Green Growth and Sustainable Development in India

Towards the 2030 Development Agenda

Summary for Policymakers

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Foreword

India is a dynamic and developing economy with a diverse society. In order to have a sustainable and holistic development there is a need for balance and harmony between the economic, social and environmental needs of the country.

There is a need to strike a balance between development and environment protection. India is walking a sustainable development path and has emphasised on climate justice and poverty eradication. With collective partnership of stakeholders, mainstreaming the essence of sustainable development and environment protection is possible. India's rich heritage and positive outlook towards environment gave a new vocabulary to the understanding of environmental issues.

This report encompasses various development and growth aspects of the environment and energy aspects at the national level. The document depicts a holistic picture of the road ahead for environmental sectors as well as energy sectors. Future scenarios, development implications and green growth strategies have been discussed in the report.

The Ministry of Environment, Forest and Climate Change would continue to extend their policy support in order to boost the discourse on environmental sustainability and inclusive development that aims at bringing about a change in the quality of life of the individuals and communities.

I congratulate The Energy and Resources Institute on its sterling efforts towards bringing together such comprehensive work in collaboration with the Global Green Growth Institute. We value efforts by knowledge communities very much and we will work together to bring about policy change at various levels.

(Prakash Javadekar)

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ABOUT THE INITIATIVE
GREEN GROWTH AND DEVELOPMENT IN INDIA

Prelude

The Ministry of Environment, Forest and Climate Change recognizes 'poverty eradication along with green growth' as central to India's sustainable development narrative. This vision also embodies the cogent definition of green growth by the Thirteenth Finance Commission of India as a narrative that enables rethinking growth strategies with regard to their impact(s) on environmental sustainability and inclusiveness. The concept of green growth assumes centrality of socio-economic inclusivity to sustainable development in India.

About the Project

The project, Initiative on Green Growth and Development in India, aims to build evidence through which the Indian economy can move towards an inclusive green growth paradigm of development. The evaluation aims to combine the rigorous studies done at the national and state levels (Punjab and Himachal Pradesh).

The collaborative research project implemented by The Energy and Resources Institute with support from the Global Green Growth Institute, uses an integrated systems modelling framework that robustly identified the opportunities for green growth in terms of; efficient use of natural resources, the adoption of new technologies, the minimization of environmental impacts, and the reduction of risks associated with natural hazards and commodity scarcities. A rich mix of quantitative analysis and stakeholder engagement was used to inform interventions and policy recommendations.

The project has benefited richly from a very effective project management architecture that comprised of a national steering committee, supported by the project management committee. At the state level, the team received strategic and technical inputs from the nodal departments; Department of Science, Technology, Environment and Non-conventional Energy, Government of Punjab along with the Punjab State Council for Science & Technology is the nodal agency of the project for Punjab while the Department of Environment, Science and Technology, Government of Himachal Pradesh is the nodal agency in Himachal Pradesh.

Approach

The study uses evidence-based analytical methods for developing policy choices and green growth opportunities. The analytical insights produced are validated against case studies from field visits, extensive government-stakeholder consultation and a comprehensive policy landscape analysis of sector-wise interventions in Himachal Pradesh and Punjab. The illustration below indicates the suite of analytical tools deployed by the team.

Outcomes

In order to understand linkages between development outcomes and green interventions, two sets of models are considered. On one side, the energy supply and demand has been analysed through an energy system model TERI-MARKAL (MARKet Allocation MARKAL). On the economy side, a simulation based dynamic, recursive computable general equilibrium (CGE) model is used. The study has been able to generate, unique high resolution, actionable climate and spatial information for policy making in the two states. In addition to the model outputs (SWAT, PRECIS), the study has also looked at field based case studies for specific challenges faced by the state governments in Punjab and Himachal Pradesh.

GREEN GROWTH AND SUSTAINABLE DEVELOPMENT IN INDIA

Green Growth in Indian Context

The 2030 Sustainable Development Agenda with 17 sustainable development goals and 169 targets that were adopted in September 2015 demonstrate the scale and ambition of member states in the new universal agenda.

The Constitution of India contains specific provisions for the protection and improvement of environmental quality. Article 48-A of the Constitution says that "the state shall endeavour to protect and improve the environment and to safeguard the forests and wild life of the country." Article 51-A (g) says that "It shall be duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures." These provisions highlight the national conscience on the importance of environment protection. The National Environment Policy of the Ministry of Environment, Forests, and Climate Change highlights important principles around sustainable development such as social justice, polluter pays, and entities of incomparable value.

The National Action Plan on Climate Change (NAPCC) along with the State Action Plan on Climate Change are important milestones for mainstreaming climate in development processes at the national and state levels. NAPCC has eight national missions that outline priorities for both mitigation and adaptation to combat climate change. The current eight missions are on the areas of solar energy, energy efficiency, sustainable habitat, sustainable agriculture, Green India, water,

India's Eight-Point Intended Nationally Determined Contribution

To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.

