India's Energy and Climate Policy

Can India Meet the Challenge of Industrialization and Climate Change?

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Ebinger is widely published both in the field of conventional energy and on nuclear energy and nonproliferation. His most recent books *Energy and Security in South Asia: Cooperation or Conflict* was published by the Brookings Press in 2012. Ebinger has 40 years of experience advising the highest levels of governments on a variety of projects funded by the U.S. Agency for International Development, World Bank, Asian Development Bank, Inter-American Development Bank, and the European Bank for Reconstruction and Development. These projects addressed the restructuring of electricity, natural gas, and petroleum state-owned companies; the creation of regulatory regimes; energy pricing reforms; institutional strengthening of energy ministries and state-owned utilities; and enactment of energy efficiency programs.

Ebinger has extensive teaching experience having served as an adjunct faculty member at the Georgetown University School of Foreign Service from 1979-2001 and the Paul Nitze School of Advanced International Studies at Johns Hopkins for over a decade. He has also been a visiting professor at Case Western Reserve University. Ebinger serves as a member of the Board of Directors at the Jackson Hole Center for Global Affairs, on the North American Board of the Energy Research Institute of India and the Howard Baker Japan Forum. He has also served as the President of the National Capital Chapter of the International Association for Energy Economics and as Vice Chairman of the Innovative Energy Group, a renewable energy development company based in Dubai.

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Acronyms and Abbreviations

Bbl	barrel
Bcm	billion cubic meters
BHEL	Bharat Heavy Electrical
BJP	Bharatiya Janata Party
Btu	British thermal unit
CAG	Comptroller and Auditor General of India
CBI	Central Bureau of Investigation
CCEA	Cabinet Committee on Economic Affairs
CEA	Central Electric Authority
CERC	Central Electricity Regulatory Commission
CIL	Coal India Limited
CNG	compressed natural gas
COP21	21st session of the Conference of Parties (of the UN Framework Convention on Climate Change)
CSO	Central Statistics Office
DFC	dedicated freight corridor
Discoms	distribution companies
E&P	exploration & production
EIA	U.S. Energy Information Administration
FRP	Financial Restructuring Proposal
GHG	greenhouse gases
GoI	Government of India
GST	Goods and Services Tax
GW	gigawatts
IEA	International Energy Agency
IEEFA	Institute for Energy Economics & Financial Analysis
INDC	Intended Nationally Determined Contribution
JNNSM	Jawaharlal Nehru National Solar Mission
kWh	kilowatt hour
LNG	liquefied natural gas
LPG	liquefied petroleum gas
mmbd	million barrels per day
MNRE	Ministry of New and Renewable Energy
MT	million tons

Mtce	Insert: $MtCO_2$ million tons of carbon dioxide
MW	megawatt
NAPCC	National Action Plan on Climate Change
NITI	National Institution for Transformation India
NMEEE	National Mission for Enhanced Energy Efficiency
NTPC	National Thermal Power Corporation
OECD	Organization for Economic Cooperation and Development
ONGC	Oil and Natural Gas Corp
PAT	perform, achieve and trade
RPO	renewable purchase obligations
SEB	State Electricity Board
SECI	Solar Energy Corporation of India
T&D	transmission and distribution
UDAY	Ujwal Discom Assurance Yojana
UNFCCC	United Nations Framework Convention on Climate Change
WRI	World Resources Institute

Summary for Policymakers

Within the energy and climate debate perhaps no issue is more contentious than the degree to which emerging economies should rely only on non-fossil fuel resources and energy efficiency to meet their growing energy demand. Perhaps the greatest example of this debate can be illustrated by the degree to which India confronts the dilemma of committing to a low-carbon economy while at the same time steadfastly developing a robust energy sector through which it plans to bring electricity access to all its citizens, including 300 million people currently lacking access even to one electric light bulb.

The realities that Western policymakers do not want to hear from India's Prime Minister Narendra Modi are twofold. First, despite the forward trajectory of enhanced Indian greenhouse gas (GHG) emissions, to date India has contributed less than 3 percent of cumulative GHG emissions, despite having 17 percent of the world's total population.[1] Furthermore, per capita U.S. emissions are roughly 10 times those of India.[2] Given this reality and the need to bring electricity not only to those not currently served but also to the tens of millions more who are underserved, further development of coal, in the words of Harjeet Singh of ActionAid, "is not an obsession for India; it's a compulsion."[3] Second, Modi has made it categorically clear both in at the 21st session of the Conference of Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris and in many other forums that India will not be able to achieve its Intended Nationally Determined Contribution (INDC) without huge infusions of financial assistance. Additionally, although India put forth ambitious targets at Paris, it was with great reservation and only with the clear assumption that developed nations will have to contribute significant amounts of financial assistance in order for India to achieve these goals. At Paris, Modi stated, "Climate change is a major global challenge. But it is not of our making. It is the result of global warming that came from prosperity and progress of an industrial age powered by fossil fuel."[4]

In an attempt to soothe over his breach with the West over India's coal policy, Indian officials, note that they are not building coal "instead" of renewables but "in addition" to renewables and reiterate that India's goal of constructing 175 gigawatts (GW) of renewable capacity by 2022 is the most ambitious program in the world.[5]

It is owing to the importance in actually achieving the targeted CO_2 reductions postulated for each electricity fuel source, this paper concentrates a large amount of analysis on each major fuel source to show that nuclear, supercritical coal, hydro, and perhaps even solar and wind are unlikely to reach the goals that policymakers have

[1] Arvind Panagariya, "India's Generous INDICs," *NITI Aayog*, accessed 19 April 2016, http://niti.gov.in/content/indias-generous-indics.
[2] Ibid.
[3] Brian Palmer, "As India Goes, So Goes Civilization," *onEarth*, 22 January 2016, http://www.onearth.org/earthwire/india-climate-change-renewable-energy.
[4] Chetan Chauhan, "Climate change not of India's making, rich nations to blame: Modi," *Hindustan Times*, 30 November 2015, http://www.hindustantimes.com/india/climate-change-not-of-india-s-making-rich-nations-to-blame-modi/story-eIBz5hUGR1CFNNiczGVCWP.html.
[5] International Energy Agency (IEA), *India Energy Outlook: World Energy Outlook Special Report*, November 2015, p. 19, http://www.worldenergyoutlook.org/media/weowebsite/2015/IndiaEnergyOutlook_WEO2015.pdf.

for them and that, consequently, Modi and the Indian economy are unlikely to meet their INDC pledges.

