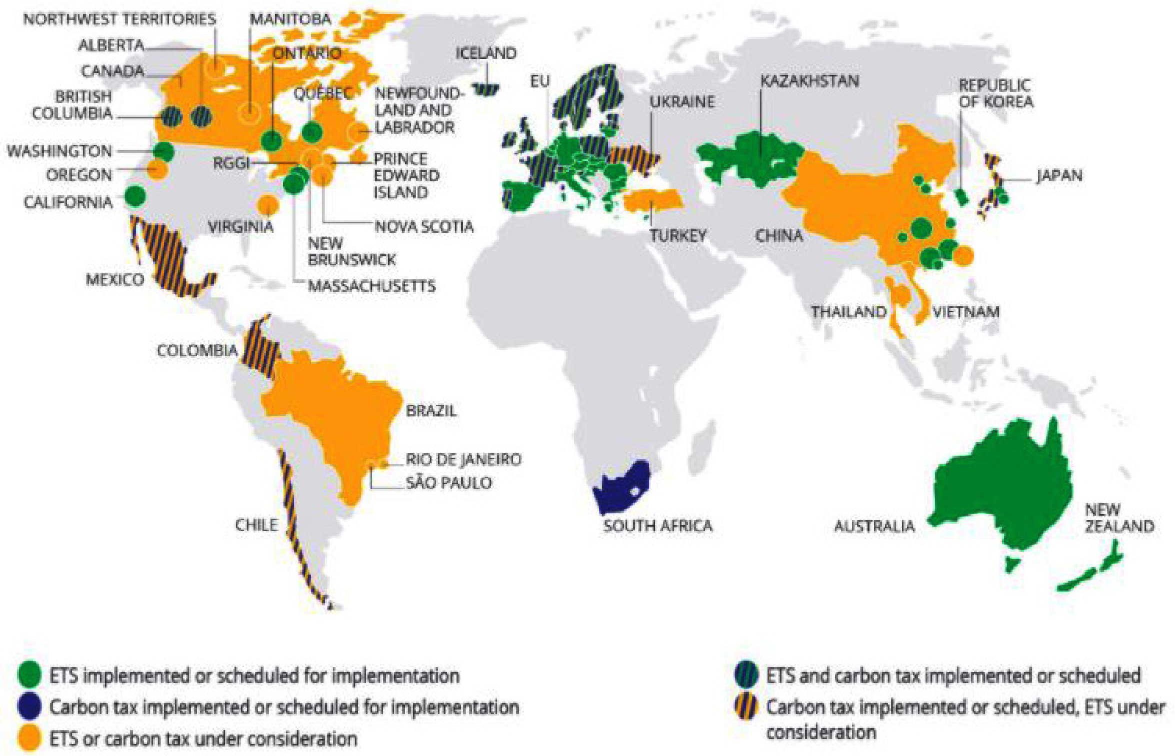
According to the IMF, the world needs a global tax of US$75 per tonne by 2030 to reduce emissions to a level consistent with a 2˚C warming target.[5] As per the High-Level Commission on Carbon Prices, led by Nobel Laureate Joseph Stiglitz and Lord Nicholas Stern, meeting the world's climate goals in the most cost-effective way while fostering growth requires individual countries to set a strong carbon price, with the goal of reaching US$40-80 per tonne of CO_2 by 2020 and US$50–100 per tonne by 2030.[6] This can be accomplished using one of two methods: a cap-and-trade system or a carbon tax charge. The first method puts a cap on the total emissions that industries can emit and allows those with low emissions to sell their extra allowances (carbon credits) to larger emitters, thereby creating a marketplace for greenhouse gas emissions. The European Union's Emissions Trading System (ETS) is the most widely known example of a cap-and-trade system. In the second method, a tax rate is defined on greenhouse gas emissions or, more commonly, on the carbon content of fossil fuels. A prominent example is Sweden, which currently has the highest carbon price in the world at US$139.[7]

By internalising the externalities associated with CO_2 emissions, carbon pricing can promote cost-effective abatement, deliver powerful innovation incentives, and ameliorate fiscal problems by adding to the government revenue.[8] Countries such as Sweden have been able to effectively thread the needle between carbon pricing and economic growth: Sweden's economy grew by 60 percent since the introduction of the Swedish carbon tax in 1991, while its carbon emissions decreased by 25 percent.[9]

Current Global Landscape

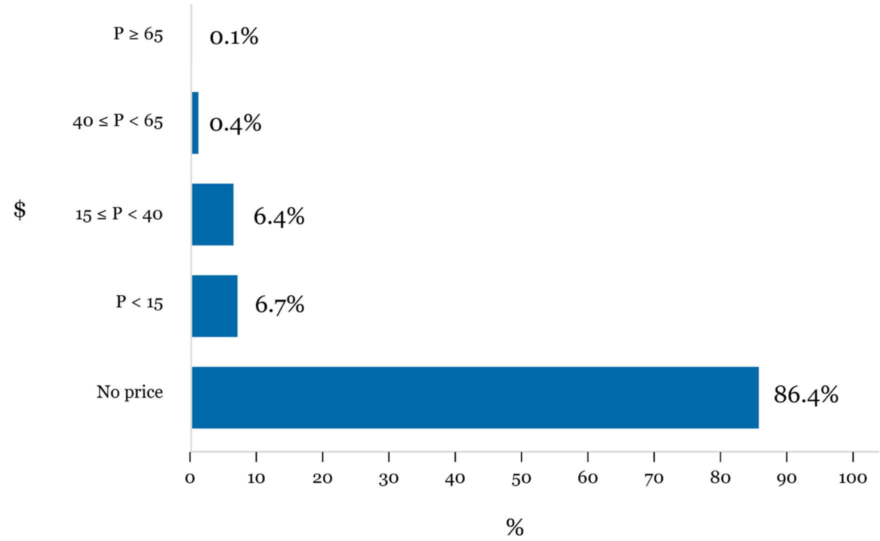
While Sweden's carbon-pricing experience holds promise, the same trend has not been observed in other geographies. After nearly three decades of policy efforts, carbon pricing continues to be a mere footnote in international climate negotiations. Proposals for realistic carbon emissions pricing have so far made little headway around the world.

Despite its apparent simplicity, carbon-pricing is supported by rather underwhelming evidence. There are 64 carbon pricing initiatives implemented or scheduled for implementation—34 in the form of an explicit carbon tax, 31 covered by an ETS—across 46 national jurisdictions and 35 sub-national jurisdictions.[10] In 2020, these initiatives covered 12 $GtCO_2e$, representing just 22.3 percent of global GHG emissions.[11] Even more striking is that **less than one percent** of global emissions are currently subject to a carbon price equal to even a low-end estimate of the social cost of carbon (See Figure 2).[12] In stark contrast to the IMF's projected global tax of US$75 per tonne, the current average price of carbon globally is US$2 a tonne.



Source: Carbon Pricing Dashboard, World Bank Group.

Figure 2: Carbon Prices around the World in 2019



Source: Danny Cullenward and David Victor, *Making Climate Policy Work*.

Carbon Pricing in India

India does not have an explicit carbon price or a market-based mechanism such as cap-and-trade. It does, however, have an array of schemes and mechanisms that put an implicit price on carbon.

Perform, Achieve and Trade (PAT) Scheme: Under this scheme, energy-intensive units from industrial sectors with high emissions are assigned specific energy reduction targets. The units are required to meet these targets by implementing energy-efficient technologies. Those that exceed the targets are awarded Energy Saving Certificates (ESCerts), each equal to one metric tonne of oil (MTOe). On the other hand, those unable to meet their assigned targets are required to purchase ESCerts (from the units that have exceeded their targets) through a centralised online trading mechanism hosted by the Indian Energy Exchange (IEX). The achievements from the first two cycles of the PAT scheme are given Table 1.

Table1: Achievements of the PAT Scheme

	Implementation Period	Energy Savings Target (Mn Tonne of Oil equivalent)	Actual Energy Savings (Mn Tonne of Oil equivalent)	Actual Emission Reduction (MN Tonnes of CO_2)
PAT Cycle-I	2012–15	6.6	8.67	31
PAT Cycle-II	2016–17 to 2018–19	8.869	13.28	61

Source: https://beeindia.gov.in/content/pat-read-more#:~:text=PAT%20Cycle%20II%20commenced%20from,tonne%20of%20Carbon%20dioxide%20emission.

Since 2017, the PAT scheme is being implemented annually on a rolling cycle basis. The most recent cycle, PAT Cycle-VI, commenced on 1 April 2020. Consistent overachievement of the targets in the first two PAT cycles has begged the question of whether the targets were ambitious enough. Research[13,14] on the efficiency of the PAT schemes shows that high energy prices would have incentivised energy savings even in the business-as-usual (absence of PAT) scenario, underscoring the need to set realistic, additional targets that account for rising energy costs.

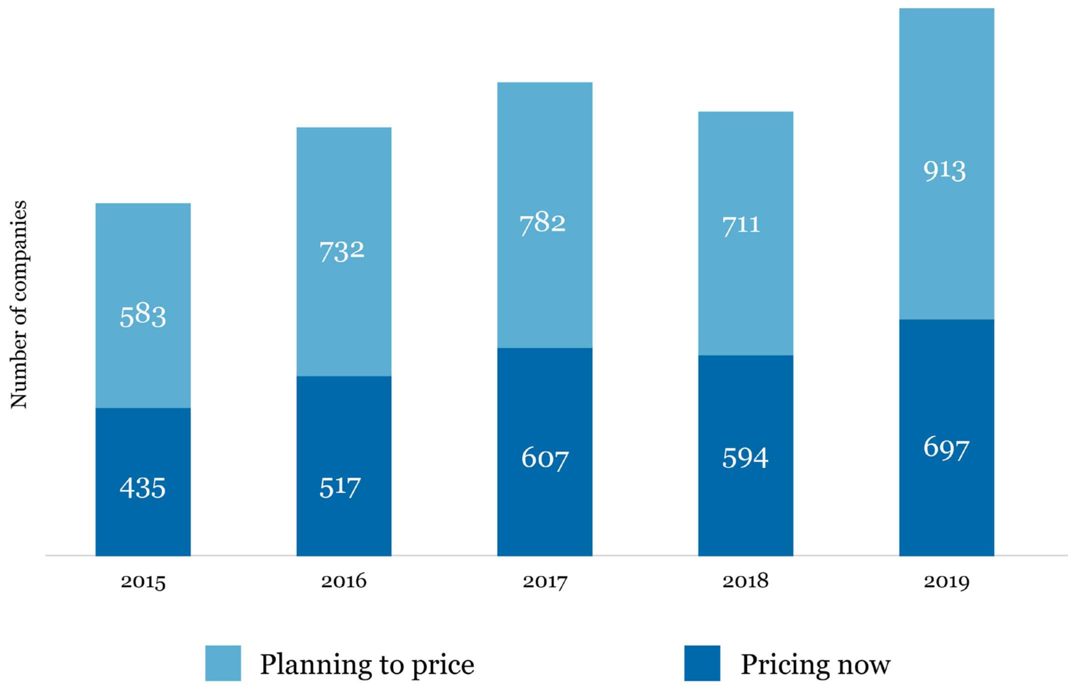
Coal Cess: In 2010, the government of India introduced a tax on coal, to be levied as excise duty on items listed in the tenth schedule to the Finance Act, 2010. These items are coal, lignite, and peat. The cess was implemented at a rate of INR 50 per tonne, and subsequently increased to INR 100 in 2014, INR 200 in 2015 and INR 400 IN 2016. Revenue collected through the cess was transferred to the National Clean Energy Fund (NCEF), which sought to finance clean-energy initiatives and research in this area. This setup, while promising in theory, failed to achieve the desired outcomes. First, a significant portion of the revenue collected through the coal cess remained unutilised. From 2010–11 to 2017–18, the coal cess collection amounts to about INR 86,440.21 crores. Of this, only INR 29,654.29 crores have been transferred to the NCEF and a mere INR 15,911 crores utilised.[15] Second, in 2017, the coal cess was abolished and replaced by the GST Compensation Cess. The proceeds from this tax are used for compensating states for revenue losses in the wake of shifting to the new indirect tax regime.

Renewable Purchase Obligations (RPO) and Renewable Energy Certificates (REC): To provide a fillip to India's growing renewable energy sector, all electricity distribution licensees are required to purchase or produce a minimum specified quantity of their requirements from renewable energy sources. The RPO for each state is fixed and regulated by the respective State Electricity Regulatory Commission. The renewable energy certificates (RECs) are market-based instruments that have been introduced to facilitate the fulfilment of RPO by the obligated entities. These certificates are traded at the power exchanges. RECs decouple the electricity component from the environmental attributes of the power generated from renewable sources and enable both the components to be traded separately. Since tradable certificates are not constrained by the geographical limitations of commodity electricity, RECs help in incentivising the production of renewable energy over and above the RPO state limit.

The enforcement of RPO targets, despite the availability of RECs, has been weak. According to the data compiled by the Ministry of Power, RPO compliance remains low across most states, with only four states managing to meet and exceed their renewable purchase obligations (RPO) in FY2019–20.[16]

Internal Carbon Pricing (ICP): Over the past few years, there has been remarkable support for carbon pricing by the private sector. As of 2019, 1,600+ companies worldwide are embedding an internal carbon price into their business strategies or are planning to do so in the next two years, up from 1,000+ companies in 2015.[17,18] In India, too, as shown in the figure below, there has been an increase in support for adopting ICP.

Figure 3: Internal Carbon Price Trends in India



Source: Carbon Disclosure Project, India Report 2020.

ICP is emerging as a popular tool that companies can voluntarily deploy to reduce emissions; channel investments towards innovative, clean, and energy-efficient technologies; enhance competitiveness; and deliver corporate sustainability goals. Further, it provides companies with an opportunity to improve their climate-risk management and responses to investor queries about the same. The Task Force on Climate-related Financial Disclosures (TCFD) has listed ICP as a key metric to assess climate-related risks and opportunities in line with its strategy and risk-management process, thus positioning it as an important option for companies thatwant to align themselves with the TCFD recommendations. Some of the leading Indian companies that have adopted an internal carbon price are listed in Table 2.

Table2: Internal Carbon Prices of Companies in 2019

Company	Price in INR	Price in USD ($)	Type of price used
ACC	2541	33.94	Implicit price; Shadow Price
Ambuja Cements	2163.9	30.74	Implicit Price
Dalmia Bharat Ltd	773.34	11	Shadow Price
Dr Reddy's Laboratories	937	13.32	Implicit Price
Godrej Consumer Products Limited	750	10	Shadow Price
Godrej Industries	740	10	Shadow Price
Hero Motocorp Ltd	private	private	private
Hindustan Zinc	1118.46	15.9	Implicit Price
Infosys Ltd	1001.82	14.25	Implicit Price
JSW Cement Ltd	1566	21	Shadow Price
JSW Steel Ltd	1400	20	Shadow Price
Mahindra & Mahindra	982.42	13.97	internal fee
Mindtree Ltd	private	private	private
Shree Cement	private	private	private
Tata Chemicals	1406.07	20	Shadow Price
Tata Consultancy Services	1131	16.08	Implicit price; Shadow Price
Tata Consumer Products Ltd	315	4.48	Offsets
Tata Motors	980	14	Shadow Price
Tata Steel	2720-975	38.68-15	Implicit price; Shadow Price
Tech Mahindra	703.03	10	Implicit price; Internal fee
Ultratech Cement	750	10.66	Shadow Price
Wipro	3622.91	50.11	Shadow Price

Source: Carbon Disclosure Project, India Report 2020.

The steady rise in the number of Indian companies that have undertaken ICP shows increased momentum towards a low-carbon future in corporate India. Companies need strong policy signals to sustain this momentum and build on it, as they embark on a decarbonisation pathway. A clear, robust regulatory framework for pricing carbon can play a key role in increasing the uptake of carbon pricing by businesses in India. Countries such as China, Mexico and South Africa offer policy precedents. For instance, ICP adoption in Chinese companies doubled in response to China's plan of rolling out the world's largest emission trading scheme in 2017.[19]

India's existing decarbonisation plan for the industrial sector is driven by the initiatives and strategies explained above. While improving enforcement and efficiency across the individual measures is vital, the critical challenge is to explore the potential for linking with the global carbon markets.

Challenges in Pricing Carbon

This section explores the key challenges to pricing carbon. The first three are broadly domestic in nature, while the fourth has global implications.

The political economy of carbon pricing constitutes the single-largest hurdle to its successful implementation across the world. The academic logic that presents tax as a tool for addressing market failures, while compelling in theory, is incompatible with the political reality of such an intervention. As is the case with any major policy that attempts to change the status-quo, efforts to catalyse the transition to a low-carbon economy will create winners and losers, economic as well as political.[20] The central challenge with carbon pricing is its diffused benefits and concentrated costs, such that the scattered beneficiaries of the policy are less likely to support it in the political process.[21] On the other hand, carbon-intensive companies (and communities) will vehemently oppose a carbon price, such as oil producers and refiners, large electric utilities with carbon-heavy fleets, large energy-intensive manufacturers, and other such concentrated interests.