1. To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
2. To reduce the emissions intensity of its GDP by 33–35 per cent by 2030 from 2005 level.
3. To achieve about 40 per cent cumulative electric power installed capacity from non- fossil fuel–based energy resources by 2030 with the help of transfer of technology and low cost international finance including from Green Climate Fund (GCF).
4. To create an additional carbon sink of 2.5–3 billion tonnes of CO_2 equivalent through additional forest and tree cover by 2030.
5. To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health, and disaster management.
6. To mobilize domestic and new and additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.
7. To build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative research and development for such future technologies.

Source: Intended Nationally Determined Contribution submitted by Government of India

Himalayan ecosystem, and strategic knowledge. The government is proposing to set up new missions on wind energy, health, waste-to-energy, coastal areas, and also redesigning the National Water Mission and National Mission on Sustainable Agriculture.

Under the Copenhagen Accord, India communicated its domestic mitigation action as an endeavour to reduce the emissions intensity of its GDP by 20–25% by 2020 in comparison to the 2005 level. More recently in its Intended Nationally Determined Contributions (INDCs), India has announced to reduce the emissions intensity of its GDP by 33–35% by 2030 in comparison to the 2005 level.

The concept of Green Growth spans much beyond climate mitigation and adaptation and aims at achieving economic growth that is socially inclusive and environmentally sustainable. The Ministry of Environment, Forest, and Climate Change recognized green growth in its vision, wherein 'poverty eradication' along with green growth is seen to be central. The Finance Commission of India articulated green growth as involving "rethinking growth strategies with regard to their impact(s) on environmental sustainability and the environmental resources available to poor and vulnerable groups." It is clear—from the articulation by the Finance Commission as well as the Ministry of Environment, Forests, and Climate Change—that inclusivity is central to green growth in India.

The Fourteenth Finance Commission has introduced a forward-looking incentive-based grant rewarding the states with quality forest cover measured by moderate and very dense forest cover. The Government of India has an ambitious renewable capacity target of 175 GW by 2022. In the last 15 months, the government quadrupled the coal cess from ₹50 per tonne to ₹200 per tonne, the proceeds of which will go towards the National Clean Energy Fund. The Smart Cities Mission of the Government of India aims to promote cities that provide not just infrastructure but also give a good quality of life to its citizens, a clean and sustainable environment through application of 'smart' solutions.

What is Green Growth?

Green growth involves rethinking growth strategies with regard to their impact(s) on environmental sustainability and the environmental resources available to poor and vulnerable groups.

(Para 3.15, Thirteenth Finance Commission Report)

The Ministry of Environment, Forests, and Climate Change recognizes green growth and poverty eradication to contribute to the vision of sustainable development.

India's Green Growth Challenges

India is emerging as the one of the fastest growing economies in the world and is currently Asia's third largest economy by GDP.[1] India's gross national income for 2014–15 was ₹105.27 trillion with an annual growth rate of 7.4% (Economic Survey 2014–15).[2] The share of services sector is the largest in total GDP of India at 57% (in 2013), followed by industrial sector at 25%, and balance 18% being contributed by the agriculture sector.[3] In 2014, India's total population stood at 1.29 billion and its share in the world population was around 17.84%. Globally, economic growth seemed to have picked up in the last one year and it is expected to further improve in 2015–16. Key development indicators for India and select countries are listed in Table 1.

For India to achieve development objectives, its economy should continue to grow. But for a country like India, where development is an imperative, environmental consequences can be substantial as it will place serious constraints on natural resources such as land, water, minerals, and fossil fuels, driving up energy and commodity prices. The extent to which its economy will "grow green" will depend on its ability to reduce the quantity of resources required over time to support economic growth that leads to enhancement of social equity and job creation. Green growth could play an important role in balancing these priorities. However, managing fiscal deficits and public debts are two key challenges for national policy making, which could make technological change required for green growth more difficult. Fiscal considerations and trade balance will also continue to be important drivers for shaping India's macro-economic policy. Hence, it becomes essential to understand and maximize the development benefits, such as on such

1 World Bank Development Indicators. Details available at <data.worldbank.org>.
2 New Series, Advanced Estimates.
3 Source: World Bank Development indicators.

Table 1: Key development indicators for India and select countries							
	GDP in billion (constant 2005 US$)[a]	GDP per capita (constant 2005 US$)[a]	CO_2 emissions (MT)[b]	CO_2 emissions (metric tons per capita)[b]	Energy use (kilograms of oil equivalent per capita)[c]	International Trade Balance in Goods[a]	Cash surplus/deficit (% of GDP)[c]
Brazil	1206	5853	439.41	2.19	1391.90	-4.13	-1.84
China	5274	3866	9019.52	6.71	2142.81	370.02	_
European Union	15372	30241	3574.10	7.07	3253.82	134.78	-3.63
India	1600	1235	2074.34	1.66	623.72	-139.88	-3.81
Japan	4780	37595	1187.66	9.29	3545.60	-120.64	-7.97
Russian Federation	1000	6844	1808.07	12.65	5283.41	188.04	2.67
United States	14797	46405	5305.57	17.02	6814.82	-727.15	-7.56
South Africa	329	6086	477.24	9.26	2674.82	-18.1	-4.47
World	58055	7996	34649.483	4.94	1897.95	_	-4.94

Note: Data for various years: [a]2014, [b]2011, [c]2012

Source: World Development Indicators (data.worldbank.org); Column on International Trade from OECD.stat

as income, energy access, and trade, of green growth interventions across all key sectors.