This paper pays a great deal of attention to the Indian power sector where past policies have led to such a deterioration, especially in the transmission and distribution networks, that it will take years and investments in excess of $2 trillion to get India to the point where large volumes of intermittent renewables can be integrated into the grid.

The paper also examines the institutional, social and economic bottlenecks plaguing the entire energy sector from inadequate billings and collection systems, bribery of meter readers in various forms, rival bureaucracies at the state and federal levels, power theft, lack of market-based pricing and nonpayment of bills by wealthy industrialists, agricultural landlords, government agencies and the military that will hinder meaningful reform throughout the energy economy.

Finally, the paper addresses the strong arm tactics that the government of India (GoI) has used in seizing land reserved for forest preserves and tribal peoples and opening it up for coal and other industrial activities.

Through analysis of the Indian energy sector, the paper will illustrate the chief issues that will form the cornerstone of this national discussion:

1. The long term role of fossil fuels (oil, gas, and coal) in the economy and the degree to which, if domestic supplies are available, they should be imported with attendant economic, security and environmental ramifications
2. Transportation bottlenecks including railways, roads, and port infrastructure
3. Energy and emissions related to the construction of new infrastructure developments including smart cities and expanding urban populations
4. The significant upgrades to the transmission and distribution systems throughout India that require massive investments
5. The ongoing issues related to rampant corruption throughout the energy sector
6. Land acquisition policies for generation facilities and transmission corridors for electricity and oil and gas pipelines, as well as their impact on local populations, water supplies for agriculture, and the local and national environment
7. Tariff policies, with special emphasis on capacity to pay
8. The security concerns of large scale energy trade with India's neighbors for electricity and natural gas
9. India's attempts to diversify away from petroleum for its transportation sector

It is against this background that the paper highlights the significant political, economic, and logistical obstacles facing India's efforts to meet its INDC obligations. In this sense, I hope policymakers take serious heed and manifest a dynamic resolution to these highlighted issues within the timeframe necessary to avoid the catastrophic impacts of climate change on a global scale.

1. Introduction

In December 2015, 196 parties convened in Paris with the urgent task of reaching an agreement to reduce emissions of greenhouse gases. Many delegates attending COP21 arrived frustrated by what they saw as an unwillingness by the major emitters to take bold actions despite growing indications of global climate change such as droughts, floods, declines in bio-diversity, ocean acidification, melting glaciers, and disappearing Arctic sea ice. Nonetheless, despite major differences between the Organization for Economic Cooperation and Development (OECD) nations and the developing world, by the end of the meeting, the fact that almost every nation put forward its own INDC and pledged to meet it generated a sense of euphoria that a major breakthrough on climate policy had occurred and that the world would at last galvanize to meet the global threat head on. However, as the champagne corks popped, a number of leading climatologists argued that startlingly strong scientific data indicated that prospects for keeping the global temperature rise to 2 degrees Celsius (3.6 degrees Fahrenheit) might be unachievable.[6]

Indeed, in the fall of 2015, Ambassador Christiana Figueres, executive secretary of the UN Framework Convention on Climate Change, stated that even if the national emission reduction pledges made at Paris were implemented, the world is already on a trajectory towards a temperature increase of 3 degrees Celsius (5.4 degrees Fahrenheit).[7] In such a world, according to most scientists, there will be a significant drop in food production, more intense weather, and an increase in urban heat waves akin to the one that killed thousands of people in India in 2015.[8] A warmer world will lead to more climate refugees streaming across international frontiers, exacerbating geopolitical tensions, and more melting permafrost setting off massive methane emissions.[9] As forest fires and rising temperatures lead organic material long preserved in frozen ground to decompose, scientists estimate that by 2100 melting permafrost on a global basis could release as much as one half of the GHGs that the UN Intergovernmental Panel on Climate Change believes could make it impossible to hold global

[6] Tom Bawden, "COP21: Paris deal far too weak to prevent devastating climate change academics warn," *The Independent*, 8 January 2016, http://www.independent.co.uk/environment/climate-change/cop21-paris-deal-far-too-weak-to-prevent-devastating-climate-change-academics-warn-a6803096.html.

[7] Renee Lewis, "As UN says world to warm by 3 degrees, scientists explain what that means," *Al Jazeera America*, 23 September 2015, http://america.aljazeera.com/articles/2015/9/23/climate-change-effects-from-a-3-c-world.html.

[8] Hilary Whiteman, "India heat wave kills 2,330 people as millions wait for rain," *CNN*, 2 June 2015, http://www.cnn.com/2015/06/01/asia/india-heat-wave-deaths/.