Households (and firms) have little appetite for new taxes that reduce their disposable incomes (and profits). There is a large body of evidence documenting manifestations of public displeasure towards carbon taxes. Some noteworthy demonstrations include the "Gilets Jaunes"[22] demonstrations in France against fuel price increases; unsuccessful ballots on carbon taxes in US states; and public protests in countries such as Mexico, Iraq, Ecuador, Brazil and Chile. There have been several protests in India, too, against hikes in the price of fuel—for instance, the June 2020 protests against the increase in fuel prices, organised by the members of the Congress Party in several cities across the country.

Carbon tax policy (whether through cap-and-trade or an outright tax) has also been accused of being regressive,[23,24] affecting lower-income households more than their middle and high-income counterparts, since they spend a higher proportion of their incomes on energy-intensive goods and services. The distributional and welfare concerns associated with a carbon tax are primarily determined by how the revenues are spent. If the proceeds from the tax are diverted for financing the fiscal deficit, the impact is likely to be more regressive, compared to the proceeds being used for compensating households (in the form of lump-sum dividends or cuts in other taxes). This idea is explained in further detail in the following section.

Another key barrier to carbon pricing is the concern that higher domestic prices will raise costs for local industries, making them less competitive in global markets. However, evidence that a carbon price leads to a fall in competitiveness is rather scarce. Several assessments find no statistically significant effects of carbon or energy prices in different dimensions of competitiveness, including net imports, foreign direct investments, turnover, value added, employment, profits, productivity, and innovation.[25,26] This is primarily because carbon price levels are low internationally and trade-exposed sectors are often granted exemptions from carbon taxes.[27] From an international standpoint, carbon leakage—the movement of carbon-intensive industries to countries with a lax carbon policy—is another serious concern. However, robust evidence of carbon leakage has not been documented, owing to the same reason as above. Concerns relating to competitiveness are likely to become more serious as international carbon price levels rise and sector coverage deepens.

Policy Pathways for India

A Revenue Neutral Approach: Carbon Pricing with Revenue Recycling

In light of the political volatility and distributional concerns associated with carbon pricing, combining it with a mechanism for revenue recycling would help make the model more palatable. Under such a framework, the proceeds generated from the carbon tax would be earmarked and returned to society. The two most common recycling methods are:

1. diverting funds to green spending initiatives

2. recycling to firms and households

India has experience with the modified version of the first option with regards to its coal cess, as discussed in section one of this paper. An important lesson from the experience with the coal cess is the need to efficiently utilise the revenue by identifying and financing green projects/initiatives/research. That approximately half the funds collected through the coal cess and transferred to the National Clean Energy Fund (NCEF) remained unutilised, indicates a lack of viable projects. Therefore, it is *critical to devise a roadmap for identifying viable projects before implementing such a strategy*. Moreover, this roadmap would help avoid carbon dependence in public finance, as seen in the case of the coal cess revenues, which have now become important sources for GST compensation.

Incidentally, in India, states own natural resources but the pricing/taxation is decided by the Central government. With regards to coal, the royalties have been kept constant for years (which accrue to districts) while GST is at the lowest slab. The main mechanism for taxing coal is the cess, all of which accrues to the Centre. In other words, the implementation of the coal cess is more aligned to the idea of revenue maximisation instead of emission mitigation. While implementing a carbon tax, itwill be *vital to ensure that an incentive mismatch of this nature does not occur*.

The second method for recycling revenue entails the use of tax proceeds for compensating households and firms A revenue recycling mechanism that has delivered favourable results internationally is the *fee-and-dividend approach*. It features a carbon tax (fee) on fossil fuels whose proceeds are used to pay dividends to households. Some regions where this approach has delivered promising results include Switzerland and Canada.

In Switzerland, a carbon tax on fossil heating and process fuels was introduced in 2008. Two-thirds of the collected revenue is redistributed to households (on a per capita basis) and to firms (in proportion to their payroll),while the remainder is being used to pay for a building energy efficiency programme and a technology fund.[28] The tax was introduced at a level of CHF 12 per tonne of CO_2 (US$13.5/ tCO2) in 2008 and has risen to 96 CHF/tCO_2 (US$108/ t$CO_2$) in 2018. The tax is estimated to have resulted in a reduction of 6.9 million tonnes of carbon from 2008 to 2015.[29]

More recently, in 2018, the Liberal government in Canada, led by Prime Minister Justin Trudeau, announced a carbon tax for provinces that did not have an adequate carbon pricing model of their own. This includes the provinces of Saskatchewan, Manitoba, Ontario, and Alberta. The tax started at US$20 per tonne in 2019 and will be raised by US$10 per tonne each year, until it reaches US$50 per tonne in 2022.[30] For individuals and businesses with a relatively small carbon footprint, the carbon levy is applied to liquid and gaseous fuels at the point of purchase. The proceeds from the tax are remitted to residents, making the tax revenue neutral. This rebate is called the Climate Action Incentive, and the amount varies between provinces and household size. The rebate can be as low as US$439 in 2021 in Ontario to as high as US$1,419 for a family of four living in Saskatchewan in 2022.[31] To address concerns pertaining to competitiveness, several key industries that face intense trade competition, e.g. steel and chemicals, have been exempted from this tax. Instead, these companies are required to participate in a separate programme and are taxed on a proportion of their emissions.

Given Switzerland and Canada's experiences, identifying a clear strategy for the recycling of carbon revenues is a critical step for increasing the public acceptability of carbon pricing in India. However, revenue recycling is no silver bullet and comes with its share of challenges. Implementing an economy-wide revenue recycling programme would involve the same challenges that a large-scale welfare programme does. More specifically, it will be *important to get the right answers to critical questions such as the rebate size, distribution/payment channel, duration and frequency,* and put systems in place to *ensure targeting efficiency and adequate monitoring*. India's JAM trinity (Jan Dhan accounts, Aadhaar numbers, and Mobile phones) could be leveraged for this purpose.

Existing literature on climate policy shows that carbon pricing is likely to work well in countries with a high level of political trust and low levels of perceived corruption.[32] India, unarguably, is a poor performer in both categories. The public is more likely to accept a carbon price if they understand how the revenues would be deployed. This underscores the need to *establish a robust system of communication, public dialogue and social deliberation*. In Sweden, a sound communication strategy reinforced political trust and transparency prior to the implementation of the carbon tax, and played a pivotal role in increasing its public acceptability.[33]

Adoption of a phased and incremental approach while introducing the tax is another key strategy for making a carbon tax successful, as observed in the case of Denmark and Finland.[34] Similarly, Indonesia phased out its consumer fossil-fuel subsidies, which accounted for almost three percent of its GDP in 2008, by reducing its subsidies in a phased manner. To offset the backlash, it conducted effective public communication campaigns and instituted financial compensation programmes for poorer citizens who were hit the hardest by increased fuel prices.

Table 3: Key Challenges to Carbon Pricing and Policy Pathways for India

Challenges	Policy Pathways
Political Economy Considerations	Implementing a two-pronged strategy that includes taxation plus revenue recycling.
Public Opposition	1. A fee-and-dividend strategy, under which tax proceeds are used to pay dividends to firms and households. 2. A robust strategy for communication, public dialogue and social deliberation to allay public fears. 3. Implementation of the tax through a phased and incremental approach to gradually increase acceptability.
Challenges to Revenue Recycling	1. When revenues are directed towards green projects/initiatives/research, it is critical to: - devise a clear, transparent roadmap for identifying viable projects; - sequester revenue to avoid carbon dependence in public finance. 2. When revenues are recycled using a fee-and-dividend approach, it is important to: - have a clear and considered identification of size, distribution/payment channel, duration and frequency; - ensure targeting efficiency and adequate monitoring.
Concerns Regarding Economic Competitiveness	Protecting trade-exposed sectors.

Way Forward

Based on international experience, it is evident that carbon pricing cannot be the cornerstone of global climate policy, nor should it be expected to. This chapter argues that the political economy considerations, coupled with the distributional implications of a carbon tax, make it an extremely complex instrument to implement. Moreover, a carbon tax would deliver the promised outcomes only if the price is high enough. The IMF estimates that a tax of US$75 per tonne will increase the price of coal by 230 percent, natural gas by 25 percent, electricity by 83 percent, and petrol by 13 percent.[35]

For emerging economies, especially India, instituting that high a price would not be a viable option, at least not in the short-run. Carbon pricing in India has frequently met with political and public opposition. Post-pandemic, these hurdles will become even harder to overcome. Carbon taxes must therefore be carefully crafted to avoid political pitfalls and mitigate distributional concerns. A deep dive into the key challenges and their solutions highlights that pathways to implementing a carbon price in India do exist. However, the Indian economy may not be perfectly ready to traverse them just yet. In FY19, subsidies for oil, gas and coal amounted to INR 83,134 crore (US$ 12.4 billion), compared to INR 11,604 crore (US$ 1.7 billion) for renewables and electric mobility.[36] Further, as a part of its COVID-19 recovery response, India announced policies that include up to INR 73,013 crore in favour of coal and other environmentally intensive sectors, with only INR 9,621 crore for the renewable energy industry.[37] In the short term, India should focus on phasing out fossil-fuel subsidies and improving the efficiency of existing policies that place an implicit price on carbon.

Recent advancements in renewable technology, a decline in the cost of renewables, and the downturn in global energy prices provide a conducive policy environment to scale up renewables.[38] India must capitalise on this opportunity to accelerate the decline of the fossil-fuel industry and catalyse the economy's green transition. In the medium to long term, a carbon price would be a necessary policy tool to engender systemic change. India must start laying the groundwork for introducing a carbon price. Two important aspects of that are: a) streamlining and strengthening the country's digital infrastructure, and social protection machinery to effectively implement a revenue recycling mechanism; and b) developing a strong strategy for communication and social deliberation to build a coalition for change.

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2.2

Fostering Market Demand for Green Industries

Ria Kasliwal

Introduction

India's climate policies have consistently aimed at fostering green growth in the country, with the development of green industries being a focus area. However, despite concerted efforts and huge growth potential, India's 'green market'[a] remains at a nascent stage. While the growth of green industries requires policies that stimulate both demand and supply to achieve market growth,[1] Indian policies have only managed to successfully increase production capacities for green products without a similar boost in demand.

Indeed, green industries in India find it difficult to capture the market owing to consumer perceptions and preferences.[2,3,4] Consumers tend to purchase goods that are produced using more pollutive processes even as they are willing to switch to sustainable products; there are various reasons: they are restricted by the large costs of environmentally sustainable products; there is a lack of an enabling environment to create better access to green products; an overall dearth of information about available green products and their benefits; and a lack of confidence regarding what is termed 'green' by companies.[5]

Several studies show that a change in consumption behaviour patterns towards environmentally sustainable goods and products can lead to a larger market share for them.[6,7] A shift in consumer perceptions and preferences towards green products can be achieved by addressing the issues on the demand side. Thus, it is paramount for a green industrial policy to incorporate market creation strategies aimed at increasing market demand for, and access to green sectors over traditionally polluting sectors. This chapter studies the biggest sources of industrial emissions and recommends policy instruments aimed at demand-creation for greener sources.

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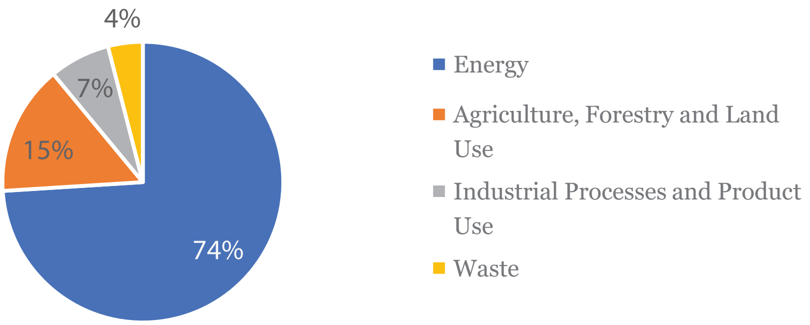
a 'Green market' here refers to a market for environmentally sustainable products and processes.

Scope of the Study

Emissions from India constitute seven percent of the total global emissions.[8] According to GHG Platform India, the energy sector and industrial process and product use (barring Agriculture)[b] are the highest emitters in India (See Figure 1).

Figure 1. Emissions from India, by Sector



Source: *GHG Platform India.9*

Industry in India drives emissions emerging from these two sectors. Within the energy sector (See Figures 2 and 4), the three biggest emitters are electricity and heat generation, industries (comprising manufacturing and construction),[c] and transportation. Within the industrial processes sector (See Figures 3 and 5), the mineral industry (comprising iron and steel, and cement) is the biggest emitter. Since the manufacturing and construction industry is the sole contributor of industrial emissions, and industry is a big consumer of electricity and heat generation, as well as road transport, the emissions from these sectors are largely driven by industries. Overall, industrial emissions are responsible for a quarter of the emissions in India.

b Given the theme of the report, Energy and Industrial Processes are the focal points for this chapter.

c As explained further in the chapter, the largest emitters in manufacturing and construction industry are cement, iron and steel industries.

Figure 2. Sector-wise Emissions – Energy

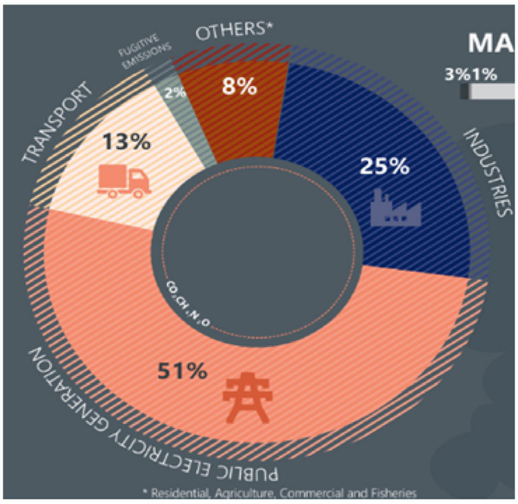


Figure 3. Sector-wise Emissions – Industrial Processes

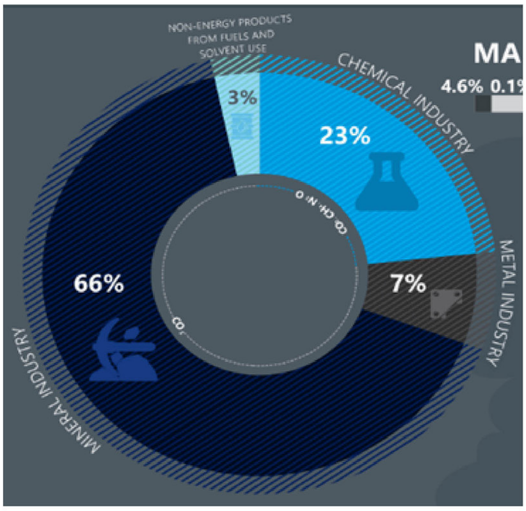


Figure 4. Sector-wise Emissions Trend – Energy

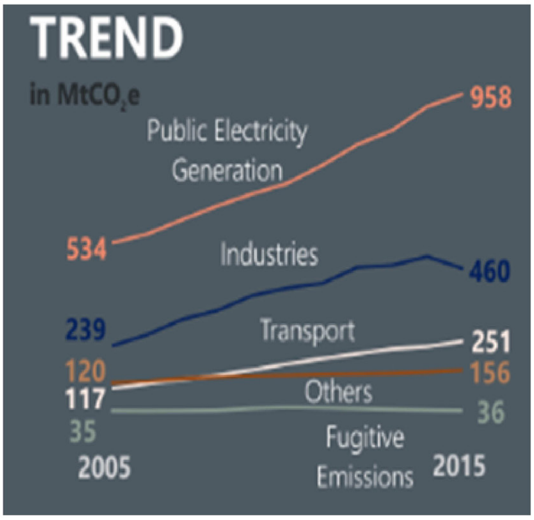
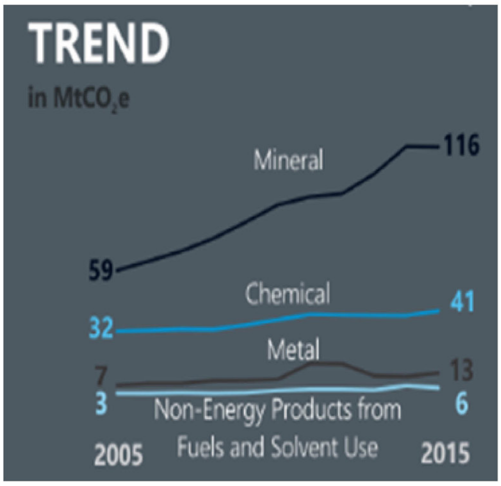


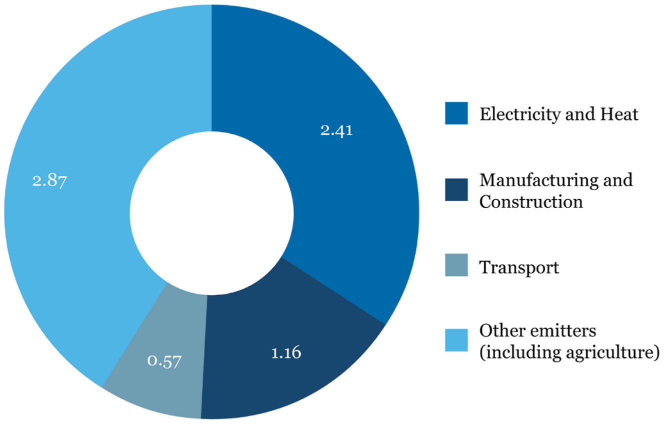
Figure 5. Sector-wise Emissions Trend – Industrial Processes



Source: GHG Platform India.[10]

To understand the magnitude of the emissions from these sectors from India, one must note that Electricity and Heat constitute 2.41 percent of the seven percent global emissions from India; Manufacturing and Construction constitute 1.16 percent; and Transportation constitute 0.57 percent (See Figure 6).