It is observed that countries with higher human development have a higher ecological footprint (Figure 1). Therefore, as India accelerates its development journey to lift the millions of people out of poverty, the challenge before it is to provide improved quality of life to their citizens within the ecological space and constraints—and the fault lines on key green growth indicators are already visible, as described below.

Air and Water Pollution: Concentration of the pollutants monitored show that respirable suspended particulate matter concentrations violate the National Ambient Air Quality Standards for most cities. According to Central Pollution Control Board, Class I cities and Class II towns in the country generate around 38,254 million litres per day (MLD) of sewage of which only 11,787 MLD (31%) is treated and balance is discharged untreated.

Forests: According to the Forest Survey of India, forest and tree cover spreads across 78.92 million hectares and constitutes 24.01% of the geographical area of the country. There has been an increase in forest cover by 5,871 sq. km compared to 2011 assessment by Forest Survey of India; but there has been slight decline in moderately dense, and increase in open forest category. There has been a decline in growing stock of the country by 389 cu. m between 2011 and 2013, which suggests a decline in quality of forest despite the increase in overall increase in forest and tree cover.

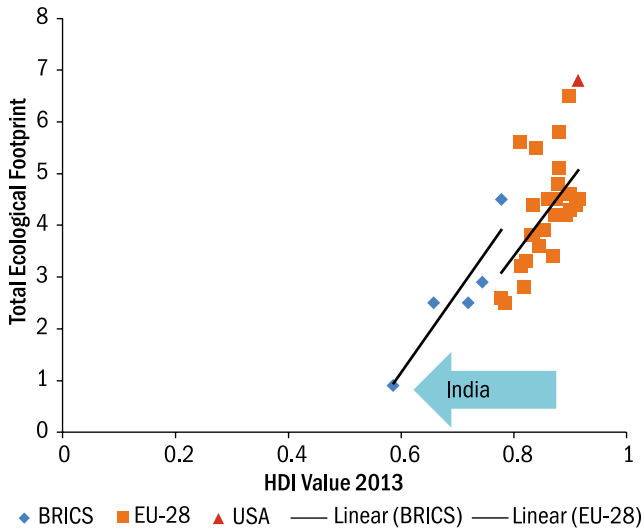

Figure 1: Ecological footprint and human development

Bio-Diversity: India is a mega-diverse country with only 2.4% of the world's land area and harbours a significant proportion of recorded species. Of the

34 global biodiversity hotspots, four are present in India, that is, the Himalayas, the Western Ghats, the Northeast, and the Andaman and Nicobar Islands. According to International Union for Conservation of Nature Red List, in 2015, 1,039 species were categorized as threatened species for India.

Water: India is moving towards perennial water shortage. The National Institute of Hydrology estimates water availability for India to be 938 cubic metre per capita per year. A country with less than 1,700 cubic metre per capita per year is considered as water stressed. Irrigation is the heaviest user of surface and ground water presently and is projected to be so even in 2025 and 2050. Additional water demand will come from the domestic and industrial sectors. There is an urgent need for water efficiency measures in all sectors but especially irrigation.

Climate Change: Past observations indicate that the annual mean temperature of India has showed significant warming trend of 0.51°C per 100 year, during the period 1901–2007 with increased warming during 1971–2007 (Kothawale et al. 2010; INCCA 2010). Projections for 2030 also indicate a warming trend for the Indian sub-continent. The ecological impacts anticipated with even 2°C of warming are quite intense in itself and the situation could be much worse at higher temperature rise.

Energy: Energy supply in India is heavily dependent on fossil fuels with coal and petroleum products together accounting for about 88% of the total primary energy supply. Most of the oil consumed in the country is imported, posing serious challenges for long-term energy security. According to International Energy Agency, in 2012, India had more than 300 million people who were deprived of electricity and more than 800 million people were dependent on solid biomass as fuel for cooking. According to Census 2011, 43% of rural households used kerosene as primary energy source for lighting. Since energy access has strong development implications, this is a serious challenge that the government is currently trying to address.

Urbanization: Cities contribute to almost two-thirds of India's Gross Domestic Product (MoUD, undated)[4] and will assume even greater role as India embarks on higher economic growth. At the same time, Indian cities face severe challenges related to quality and availability of infrastructure, such as power, telecom, roads, water supply, and mass transportation, which could pose serious constraints to economic growth if left unaddressed.

4 Available from: http://jnnurm.nic.in/wp-content/uploads/2011/01/PMSpeechOverviewE.pdf; last accessed October 18, 2015.

Green Growth Interventions and their Impact

The objective of this integrated techno-economic analysis is to understand the impact of energy-related green growth interventions on future energy demand, emissions, energy access, energy security, and development indicators. In order to understand these inter-linkages, an integrated modelling framework has been used, combining a bottom-up energy systems model (TERI-MARKAL) along with a top-down simulation-based dynamic, recursive computable general equilibrium model. This integrated modelling framework was used to conduct scenario analysis around the following green growth interventions:

1. Energy efficiency and conservation measures in energy demand sectors (agriculture, transport, industry sector, commercial building, and residential sector)
2. Enhancement of modern energy access
3. Promotion of clean energy supply through renewables and cleaner fossil-fuel–based energy generation technology, and
4. Resource (soil and water) conservation in the agriculture sector.