[9] Steve Trent, "Climate Refugees: Human Insecurity in a Warming World," *Sustainable Security*, 27 January 2015, http://sustainablesecurity.org/2015/01/27/climate-refugees-human-insecurity-in-a-warming-world/.

temperature to a 2 degree centigrade rise—and these figures are not included in the INDC targets promulgated in Paris.[10]

Ambassador Figueres is not alone in warning that much more drastic action is needed if there is any chance that the United Nation's 2 degrees Celsius target can be kept. In November 2015, Climate Advisors, a leading consultancy, warned that even if all the INDCs announced in Paris were met, the resulting reductions would amount to only about 40 percent of the cuts in carbon emissions that will be needed to keep the temperature rising above the 2 degrees Celsius target.[11] Indeed, it points out that while the commitments made in Paris, if actually implemented, could slow the rate of growth in global emissions by about one third, global emissions will keep rising.[12]

Perhaps even more alarming as the world headed into Paris was the admission by Beijing in mid-November 2015 that China had used 17 percent more coal in the last few years than previously reported, an amount equal to the entire fossil fuel consumption of Germany.[13] An even more sobering report by Wood Mackenzie, released on December 1, 2015, suggests that even these revised numbers may be too low since they do not account either for private coal consumption or illegal production. The report suggests that if these are taken into account, Chinese production may be 200 million tons (MT) to 600 MT higher.[14] While there can be no doubt that China has taken many policy steps, including the establishment of regional carbon trading schemes on a pilot basis largely in response to rising public anger about CO_2, NO_X and SO_X and other particulate emissions, the Chinese revelation seriously calls into question earlier commitments and raises renewed concerns about the reliability of other countries' baseline statistics against which the climate goals at Paris were set and how achieving them can be independently varied down the road.

Still, despite these data limitations, the agreement emerging from COP21 was a major step in the right direction. As U.S. Special Envoy for Climate Change Todd Stern said at a recent event at Brookings, we now have the "first universal lasting climate regime that is really applicable to all parties" alongside a legally binding transparency and accountability system that can hold countries accountable for their progress.[15] Widespread celebration over the agreement, however, masked many of the critical issues that still remain to be addressed. Alongside the question of credibility in emissions reporting, in many rapidly developing countries, projections for increased fossil fuel consumption stand in stark opposition to plans for reducing emissions. Greater deployment of solar and wind power doesn't lead to fewer emissions if the share of coal-fired power increases right along with it.

Nowhere is the issue of data reliability and veracity in the global climate debate more important than in India which is on track to become the world's most populous nation and is already the

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[10] Intergovernmental Panel on Climate Change, "Summary for Policymakers," *Climate Change 2013: The Physical Science Basis*, updated 29 January 2016, http://www.climatechange2013.org/images/report/WG1AR5_SPM_FINAL.pdf.

[11] Nigel Purvis, Maria Belenky, Rebecca Lefton, and Claire Langley, "Climate Diplomacy after Paris Opportunities for U.S. Leadership," *Climate Advisors*, November 2015, http://www.climateadvisers.com/wp-content/uploads/2015/11/Climate-Diplomacy-After-Paris-Final-Version-PDF.pdf.

[12] Purvis et al., "Climate Diplomacy."

[13] Chris Buckley, "China Burns Much More Coal than Reported, Complicating Climate Talks," *New York Times*, 3 November 2015, http://www.nytimes.com/2015/11/04/world/asia/china-burns-much-more-coal-than-reported-complicating-climate-talks.html?_r=0.

[14] Wood Mackenzie, *China in transition: carbon policy and the impact on energy markets*, December 2015, http://www.woodmac.com/reports/energy-markets-china-in-transition-carbon-policy-and-the-impact-on-energy-markets-34575507.

[15] Todd Stern, "Unpacking the Paris climate conference: A conversation with Todd Stern," Speech at the Brookings Institution, Washington, D.C., 17 December 2015.

world's third largest electricity market in terms of gross generation. Of the 10 largest electricity systems in the world India is projected to have one of the fastest growing markets over the next decade.[16] Furthermore according to a report by the Institute for Energy Economics & Financial Analysis (IEEFA), "while Indonesia and Australia are the world's two largest exporters of coal, India's domestic production is larger than either. Combined, China, the United States and India produced nearly 68 percent of the world's total coal in 2014, and account for 72 percent of the world's total consumption."[17] Clearly if pollution from CO_2 is going to be reduced what happens in India is of concern to everyone in the world.

While what happens in India's future coal consumption is vitally important for climate change, it is important to note that India's coal production in 2013 was about 340 million tons of coal equivalent (Mtce).[18] Comparatively, China's coal production in 2012 was estimated by the U.S. Energy Information Administration (EIA) at 4.4 billion short tons.[19] Against this reality, India's plans to increase coal production from 600 million metric tons in 2013, to 1.5 billion metric tons by 2020 while dramatic is only part of a much larger global problem.[20] Furthermore, in 2014, while India was the third largest CO_2 emitter in the world with a total of 2,597 million tons of CO_2 ($MtCO_2$), it ranked far behind the United States and China. Similarly India's per capita emissions were far below at only 1.9 tons of CO_2/person (compared to the United States at 17 tons of CO_2/person and China at 7.1 tons of CO_2/person).[21] Evidently, as the world struggles to reduce CO_2 emissions far beyond what was pledged in Paris, it is incumbent on all nations to try to not create enhanced emissions but to reduce them.

In this regard, India's climate change commitments and its ability to achieve them lie near the top of the global climate change agenda. Many crucial issues confronting India also highlight challenges facing other developing economies: Is it really possible to reduce or eliminate fossil fuel use dramatically through an even more rapid development of renewables? Can climate obligations be kept without sacrificing expanded energy access to those not currently served by commercial energy and slowing economic growth? At what point is the cost for choosing international climate obligations over domestic social priorities simply too high, especially when 300 million people in India (and another 900 million elsewhere) do not even have a light bulb?

Clearly Paris represents a watershed in the world's approach to addressing climate change. For the first time in history, the global diplomatic community acknowledged that global warming is in fact a problem and that instead of a top down approach that a new bottom-up approach is necessary with each nation deciding on the best policies to reduce GHG emissions. This approach has enjoyed some success in the United States where in several states emissions have plateaued. India has a unique opportunity to draw upon these lessons, and, because of its scale, could be a leader in showing other emerging economies that progress is possible.