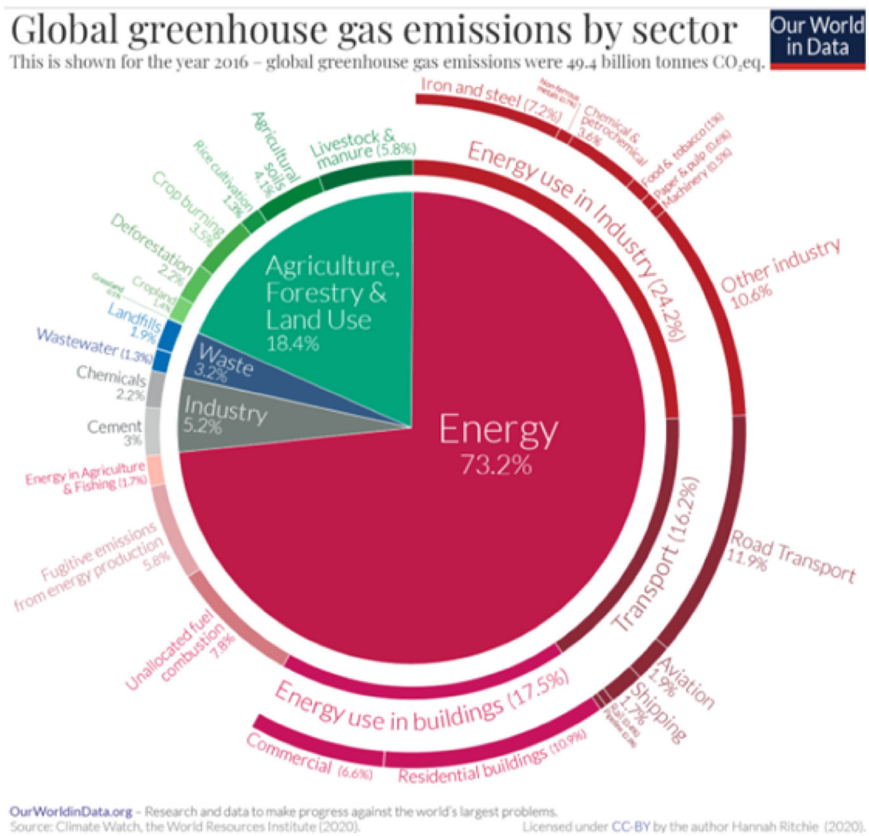
Figure 6. India's Contribution (7 Percent) to Global Emissions, by Sector



Source: Climate Watch.[11]

The breakup of sector-wise emissions from India matches global patterns (See Figure 7); thus, addressing emissions from these sectors is important for the world at large. While the energy sector contributes the most to global GHG emissions, within energy use, the highest emitters (as was the case in India) are industry (iron and steel being the largest), transport (especially road transport), and electrification and heating (specifically for buildings). Similarly, industrial process (particularly cement production) is the third-largest global emitter.

Figure 7. Global Greenhouse Emissions, by Sector



Source: Our World in Data.[12]

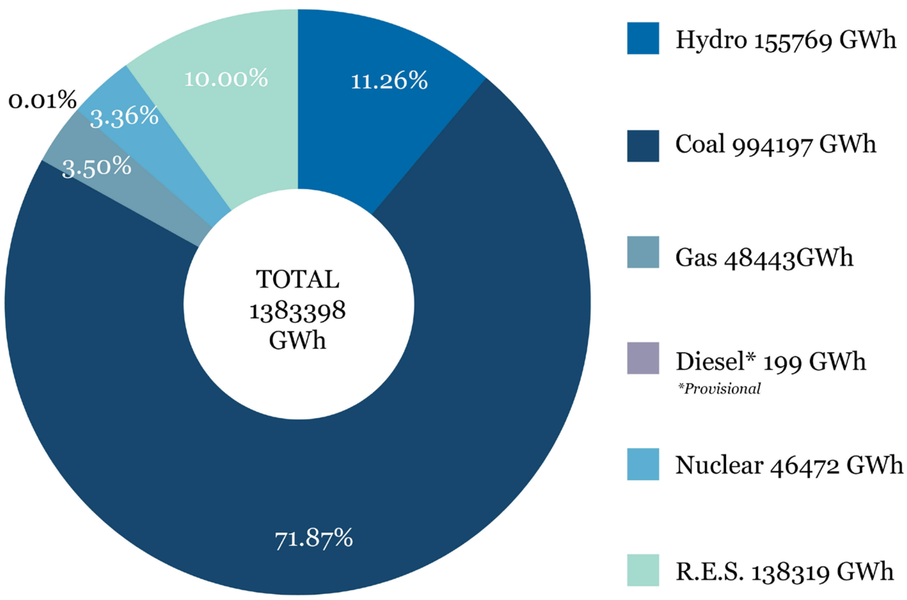
Polluting Sectors: An Overview

This section provides a brief overview of the three sectors, highlighting the source of pollution in each along with sustainable alternatives; the efforts undertaken by the government; the current gaps; and how the growth potential of these sectors requires the emissions to be addressed in an urgent manner.

Electrification and Heat Generation

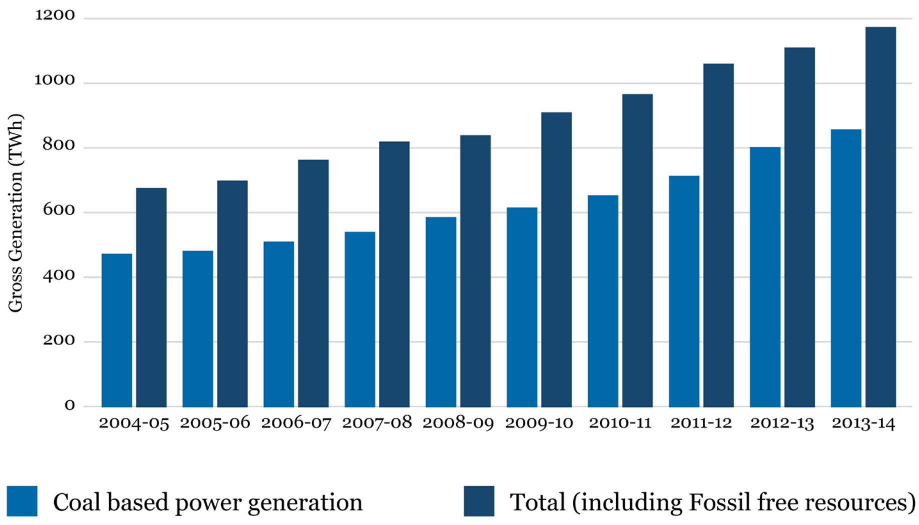
India ranks, respectively, third and fourth globally in terms of electricity production and consumption.[13] Fossil fuels—and coal in particular—dominate electricity and heat generation in India. In 2018-19, coal was used to generate over 70 percent of the country's electricity, followed by renewable energy (RE) sources (See Figure 8). Indeed, the share of coal in India's electricity generation has been on the rise in recent years (See Figure 9).

Figure 8. Gross Electricity Generation in India, Mode-wise (2019-20)



Source: Govt.[14]

Figure 9. Share of Coal-based Power Generation (2004-05 to 2013-14)



Source: Shakti Foundation.[15]

The dominance of coal has made electrification highly polluting, with emissions from fossil fuels[d] contributing to 96 percent of total emissions from the electricity generation sector. Since industries are the largest electricity consumers, comprising 44.11 percent of the total electricity consumption in the country, industry reports massive Scope 2 emissions[e] that need urgent attention.[16]

To de-carbonise the electricity generation sector, the Government of India has made a push towards increasing the renewable generation capacity in the country, which is in line with its commitments to the Paris Agreement on Climate Change. Aiming to improve the affordability of solar and wind power, India introduced the National Mission on Enhanced Energy Efficiency,[f] focusing on the industrial and commercial sector.[17] In light of the increased emphasis on deploying RE sources, India's expenditure on solar energy surpassed its spending on coal-fired power generation for the first time ever in 20190-20. Furthermore, during the COVID-19 pandemic, India's proportion of RE rose from 17 percent to 24 percent, while coal-fired power declined from 76 percent to 66 percent. Consequently, the number of people working in RE in India has increased fivefold since 2015.[18]

d Here, we are including coal and lignite in fossil fuels.

e Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by a company.

f The mission includes the Perform Achieve and Trade (PAT); the Energy Efficiency Financing Platform (EEFP); Framework for Energy Efficient Economic Development (FEEED); and the Market Transformation for Energy Efficiency (MTEE).

Based on India's current policies and its aim to reach 100-percent electrification to meet India's SDG Targets, the country's electricity demand could triple by 2040, due to increased appliance ownership and cooling needs.[19] This steady rise in the demand for electrification presents an opportunity for RE to overtake coal as the main source of electricity generation—that is, provided that market access and demand for RE is boosted. While a commitment to sustainability has led many companies to pledge to use 100 percent renewable-powered electricity,[g] lack of access to certified, commercially supplied RE at a low cost remains a barrier.[20] Moreover, the general market for RE remains largely uneven, which creates an additional obstacle for demand. The NITI Aayog has observed that consumers of electricity are restrained by higher costs in states with poor RE source, whereas DISCOMs are hindered by the lack of demand in states rich in RE sources.[21]

Thus, phasing out coal and replacing it with RE via increased accessibility and affordability is crucial to reducing the emissions emerging from electrification. A greater emphasis on facilitating access to RE will also be key in attracting global RE100 companies.

Construction and Manufacturing

The manufacturing and construction industries together account for 18.4 percent of the total emissions from the energy sector. Within this, the biggest polluters are cement, and iron and steel.[22]

Cement: India is the world's second-largest cement producer, accounting for over eight percent of global installed capacity. In 2010, the cement industry's share of India's total CO_2 emission was around seven percent. The construction industry's demand for cement drives production and is thus a crucial contributor to total CO_2 emissions. The construction of housing and real estate, followed by infrastructure (e.g. the development of roads) and industrial development are the largest consumers of cement.[23]

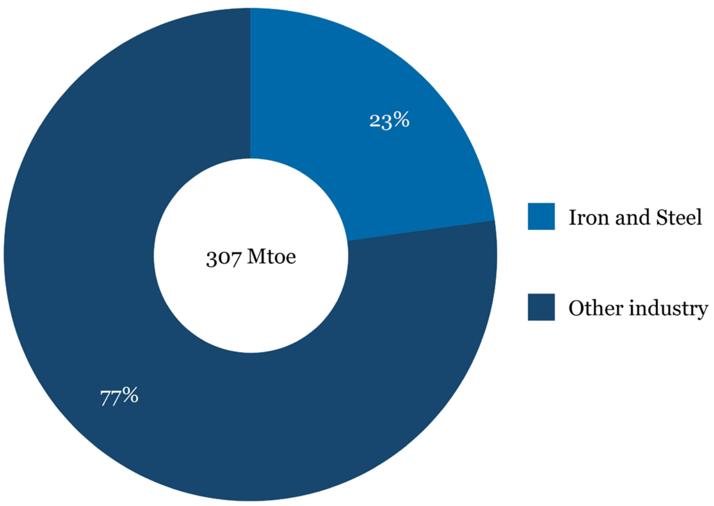
g These are called RE 100 companies.

With India recognising cement production as a significant source of unsustainable production practices, there have been concerted efforts by the country's private sector to embrace green practices.[24] Consequently, India's CO_2 emission in the cement sector has come down to 670-700 kg per tonne of cement, compared to the global average of 900 kg per tonne of cement.[25] However, while CO_2 emissions from cement has been on a steady decline, it still makes up five percent of India's total emissions.[26] This is largely due to the unaffordability of the green production practices for small- and medium-scale companies.[27]

With increased emphasis on infrastructure (NIP), housing (PMAY), real estate (smart cities) and industrial development (Make in India) by several Indian policies,[h] cement production in India is expected to be 800 million tonnes by 2030.[28] Given the anticipated spike in the demand for cement, studies show that significant efforts will be needed to meet the 2050 objective of a 40-percent reduction in CO_2-based emissions from cement production.[29]

Iron and Steel: India is the fourth-largest producer of crude steel in the world. The sector contributes around three percent of the country's gross domestic product (GDP), employing around 2.5 million people.[30] It also adds 6.2 percent to the national GHG load.[31] Within industry, the iron and steel sector is the largest energy-consuming sub-sector, accounting for over 20 percent of industrial energy use (See Figure 10).

Figure 10: Iron and Steel's Share of Industrial Energy Use 2018-19



Source: TERI report.[32]

h Most recently, the Union Budget 2021-22 laid special attention to infrastructure development.

While critical for economic growth, the iron and steel sector is both energy- and resource-intensive, and the rapid growth of Indian steel demand has had significant environmental and economic consequences. The iron and steel sector accounts for 28.4 percent of the entire industry sector emissions, which constitute 23.9 percent of the country's total emissions.[33]

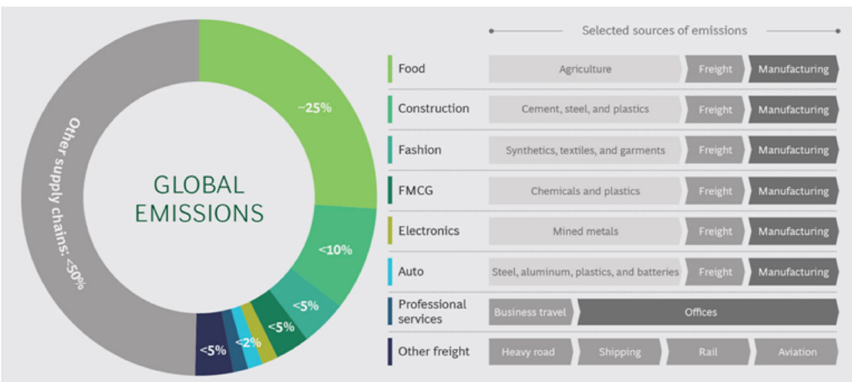
To drive a reduction in energy use in the steel sector, one of the major initiatives undertaken by the Government of India is the Perform Achieve and Trade (PAT) scheme.[34] Despite this, the average energy efficiency level of the industry remains low compared to global peers, and emissions from the sector are still significant and rising. The National Steel Policy, 2017 envisages 300 million tonnes of production capacity by 2030-31.[35] There is enormous potential for growth in the consumption of iron and steel, due to the thriving automobile and railways sectors, infrastructure development, and construction. In light of the present policies and the increased demand for iron and steel, experts estimate that emissions from the sector will increase to 837 $MtCO_2$ per annum by 2050, i.e. nearly half of India's total CO_2 emissions in 2018.[36]

This massive yet anticipated demand in manufacturing and construction creates an excellent opportunity for India to reduce emissions by increasing access to affordable low-carbon options for consumers.

Transportation Sector

The transportation industry, including both passenger and freight, is vital for growth. The production of any commodity or service requires the transport of people and goods. Freight transportation, in particular, is a source of significant supply-chain emissions from all industries globally (See Figure 11).

Figure 11: Supply Chains that Dominate Emissions – Freight's Contribution



Source: BCG analysis[37].

In India, road transport is a dominant form of transportation, carrying almost 90 percent of the country's passenger traffic and 65 percent of its freight—contributing 5.4 percent of India's GDP.[38] Consequently, within the transport sector, road transport utilises 78 percent of the total energy share and contributes 87 percent of the total CO_2 equivalent emissions. The two major fuels used by the transport sector are gasoline and diesel,[i] both of which are highly carbon intensive[j] and release greenhouse gases and other pollutants on combustion.[39]

India's road transport has witnessed remarkable growth in recent years and is expected to grow at a significant rate in future. Current projections indicate that road transport traffic will grow more than five times from 2011-12 to 2031-32.[40] [k] This growth will have a significant impact on the overall GHG emissions of the country. Recognising the need to decouple the growth of the transport sector from rising GHG emissions, the Government of India has already undertaken several initiatives to promote a sustainable mode of transportation. The National Action Plan on Climate Change (NAPCC), launched in 2008, includes "sustainable transport" under the National Mission on Sustainable Habitat. The Indian government is focusing on decarbonising the transport sector through increased efficiency, cleaner fuels (promoting the use of Liquefied Natural Gas [LNG] and Compressed Natural Gas [CNG]),[l] electric mobility (Electronic Vehicles [EVs]),[m] creating an enabling environment,[n] and modal shift.[41]

Despite these efforts, the projected increase in road transport will lead to increased consumption of fossil fuels. Unless the demand for cleaner fuels and EVs is boosted increases in transport will continue to have serious health and environmental impacts.

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i India's rapid growth in oil consumption is mainly driven by the transport sector.
j They contain 80-85 percent of carbon by weight.
k Projections suggest 6559 billion tones-km (freight traffic) and 163,109 billion passenger km (2031-32).
l Policies incentivising gas-driven mobility.
m Around 90 percent of EV support is for consumption, aiming to lower prices for faster adoption. The balance of approximately 10 percent is made up of schemes that support both production and consumption.
n Setting up city gas distribution networks, converting public transport to CNG, and creating green corridors for inter-city traffic.