For understanding the implications of these green growth interventions on energy and development indicators, four scenarios were considered—varying in the type and range of interventions considered. These scenarios are (a) Reference (REF), (b) Policy (POL), (c) Ambitious-1 (AMB-1), and (d) Ambitious-2 (AMB-2). The REF Scenario is in line with a business-as-usual scenario. POL Scenario assumes effective implementation of existing policies. The Ambitious Scenarios comprises of measures that includes implementation action over and above what is considered in the POL Scenario.

Figure 2 depicts the fuel-wise primary energy supply across the four scenarios. Under the REF scenario, primary energy supply grows by more than double, from 869 Mtoe in 2015 to 2,017 Mtoe in 2031. Coal

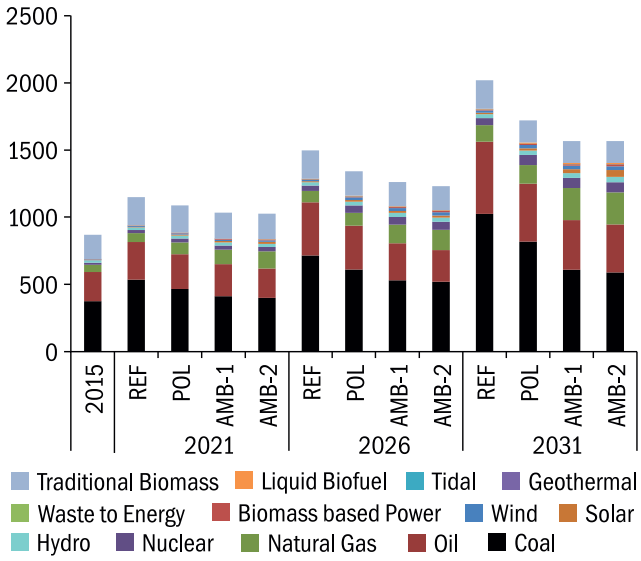

Figure 2: Scenario-wise primary energy supply (Mtoe)
Source: TERI MARKAL Model Results

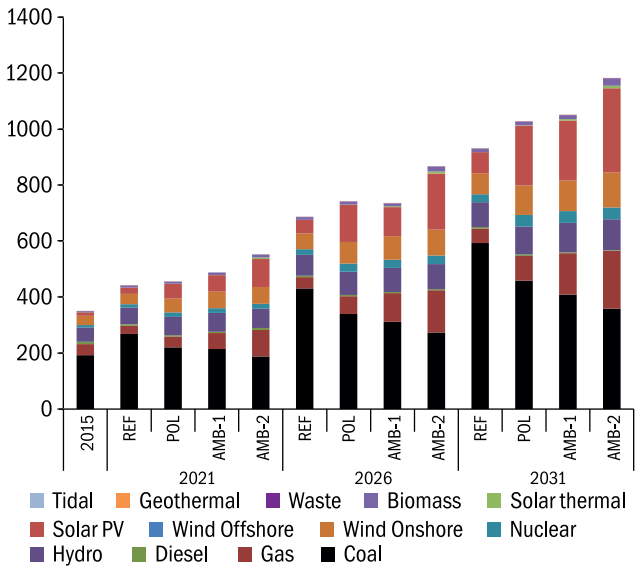

Figure 3: Scenario-wise power generation capacity (GW)
Source: TERI MARKAL Model Results

is projected to remain the mainstay of Indian energy system, although its share reduces considerably during the projection period. By 2031, in the POL scenario, primary energy supply from coal drops to 818 Mtoe, while under the AMB-1 and AMB-2 scenarios, it further drops to 609 Mtoe and 590 Mtoe, respectively. Correspondingly, the share of renewables in the primary energy supply mix increases by 2031 in the POL and Ambitious scenarios. Share of traditional biomass in primary energy supply reduces from 20% in 2015 to about 10% in 2031 (across scenarios) owing to better access to clean energy (such as improved cook-stoves) and improved quality in rural areas. In the long run (by 2031), natural gas also takes an important place in the Indian energy mix, especially under the Ambitious scenarios.

Figure 3 depicts the power generation capacity mix across the four scenarios. Although the share of coal-based installed capacity decreases substantially by 2031, it continues to be the single largest source of electricity generation. Amongst renewables, solar-based installed capacity increases substantially by 2031, from 12 GW in 2015 to 215 GW under POL scenario, and 220 and 310 GW under AMB-1 and AMB-2 scenarios, respectively. Overall, the share of non-fossil power generation sources increases from about 32% in 2015, to about 46% under POL scenario, and 47% and 52% under AMB-1 and AMB-2 scenarios, respectively.