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[16] Tim Buckley, "India's Electricity-Sector Transformation," *Institute for Energy Economics and Financial Analysis*, August 2015, p 4, http://ieefa.org/wp-content/uploads/2015/08/IEEFA-Indian-Electricity-Sector-Transformation-11-August-2015.pdf.
[17] Ibid.
[18] IEA, *India Energy Outlook*, p. 103.
[19] "China," *U.S. Energy Information Administration*, 14 May 2015, https://www.eia.gov/beta/international/analysis_includes/countries_long/China/china.pdf.
[20] Diane Kearney, "India's coal industry in flux as government sets ambitious coal production targets," *U.S. Energy Information Administration*, Today in Energy, 25 August 2015, https://www.eia.gov/todayinenergy/detail.cfm?id=22652.
[21] "Global Carbon Atlas: Ranking," Global Carbon Project, 2015, http://www.globalcarbonatlas.org/?q=en/emissions.

The growth of India's energy sector–both renewable and fossil fuel-based–has been driven by energy security concerns that many countries might find familiar. It is no secret that India has enjoyed vigorous economic growth over the last decade; it is less well known, especially among non-Indian geopolitical specialists, that the country is in the nascent stages of a major economic and demographic transformation that will have a far-reaching impact on international affairs. According to India's INDC, the country "houses the largest population of global poor (30 percent), around 24 percent of the global population without access to electricity (304 million), about 30 percent of the global population relying on solid biomass for cooking, and 92 million without access to safe drinking water."[22] For much of its recent history, India has strived to bring electricity and clean cooking fuels to this under-served portion of its population. How it meets this demand, while also serving the burgeoning energy needs of its burgeoning middle class, will have a major impact on the global carbon trajectory for GHG emissions.

The seriousness of Indian commitments to reducing the pace of global climate change is one of the central questions emanating out of Paris and the focus of this study. My experience working in India for nearly 40 years on a variety of energy reform projects in 10 states (for the central government and for international private investors) has given me a unique perspective on how India works, as well as the difficulties of implementing institutional and policy reform given India's social, economic, and political complexity. My experience has also made me acutely aware of the challenges posed to the country on how to raise the amount of capital that will be required for India to transform itself at the same time addressing global climate change concerns. The discussion in this paper also draws upon an extensive analysis of the existing literature concerning India's energy sector as well as conversations held within the Brookings Coal Task Force in Washington and my colleagues at Brookings India. While grateful to stakeholders and experts on the region that contributed their views in our task force meetings, my conclusions remain entirely my own.

[22] Government of India, I*ndia's Intended Nationally Determined Contribution: Working towards Climate Justice*, India's Submission to the UN Framework Convention on Climate Change, 01 October 2015, p. 5, http://www4.unfccc.int/submissions/INDC/Published%20Documents/India/1/INDIA%20INDC%20TO%20UNFCCC.pdf.

2. The Indian Energy Landscape

Within the energy and climate debate in India perhaps no issue is more contentious than the degree to which non-fossil fuel resources and energy efficiency can hold down the more extreme projections for the growth of domestic coal production as well as skyrocketing growth in coal- and lignite-fired power generation. Within this debate, there are sidebar arguments about the volume of coal needed, especially in the high growth scenarios, and whether enough coal can be produced domestically, given various institutional, economic, and political constraints—and, given those constraints, how much will have to be imported, either because domestic coal is not available or because imported coal is usually better from an environmental and efficiency standpoint.

Given its future growth trajectory, which actions India does or chooses not to take in shaping its future energy mix could define the success or failure of global efforts to mitigate climate change. Standing at the center of global energy, environmental, and geopolitical concerns, India, according to the International Energy Agency (IEA), will account for "25 percent of the rise in global energy use to 2040."[23] By 2022, India will surpass China with the world's largest population, and as the government expands electricity and other forms of commercial energy to people still lacking even rudimentary access to electricity, along with millions still dependent on biomass and other traditional energy sources for cooking, the country will see an unprecedented growth in energy demand over the next several decades.[24]

To meet this burgeoning demand, as previously noted, India plans to install an incredible 175 GW of renewable capacity by 2022. Placed in perspective, if India meets its expansion goals, it will double the existing solar capacity of the entire world within a decade. And yet, India's ambitious renewable expansion will take place alongside—not in place of—massive growth in fossil fuel consumption. This is not to argue that achieving a goal of 175 GW from renewables would not be a prodigious achievement. Rather it is only to raise a cautionary note that fossil fuel consumption will also rise dramatically. Indeed, by 2040, India will be among the world's largest oil consumers and importers with domestic oil product demand projected to be 9.8 million barrels per

[23] IEA, *India Energy Outlook*, p. 139.

[24] United Nations, *World Population Prospects: The 2015 Revision, Key Findings and Advance Tables, Department of Economic and Social Affairs*, Population Division, June 2015, Working Paper No. ESA/P/WP.241, p. 4, http://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf; IEA, India Energy Outlook, p. 29.

day (mmbd) and crude oil imports in excess of 7 mmbd (a 100 percent increase over 2015).[25] Over the next 25 years, India will have the largest absolute growth in global oil and coal consumption of any country.[26] The latest data, as of January 2016, indicates that India has over 75 GW of new coal generation capacity under construction with another 214 GW at various planning stages.[27] To fuel these plants, as well as new and existing cement and steel facilities, as noted, India plans to more than double domestic coal production helping to offset some of India's coal imports, which account for nearly 200 million tons of coal.[28]

These prodigious growth plans need to be viewed against a host of obstacles that India has had in the past and may continue to have in the future in expanding its coal production. As the Sierra Club's "Boom and Bust 2016" report notes, since 2010, nearly 390 gigawatts of projects have been put on hold owing to a host of hurdles.[29] These include the inability of financially-strapped distribution companies to pay for fuel, land acquisition difficulties, environmental opposition against new coal mines and power plants, and the high cost of coal imports relative to the distribution companies' ability to charge their customers tariffs that reflect the real cost of power.[30]

India's current energy trends and the future of its energy mix thus play a critical role in assessing global progress towards the two-degree Celsius threshold. This chapter assesses the status of low-emitting sources (wind, solar, biomass, hydropower, and nuclear) and fossil fuels in India's energy mix, as well as the current challenges facing India's energy infrastructure and regulatory framework.