Policy Instruments

Given these sectors' contribution to GHG emissions and the future growth potential, it is important to address emissions from them. The overview of the sectors in consideration further clarifies the importance of reducing emissions by bridging demand and market access gaps. This section lists policy instrument suggestions for stimulating the demand for alternative or green industries.

A. **Phasing Out Harmful Subsidies**: To help the market for green products prosper, a policy must first ensure that subsidies to environmentally harmful sectors are removed. This will boost the demand for greener alternatives. Thus, gradually phasing out harmful subsidies aimed at cost-effective production and consumption of environmentally unsustainable products and processes allows market signals to align with the true values of polluting sectors. This is the first step towards incentivising the emergence of green industries.[42]

1. As explored in the chapter on carbon pricing, **subsidies for fossil fuels**, like coal are seven times more than subsidies for RE. In 2019-20, coal subsidies were estimated at US$2.3 billion.[43] Phasing out harmful subsidies aimed at cost-effective coal production exposes consumers to the real cost of coal, incentivising the shift to other sources of electricity production, i.e. RE.

2. **Phasing** out oil and gas subsidies entirely might have a significant negative impact on the poor, due to the lack of alternative green and affordable modes of transport. However, between 2017-18, oil and gas subsidies saw a 65-percent increase.[44] Efforts should be made to not increase the load of existing subsidies on oil and gas.

B. **Large Scale adoption of Green Certifications**: A large-scale adoption and promotion of green certifications by the government will impress upon the market the importance of and possible fiscal benefits associated with such certifications. As a result of the BEE certifications, for instance, not only did producers transition to developing more energy-efficient products, but people also moved towards products with green ratings, thereby fostering a larger market for green industries.[45]

1. Buildings that use energy-efficient systems and are overall less environmentally taxing must be identified and given GRIHA certifications.[46] This could begin with new commercial, industrial and government buildings, and eventually include residential and old buildings.

2. In parallel, the use of GreenPro Certification[47] must be widely adopted for identified green-building materials, and industrial and consumer products.

3. Certified RE must be developed and can be supplied through multiple electricity supply companies, allowing consumers to choose their RE supplier.[48]

4. A green vehicle matrix must be developed, wherein passenger vehicles using CNGs, heavy transport vehicles carrying freight and using LNGs, and vehicles using hydrogen fuels must be identified, with varying levels of green being given appropriate certifications. For instance, EVs could be awarded a higher level of green vehicle certification.

C. **Creating Mandates and Targets**: The creation of mandates and targets by governments support increased production and demand for green industries. This signals India's prioritisation of green products and incentivises the transition to green goods and processes.[49]

1. Since a large proportion of India's energy needs is dependent on coal, a blanket ban would not work. However, creating targets towards the eventual phasing out of coal-use for electrification could incentivise consumers to shift to other sources of electricity generation.

2. The government must introduce an RE portfolio, whereby every industry must fulfil a part of their electricity generation needs using RE sources.

3. A gradual mandate must be released that requires every new commercial, industrial and government building (and eventually, residential and old buildings as well) to hold a certification for partial (specifying the target) or complete green materials used (GreenPro and GRIHA certifications). The Andhra Pradesh government has already pushed for making ECBC mandatory for obtaining building approval.[50] At the national level, these

mandates can be first deployed in industrial parks and SEZs, with the provision of special rebates.

4. Expanding on the already existing target for EVs for 2030[51], a target could be set for the newly devised certification for green vehicles in the country.

D **Fiscal Incentives**: The easiest way to promote demand for a particular industry is to make it more cost-effective than its competitors. Thus, increased affordability will enable consumers to switch to greener industries.[52]

1. In India, around 91 percent of RE subsidies are for production, while the remaining schemes support both production and consumption. This creates the need for focused subsidies for end consumers on the use of RE for electrification needs, in addition to the already introduced subsidies such as low GST and viability gap funding.[53] Introducing a price guarantee for RE-based power usage for industrial consumers and rebates for small-scale consumers using RE at home[o] will incentivise end consumers to increase the demand for renewable sources of energy for electrification in their industries and homes.

2. To allow small and medium industrial producers of cement, iron and steel to switch to greener and more efficient processes, they can be provided with fiscal incentives.[54] These can include land-related support; expenditure-related incentives such electricity duty exemptions, rebates, and subsidies; and capital investment-related incentives. These special incentives for small and medium producers, as well as existing subsidies to steel, cement and iron producers, should be contingent on their level of transition while ensuring that there is no green washing.

3. Large industrial and commercial consumers of iron and steel, and cement can be given subsidies to allow them to transition to greener manufacturing and construction companies. These must be in accordance with firm sizes, such that smaller firms get bigger subsidies to switch.

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o California Solar Initiative, launched by the city of California, provides similar extensive rebates to small-scale consumers to promote the usage of RE.

4. Rebate can be offered for certified green residential buildings located in urban areas where land value is usually high and additional rebate for rural and semi-urban areas, both based on the degree of greenness. Additionally, rebate can be extended to property tax for partially and fully GRIHA-certified commercial and industrial buildings, based on the degree of greenness.

5. Since India is a two-wheeler dominant country, and the sales for EVs in 2018 were only 0.3 percent of total two-wheeler sales,[55] the government must extend the already available subsidies for buying two-wheeler EVs in India.

6. The success of CNG in Delhi has been a testament to the benefits of technology, which allows retrofitting in existing vehicles for a green transition.[56] This can be applied to freight as well as passenger vehicles, by subsidising the retrofitting procedure and facilitating the transition to CNG, LNG and hydrogen fuels. Further, the subsidies on creating charging infrastructure (for EVs, CNG, LNG, and hydrogen-fuelling stations) can be expanded.

E. **Public Procurement**: The best tool for the government to increase the cost-effectiveness and efficiency of cleaner sources of energy is the undertaking of mandatory green procurement requirements. In India, this will also allow governments to create a demand for green products, especially since 30 percent of the country's GDP is spent on public procurement. Considering the massive size of public spending, the public sector in India can be a prime driver towards sustainable production and consumption, creating both environmental and economic benefits. Furthermore, public procurement would highlight "greening" as a government priority and provide clear directives and expectations to politicians and procurement officials.[57] <u>The first step will be to introduce a clear mandate and targets for the procurement of sustainable items in tenders.</u>

1. A clear <u>transition of government and public resources</u> to cleaner and less polluting RE sources of electrification will constitute the first step towards establishing the state's green priority. For instance, electrification in parks must be shifted to RE sources.

2. New government and public buildings must aim at getting the highest level of <u>GRIHA</u> certification. The recent government-initiated "Housing for All"

programme[58], for instance, presents significant green building potential. Further, efforts must be made to use only GreenPro products for government requirements.

3. There must be a concerted effort to use retrofitting to increase the rate of transition of public transport vehicles (such as intra- and inter-city buses) to green vehicles, aimed to eventually achieve successful targeted conversion to EVs.

F **Creating Enabling Environment**: The policy interventions mentioned here will only work if the environment is suitable for their optimal utilisation. This makes it equally important to create policies that help bridge gaps in effectiveness to facilitate those that aim at improving access to green products in the market.

1. While India is heavily focused on EVs and is making efforts to provide affordability for the product, the lack of charging stations is an obstacle to the adoption of these green vehicles. Public investment and nationwide development of charging infrastructure[59] are therefore necessary to encourage the usage of EVs.

2. Charging stations for CNGs, LNGs, and hydrogen fuels must also be developed. This can also be done in collaboration with various up and coming private-sector start-ups in the line.

3. Better alignment between state and central policies on corporate RE sourcing and its enforcement will help bridge implementation gaps.[60] The recent mandate by the Centre, that states must pay RE generators and clear their dues, reflects a disconnect between Central and states policies.

Additional Policy Instruments

A. Green Marketing: Currently, there is a lack of information for consumers and producers regarding the availability and affordability of green technology, and about phasing out harmful polluters. There is a need to invest in awareness campaigns. Green marketing must especially focus on consumers, to allow them a chance to opt for greener products, incentivised by the available subsidies and the need to switch targets. At the same time, green marketing will allow producers—particularly, the small- and medium-scale enterprises—to learn about targets and public procurement and align their production strategies accordingly.[61]

B. **Monitoring and Evaluation of Subsidies**: As illustrated, it is important to provide useful subsidies while phasing out the harmful ones. However, subsidies must be identified as useful, outdated, or harmful by monitoring existing and new subsidies for green industries and polluting industries. This will help improve the transferring of resources for better use and the filling of gaps to create a greater market for green goods. Compulsory environmental audits in buildings, and monitoring the gaps in EV subsidies, for instance, can help formulate a more fruitful industrial policy.[62]

Impact

The suggested policy instruments are intended to increase market access and boost the demand for green industries as alternatives to conventional highly polluting industries. The impact would create environmental benefits whilst also fostering green growth for India.

Electricity and Heat Generation: Investments in RE have the potential to create thrice as many jobs as compared to investments in fossil fuels such as coal. Furthermore, the creation of clean energy and closing the energy access gap are good business, since the cost of renewables has fallen enough to build new RE capacities instead of operating on existing coal capacities. [63] In India, 50 percent of coal production will become uncompetitive by 2022, reaching 85 percent by 2025.[64] If subsidies enhancing the competitiveness of coal production are phased out, this figure will be much higher. Thus, India can become a true global superpower in the fight against climate change if it expedites its shift from fossil fuels to RE.

Construction and Manufacturing: Industry projections suggest that India's green building market for new buildings is estimated to be somewhere between US$30 billion to US$ 40 billion.[65] Additionally, a recent TERI report estimated that investments in green building and RE have the potential to generate 2.4 million un-skilled and 6.1 million skilled jobs in India.[66]

Transportation: The global automotive market's projected shift towards EVs creates a huge opportunity for India. According to a government blueprint, the EV sector is expected to create 10 million jobs in India and be a USD 206 billion opportunity.[67] Given the country's increased focus on LNG and CNG, the total consumption for these greener fuels is set to witness a projected year-on-year increase of 28 billion cubic metre (BCM) during 2019-25. Finally, as the Asia Pacific region prepares to increase its LNG imports, from 69 percent in 2019 to 77 percent by 2025, India has the potential to supply this increased demand to a large extent and account for 20 per cent of incremental trade. [68]

Table 1: Summarised Recommendations on Policy Instruments

<table>
<tr><th rowspan="2">Policy Instruments</th><th>Electricity</th><th colspan="2">Construction & Manufacturing</th><th colspan="2">Transport</th></tr>
<tr><th>Coal</th><th>Cement</th><th>Iron & Steel</th><th>Oil</th><th>Gas</th></tr>
<tr><td>Phasing Out Subsidies</td><td>Subsidies aimed at cost-effective and higher production of coal should be phased out.</td><td colspan="2">NA</td><td colspan="2">Efforts aimed at not increasing the load of existing subsidies.</td></tr>
<tr><td>Large Scale adoption of Green Certifications</td><td>> Developing certified RE.</td><td colspan="2">> GRIHA building certifications according to the degree of greenness.
> GreenPro Certification for products and processes.</td><td colspan="2">Introduction of green vehicle matrix and certification dependent on varying degrees of greenness.</td></tr>
<tr><td>Creating Targets</td><td>> Signalling the eventual phasing out of coal use.
> Introduction of RE Portfolio.</td><td colspan="2">Mandate on essential GRIHA and GreenPro certifications as per the targets for specific buildings.</td><td colspan="2">Laying out a nationwide target for Green Vehicles.</td></tr>
</table>

Fiscal Incentives to Consumers	Subsidies Or Price Guarantees	Price guarantee for RE-based power usage for commercial and industrial consumers.	> New subsidies to small- and medium-scale producers, and the continuation of existing subsidies based on transition. > Subsidies (in accordance with firm size) to large commercial and industrial consumers for transitioning to greener construction and manufacturing firms.	Extending subsidies for two-wheeler EVs. Expand the subsidies for creating charging infrastructure for EVs, CNG, LNG and hydrogen fuelling stations.
	Concessions /Rebates	Rebates for small-scale residential and commercial consumers using RE.	> Rebate on certified green residential buildings based on the degree of greenness. > Rebate on property tax on partial and complete GRIHA certified commercial and industrial buildings.	
Creating Enabling Environment		Better alignment of central and state policies on corporate sourcing of RE.		Wide-scale development of charging infrastructure for EVs, CNG, LNG, and hydrogen-fuelling vehicles.
Public Procurement		Transitioning government and public electricity demands to RE sources.	Mandatory GRIHA certifications for government and public buildings and the use of GreenPro products.	Increasing the rate of transition of public transport vehicles to green vehicles.

Source: Author's own.

Conclusion

For a green industrial policy to work, both market demand and supply must be stimulated. So far, the Government of India has developed policies that enhance both supply and demand, but these have stressed disproportionately more on the former.

Moreover, for the policies aimed at incentivising demand creation for green products and green transition in the country, there is substantial gap between the guidelines and implementation. The main reason for this is the absence of a regulatory framework to operationalise the guidelines. For instance, the National Cooling Action Plan proposes important strategies for creating a greener India; however, it is far too ambitious given the lack of any accompanying structural support.[69] Unless they are backed by adequate and essential regulatory and institutional bodies, action plans aimed at transitioning the Indian market and industries to greener versions are bound to fail. It is therefore important to not only bridge the demand gap for an optimal transition to green growth, but also create appropriate legal frameworks to actualise their potential.

This chapter focused on policy interventions aimed at shifting consumption perceptions and preferences from traditionally polluting sectors to alternative green sectors. It examined the largest emitters in India—electrification and heat generation, construction and manufacturing, and transportation—and suggested policy recommendations aimed at increasing the demand for already established alternatives in these sectors. Policy interventions suggested are *phasing out harmful subsidies*, *large-scale adoption of green certifications*, *fiscal incentives to consumers*, *creating an enabling environment*, and *public procurement*. Additional policy instruments include *green marketing*, aimed at increasing knowledge and awareness about green products, its benefits, and the financial incentives associated with them; and *monitoring and evaluation of existing subsidies* in these sectors to alleviate the demand gaps.

An increase in the demand for green products not only can boost sustainability, but also create a huge potential for fostering economic growth and increasing jobs in the country in a post-pandemic world. Given the rapid global shift towards green sources, investing in green industries will further India's prominence and centrality in the global climate action. Undoubtedly, the first step towards this is to foster demand at home.

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2.3

The Debt and Investment Puzzle: Financing Greener Industry

Mihir S Sharma

Part I: Financial constraints and industrial growth in India

As argued elsewhere in this report, India's industrial sector has consistently performed below potential. De-industrialisation in India set in relatively early in the country's growth trajectory. For the country as a whole, "registered", or formal, manufacturing's share of gross domestic product or GDP peaked in 2008. In no state of India, barring Gujarat, did manufacturing cross a 20 percent share of state GDP.[1]

The literature has advanced several distinct reasons why this might be the case. These include trade policy effects, regulatory restrictions, arbitrary tax administration, and problems obtaining land or labour of the appropriate skill level. A large part of the reason, however, has also been financial constraints. One survey, in 2005, found that over 20 percent of firms viewed "the cost and access to finance" as major obstacles to expansion. Related econometric work has shown that, in the post-reforms period, firms dependent on external rather than group financing have seen a relative decline in investment.[2] This is also true for the informal sector, which composes a large proportion of Indian manufacturing, particularly when measured in terms of employment.[3]

This historic pattern continues to be relevant today. Lending dynamics have followed a particular path since the financial crisis of 2008. An initial binge of lending, as part of the informal post-crisis stimulus, led to a significant non-performing asset problem with Indian banks. This was particularly true of the public sector banking system, which has more than two-thirds of the market, and which tends to take the lead in lending to the industrial sector. The burden on banks' books stopped short of precipitating a proper crisis, but nevertheless caused an unwillingness to lend. Meanwhile, the banks' counterparties in the industrial sector were also weighed down by debt; Credit Suisse estimated that around 40 percent of its database of corporate debt was associated with companies that simply did not earn enough even to pay interest on what they owed. In the Economic Survey for 2016-17, Chief Economic Advisor Arvind Subramanian called this the "twin balance sheet problem" in which both the banking and the industrial sector were under stress.[4]

A short interregnum followed, in which period the duty to lend to industry was taken up the non-bank financial sector. These "shadow banks" borrowed on the market and lent on to firms, including stressed firms. They performed a vital intermediary task, but one that they were not designed nor regulated for. Non-bank financial corporations, or NBFCs, were "expanding loan books by 25 per cent per annum" in the years to 2018, while "while the public sector banks [were] barely expanding at all".[5] The inevitable happened, and one major shadow bank – Infrastructure Leasing & Financial Services, or IL&FS, defaulted on some of its debt, requiring a state takeover. Lending from the sector decreased sharply.[6] Banks, which were still stressed, could not pick up the slack.