Figure 4 shows final energy demand under the four scenarios. The three major energy-consuming sectors, namely industry, residential, and transport, continue their dominance of the final energy demand, contributing about 90% over the modelling horizon under REF scenario. Transport sector energy demand witnesses a noticeable increase, growing by almost three times, from 125 Mtoe in 2015 to about 360 Mtoe in 2013 (under the REF scenario). Under the POL and AMB scenarios, the final energy demand is somewhat

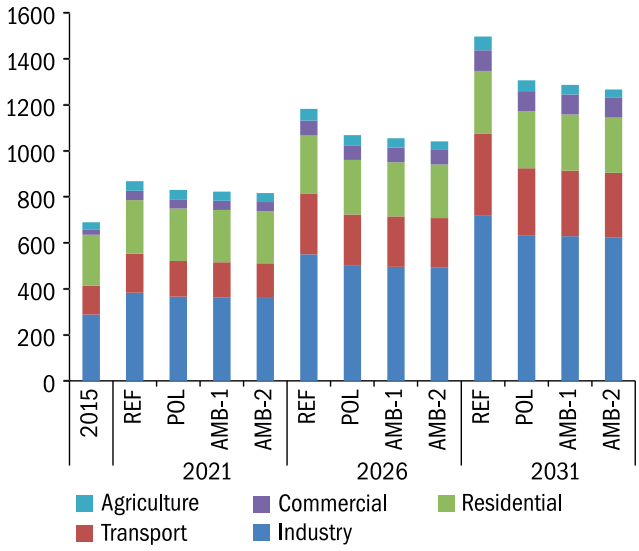

Figure 4: Scenario-wise final energy demand (Mtoe)
Source: TERI MARKAL Model Results

reduced, owing to the demand side management measures in various end use sectors.

Figure 5 highlights that the import dependence for coal increases substantially between 2021 and 2031, under the REF scenario. However, with aggressive push on solar and other renewables, coal's import dependency goes down substantially from 55% under REF scenario to 19% under the AMB-2 scenario in 2031. Import dependency for oil continues to remain significant over the modelling horizon, although it reduces marginally under the Ambitious scenarios as compared to POL scenario. It is also important to note that with increasing share of gas in India's energy mix, coupled with serious constraints on domestic gas availability, leads to a marked increase in import dependency of natural gas under the POL and AMB scenarios. This has direct implications for energy security of the country, with an associated impact on current account deficit as well.

As can be noted from Tables 2 and 3, green growth and development measures bring about a positive change by lifting additional people above poverty, thereby impacting the key education and health indicators as well. These green growth interventions include increased share of renewable energy (RE), sustainable agriculture practices, better natural resource management, and structural changes within industry and infrastructure sector. The income generated from these measures and new investments get distributed, especially across the rural households, thereby reducing the inequality. Also, there are a number of additional skilled and unskilled jobs created over the modelling horizon, in RE, energy efficiency, and resource efficiency related sectors, especially under the POL and Ambitious scenarios. A complementary increase in both the skilled and unskilled job creation in the Ambitious scenarios of 2031 create incremental income generation, reduction in income inequality across and within rural and urban household classes, and reduces the poverty levels by 2031.

Policy Implications

Coal: As seen in the modelling exercise, coal will remain the major source of energy until 2030. Thermal plants that use coal also need to undergo massive technological changes if they are to remain sustainable. Technological change will need regulatory interventions since the capital costs of setting up plants with up-to-date technologies are far higher as compared to subcritical plants. Renovation and modernization measures need a major boost. Research and Development (R&D) for clean coal technology needs a time-bound roadmap.

Oil & Gas: For this sector, disclosure of energy usage and process-related carbon emissions should be encouraged, to start with voluntary and progressively to be made mandatory. This would lead to greater clarity and public awareness, which can further facilitate policy action in the future. Exploration and production contracts should include incentives for

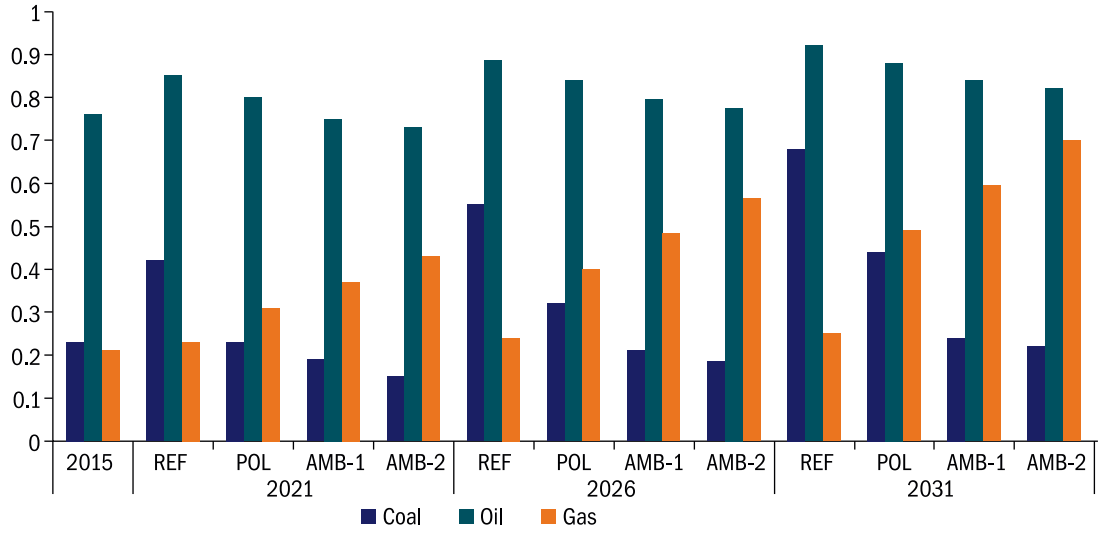

Figure 5: Import dependency of Coal, Oil and Gas
Source: TERI MARKAL Model Results