The State of India's Fuel Mix

In the rush to project that India will move away from coal and into a world of renewables (including large hydro) and nuclear power, many energy scholars at times gloss over the fact that nearly three quarters of Indian energy demand is supplied by fossil fuels and that this share has been rising as people migrate to cities, where they move away from cooking with biomass either to liquefied petroleum gas (LPG) or in some cases charcoal.[31] In addition, some wealthier consumers replace kerosene use with electricity, while the urban poor continue to utilize kerosene especially for lighting. Nevertheless, coal remains the primary fossil fuel in India, accounting for nearly 75 percent of power generation and 43 percent of primary fuel consumption.[32] Understanding the state of India's fuel mix—and the place of coal therein—is essential to understanding the challenges India faces in implementing a climate-conscious economic growth agenda. While a more detailed analysis of the future of India's energy

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[25] IEA, *India Energy Outlook*, p.118.
[26] Ibid, p. 139.
[27] "Global Summary Comparison 2015-2016," *Global Coal Plant Tracker*, accessed 11 April 2016, http://endcoal.org/wp-content/uploads/2016/01/Global-Coal-Plant-Tracker-December-2015-Summary-comparison-2015-2016-New.pdf.
[28] Pallavi Pengonda, "Could Coal India become a victim of its own success?" *Livemint*, 06 January 2016, http://www.livemint.com/Money/Kn5Mop973y34QjOOiTUu6J/Could-Coal-India-become-a-victim-of-its-own-success.html.
[29] Christine Shearer, Nicole Ghio, Lauri Myllyvirta, Aiqun Yu, and Ted Nace, "Boom and Bust 2016: Tracking the Global Coal Plant Pipeline," *Sierra Club*, Coalswarm, Greenpeace, March 2016, p. 45, http://sierraclub.org/sites/www.sierraclub.org/files/uploads-wysiwig/final%20boom%20and%20bust%202017%20(3-27-16).pdf.
[30] Ibid, p. 46.
[31] For examples see: Gevorg Sargsyan, Mikul Bhatia, Sudeshna Ghosh Banerjee, Krishnan Raghunathan, and Ruchi Soni, "Unleashing the Potential of Renewable Energy in India," *The World Bank*, 2011, http://elibrary.worldbank.org/doi/pdf/10.1596/978-0-8213-8780-1; and Rahul Tongia (Ed.), "Blowing Hard or Shining Bright?: Making Renewable Power Sustainable in India," Brookings India, New Delhi, 2015, http://www.brookings.in/wp-content/downloads/renewable_energy_final_new.pdf.
[32] Primary fuel consumption includes transportation and cooking – oil products constitute 29 percent of final consumption and biomass accounts for another 34 percent, and excludes coal used for power generation. For data see Central Statistics Office (CSO), *Energy Statistics 2015*, Economic Statistics Division, Ministry of Statistics and Programme Implementation, March 2015, http://mospi.nic.in/Mospi_New/upload/Energy_stats_2015_26mar15.pdf.

landscape is presented later in this paper, a brief overview of India's INDC goals is presented here.

On October 1, 2015, India released its long-awaited INDC to the UNFCCC. India's INDC's ultimate goal, by 2020, is to bring the country's total GDP emissions intensity down by 20 to 25 percent over 2005 levels.[33] As noted, the plan builds on India's previous commitment to build 175 GW of renewable energy by 2022 and sets a new target for non-fossil fuel based power capacity to nearly 40 percent in 2030, though achievement of these goals is contingent on receiving large financial support from the developed world.[34] The INDC also made a commitment to reduce India's emissions intensity per unit of GDP by 33 to 35 percent below 2005 levels and to create an additional carbon sink of 2.5 to 3 billion tons of carbon dioxide through reforestation.[35] All of these goals are to be achieved by 2030.

Wind

To date most of the expansion of renewable capacity has been wind-powered generation, accounting for 23.76 GW of the 36 GW of renewable capacity in 2015, excluding hydro.[36] India is now the fifth largest wind power producer in the world and has begun to develop an export capacity, especially to East Africa. While India is believed to have a theoretical wind capacity of more than 100 GW, it has set a target of 60 GW of installed wind capacity by 2022.[37] However, with the decision in the new budget passed at the end of March 2016 to remove accelerated depreciation for wind facilities it seems likely that this target may be missed or slowed.

Solar

It is in the solar arena, however, that India hopes to achieve a significant portion of its 40 percent fossil-free electricity capacity by 2030.[38] The GoI hopes to achieve this goal not only through the rapid acceleration of renewable capacity but also sizeable growth in nuclear power and large-scale hydro. Even prior to Modi's ascension to the prime minister's office in 2014, India had been pursuing an expansion in solar energy capacity. By the end of 2015, India's total installed solar generation was just less than 5 GW.[39] That same year, India released its INDC goals, announcing an ambitious target of 100 GW of installed capacity by 2022 with further additions in the pipeline.[40] This plan is predicated on the achievement of several initiatives including: the development of 25 solar parks, construction of ultra-mega solar power projects, canal top solar projects to reduce pressure on land availability and water conservation, and the introduction of 100,000 solar pumps for farmers.[41] In addition, the GoI has set a challenging target of 4,200 megawatts (MW) of grid-interactive rooftop solar PV plants by 2019-2020.[42] Already it is possible to generate solar power from rooftops at around INR 6.50/kWh. During the last year, India has experienced