As a consequence, India is in a private investment crisis, and has been for almost a decade. According to the Reserve Bank of India, even pre-crisis, investment plans by the private sector had been shrinking for seven years.[7]

The broader macro-economic picture over the past decade is extremely relevant to the question of industrial financing. In a country where the government sector runs a deficit (or, in other words, dis-saves), there are a limited set of sources for private corporate investment. Either the pool of financialised domestic household savings can be tapped; or global capital can be used. In 2019-20, before the pandemic hit, household financial savings comprised around 7 percent of GDP.[8] Net financial savings have not had a good decade. Even the withdrawal of high-value currency notes in 2016 – the famous "demonetisation" experiment – did not result in a sustained move towards net financial savings, which in fact declined.[9] Indeed, net household savings going to banks in the year after demonetisation were almost half the proportion they were before demonetisation.

This period of poor household financial savings – as opposed to physical savings, in gold and other physical assets – has coincided with a problematic fiscal trajectory. Even prior to the pandemic hitting, the Indian government was consistently missing its fiscal targets. The fiscal deficit number in the Union Budget was itself considered questionable, as a large amount of sovereign borrowing was taking place off-budget. The bond markets were flooded with government borrowing, driving other borrowers out. This has been a long-term problem when it comes to the development of a corporate bond market in India, but it has been enhanced in recent years with a new flood of government paper.

However, even if off-budget and contingent liabilities of the government are ignored, the Union and state governments put together are still monopolising India's household financial savings. Taken together, pre-pandemic, the general government borrowing in India was 9-10 percent of GDP.[10] A simple way to think about the crisis of private corporate investment in India, therefore, is that all of India's household financial savings is going to finance the government's deficit.

As the pandemic has raised the requirements for government spending while simultaneously decreasing its revenue from both tax and non-tax sources, the borrowing requirements for the government going forward will only increase. Indeed, there is every expectation that India will no longer have a moderate level of debt as a proportion of GDP, but will head up to debt of around 90 percent of GDP – a level more associated with sclerotic economies in Latin America and elsewhere than with an Asian tiger.[11] India has broadly kept debt at around 70 percent of GDP since the liberalisation era began. Becoming a high-debt economy fundamentally changes dynamics for both firms and households. More importantly, servicing this pile of debt will take even more out of the limited household savings in India, which will again reduce the amount available to the private corporate sector, which will in turn be forced to further cut back on investment plans.

In other words, since the crisis, India has had a corporate financing crisis, which has led to a private investment crisis – and the drivers behind it are only likely to intensify in the coming years.

Part II: The implications for the green transition

What are the implications of this overall picture of private investment in India for the country's green future? It should be clear that, first, the fiscal crunch being faced by the government severely limits its ability to finance the industrial transition through subsidies or tax breaks. Questions of, for example, "greening the stimulus" in India in the manner that the European Union or the United States have done must run up against the fact that the post-Covid stimulus in India contained very little in terms of fresh spending pledges.[12]

Second, the pandemic has imposed new realities on regulatory agencies in the emerging world, including in India. There is less appetite now for environmentally conscious coercive legislation that might reduce job growth, raise user fees, endanger current employers, or reduce the tax base even temporarily. For example, the Union power ministry in India may further water down strict emissions standards for thermal power plants – which were originally scheduled to come into effect in 2017. The ministry's stated concern is that it would burden utilities and consumers.[13]

Thus any green transformation of industrial processes in India would require investment to be raised by the private sector itself. Here, however, the crisis of private investment in India begins to bite. If regular expansion and investment is constrained by the availability of financial capital, why would companies shift towards greener processes even if there is a belief that they will pay off in the long run?

In examining the degree to which this reduces the likelihood of de-carbonisation related investment by the Indian corporate sector, one major problem is that abatement costs in India are hard to estimate. Some broader published work makes the point that abatement costs are cheaper for larger cuts in emissions in India than in other major geographies.[14] However, work comprehensively outlining the various sectoral costs for abatement is still awaited. The absence of such work is one reason why the Indian government continues to be dubious about setting legally mandated net zero targets. In 2015, the government estimated that meeting India's NDC targets would cost the economy US$2.5 trillion[15]; but it is unclear how much that figure would need to be adjusted and decomposed under post-pandemic scenarios. Certainly the additional investment needs are daunting. In the energy sector alone, the International Energy Agency estimates that "delivering upon stated clean energy transition objectives and energy demand growth requirements in India will require increasing the annual level of investment in the energy sector by approximately 25 percent from 2018 levels on average during 2019-25 and by almost 50 per cent on average during 2025-40".

The power sector, crucial for the future de-carbonisation path, is a clear instance of both this cost uncertainty and the financial burden posed by new regulatory requirements. The International Energy Agency, for example, has noted in 2020 that the cost for the power industry to introduce new emissions control technology that complies with regulatory requirements is uncertain: "Estimates vary" between $49 billion and $145 billion.[16] Certainly, the capital costs for a new flue gas desulphurisation unit are considerable, estimated in 2018 at being between $72,500/megawatt and $93,800/megawatt depending on the sort of unit used.[17] In 2017, it was estimated that about 166 gigawatts' worth of generation capacity required the installation of flue gas desulphurisation. One conservative figure for the capital expenditure required for pollution control technology is $12 billion.[18]

This comes at a time when about 55 gigawatts' worth of coal plants are already under severe financial stress, which threatens to spread to the banks that have already lent them a considerable amount of money. In the months before the pandemic, the banking sector was estimated at having to support $40-60 billion in "non-performing or stranded assets" in the thermal generation sector.[19] Banks have been unwilling on their own to lend further to private power companies in particular.[20] If electricity distribution companies are added to this list, then that figure for stressed assets might be more than $100 billion. While the government may claim that dilutions of regulatory requirements are a product purely of the desire to minimise fresh burdens on utilities and consumers, there is little doubt that it will also consider its position as guardian of the financial sector and indeed owner of 70 per cent of the banking system.

Other industrial sectors present similar problems. Iron and steel production in India currently accounts for about 12 per cent of emissions from the combustion of fossil fuels in India, but The Energy and Resources Institute has projected that this will rise to a third in coming decades,[21] alongside a five-fold increase in demand in their baseline scenario.[22] Indian steelmakers are reluctant to put a clear figure on the cost of decarbonisation. Some associated companies in Europe, however, have committed to net zero requirements by 2050, such as Tata Steel in Europe. ArcelorMittal, which is the largest steelmaker in Europe, has said that bringing its plants into line with a carbon-neutral target date would cost between 15 billion and 40 billion euros.[23] In India, retrofitting costs will vary. The stakes, however, could not be higher: the IEA is of the opinion that the iron and steel industry in India "take centre stage" in global decarbonisation efforts.[24] The global resources consultancy BHP is not sanguine about the IEA's hopes, however, pointing out that "disruptive" policy would be needed for decarbonisation in the sector in India. It specifically mentions the "enormous amount of capital that needs to be mobilised to improve investment on each front.... Fundamentally transforming a sector with a long-lived incumbent capital stock as well as economy-wide infrastructure requirements that are not yet in place, takes concentrated effort over a very long time. This is not like switching to smart phones or adopting ride hailing."[25]

In general, work on the abatement costs in sectors focuses on how to further de-carbonise them beyond existing government ambitions. As the already-quoted instance of watering down and delaying implementation of environmental regulations for thermal power plants shows, this may be the wrong baseline to use. Some recent work by the World Bank in cooperation with the Indian government has tried to put a specific figure to the upfront costs of greater ambition in the power sector in particular.

Meanwhile, the steel sector in India is also wrestling with its financial constraints, particularly a debt overhang following some "ill-timed" purchases.[26] In the early months of the pandemic, credit ratings for two of the largest Indian steelmakers, JSW Steel and Tata Steel, were downgraded because of concerns regarding their debt dynamics.[27] Increases in the price of steel later in the pandemic may allow some Indian firms to pare down their debt by 15 per cent, according to reports in March 2021.[28] When special pandemic-related moratoriums on banks' evaluation of their assets expire, however, the Reserve Bank of India expects a spike in bad debt – with steel loans one of the sectors "poised to hurt the most".[29] In other words, here again a sector that has ambitious decarbonisation requirements, requiring deep and broad investments in new technology, simply will not be able to access the finance it requires for this new spending through the usual pathways.

The broader picture is clear. Across much of the Indian industrial landscape, reducing emissions requires dealing with heavy, emissions-intensive legacy infrastructure. Costs of a green strategy will be correspondingly high. Meanwhile, the financial sector is facing macro-economic headwinds minimising its willingness to lend for private investment. Indeed, even if those constraints were to magically disappear, the sectors with the most obvious requirements for green capital – power, iron & steel, cement,[a] and so on – are also among those already burdening the financial sector's books. Thus they will struggle to attract the capital they need even under the most positive macro-economic scenarios. No regulatory restrictions, technological innovations, or other forms of industrial policy will be in any way effective unless this basic constraint on financing is removed.

Any green industrial policy for India will have to reckon with this near-impossible situation when it comes to financing environmentally-relevant investment. India needs new pathways for capital.

a Two of these sectors are examined in Ria Kasliwal's chapter in this report.

Part III: Recommendations for financial reform

The constraints on financing of green investment by Indian industry can be addressed, overall, by one of two broad classes of policy mechanism. Either the domestic pool of financial savings for green industrial investment can be increased; or global financial flows can be catalysed.

The domestic savings-focused mechanisms will require, in particular, a revision of the Reserve Bank of India's approach to what it calls "priority sector lending", or the preferential lending by financial institutions to specific sectors. In recent guidelines on priority sector lending, the RBI has included several renewable energy-related end uses, including solar panels in agriculture, solarisation of grid-connected agricultural water pumps, and compressed bio-gas.[30] It could be argued that lending to companies for their de-carbonisation efforts are a prime candidate for inclusion in the priority sector lending categories. That would, for example, incentivise banks to de-emphasise the size of their existing loans to a sector while weighting a decision to lend to a company in that sector to finance its de-carbonisation efforts. The RBI itself has said enhancing domestic green finance would require a reworking of monitoring and verification as well as several other policy changes.[31] Nevertheless, altering priority sector lending guidelines remains the most immediately achievable lever to avoid the macro constraints on private capital flowing into the relevant sectors. That said, other changes in the priority sector lending guidelines may limit the effectiveness of any push to increase the list of priority sectors eligible for preferential finance. In particular, geographical restrictions have now been put on priority sector lending that would effectively exclude several industry-heavy districts from the scope of the policy.[32]

Global funds for green investment are perhaps a more useful and accessible source in the current post-pandemic macro-economic situation in India. During the pandemic year of 2020, Morningstar estimated that open-end and exchange-traded funds in the United States focusing on environmental, social and governance (ESG) indicators mopped up over $50 billion of net new investment.[33] This was more than double the previous year, and meant that one dollar in four of net flows into mutual funds in the United States went to ESG funds. In the United States, the Forum for Sustainable and Responsible Investment now believes that a third of the total assets under management are with either institutional or retail "sustainable" funds.[34] Similar numbers could be quoted for European funds in the same time period.

This speaks to a broad appetite in the global north, which has only grown during the pandemic, for ESG investment. The questions are two-fold: can a section of this ESG investment be directed towards Indian industry to finance its de-carbonisation efforts? And, if so, what policy changes might make this possible?

Recent work by the Climate Policy Initiative demonstrates the scale of the challenge.[35] Only five per cent of green finance in India originated from private sector sources outside India. Over half of public (bilateral) funds went to transportation projects – Japanese funding of metro railways being a major component. Other than that, power generation – specifically renewables – comprised 80 per cent of the green finance database. Energy efficiency and power transmission finance came largely from public funds. The report's authors, however, highlight that "a large share of public financial institutions in energy efficiency and power transmission financing can partly be attributed to limited data availability with regard to private investments into R&M and retrofitting". This problem might conceivably be said to extend also to investments in retrofitting and efficiency elsewhere in the industrial economy. The report's overall figures for green finance in 2016-18 indicate a practically negligible percentage, under 5 per cent, of green finance went to non-power, non-transport activities. As it stands, the Indian industrial sector ex-power and ex-transport is struggling to attract green finance.

How can this be remedied? The steps that must immediately be taken on the policy level must focus on **transparency and reporting**. One reason that ESG funds can flow clearly into the transport and the renewables sectors in India is that their mitigation potential is clearly understood and the environmental end-product of the financing can be clearly gauged by an investor. In addition, in the renewables sector in particular, the companies that are raising this finance typically have fresh and transparent (even if burdened) balance sheets and a singular focus on ESG activities. Extending such a flow of funds to sectors that have legacy debt overhangs and a longer transition window in their mitigation efforts is not straightforward. A necessary requirement, however, is the **decomposition and de-linking of Indian corporations' ESG-relevant efforts from their legacy businesses, and in some cases the creation of fresh vehicles for their de-carbonisation efforts that could raise funds independently**. In Indian conglomerates, for example, this might take the form of a new company (Tata ESG?) that would raise funds that it could credibly commit to direct towards de-carbonisation efforts elsewhere in the group. Appropriate regulations for related-party transactions might have to be framed for this to be incentivised.

At the regulatory level, **norms and a taxonomy for green end-uses of investment** must be indigenously designed. The European Union's Green Investment Taxonomy may not be immediately applicable to emerging economies like India. It could, however, be taken as an initial base. Certainly, effort should be put into harmonising an Indian taxonomy for green investment with existing parameters, to enable easy interfaces between the two jurisdictions' financial institutions. Another point of departure for an Indian green investment taxonomy is the National Industrial Classification 2004,[36] which has 99 divisions for value addition in the Indian economy, with each having multiple subdivisions. This could be updated and given a green focus. Any taxonomy should contain a life-cycle approach to a particular investment: what is its overall contribution to carbon mitigation when placed within an ecosystem with related activities? The EU taxonomy says, for example, that electric vehicles' emissions reductions should be judged only after including whether it receives "charging from low-carbon electricity sources, not adding to congested traffic conditions and whether, at the end-of-life stage, the battery is reused or recycled in an environmentally sustainable way".[37]

There is a direct connection between this recommendation and the broader problem of investment finance that has been discussed above. A taxonomy that includes ecosystem and circular effects would open up avenues of investment even for conglomerates or companies that are transitioning away from carbon-intensive modes of production. Although ESG financing has grown more popular, transition finance is nevertheless frowned upon by many green investors. A properly defined taxonomy will help address that problem.

Two other modifications will need to be made to the financial system in order to deepen the ESG market in India: **disclosure and monitoring**. Disclosure, in particular, can be built into the existing financial reporting system. So far the Indian financial regulators have been somewhat unwilling to consider climate-related disclosure questions. This may be because they are concerned in particular that climate risk in existing lending would cause a further loss of confidence in state-run banks. There is a via media to be found here, however, in that setting out clear norms for disclosure of ESG-related financing – as determined by the taxonomy – might not set off alarm bells among regulators concerned about the stability of legacy lending. Monitoring, meanwhile – in the green bonds market for example – is usually left to the issuer.

This has led to concerns about "greenwashing" worldwide. The history of carbon offsets in India shows that a lack of monitoring capacity is capable of destroying the growth of even promising financial assets. Offsets never really recovered from the "Coldplay forest" scandal, involving the rock band, in 2006.[38] Solving the monitoring problem will not be easy; it is a serious collective action problem that might require the creation of a new institution.

Recent successes in climate finance have demonstrated, indeed, that **institutional backing – with an implicit sovereign guarantee** – is extremely helpful. The Climate Policy Initiative argued in 2020 that "PSUs play an important role in mobilising and increasing green capital flows... the creation of dedicated PSUs has been a catalyst." Energy Efficiency Services Limited, for example, has traditionally focused on smart meters, LED lighting, and power grid efficiency. It is easy to see how a similar public sector unit that focuses on lending for industrial process transition could play a similar role in easing financial constraints.

Each of the recommendations in Part III is designed to respond to the specific problem about financial scarcity and debt-related risk outlined in Part I. It bears repeating that policy design in today's India – and indeed in any developing economy affected by capital scarcity in the post-pandemic era – cannot be structured around incentives, subsidies, or regulatory constraints alone. Without finance, all other recommendations in this report will fail. Creating structures that allow the finance to flow, therefore, will be essential for an industrial green transition.

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3

INCENTIVISING THE GREEN INDUSTRIAL TRANSITION

3.1

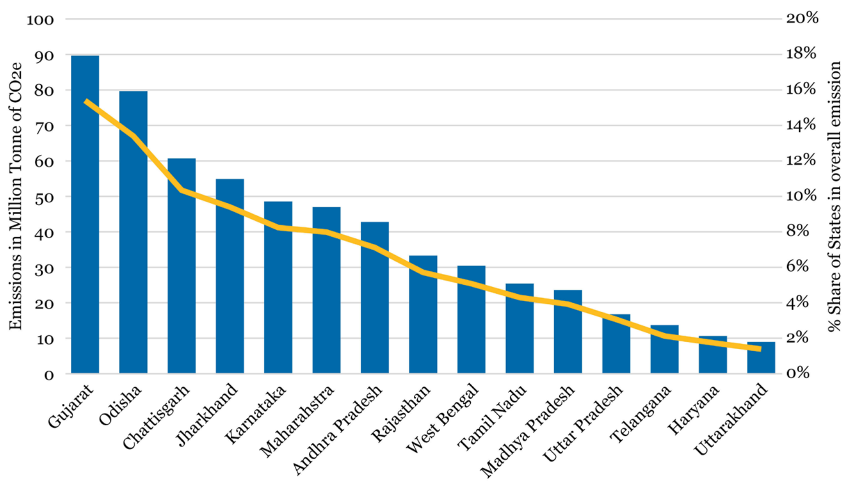
The Role of State Industrial Policies

Manan Thakkar and
Aakriti Rana

Introduction

India's national industrial policy was last updated in 1991, and every five years, it is supplemented by specific policies issued by individual states. In addition to national measures towards sustainable growth, a number of states have explicitly included policies to support industries in reducing air and water pollution, using clean energy, and setting up green industrial parks. This chapter examines the industrial policies of 14 states, with a view to evaluating their success in greening India's industrial sector. These are Gujarat, Odisha, Chattisgarh, Jharkhand, Karnataka, Maharashtra, Andhra Pradesh, Rajasthan, West Bengal, Tamil Nadu, Madhya Pradesh, Uttar Pradesh, Telangana, Haryana and Uttarakhand, which together account for more than 90 percent of India's industrial emissions.[1]

Figure 1. Emmissions from top 15 states,2013



Source: CEEW analysis, 2017[2]

The chapter evaluates six elements of a "green focused" policy: wastewater treatment systems, water and energy conservation, renewable energy, pollution control, and arranging for common facilities at industrial clusters to ensure sustainable development.[a]

a A table comparing the policy measures for each of the six elements is provided in the Annexure.