Table 2: Scenario-wise impact of green growth measures on education and health indicators								
Indicator	Units	Baseline	Policy Scenario		Ambitious-1 Scenario		Ambitious-2 Scenario	
		2007	2021	2031	2021	2031	2021	2031
Literacy rate (adult male)	Percentage of people ages 15 and above	75.19	76.33	80.29	80.70	86.85	83.13	89.55
Literacy rate (adult female)	Percentage of people ages 15 and above	50.82	55.91	61.50	57.43	64.90	60.13	67.23
Literacy rate (total)	Percentage of people ages 15 and above	62.75	66.41	70.66	71.82	78.17	75.53	82.39
Infant mortality rate (IMR)	Under 5 years (per 1,000 live births)	72.10	34.11	13.41	32.97	12.96	29.65	9.10
Source: Modelling Estimates								

Table 3: Scenario-wise impact of green growth measures on poverty and jobs							
Indicator	Units	Policy Scenario		Ambitious-1 Scenario		Ambitious-2 Scenario	
		2021	2031	2021	2031	2021	2031
Poverty	Millions of persons BPL	9.30	8.37	8.09	7.28	7.36	7.06
Number of additional skilled job creation	In lakhs	61	70	63	74	68	79
Number of additional unskilled job creation	In lakhs	24	29	26	31	29	38
Source: Modelling Estimates							

energy saving in operations; fiscal arrangements in the form of tax incentives can encourage the reduction of associated gas flaring. In the midstream oil and gas segment, a roadmap that plans an integrated fuel transport policy must be created. In the refining segment, Solomon Energy Efficiency Index can be applied as a measuring standard that would help policymakers set reasonable energy use reduction goals in the medium and long run. To begin with, reporting efficiency according to the guidelines of such an index may be promoted. On the consumption side, a Green Gas Quadrilateral must be created by setting up natural gas pumps along the Golden Quadrilateral highways in order to promote the use of gas as a transport fuel.

Renewables: India targets an installed RE capacity of 175 GW by 2022, of which 100 GW will come from solar power, 60 GW from wind energy, 10 GW from small hydro power, and 5 GW from biomass-based power projects. Renewable energy forecasting is required for grid security. However, due to lack of quality data and insufficiently developed forecasting tools, accurate RE forecasting is difficult. Significant amount of generation integration will depend on the accuracy of the forecast. To achieve low-cost manufacturing and therefore lower capital costs and to capitalize on its inherent advantages in the solar sector, India needs strengthening and upgrading its solar R&D and manufacturing capabilities.

Transmission Grid: Inadequate grid infrastructure is a key issue that needs to be addressed urgently. Across most of the states with significant RE potential, the grid does not have sufficient spare capacity to be able to evacuate increasing quantum of RE electricity. A comprehensive programme to introduce smart grid will realize lots of benefits including better forecasting of demand and supply through centralized as well as decentralized power sources (renewables) with better grid stability. Public–Private Partnership (PPP) and engineering, procurement, and construction models can boost infrastructural development. Higher deployment of advanced technologies, such as the Thyristor Controlled Series Compensation, High Surge Impedance Loading lines, high temperature,

high capacity conductors, multi-circuit towers, and mono pole towers are essential to enhance the power transfer capability of existing and new transmission lines. There is a need for increase in the transmission system at higher voltage levels and sub-station capacities to support transmission network to carry bulk power over longer distances. Moreover, there is a need to optimize right of way, minimize losses, and improve grid reliability.

Power Distribution: Since the financial viability of the power sector as a whole depends on the revenues collected at the distribution end, it is vital that the distribution system is made financially viable. This can be made possible by improving the operational performance by achieving 100% metering to achieve 100% billing/collection efficiency and to reduce the commercial losses.

Nuclear: Financial, administrative, and, most importantly, statutory independence is absolutely essential for the power regulator, which can be achieved by the 'Nuclear Safety Regulatory Authority Act' draft legislation that was tabled in the Parliament in September 2011. A public communications strategy that involves local and regional people, local businesses, and organizations in the decision-making process is essential. There are good examples of public engagement best practices and strategies followed in different countries. For instance, Finland follows a pre-defined timetable based on step-wise decision-making process for establishing a nuclear power plant.

Hydropower: On the national level, the hydropower sector is governed by the National Hydropower Policy of 2008. Various state governments have put in place such policies like the Hydro Power Policy, 2006 of Himachal Pradesh; Policy for Harnessing Renewable Sources in Uttarakhand with Private Sector/Community Participation, 2008; the Hydro Electric Power Policy of Arunachal Pradesh; among others. These policies have framed laws that govern land acquisition, law and order, impact on the environment via environmental impact assessments and impact on the people via social impact assessments. It is important to look at measures to iron out the issues in the current policy framework. Creating policy and institutional mechanisms to favour alternative designs to increase dam life as also to reduce the divergence, the designed and actual dam life must be taken into account.