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[33] GoI, *India's INDC*, p. 8.
[34] GoI, *India's INDC*, p. 29.
[35] Ibid.
[36] Bhagyathej Reddy Y, Abhishek Anand, and Susheel Kumar, "Renewable energy's transformation of the Indian electricity landscape," *PricewaterhouseCoopers*, 2015, p. 4, http://www.pwc.in/assets/pdfs/publications/2015/renewable-energys-transformation.pdf.
[37] GoI, *India's INDC*, p. 9.
[38] IEA, *India Energy Outlook*, p. 13.
[39] Central Electricity Authority "All India Installed Capacity (in MW) of Power Stations," *Government of India Ministry of Power*, 29 February 2016, http://www.cea.nic.in/reports/monthly/installedcapacity/2016/installed_capacity-02.pdf.
[40] GoI, *India's INDC*, p. 9.
[41] Ibid.
[42] Cabinet Committee on Economic Affairs, "A Big Boost for Solar Rooftops in India," *Press Information Bureau Government of India*, 30 December 2015, http://pib.nic.in/newsite/PrintRelease.aspx?relid=134026.

unpresented growth of 66 percent for installed rooftop solar capacity reaching 525 MW.[43] Additionally, according to India's INDC, "[the] Government of India is also promoting the solarization of all the 55,000 petrol pumps across the country out of which about 3,135 petrol pumps have already been solarized."[44] It should be noted that many of these grandiose programs launched with such vigor by the Prime Minister often receive inadequate funding to implement them on a substantial scale or are slowed by other policies given conflicting budgetary priorities. For example, India's 2016 budget calls for a dramatic reduction in the amount given for accelerated depreciation for rooftop solar projects commencing in 2017. Offsetting this change, however, is a projected surge in funding for rooftop solar in 2016 in anticipation of a change in policy next year.

Despite financial constraints, the Indian solar sector is of great interest to both domestic and international investors. Ernst & Young estimates that nearly $100 billion of investment will be needed for renewables, largely solar, over the next five years.[45] Companies such as General Electric, recognizing the need down the road for electricity storage if renewables are going to take off on the scale envisioned by PM Modi, recently announced that its consulting business was chosen by IL&FS, one of India's leading infrastructure developers and financiers "to examine the feasibility of integrated wind, solar and energy storage projects at sites in Ramagiri (Andhra Pradesh) and Nana Layja (Gujarat)."[46]

Biomass

Prime Minister Modi also has ambitious plans for biomass energy. According to India's INDC, biomass only accounts for "about 18 percent of total primary energy use in the country and more than 70 percent of the country's population depends on it."[47] However, because a large amount of it is used indoors, it causes terrible pollution and sanitation issues, posing a major health hazard. Similarly, when biomass is used outdoors, it contributes to urban pollution since, even if burned on the outskirts of major urban areas, the smoke often wafts into the city, causing major local pollution and serious health hazards.[48] While biomass is estimated to account for about 4.4 GW of capacity today, there are plans to increase its contribution to 10 GW by 2022.[49]

Hydropower

Historically, hydropower has played a significant role in India's electricity mix. In 2015, hydroelectric installed capacity comprised about 46.1 GW, of which 4.1 GW was from small plants up to 25 MW and the rest large-scale hydro.[50] However, despite many available resources both in India and in its neighboring countries (Bhutan, Nepal, and Pakistan), hydroelectricity's role has declined since the sixth Five Year Plan (1980 to 1985), when it accounted for 34 percent of total installed power generation capacity.[51] Since 2003, successive governments have expressed interest in re-energizing the underutilized resource with a 50,000 MW hydropower initiative.[52]

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[43] "India's rooftop solar capacity at 525 MW; TN leads the way," *Zeenews*, 18 November 2015, http://zeenews.india.com/news/eco-news/indias-rooftop-solar-capacity-at-525-mw-tn-leads-the-way_1823385.html.
[44] Ibid.
[45] Ben Warren (Chief Editor), "Renewable Energy Country Attractiveness Index," Issue 43, *Ernst & Young Global Limited*, March 2015, p. 7, http://www.ey.com/Publication/vwLUAssets/Renewable_Energy_Country_Attractiveness_Index_43/$FILE/RECAI%2043_March%202015.pdf.
[46] "GE to Evaluate Renewable Integration and Energy Storage Possibilities in India," *General Electric*, 2 March 2016, http://www.genewsroom.com/press-releases/ge-evaluate-renewable-integration-and-energy-storage-possibilities-india-282696.
[47] GoI, *India's INDC*, p. 9.
[48] World Health Organization (WHO), "Household air pollution and health," updated February 2016, http://www.who.int/mediacentre/factsheets/fs292/en/.
[49] GoI, *India's INDC*, p. 9.
[50] Ibid.
[51] Charles K. Ebinger, *Energy and Security in South Asia: cooperation or conflict?*, Brookings Institution Press, Washington D.C., 2011, p. 45.
[52] Ibid.

Despite hydropower's vast potential—Nepali hydropower alone could, if developed, provide over 43,000 MW of export capacity—there are a number of impediments to its growth.[53] First and foremost, hydropower projects routinely run over budget and behind schedule as a result of the myriad approvals—especially environmental permits—that are required, as well as the legal complexities of land acquisition, both for the dam as well as for the transmission lines needed to evacuate the power. There are also contentious issues relating to the high level of sediment in the rivers, which, if not addressed, can reduce reservoir storage capacity as well as cause substantial damage to generation turbines. In addition, the melting of the Himalayan glaciers is placing strains on the availability of water supplies, raising questions about the wisdom of a further expansion of Indian hydropower as well as about imports from Bhutan and Nepal.[54] Furthermore, the scarcity of available land creates political opposition to new projects, especially where populations have to be displaced to allow construction of the reservoir. There is also great concern about the high level of seismic activity in the Himalayas, which could pose a grave risk of a dam collapsing, threatening the lives of tens of thousands of people. India's fledging environmental movement, supported by international groups, has also opposed several projects based on the proposed facility's impact on local and regional flora and fauna, including fisheries, as well as the impact on the downstream riparian environment. India is also concerned about China's diversion of the critical headwaters of several rivers on the Tibetan Plateau-most notably the Brahmaputra, which is a vital water source for both India and Bangladesh. These developments are of grave concern to senior Indian military officers who see this and Chinese territorial claims in India's hydro-rich northeast as major security threats to the country.[55]