1. Wastewater management systems

Till the 1990s, only one Central Effluent Treatment Plant (CETP) was in operation in the whole of India: at Jeedimetla, Hyderabad. By 2016, the total number had increased to 193 according to the Central Pollution Control Board (CPCB). In spite of numerous efforts from the government, however, extensive regulations need to be put in place to manage the discharge of effluents into water bodies. In 2017, 70 percent of sewage went untreated in India. The National Green Tribunal (NGT) ordered the Ministry of Environment and Forests (MoEF) in April 2020 to issue stricter norms for effluent discharge from sewage treatment plants.[3] In addition, thermal power plants (TPP) which should use recycled or treated water for better utilisation, use fresh-untreated water.

In order to prevent effluent discharge into water bodies, many Indian states provide financial incentives to industrial units for setting up waste treatment plants. Evidence suggests that these are useful only when supplemented by strict regulations and monitoring. For example, Madhya Pradesh's industrial policy of 2014 has clearly specified financial support for setting up effluent treatment plants (ETPs) as well as strict monitoring—this has led to excellent results. Haryana, in contrast, has provided numerous subsidies on every step to proliferate zero liquid discharge units, but in 2019, the Haryana State Pollution?Control Board (HSPCB) found that nine of the CETPs set up in the state's industrial areas were violating safety standards.[4]

To be sure, however, industrial policies alone do not provide a complete picture. For instance, despite lack of direction in promoting green technologies in the Jharkhand industrial policy, Jamshedpur became the country's first "zero liquid discharge" (ZLD) city following the completion of the Bara project. Similarly, Telangana has been witnessing an upsurge in the building of liquid waste treatment plants despite a lack of fiscal incentives.

2. Water and Energy Conservation Methods

Using energy and water efficiently is essential for India's industrial sector. According to the Economic Survey, by 2050, India will be a global hotspot for water insecurity, and the industrial use of water must be regulated strictly to minimise waste. India has already made strides in energy efficiency and has put essential focus on its climate commitments.[5]

A lot of India's efforts to promote energy efficiency are implemented at the level of the central government. Of the 14 states studied in this chapter, nine of them (West Bengal, Madhya Pradesh, Telangana, Andhra Pradesh, Jharkhand, Chattisgarh, Haryana, Tamil Nadu and Uttar Pradesh) do not have announced policies for energy or water conservation.

The central government has made energy audits mandatory for industries that are notified as designated consumers of energy under the Energy Conservation (EC) Act 2001[b] to help in identifying opportunities for increasing efficiency. Similarly, the General Guidelines for Water Audit & Water Conservation were announced in 2017 by the central government.[c] Most state governments, therefore, support industries by defraying the cost of the audit.

While the Jal Shakti Ministry ranks Indian states based on water efficiency, there is no analysis of outcomes in the industrial sector. Delhi has been ranked worst for water efficiency in India while Gujarat has topped the list.[d] Rajasthan has taken great leaps in water conservation, and now ranks third in water efficiency. Rajasthan has set up SCADA (supervisory control and data acquisition), a computer system for gathering and analysing real-time data, which has enabled the state to improve water efficiency. To make villages of Rajasthan self-reliant in water, the state government launched Mukhyamantri Jal Swavalamban Abhiyan (MJSA) in January 2016. MJSA led to an average rise of 4.66 feet in water table in 21 non-desert districts of Rajasthan. The Rajiv Gandhi Jal Sanchay Yojana (RGJSY), launched in all 33 districts of the State in 2019, had identified 1.80 lakh works to be executed in its first phase for creating a robust water harvesting infrastructure in over 3,900 villages.[6] As a result, Rajasthan was awarded for water conservation and efficient use of practices by the National Water Mission of GoI under Category Two of the awards—or the Promotion of citizen and state action for water conservation, augmentation and preservation.[7]

b Aluminium, Cement, Chlor-Alkali, Fertilizer, Iron & Steel, Paper & Pulp, Railways, Thermal Power and Textile

c "Draft General guidlines for water audit and water conservation", Ministry of water conservation, RD&GR

d Jal Shakti ranking 2019: The survey was based on various parameters on efficiency targets and the study included the review of central as well as the state government water departments by the Union Ministry of Jal Shakti.

3. Renewable/Green Energy Sources

Production of renewable energy in India has experienced massive growth in recent years, with installed capacity more than doubling as compared to the level in 2012. While on a national level, subsidies for production of renewable energy have produced positive outcomes, it is essential to analyse the performance of individual states in transitioning to green energy.

Except for Chhatisgarh and Madhya Pradesh, all states in the sample include renewable energy promotion in their industrial policies. Most states provide fiscal incentives for this purpose, in the form of subsidies, reduced cost of capital, or direct investment. Incentives are provided to both SMEs and large industrial units.

As of March 2017, the following 10 states had a total RE installed capacity of 51,088 MW, which was about 89 percent of the total 57,260 MW Renewable Energy capacity of India. Karnataka produces the highest capacity of solar power at 7,100MW followed by Telangana, Rajasthan, Andhra Pradesh and Gujarat at 2,654MW as of May 2020. Rajasthan has been fast promoting assistance for the use of green energy. Unfortunately, however, in line with other industrial policies, data specific to industrial units is not available. This makes assessment difficult.

Table 1.

RE Installed Capacity in MW	
State	**Installed Capacity**
Tamil Nadu	10,625
Maharashtra	7,648
Karnataka	7,458
Gujarat	6,672
Rajasthan	6,238
Andhra Pradesh	6,164
Madhya Pradesh	3,538
Telangana	1,546
Punjab	1,153
Assam	46

Source: Niti Aayog Data[8]

4. Pollution Control Policies

As per the Water Act 1974 and Air Act 1981, for "any industry, operation or process or an extension and addition thereto, which is likely to discharge sewerage or trade effluent into the environment or likely to emit any air pollution into the atmosphere", it is mandatory to obtain Consent to Establish and Consent to Operate from the State Pollution Control Boards before beginning construction and production activities, respectively.[9]

Moreover, some states have provisions for green energy certificates that the Bureau of Energy Efficiency issues to relevant industrial units. This reduces the compliance and regulatory requirements for the unit to operate.

The guidelines for Continuous Emission Monitoring System (CEMS) mandates high-polluting industries to install 24x7 real-time monitoring of emission and effluent discharge points. Continuous monitoring helps pollution control boards as well as the industry to keep pollution levels in check on a real-time basis. In February 2014, CPCB asked 17 categories of highly polluting industries—such as distilleries, tanneries, oil refineries, sugar mills and cement plants—to install CEMS. As of 2019, 4,251 industries across the country have installed the system.[10] CEMS can provide the state pollution control boards with real-time data and allow them to target their inspections better.[11] Even after these CEMS are installed, however, the biggest challenges are poor data quality and substandard equipment. Since the installation of such monitoring systems does not add to the profits of the industry, they generally use the cheapest available, with highly infrequent maintenance.

Except for West Bengal, Karnataka, Telangana, Tamil Nadu, and Uttar Pradesh, all states in the sample have announced policies for pollution control. While Chhatisgarh and Gujarat provide support to the MSME sector, all other states are focused on large industrial units.

Most states provide a mix of financial support to access green technology and certification schemes to manage pollution. The Government of Haryana is one of the few state governments whose industrial policies talk about Electric Vehicles (EVs) as an alternative to transportation in industrial estates and provide the required infrastructure for it. The National Electric Mobility Mission Plan (NEMMP 2020) is working towards incentivising demand-side acquisition of electric or hybrid vehicles as well as promoting R&D in the domain. Many other states and union territories—namely, Delhi, Andhra Pradesh, Tamil Nadu, Uttar Pradesh and Telangana—have specified EV policies that provide for subsidies for firms that produce EVs, acquiring electric government buses, providing charging infrastructures and other tax benefits. To support these state policies, the Faster Adoption and Manufacturing of Electric Vehicles (FAME) Scheme was launched in 2015 by the central government to incentivise the faster adoption and manufacturing of hybrid and electric vehicles in the country.

Unfortunately, the data for changes in the level of pollution over the policy implementation period is unavailable. Only 15 states in India have PM 2.5 (Particulate Matter 2.5) monitoring systems, and even states which incorporate pollution control mechanisms in their policies have not put in place the requisite monitoring equipment. Surprisingly, West Bengal, which has weak pollution control policies has a monitoring system in place which outshines the rest of the country.

5. Sustainable Industrial Parks/Clusters

An eco-industrial park promotes waste reduction, efficient use of resources, and aids business cooperation, to manage the pollution caused by their manufacturing activities. Many state industrial policies have provisions for central infrastructure like CETPs to ensure sustainable management of waste and effluents. Some of the state policies analysed in the succeeding section are trying to ensure environmentally sustainable industrial development through the creation of industrial parks, with infrastructure support for the management of pollution and waste. Except for West Bengal, Odisha, Rajasthan and Maharashtra, all states in the sample support the creation of sustainable industrial parks.

Telangana's green industrial zoning policies have been minimal but highly effective due to quality parameters put in place under the Site Master Plan. The application of the quality parameters helped the park in Jadcherla to qualify for a silver rating and A-GRIP to qualify for a gold rating as per the German Sustainable Building Council rating system.[12]

In Gujarat, implemented actions in Naroda, Sachin and Vapi were not entirely aimed at environmental benefits in the beginning but more for economic performance. Over the years, these practices have grown from micro- to macro-level applications and have provided numerous benefits, particularly in waste management. The Gujarat Pollution Control Board (GPCB) has been highly effective in monitoring pollution and imposing penalties on violators.[13]

Conclusion

State governments are taking steps towards encouraging green industries and better treatment of toxic waste for more sustainable and equitable development. From the 14 states evaluated in this analysis, it can be gleaned that governments are encouraging greener development through financial incentives as well as providing better infrastructure in certain industrial clusters for better management of waste.

Overall, the states of Gujarat and Telangana appear to be the most focused on sustainable industry, while West Bengal has a relatively small number of policies in this direction. Unfortunately, lack of sufficient publicly available data allows for only a restricted examination of the existing scenario.

This analysis offers the following recommendations for strengthening Indian states' green industrial policies.

1. Increased investment in technology: India's research and development budget amounts to only 0.7 percent of GDP. Given green-technology innovations, and the resulting improvements in energy efficiency, it is essential to invest in research in this sector. Financial incentives and punitive measures will be insufficient to ensure that India is able to meet its development needs for industrial products alongside meeting the country's climate goals.

2. Greater transparency in policy formulation and budgetary allocations: There is a lack of transparency at each stage of the policy process. First, budgets should be allocated clearly for each policy, with clear implementation targets. Second, monitoring and evaluation systems need to be improved, to ensure that companies are complying with regulations. There is urgent need for periodic collection and publication of monitoring data for efficient planning and implementation of initiatives for greening of industries.

3. Impact evaluation of policies: Finally, the impact of policies on companies' decisions and, consequently, on the environment should be assessed, to comprehend the effectiveness of different mechanisms. With limited data, the relative efficacy of incentives, punitive measures and monitoring mechanisms, remains unclear. In order to make any progress towards greener industry, it is important to understand how existing policies are being implemented, what the key bottlenecks and success stories are, and the impacts of these policies.

Annexe

Table 1: Policy instruments to support setting up of wastewater management systems

State	Sector focus	Year of policy implementation	Project	Policy Type	Limit (max) / Budget allocated
Haryana	MSME	2020	ETPs	Tech upgradation + Subsidy* - 50%	Cap of INR 25 Lakh per project
	MSME	2020	ZLD$^{\gamma}$	Subsidy* - 25%	HSVP + GOI
	MSME	2020	ZLD$^{\gamma}$	Subsidy - 50% on each: 1. Technology acquisition 2. Patent 3. Testing equipment	Cap of: Tech - INR 25 lakh Patent - INR 25 lakh Testing - INR 10 lakh
	MSME	2020	ZLD$^{\gamma}$	Interest subsidy - 5% (CLSS)	Cap of INR 10 lakhs per year
Madhya Pradesh	MSME	2014 (amended in Dec'2018)	ETPs	Subsidy* - 50%	Cap of INR 2.5 Lakh per project
	Industrial areas/parks	2014-2019	ETPs, STPs, ZLD etc	PPP	Not specified
Orissa	MSME	2015	ZLD	Subsidy* - 20%	Cap of INR 20 Lakh per project
Gujarat	Industrial area	2020-25	CETPs	Subsidy* - 40%	INR 50 crores + total support limit of 75% of total fixed capital investment
	Industrial area	2015-2020	CETPs	Financial assistance	Not specified
Andhra Pradesh	Industrial area	2015-2020	ETPs, STPs, ZLD etc	Subsidy* - 25%	Cap of INR 50 Lakh per project
Maharashtra	Industrial area	2018-2023	ETPs, STPs, ZLD etc	Financial assistance	Critical Industrial Infrastructure Fund (CIIF) of INR 1,000 crore

State	Sector focus	Year of policy implementation	Project	Policy Type	Limit (max) / Budget allocated
Karnataka	Industrial area	2020-2025	STPs	Subsidy - 50%	Cap of INR 1 crore per project
	Industrial area	2020-2025	CETPs	Subsidy - 50%	Cap of INR 500 Lakh per project
	Large enterprises	2020-2025	ETPs	Subsidy* - 50%	Cap of INR 250 Lakh per project
	MSME	2020-2025	ETPs	Subsidy* - 50%	Cap of INR 50 Lakh per project
	MSME	2020-2025	ZLD	Subsidy* - 50%	Cap of INR 7.5 Lakh per project
Jharkhand	Industrial area	2016	CETPs	Financial assistance	Not specified
Uttar Pradesh	Industrial area	2017-2022		Financial assistance	Not specified
Telangana	Industrial area	2014	CETPs	PPP	Not specified
Rajasthan	Industrial area	2019-2024	CETPs + ETPs and ZLD networks	Financial assistance	Not specified
	Industrial area	2019-2024	Reuse and Recycling of Industrial Waste Plant	Subsidy - 50% (to suppliers of plant)	Cap of INR 50 lakh - one time assistance
	Industrial area	2019-2024	ZLDᵞ	Subsidy - 50% on investment	Cap of INR 5 lakh - one time assistance
		2019-2024	ZLD	Capital subsidy - 20% (suppliers for the plant)	Cap of INR 50 lakhs (On an investment of INR 25 crore in Biotechnology Sector)

* Subsidy provided on the total fixed capital investment of green measure projects

(γ) Zero liquid discharge project under GOIs Zero defect or Zero effect (ZED) scheme

ETPs: Effluent treatment process plant

STPs: Secondary (sewage) treatment plants

ZLDs: Zero liquid waste discharge units

CETPs: Common Effluent treatment plants

PPP: public private partnership

States with no policies (last 2 policy cycles) for wastewater management are: West Bengal, Tamil Nadu and Chattisgarh.