Transport: Greening of the transport sector in India would seek a holistic strategy that involves planned interventions in order to make a decisive shift to green transport, interventions, and massive investments are required in the coming decades in the form of modal shifts actions, specific infrastructure development and upgradation works, fuel and system efficiency improvements, and mobility management. An integrated data management system and centre for regular monitoring of transport data can be set up. The spatial arrangement of the various land uses or activities across the city is a very important factor in determining the intra-city travel demand. Therefore, any efforts towards integrated land-use and transport planning can significantly help in reducing the need to travel and lead to reduction in associated costs. Upgradation in terms of fuel quality and fuel efficiency can promote cleaner fuel by reducing sulphur content and can lead to significant reduction in emissions.

Electric Mobility: Electric vehicles as a green growth intervention yield multiple co-benefits, including energy security, job creation (through technology innovation and local manufacturing), and reduced local air pollution. Government of India recently announced the Faster Adoption and Manufacture of Electric Vehicles in India Scheme, which is a step in the right direction. However, in order to accelerate the uptake of this green technology, it is recommended that the scheme be further augmented with substantial additional funding and provisions made for granting 100% capital subsidy to state governments that are keen to adopt electric buses in public transportation.

Financing: Financing models for green energy need to be customized to the specific financing needs of technologies in different stages of innovation. Public finance through the government and low-cost finance from bilateral/multilateral agencies has a crucial role in supporting R&D and innovation of new technological solutions that are in pre-commercial stage currently. Bank finance is important for developing the market for commercially available technologies.

Buildings: New stock needs to be built on the principles of green buildings to accrue social,

environmental, and economic benefits. Retrofit measures to make the existing building stock energy efficient and water efficient need to be undertaken. There is a need to ensure all new construction for commercial buildings (as defined by the Energy Conservation Building Code—ECBC) to be ECBC compliant. Greening of rooftops and public spaces in all urban areas to prevent urban heat island effect can be explored. Alternate building materials that perform equal or better than the conventional ones should be encouraged to bring in environmental sustainability.

Agriculture: Technical options for improving energy efficiency in irrigation include facilitating upgradation of inefficient pumpsets to energy-efficient pumpsets through the AgDSM programme that seeks to establish viable models for PPP. Promotion and effective adoption of solar pumping systems is necessary as it could facilitate a reduction in diesel consumption in irrigation and therefore savings of a non-renewable fossil fuel.

Clean Fuel: Considering the fast growth in the vehicular sector, more stringent steps should be taken. Instead of following chronological order for the norms, BS-V fuels should be considered by enabling the Indian refineries to leapfrog from BS-II to BS-V and BS-VI. Old vehicles should be gradually phased out with proper scrapping mechanism in place. There is need for enhanced and faster penetration of cleaner fuels like LPG. There is also need for increased penetration of improved biomass-based chullahs with higher efficiencies and lower emissions.

Air Quality: Instalment of air pollution control equipment (APCE) should be made mandatory for all the industries. Efficiency of installed APCE's should be checked at regular levels. Electrostatic precipitators are installed in power plants but inspection and maintenance systems should be enforced at regular time intervals by the government. The recently announced National Air Quality Index, which considers eight pollutants (PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, O_3, NH_3, and Pb), could be expanded to more cities for better monitoring of air quality in these emerging economic centres.

Water: Integrated water resource management needs to be explored for water conservation using rainwater harvesting and groundwater recharge as well as rejuvenation of lakes and ponds in the river basin catchment. Water use efficiency can be enhanced in irrigated agriculture by increasing the output per unit of water, reducing loss of water to unusable sinks, reducing water degradation, and reallocating water to higher priority uses. Developing water quality database and management using real-time monitoring, linking billing with water supply network designs using Supervisory Control and Data Acquisition, and cloud computing systems. Institutional capacity building is of utmost importance in order to ensure that the mechanism of overall framework ensures efficiency in treating water as a finite but renewable resource to be carefully managed and judiciously utilized.

Forests: Linkages need to be established between research institutions, state forest departments, and private sector to produce good quality planting material. As envisaged in Twelfth Five Year Plan model, nurseries can be established in selected forest divisions. Joint Forest Management institutions need to be strengthened through establishing strong linkages with gram panchayats and allocation of green funds. Village-level green volunteers can be trained for conservation of natural resources. Claims to individual and community rights should be completed. Livelihoods of the right holders should be strengthened through training them in modern agriculture, animal husbandry, and forest management.

Bio-diversity: It is important to dovetail the national efforts for biodiversity conservation with the international goals and processes such as Aichi Biodiversity Target and Nagoya Protocol. The national targets are cross-cutting in terms of issues as well as respective jurisdictions of ministries of central government and state governments. However, there is a limitation in terms of funds available for achieving the national targets for biodiversity conservation.