Despite these problems which are highly contentious among both advocates for and against hydropower expansion, the Indian government and the IEA forecast that hydropower will grow to 100 GW by 2040.[56] To be fair, most projections see the greatest growth in the latter part of this time horizon and believe that new facilities will mostly be in India's northern and northeastern regions. At the same time, there is great enthusiasm for smaller (10 MW or less) run of the river projects particularly to meet the power needs of remote mountainous areas. India's 2015 national budget announced allocations to increase small hydro installed capacity up to 5 GW by 2022.[57]

Nuclear

As part of its effort to diversify away from fossil fuels and unreliable sources of imported energy, India has pursued the development of both conventional and advanced nuclear technologies since the early 1950s. India has 21 reactors in operation with a total capacity of 5,302 MW.[58] Nuclear power generation currently accounts for about 2.2 percent of total installed electricity generation capacity and is growing with an additional six reactors at an installed capacity of 4,300 MW in various stages of construction or commissioning.[59] Forecasts for nuclear power development vary widely in India, as progress in finishing nuclear projects has been sluggish owing largely

[53] Priti Kumar, et al, "Nepal: Scaling Up Electricity Access through Mini and Micro Hydropower Application," *The World Bank*, Vol. 1, No. 96844, 2015, p. x, http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/SAR/2015/09/30/090224b0831133c0/2_0/Rendered/PDF/Nepal000Scalin0ing0a0future0roadmap.pdf.
[54] Ebinger, *Energy and Security in South Asia*, p. 45.
[55] Ibid, p. 46.
[56] GoI, *India's INDC*, p. 9; IEA, India Energy Outlook, p. 132.
[57] Reddy Y et al, "Renewable energy's transformation of the Indian electricity landscape," p. 4,
[58] "Nuclear Power in India," *World Nuclear Association*, Updated April 2016, http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/india.aspx.
[59] GoI, *India's INDC*, p. 10.

to safety concerns in a post-Fukushima era and funding. For example, the Jaitapur nuclear project, originally commissioned back in 2009, has been fraught with liability constraints and drastic cost increases, pushing the start of construction to early 2017.[60] However, concerns about climate change and India's keen interest in developing a thorium fuel cycle are powerful catalysts, pushing the country to accelerate their nuclear development.[61]

While some observers believe that India, as a non-signatory to the Treaty on the Non-Proliferation of Nuclear Weapons, may emerge as one of the world's leading commercial nuclear technology exporters—especially if it can commercialize its research on thorium reactors, for which India has huge thorium reserves—I remain skeptical that India will easily overcome its chronic technological problems as well as public opposition to become a major player in the international market, as discussed further in this paper. Nonetheless, with Russia and China also potentially emerging as major commercial nuclear vendors, the geopolitics of the nonproliferation regime may change dramatically as traditional vendors in France, Japan, and the United States find it difficult to compete against vendors enjoying significant government financial support.

Coal

Despite the significant plans for growth in non-CO_2 emitting sources (solar, wind, hydro, biomass, and nuclear), coal-based power has been and will remain critical to India's energy infrastructure and development trajectory, though the extent of which is debatable. According to the EIA, China and India together comprised 98 percent of the global increase in international coal trade from 2008 to 2013; however, China's imports have started to decline moderately commencing in 2014, while India's imports have continued to rise as consumption has outpaced domestic production.[62] However, it should also be noted that China's domestic coal production has continued to rise, albeit modestly. As of February 29, 2016, electric power coal generation accounted for 175 GW, over half of the country's total installed electricity capacity of 288 GW.[63] However, it is important to note that as a result of a variety of factors discussed later in the paper, electric power generation has been running at very low plant load factors with a large amount of coal capacity, shut down as the result of a lack of demand and the collapse of global commodity prices that have led other fuels to be competitive or even slightly lower in price than coal.[64] Nonetheless, despite these difficulties, coal remains paramount as highlighted in India's INDC submission, which states categorically that "coal will continue to dominate power generation in [the] future."[65]

Coal and lignite are not only both abundant and cheap, making them ideal from a cost perspective as fuels to expand energy access in India. The industry also remains a major generator of employment, with IEA estimates of roughly 1.5 million people working in the coal sector. Yet competition is growing as employment opportunities in renewables increase.[66] The coal industry has benefited from long-standing institutional arrangements that have won it powerful allies in both industry and government at both the central and state levels. Coal subsidizes other rail freight and