Table 3: Renewable Energy

State	Sector focus	Year of policy implementation	Project	Policy Type	Budget allocated/ Requirements
Andhra Pradesh	Large enterprises	2015-2020	Solar, wind and bio-energy	Subsidy - 25%	Cap of 50 crore
	Industrial units	2015-2020	Solar, wind and bio-energy	Zero rated category schedule of the VAT Act	Recycling waste into environment friendly products/energy
Gujarat	Vehicles	2014-2019	Bio-mass based power	Preferential tariff	Preferential tariff of Rs.5.04-5.27/ kWh on projects
	MSME	2014-2019	Solar Energy	Subsidy	Increase in the price for purchase of surplus solar power from INR 1.75/unit to INR 2.25/unit.
	Industrial units	2014-2019	Solar Energy	Interest subsidy	7% of term loan - maximum amount of Rs. 35 lakhs pa for 7 years for Category I Talukas 6% of term loan - maximum amount of Rs. 30 lakhs pa for 6 years for Category II Talukas 5% of term loan - maximum amount of Rs. 25 lakhs pa for 5 years for Category III Talukas
	Industrial units	2014-2019	Solar Energy	Creating gandhinagar a Solar city	Capacity to harness 3500 MW of wind power, 900 MW of Bio-mass power and 10,000 MW of Solar Power
Maharashtra	Industrial units	2013-2019	Green Energy and Bio-fuel Production	Thrust sector	Not specified
	Industrial units	2013-2019	Unconventional energy Captive Power Plants	Green Industrialization Assistance	Not specified
	Industrial units	2013-2019	Green Energy and Bio-fuel Production	Financial incentives - 20%	2 year additional eligibility period shall be applicable
	MSME	2013-2019	Green Energy and Bio-fuel Production	Encourage investment	Not specified

State	Sector focus	Year of policy implementation	Project	Policy Type	Budget allocated/ Requirements
Rajasthan	Industrial units	2019-2024	Solar & wind energy	Investment subsidy - 25%	State tax due and deposited for 7 years: on investment of INR 10 cr or more
	Industrial units	2019-2024	Solar & wind energy	Employment Generation Subsidy - 25%	Employment Generation Subsidy, subject to upper limit of 75% for 7 years
	Industrial units	2019-2024	Solar & wind energy	Interest Subsidy - 5%	5% Interest Subsidy on term loan taken for a period of 5 years Cap of INR 25 Lakh p.a.
	Industrial units	2019-2024	Solar & wind energy	Exempted from charges	Exemption from Electricity Duty for additional 3 years
	Industrial units	2019-2024	Solar & wind energy	Capital subsidy - 20%	Cap of INR 50 Lakh
	Industrial units	2019-2024	Solar energy	Exempted from charges	Rebate in transmission charges: manufacturing of Photovoltaic cells and battery modules
Tamil Nadu	Industrial units	2014-2019	Solar and Wind energy	Encourage investment	Set a target of 3000 MW of Solar power by 2015
Odisha	Industrial units	2015-2020	Unconventional energy Captive Power Plants	Exempted from charges	Exempted from electricity duty 100% for the period of 5 years from the day of commissioning
Haryana	Industrial units	2015-2020	Unconventional energy Captive Power Plants	Exempted from charges	100% reimbursement for Transmission and Wheeling charges 100% exemption from banking charges
Karnataka	Large enterprises	2014-2019	Unconventional energy Captive Power Plants	Reimbursement of equipment cost	50% of the amount paid for the renewable energy plants
	Large enterprises	2014-2019	Solar, wind and bio-energy	Subsidy - Rs. 0.50 per unit	Subsidy to general category entrepreneur
West Bengal	Industrial units	2013-2018	Solar, wind and bio-energy	Encourage investment	Set a target of setting up 2706 MW capacity
Uttar Pradesh	Industrial units	2017-2022	Unconventional energy Captive Power Plants	Encourage investment	Promote: 1. Micro-hydro electric power generation 2. Grid based power projects 3. solar power plants 4. power generation sectors like biogas, biomass and garbage
Telangana	Industrial units	2014-2019	Solar, wind and bio-energy	Encourage investment	Demand and supply of non-conventional energy, especially solar power.
Jharkhand	MSME	2016	Comprehensive Project Investment Subsidy	Subsidy - 20%	Eco-friendly power generation equipment

Table 4: Pollution Control

State	Sector focus	Year of policy implementation	Project	Policy Type	Budget allocated/ Requirements
Chattisgarh	MSME	2016-2021	Certification	Reimburse 50% of cost of certification	Cap of INR 5 lakh
	MSME	2016-2021	Carbon credits	subsidy - 50%	Cap of INR 25 lakh Environment Management Project Subsidy
	MSME	2016-2021	Environment friendly development	CTO	Increased to 15 years for green category
Gujarat	MSME	2014-2019	Environment friendly development	Non- polluting units incentives	Not specified
Madhya Pradesh	MSME	2014-2019	Certification	Non- polluting units incentives	Exempted from certification by state PCB
	MSME	2014-2019	Certification	Polluting units penalty	Re-issue every 3 years
	Industrial units	2014-2019	Green technology	Reimburse 15% of total capital expenditure	Cap of INR 15 crores
	Electric vehicles	2014-2019	Green technology	Thrust sector	EV & Related Infrastructure Policy 2018
Rajasthan	Large enterprises	2019-2024	Green building measures	Subsidy - 50% to supplier of STPs	Green Building Measures for minimum floor space of 2000 sq mtrs
	Industrial units	2019-2024	Green technology	Assistance	Not specified
	Electric vehicles	2019-2024	Green technology	Financial assistance	Not specified
	Electric vehicles	2019-2024	Green technology	Interest Subsidy - 5%	On term loan taken by the Electric Vehicle manufacturing Unit (Investment INR 50 crores or more)
	Electric vehicles	2019-2024	Green technology	Capital Subsidy - 25%	Cap of INR 50 lakh.
	Industrial units	2019-2024	Certification	Reimburse 15% of expenditure	Cap of INR 5 lakhs

State	Sector focus	Year of policy implementation	Project	Policy Type	Budget allocated/ Requirements
Andhra Pradesh	Large enterprises	2015-2020	Green building measures	Subsidy - 25%	Cap of INR 50 crores on green rating: - IGBC/LEED Certification - GRIHA system
	Large enterprises	2015-2020	Green building measures	Subsidy - 25%	Cap of INR 50 crores on projects approved by Empowered Committee of Secretaries
	Large enterprises	2015-2020	Clean production Methods	Capital Subsidy - 35%	Cap of INR 35 lakh (to be certified by APPCB)
Jharkhand	MSME	2016	Comprehensive Project Investment Subsidy	Subsidy - 20%	On pollution control
	Industrial units	2016	Environment friendly development	No CTO and CTE approval	Green industries with investment less than INR 50 lakh
	Industrial units	2016	Certification	Reimburse 50% of expenditure	Cap of INR 5 lakh ► Green Energy Certificate ► Bureau of Energy Efficiency (BEE) Certifacate ► ISO-14000 Environmental Management System ► LEED Certification in New and renewable Energy ► Internationally accredited eco-labels OKE-TEX 100 etc.
Haryana	Industrial units	2015-2020	Environment friendly development	Exempted from consent management	Not specified
	Electrical vehicles	2015-2020	Environment friendly development	Green transport media	Connectivity of all the Industrial Estates to the nearby urban centers through public transport
	Electrical vehicles	2020-2025	Environment friendly Development	EV charging infrastructure	Not specified

State	Sector focus	Year of policy implementation	Project	Policy Type	Budget allocated/ Requirements
Maharashtra	Industrial units		Environment friendly development	Walk to work concept	Satellite offices shall be developed, accommodation facilities for employees within 5 km radius of the work area.
	Industrial units		Environment friendly development		Non-polluting industry will be allowed such as service sector in residential area
	Industrial units		Certification		Procedural simplification in environmental clearance

CTO: Consent to operate

CTE: Consent to establish

Certification: ISO categories, BIS certification, Bureau of Energy Efficiency (BEE) certification, LEBP certification in the field of new and renewable energy, AGMARK, Euro Standard or other equal national/international certification

Table 5: Industrial Zoning and Common Facilities in Industrial Parks

State	Year of policy implementation	Project	Policy Type	Description
Andhra Pradesh	2020-2023	Industrial Zoning	Environmental Impact Assessment (EIA)	Industrial land environmentally zoned as per the EMP. APIIC will conduct an EIA before allotment
	2020-2023	Industrial Zoning	Environmentally sustainable industrial development	Common facilities set up in APIIC industrial parks
	2020-2023	Industrial Zoning	Green Category MSME approval	Conditional on formalizing all approvals within three years
	2020-2023	MSME Parks	PPP model	

State	Year of policy implementation	Project	Policy Type	Description
Gujarat	2014-2019	Industrial Zoning	Environmentally sustainable industrial development	Zoning on the basis of environmental aspects, existing and proposed infrastructure including environment
	2014-2019	Industrial Zoning	Monitoring for Compliance	Support to GPCB for third party audit
	2014-2019	Green Industrial Estate	Financial Assistance	Common infrastructure and waste management projects to shift polluting industries to industrial zones
	2014-2019	Industrial Parks	Financial Assistance	1. Financial assistance to private promoters subject to preparation of Comprehensive Development Plan for 5 years by cluster group 2. Pecuniary assistance for nodal groups or hiring of experts 3. Clusters eligible for financial assistance as under the Scheme of Critical Infrastructure
	2014-2019	Industrial Parks	Financial Assistance	Financial assistance for: 1. Common infrastructure b. Strengthening Environmental Compliance c. Development of Green Industrial Estate d. Shifting of chemical based units from residential to industrial zones
Haryana	2015-2020	Global City project	Greenfield Smart City	Area of 1000 acres at Gurgaon through a Joint Venture Company of HSIIDC and the DMICDC.
	2015-2020	Industrial Parks	Monitoring for Compliance	Shifting/closing the red and orange category units to industrial parks
Chhattisgarh	2014-2019	Industrial Parks	Environmentally sustainable industrial development	Common facilities will be set up in each Development Blocks.
	2019-2024	Industrial Parks	PPP model with financial incentives	Financial incentives to Private sector for Common Facility Centers in PPP model

State	Year of policy implementation	Project	Policy Type	Description
Jharkhand	2016	Green Industrial Estate (Promoting green technology)	Financial assistance	Need based financial assistance
Karnataka	2020-2025	Product specific industrial park	Environmentally sustainable industrial development	District of Kalaburagi to develop Solar panels, inverters etc.
	2020-2025	Industrial Parks	Environmentally sustainable industrial development	KIADB (Karnataka industrial area development board) ensure common facilities
Madhya Pradesh		Industrial Parks	Environmentally sustainable industrial development	1. Shifting polluting units to industrial parks 2. Encourage common facilities in all industrial parks
Tamil Nadu	2014-2019	Industrial Parks	Environmentally sustainable industrial development	1. Promote new industrial parks through SIPCOT, TIDCO, SIDCO or through private sector 2. Provide incentives for setting up of common facilities
Telangana	2014-2019	Industrial Parks	Environmentally sustainable industrial development	Common infrastructure by raising market loans with the government guarantee
	2014-2019	Industrial Parks	Environmentally sustainable industrial development	Earmark land in private industrial parks for setting up of common utility centers
Uttar Pradesh	2017-2022	Industrial Parks	Environmentally sustainable industrial development	NIMZ in Jhansi and Auraiya will be provided facilities as mentioned in National Manufacturing Policy of Government of India
	2017-2022	Industrial zoning	Environmentally sustainable industrial development	Develop Lucknow-Kanpur, Kanpur-Allahabad and Varanasi-Allahabad zones

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3.2

The Role of Corporate Ambition

Akarsh Bhutani

Introduction

In light of the unprecedented environmental challenges in recent years, climate change adaptations have become critical to improving resource efficiency, reducing greenhouse gas emissions, and conserving biodiversity. During the Climate Action Summit in 2019, the United Nations Global Compact announced "Business Ambition for 1.5°C" as an urgent call to encourage companies and business leaders around the world to set ambitious science-based targets aimed at limiting the worst impacts of climate change.[1] The UN further highlighted that as the benefits of science-based climate action become increasingly prevalent, leading companies committed to such targets will thrive when the world undergoes a transition to a net-zero future by 2050.

The Global View

As COVID-19 spread rapidly across the world in 2020, climate change advocates anticipated a decline in the momentum among businesses in reducing carbon emissions. However, the vulnerability of the global economy and societies exposed by the pandemic instead urged the community to pledge to net-zero emission targets, with the number of companies committing to eliminate greenhouse gases tripling to 1,500. Corporate giants such as Amazon, Apple and Microsoft, too, have stepped up their corporate commitments to decarbonise their businesses within the next 10-20 years.[2]

At the same time, investors have increased their pressure on businesses, as the stakes are high in the transition to a net-zero emissions economy. Some investors, eager to capitalise on opportunities in climate initiatives, are adopting their own ambitious net-zero goals for the businesses. For instance, Climate Action 100+, an investor-led initiative, was established to focus on companies responsible for the majority of GHG emissions across the world. This initiative provides investors with a platform to engage with the focus companies (currently 167) and seek commitments on implementing strong governance frameworks on climate change, reducing GHG emissions across the value chain, and providing enhanced corporate disclosure.[3] In January 2020, BlackRock became the latest member of CA100+.[4] As the largest and one of the most influential asset managers in the world, BlackRock's participation in CA100+ is expected to further urge and ensure that companies take urgent and necessary actions in response to the climate crisis.[5]

Europe, in particular, has witnessed a significant rise in demand for sustainable investments, resulting in the addition of Environmental, Social, and Governance (ESG) criteria to the investment strategies of almost 253 European funds. By end-2020, assets with an ESG tilt in the European market amounted to €1.1 trillion. The growth in sustainable investments in Europe for the fourth quarter of 2020 was significantly higher than in the US, accounting for 80 percent of the global ESG fund inflows compared to only 13.4 percent in the US.[6]

Indian Businesses

Businesses are expected to play a pivotal role in addressing sustainability challenges in India. Reporting and disclosures on ESG matters have allowed stakeholders such as investors and regulators to comprehend how companies are contributing and adapting to the evolving challenges and opportunities of sustainability.[7] In November 2020, 24 private companies, including the likes of Tata, Reliance, Mahindra, ITD, ACC, Adani and Dalmia Cement, signed a declaration on climate change by voluntarily pledging to move towards "carbon neutrality."[8] While India is yet to commit to a net-zero emission target as a national goal, the move towards carbon neutrality by private companies is testimony to the commitment of private players. Nine mitigation measures have been listed by the companies collectively–including the promotion of renewable energy, green mobility, and enhanced energy efficiency–to move towards carbon neutrality.

Having met its previous targets and on-track to achieving the targets under the Paris Agreement, India has proved its intent to fulfil national commitments made to the international community. Similarly, Indian businesses have reaffirmed their commitment to combat climate change by setting bold emission-reduction targets and promoting renewable energy. According to the Carbon Disclosure Project (CDP) Report (2019), India was ranked fifth amongst countries with corporate commitments to science-based targets, after the US, Japan, UK and France.[9] The CDP, launched by the Global Reporting Initiative (GRI), is aimed at measuring the carbon-reduction activities undertaken by companies across the globe. From India, 58 companies shared their environment-related activities, and the report found that 98 percent of the top companies examined have either a committee or a board overlooking climate issues. A chief reason for increasing the number of committees dedicated to climate risk is the increased climate activism amongst corporates combined with the growing band of climate-conscious investors.[10]

The 2019 CDP Report further noted that India has become the first developing economy with the maximum number of companies committed to science-based targets–going from 25 companies in 2018[11] to 52 companies by December 2020.[12] The majority of these companies belong to the automobile, construction materials, and chemicals sector.

The Indian Regulatory Landscape

Given the ever-increasing challenges related to climate change, environmental risks and growing socioeconomic inequalities, the Securities and Exchange Board of India (SEBI) in August 2020 proposed to replace the Business Responsibility Report (BRR) with a Business Responsibility and Sustainability Report (BRSR), to boost the transition to a sustainable economy.[13] This is in line with global developments urging businesses to look beyond wealth generation and become responsible and sustainable towards the environment and society. The BRSR is intended to enable businesses to engage more meaningfully with their stakeholders, by going beyond regulatory financial compliance and reporting on their social and environmental impacts. The proposed format of the BRSR will increase transparency around key issues and allow market participants to identify and assess sustainability-related risks and opportunities.[14] Maintaining the previous reporting standards, the BRSR will be mandatory for the top 1,000 listed entities by market capitalisation.

In 2009, the Ministry of Corporate Affairs (MCA) in India published a set of Corporate Social Responsibility Voluntary Guidelines, recommending all businesses to formulate a corporate social responsibility (CSR) Policy.[15] This was followed by the announcement of the "National Voluntary Guidelines (NVGs) on Social, Environmental and Economic Responsibilities of Business in 2011. These guidelines were meant as principles to be adopted by companies as part of their business practices. Starting 2012, SEBI made ESG disclosures mandatory. The top 100 listed entities by market capitalisation were required to file the BRR as per the disclosure requirement of the NVGs.[16] In 2015, SEBI further extended the filing of BRRs to the top 500 entities by market capitalisation.

In 2017, the UN launched the Global Reporting Initiative (GRI) in India, in collaboration with BSE Ltd., Confederation of Indian Industry (CII), and Yes Bank Ltd., and became the first global standards for sustainability reporting in the country.[17] It was estimated that by using both the GRI standards and the SEBI BRR Framework, companies would be able to meet the growing demand for sustainability information and become more transparent and accountable to their shareholders. To align with domestic concerns, global developments, Sustainable Development Goals (SDGs), and United Nations Guiding Principles on Business and Human Rights (UNGPs), the NVGs were updated in 2019 as the "National Guidelines for Responsible Business Conduct" (NGRBC).[18] The same year, SEBI extended the BRR requirement as per the new guidelines to "the top 1,000 listed entities," applicable from FY2019-20.[19] Subsequently, India also became the first stock exchange from Asia to join the Sustainability Stock Exchange Initiative (SSE).

Climate Ambitions in the Business Sector

In addition to the existentialist imperative, Indian companies have several economic and regulatory incentives behind their ambitious climate action plans. One, India is amongst the top 10 countries most vulnerable to climate change, which creates substantial *climate risks and opportunities*.[20] Two, *access to finance* across the world is becoming increasingly dependent on environmental outcomes. Three, the structure of power tariffs in India creates an *economic incentive* to shift to cleaner forms of energy.