Waste: Instead of following the usual end-of-pipe approach, waste management must be looked at holistically and preference must be given to reduction of waste at the source. There should be efforts to institutionalize informal sector and modernization of recycling technologies. Informal waste recyclers

can be trained to collect the waste from households, do decentralized waste processing (composting or biogas), and trade recyclable waste. The current mechanisms to raise funds for waste management must be improvised. Spending on segments—other than collection—of the waste management chain such as appropriate treatment, recovery, and disposal technologies and facilities is generally rather low. Increased investment in basic collection services, the transport of waste, and cleaning up dumpsites is a starting point for greening the sector. Investment can be targeted, for example, at techniques such as route optimization and transfer stations, which can bring down the capital and operational costs of providing waste services. Economic incentives and disincentives serve to motivate consumers and businesses to reduce waste generation and dispose of waste responsibly, thereby contributing to increased demand for greening the waste sector.

Irrigation: Promotion of micro-irrigation systems amongst farmers and in command areas will have significant implications on agricultural energy demand. Appropriate encouragement, incentives, and subsidies for farmers to adopt these systems are necessary, along with awareness and training on deployment and use of these systems.

The Way Forward

Figure 6 shows an overview of progress of key aspects related to environment and energy.

The study provides a review of long-term sustainability challenges in India and concludes that implementation of green growth strategies yields multiple development benefits but requires concerted policy action and interventions.

Following key interventions are recommended to foster green growth and development in India:

Mainstreaming in decision-making processes: Climate-resilient green growth strategies need to be looked at as a cross-cutting issue that requires policy coherence and inter-departmental coordination. For further mainstreaming of environmental sustainability in decision-making processes, the government can adopt green budgeting for India wherein all departments can prepare environmental budget statements highlighting key 'green' activities undertaken in their respective departments.

Addressing data gaps: Collecting and synthesizing existing and new data is needed to facilitate preparation of strategies as well as evaluation of existing policy initiatives. Data for other parameters can be collected using existing management information systems.

Mobilizing finance: Financing is critical to the implementation of climate-resilient green growth interventions. In addition to public finance, private sector, banking institutions, and development agencies also becomes important.

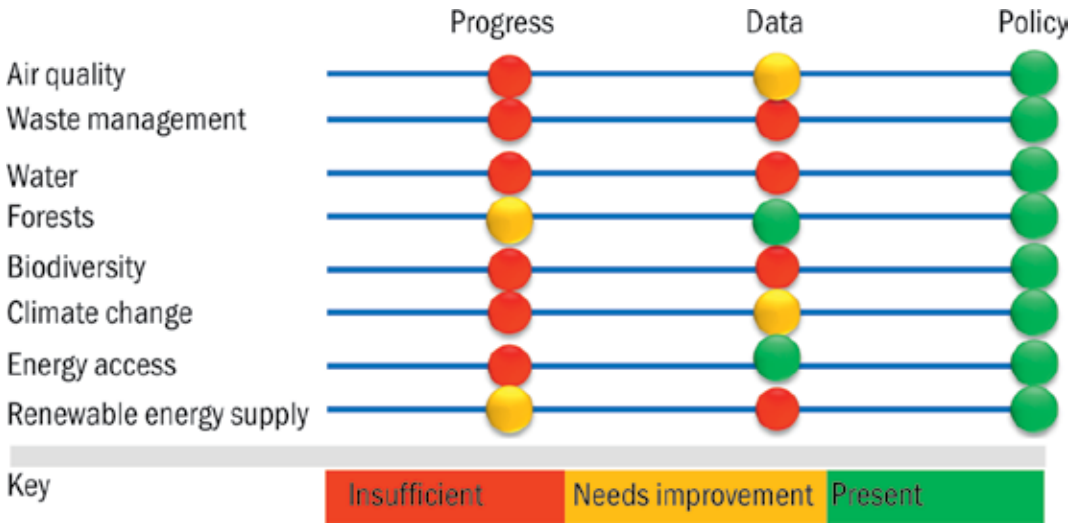

Figure 6: Overview of progress on aspects related to environment and energy

Commissioning pilots and technology demonstration: Pilots need to be commissioned in opportunity areas. Technology demonstration should be encouraged in areas of RE, waste management, RE for cold storage applications, and natural resource management. This will help in up-scaling of technologies.

Capacity building: Enhancing financial, technical, and institutional capacities of government as well as the voluntary sector is essential for the implementation of climate-resilient green growth strategies. A detailed assessment of capacity building needs sector by sector becomes essential. A greater engagement between government, research and academia, non-profit organizations, and the private sector is needed to support implementation.

Understanding emerging issues: There is a need to better understand and plan for impending socio-economic transitions, such as urbanization and changes in the structure of the economy (such as increase in manufacturing). Skill development and vocational education need priority action to create opportunities in key green growth related sectors, especially RE, buildings, and industry.

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Notes

Notes

Green Growth and Sustainable Development in India

Towards the 2030 Development Agenda

Summary for Policymakers

The project, Initiative on Green Growth and Development in India, aims to build evidence through which the Indian economy can move towards an inclusive green growth paradigm of development. The evaluation aims to combine the rigorous studies done at the national and state levels (Punjab and Himachal Pradesh).

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