Climate Risks and Opportunities

According to the 2019 CDP Report, 57 of the 59 Indian companies surveyed have a process for assessing climate-related risks.[21] Further study of the frequency and time horizon of risk assessment highlights an interesting aspect: of the 43 companies that assess their risks annually, 29 consider risks for more than six years into the future, indicating a long-term vision. From the financial perspective, the report found that 88 percent and 92 percent of reporting companies have identified risks and opportunities, respectively, that will have a substantial impact. The cost of the impact of climate risks was estimated at INR 1,550 billion and the benefits of climate opportunities were valued at INR 2,475 billion.[22, a]

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a In 2018, a study was undertaken to compute the effects of climate change on GDP by country and the global economic gains from complying with the Paris Accord. This included a large dimensional intertemporal computable general equilibrium (CGE) trade model to account for the various effects of global warming—e.g. loss in agricultural productivity, rising sea levels, and health effects on GDP growth—and the levels for 139 countries. The study assumed that producers are forward-looking and adjust price expectations and capital shocks to account for future climate effects. The potential global economic gains were estimated to be US$ 17,489 billion per year in the long run (projected for the year 2100). This estimation included only a limited set of possible damages from global warming.

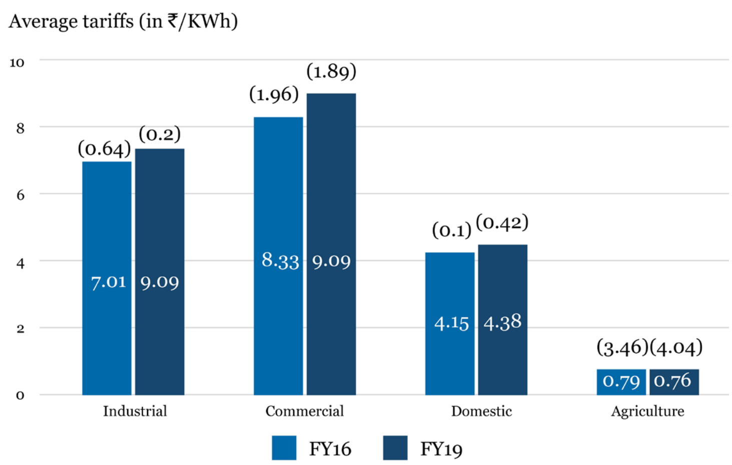
Access to Finance

Governments around the world have started to scrutinise the big companies that constitute the major contributors to GHG emissions. This, in turn, has urged companies to be more socially responsible and transparent in reporting such activities. Moreover, sustainability reporting has now gained global momentum and is used as an important communication tool by companies to disclose their sustainability plans and performance for enhancing stakeholder confidence. Investors too, are becoming increasingly interested in this framework, to use data on climate change, deforestation and water security and make informed decisions by identifying the potential risks and opportunities.[23] The 2019 CDP Report found that investors respond better to companies that disclose their environmental activities.[24] In the context of Indian companies, the report claimed, investors took into account the climate-change risk before investing in a company.

Economic Incentives

In India, the government provides heavy subsidies on electricity to domestic and agricultural consumers, resulting in commercial and industrial users being charged 52 percent and 23 percent higher than the cost of power supply at the national level. Thus, the extent of cross-subsidy amongst different users has increased the burden on industrial and commercial users. As a result, such users resort to buying power competitively through open markets or building their own captive-generation capacities as cheaper alternative sources of electricity.[25]

Figure 1: Persisting Market Distortions

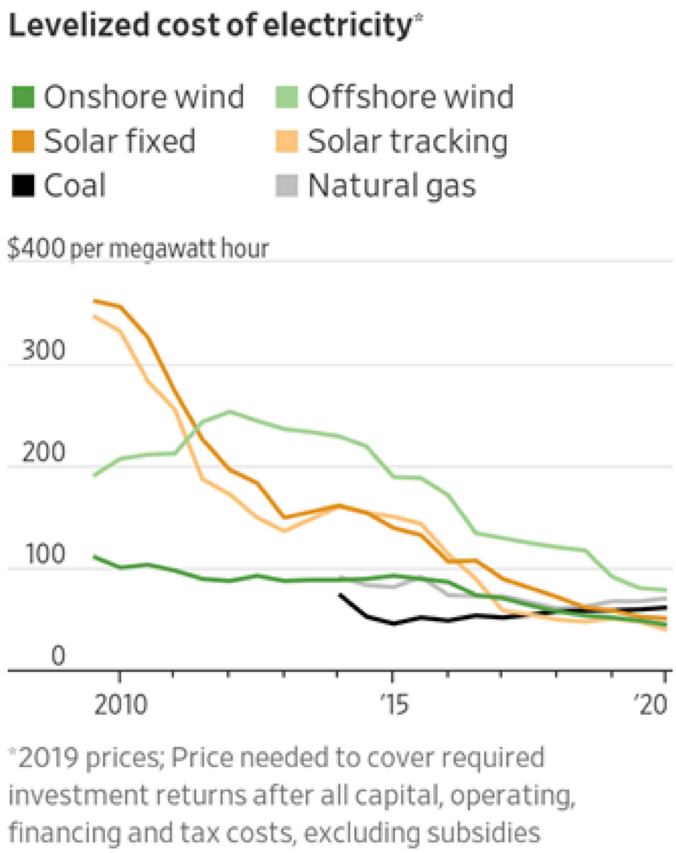


Figures in parenthesis are the cross-subsidy cost over and above National Tariff Policy 2016 threeholds borme by industrial & commercial consumers and cross-subsidy benefit above the policy threshold enjoyed by domestic & agriculture segments

Source: International Institute for Sustainable Development.

The year 2020 witnessed a significant surge in the demand for solar, wind and batteries, compared to more traditional energy options.[26] Moreover, continuous innovations in batteries and solar panels plummeted the prices to a record low. The world is currently witnessing a rapid rise in demand for renewables and a structural decline in the use of coal; however, to ensure that the peak in global oil use has passed, stronger climate action policies must be put in place.[27] A recent analysis by BloombergNEF shows that the global benchmark of levelised cost of electricity, for onshore wind and utility-scale PV, has fallen by nine percent and four percent since 2019 to US$44 and $50/MWh, respectively.[28] India's success in reducing the solar prices to as low as INR 1.99/KWh will serve as an economic incentive for the industrial and commercial consumers to switch to solar from other sources of energy.[29] As onshore wind and solar PV become cheaper and more accessible across the country, more companies will be able to identify and capitalise on the economic benefits of renewable energy.[30]

Figure 2: Levelised Cost of Electricity

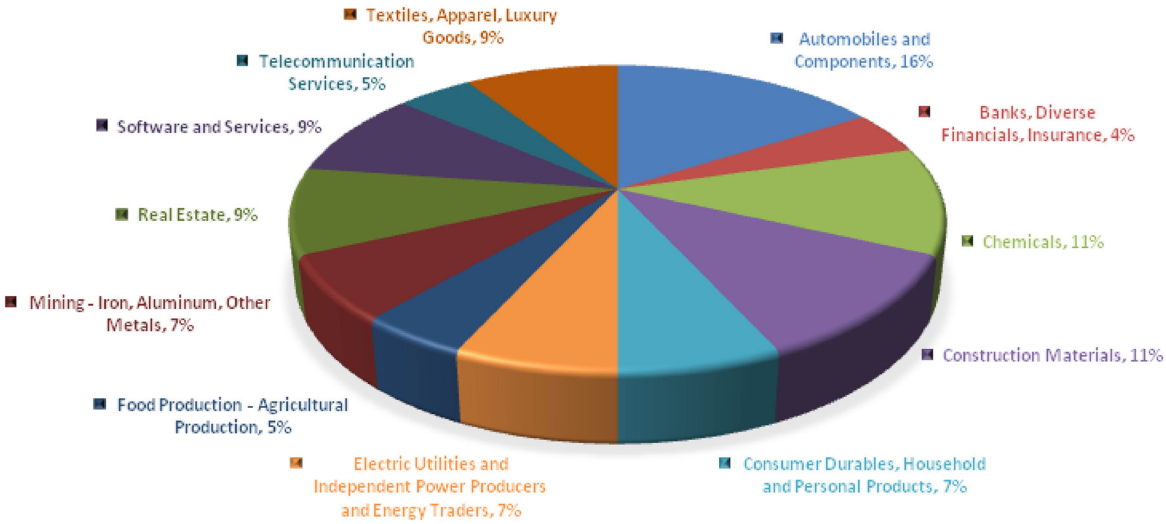


Source: BloombergNEF.

An Overview of Indian Companies' Targets

Sectoral Split of Science-based Targets

Figure 3: Sectoral Split of Science-based Targets



Source: Science-Based Targets initiative (SBTi).

Note: Sectors with only one company committed to the SBTi haven't been included in the data.

India is one of the leading countries where companies are committed to reducing emissions through the "Science-based Targets Initiative" (SBTi). As of December 2020, 52 Indian companies have committed to the SBTi. However, of these, only 13 companies have either "committed" or "set targets" to keep warming under 1.5°C. The remaining companies have only committed to the broad science-based targets and are yet to set specific targets for their business operations. To be sure, a majority of the companies that have joined the initiative belong to the "Automobile and Components" sector, followed by "Construction Materials" and "Chemicals" sector.[31]

Mahindra Electric, the electric vehicle arm of Mahindra & Mahindra, has been at the forefront in the fight against climate change. It was the first Indian automaker and second worldwide company to receive approval from SBTi.[32] The company has committed to reducing scope 1 and scope 2 GHG emissions by 35 percent per vehicle produced, from 2018 and 2033. This highlights its vision to provide clean mobility solutions and encourage other companies in the sector to join the initiative.

Since India is in its development phase, demand for cement plays a critical role in developing infrastructure for housing, power and transport. As populations continue to expand and urbanise, it is crucial for "construction material" companies to play a leading role in the action against climate change. Five of India's largest cement makers—Ultratech, Dalmia, Shree, ACC and Ambuja—have joined the SBTi and stepped up their efforts in reducing carbon emissions. Dalmia Cement has been a pioneer in this sector, committed to becoming a carbon-negative company by 2040. Moreover, Dalmia Cement was the first company globally to commit to the Climate Group's RE100 campaign (100 percent renewable energy use by 2030) and EP100 (doubling the energy productivity by 2030).[33]

Examples of Sustainability Reporting

TATA Chemicals Limited (TCL)

The first step of TCL's strategy-planning process is to understand and summarise inputs from the various stakeholders involved, to include political, economic, social, technical and environmental changes that may impact the business. This ensures that sustainability remains at the foundation of TCL's business strategy.[34]

TCL's sustainability goals are closely aligned with the UN SDGs, reflecting its ambition to become a more transparent and responsible organisation.[35] Specifically, its economic goals are in line with SDG 7, 9 and11; environmental goals with SDG 6, 12, 13, 15 and 17; and social goals with SDG 3, 4, 8, 9, 10.11, 14 and 17. To achieve its economic goals, TCL has planned for capacity expansion, with a focus on carbon reduction and building a digital ecosystem to enhance operational efficiency and productivity. The environmental goals are primarily focused on revamping energy and emissions at plant level, and conducting climate-change risk assessment and waste-mapping studies. To achieve its social goals, TCL plans to grow plantations on 500 acres of land, including a biodiversity reserve, mangroves, and wastelands.

TCL is one of the major companies in India that have committed to the science-based targets, and is playing an active role in the fight against climate change. It has a climate-change strategy in place for 2030, aimed specifically at reducing carbon emissions,[36] and plans to reduce the absolute scope 1 and 2 GHG emissions by 28 percent from 2019 to 2030.[37] These targets are consistent with the requirements for keeping warming below 2°C.

Adani Ports and Special Economic Zone Limited

Due to the growing interest from a range of stakeholders, Adani Ports has recognised the need to evaluate the societal impact of business and performance on a wider scale of ESG factors. By embedding the ESG framework in its value-creation process, the company has built a sustainability roadmap that is based on formulating appropriate policies, setting targets for minimising environmental footprint, conforming to regulatory norms, etc.[38] In line with the increasing domestic and international concerns, Adani Ports has introduced an "Environment Policy" and an "Energy and Emission Policy" to minimise environmental impacts and reiterate its commitment to the global action of sustainable energy consumption, respectively.[39] [40]

With the realisation that companies face multiple challenges (such as natural resource depletion, climate change, human rights violation) that have the potential to create a negative impact, Adani Ports aims to foster inclusive growth of society and business. Initially, the company had aligned its sustainable strategy to the UN SDGs, aiming for all its activities to support all SDGs, either directly or indirectly. However, after reviewing shareholder expectations and analysing the environmental and social impacts of their activities, they decided to set targets and align goals based on prioritisation. Adani Ports has decided to set targets on three focal areas to be achieved by 2025: Health & Safety (SDG 3); Climate Change & Energy (SDG 7 and 13); and Water and Effluents (SDG 6).[41]

Additionally, Adani Ports plays a leading role in helping India work towards the national priorities, including the Paris Agreement and India's NDCs. It has taken significant steps towards reducing its carbon footprint, and out of the targeted 35 MW renewable energy, it has already produced 9.8 MW (FY19).[42] Similarly, the company plans to improve processes and integrate technology by investing in the electrification of port infrastructure and improving process efficiencies.[43] While Adani Ports has also committed to the science-based targets, it is yet to set specific targets and is aiming to do this by FY22. Going forward, the company intends to diversify and explore the feasibility of using electric vehicles for internal cargo movement.

The MSMEs Sector

The Micro, Small and Medium Enterprises (MSMEs) sector is regarded as the backbone of the economy, contributing approximately 37 percent to GDP.[44] The sector plays a key role in exports and employment generation, contributing 45 percent of the overall exports and employing approximately 120 million people[45] across India. Since MSMEs are intertwined with the rural economy, with almost half of them operating in rural India,[46] it is important for India's economic growth to ensure that policies pay enough attention to the development of this sector. The Indian government's flagship programme "Atmanirbhar Bharat" announced a number of schemes to safeguard the sector from the economic hardships caused by the pandemic, further highlighting MSMEs as integral to supply chains and as key drivers of India's economic growth.

So far, most Indian companies active in the fight against climate change are listed organisations, i.e. the predominant contributors to emissions. However, the consequences of climate change will be borne equally. It is evident from the figures above that the Indian economy relies considerably on MSMEs. Yet, in terms of meeting climate commitments, transitioning to a low-carbon economy, and ensuring sustainable development, expectations from MSMEs are low. Limited compliance towards relevant environmental laws and the lack of a strategic roadmap to deal with transitions to a low-carbon economy makes the MSME sector highly vulnerable.[47]

The government must focus on green transition in the MSME sector, since it has the potential to create more jobs in green sectors, such as renewable energy and energy efficiency. Despite these companies recognising the business opportunities, financial and technical constraints are likely to limit their ability to invest in new interventions. In addition to the stimulus packages in response to COVID-19, the India government should take a page from countries such as Germany and South Korea, to provide a green stimulus to such companies.[48] With an increasing number of MSMEs being integrated into the global value chain, the government should encourage and promote greener processes and products to help these MSMEs become more competitive in the international markets.

Policy Suggestions

a. Leading companies can support smaller companies by looking at scope 3 emissions.

Scope 3 emissions include all indirect emissions that occur in a company's value chain.[49] Amongst the Indian companies committed to the science-based targets, only a handful are aiming to lower scope 3 emissions, while mainly focusing on scope 1 and 2 emissions. Since scope 3 emissions lie outside the company's direct control and ownership, they are hesitant in taking full responsibility for these emissions. Indeed, even when scope 3 emissions are accounted for, the responsibility might be spread across several different, resulting in ambiguity regarding the accountable party.[50]

In some cases, GHG emissions and cost-reduction opportunities lie outside business operations. By focusing on scope 3 emissions, bigger companies can play an influential role in setting targets for smaller companies to lower their emissions. This will bypass the need for government intervention and directly incentivise MSMEs that are integral to supply chains for the leading companies to lower their emissions. By addressing these indirect emissions, companies not only can prevent the worst impacts of climate change but also generate substantial economic benefits in the form of new innovations and collaborations. Companies that are part of the value chains of much larger companies should be incentivised for measuring and minimising emissions. Finally, suppliers must be assured that larger companies will continue to bring them business if they reduce their carbon footprint and design more efficient products with lower emissions intensity. This can facilitate a holistic improvement in a large company's environmental footprint, inclusive of other companies in the value chain.[51]

b. Sustainable Industrial Parks

Telangana recently announced a detailed action plan to set up a Green Industrial Park in Dandumalkapur, indicating the government's aim to not allow industrialisation to come at the cost of the environment and green cover. The focus of this industrial park is to allow the green industries under the MSME sector to flourish in the coming years[52] and promote structural change, i.e. improving environmental performance and breaking the single-minded approach of achieving economic growth even at the cost of depleting resources.[53] For developing countries such as India, these have economic, social and environmental benefits. From the government's perspective, the trade-off is between establishing new green industrial parks or implementing policies to green the existing industrial parks. For now, wherever possible, the construction of industrial parks without any focus on sustainability should not be given the green light.[54]

Similarly, the UN Industrial Development Organisation's (UNIDO) contribution to SGDs is through the facilitation of eco-industrial parks.[55] This acts as a community of businesses located on a common property, where businesses seek to achieve enhanced environmental, economic and social performance through collaboratively managing environmental and resource issues. India's Central government can follow the example set by Telangana and the UNIDO-established sustainable industrial parks across the country.

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