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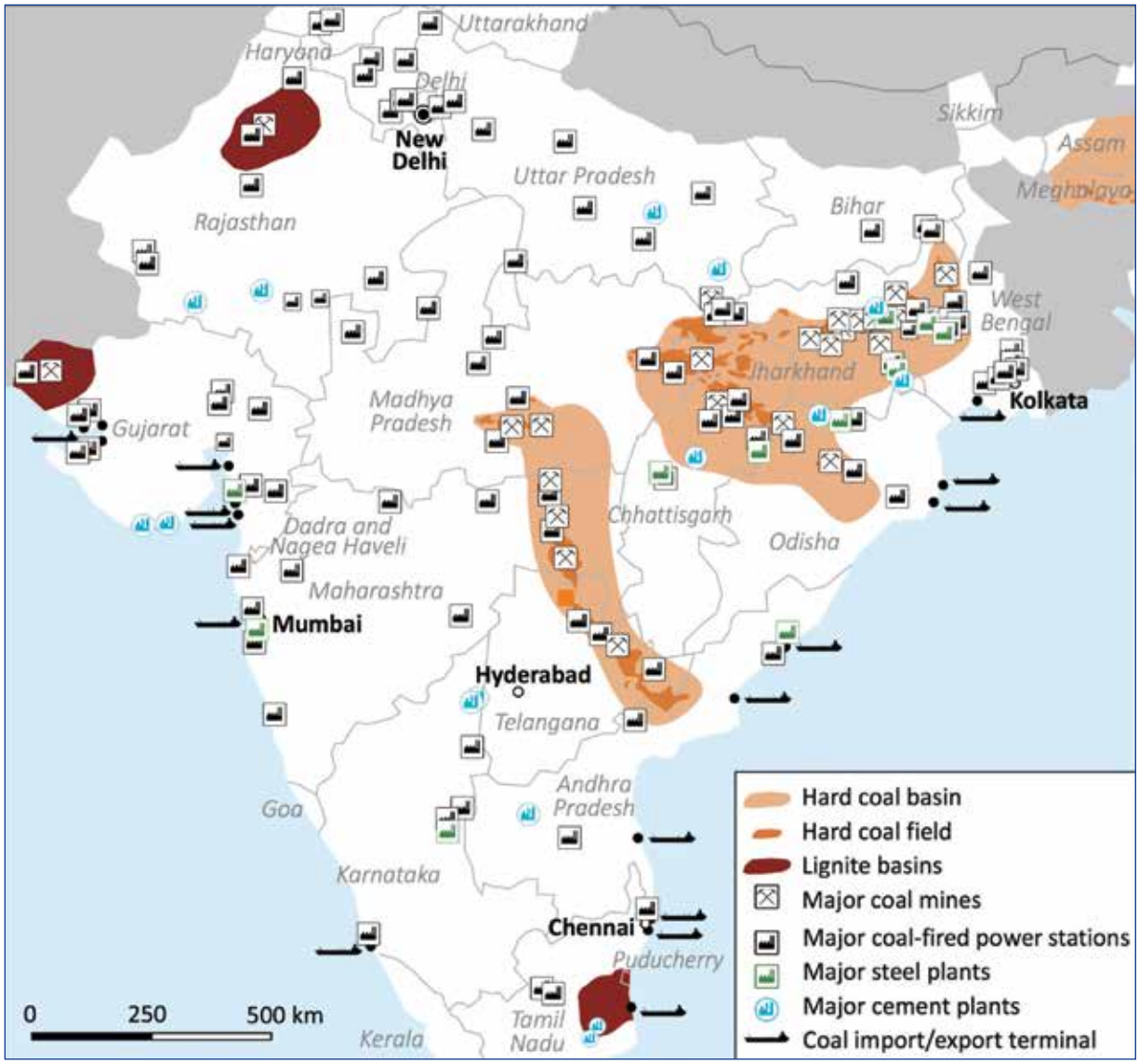
[60] Anil Sasi, "Jaitapur nuclear project: Renewed push, amid lingering concerns," *The Indian Express*, 27 January 2016, http://indianexpress.com/article/business/business-others/jaitapur-nuclear-project-renewed-push-amid-lingering-concerns/.
[61] "Nuclear Power in India."
[62] Mike Mellish, "China and India drive recent changes in world coal trade," *U.S. Energy Information Administration*, Today in Energy, 20 November 2015, https://www.eia.gov/todayinenergy/detail.cfm?id=23852.
[63] CEA, "All India Installed Capacity (in MW) of Power Stations."
[64] "Load factor of power companies may fail to pick up in FY17: India Ratings & Research," *Economic Times*, 4 February 2016, http://articles.economictimes.indiatimes.com/2016-02-04/news/70343872_1_demand-growth-india-ratings-research-electricity-demand.
[65] GoI, *India's INDC*, p. 10.
[66] IEA, *India Energy Outlook*, p. 144.

Figure 1: Main coal-mining areas and coal infrastructure in India



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.
Source: *IEA, India Energy Outlook, p. 110)*

is located predominately in a handful of politically important states such as Assam, Jharkhand, and West Bengal (see Figure 1).

While India's efforts at diversifying its power sector away from fossil fuels (especially coal) are noteworthy, it cannot bring electricity to all households by 2022 without coal. As noted, India targets non-fossil generation to constitute 40 percent of total installed power capacity by 2030; yet as of 2014, the EIA estimates non-fossil installed capacity was already at 31 percent, making this target appear quite achievable.[67] The GoI plans: (1) to achieve expanded energy access for

[67] "India," *U.S. Energy Information Administration*, 26 June 2014, p. 19, https://www.eia.gov/beta/international/analysis_includes/countries_long/India/india.pdf.

all its citizens; (2) to meet its rapid urbanization goals (construction of a 100 Smart Cities); and (3) to industrialize its economy—all of which will require coal to remain a vital component of the energy mix.[68] The continued importance of coal is demonstrated further by the formal plans of the Indian government to build 455 new coal plants, comprising 35 percent of the world's new coal fired plants planned worldwide by 2030, according to the World Resources Institute (WRI).[69] WRI's view is shared by the IEA which argues that coal will continue to make the largest contribution to electricity generation in India through 2040, owing to: (1) India's need for economic development; (2) its massive urbanization program which will require large volumes of coal to produce the requisite amounts of cement, steel, and other construction materials; (3) to expand electricity access; and (4) to develop a major manufacturing base.[70] This large expansion in coal use, of course, does not have to happen, but barring a major transformation in current Indian policy and a large infusion of outside financial support, estimated in the INDC to be in the order of $2.5 trillion (at 2014-15 prices), it seems likely that Indian electricity policy will at best change only at the margin.[71]

Recognizing that CO_2 emissions from coal need to be addressed, the Indian government has announced that going forward, only supercritical or ultra-supercritical coal plants (if and when the technology becomes commercially viable) will be allowed to be constructed.[72] While this commitment is commendable, it will pose difficult financial problems for the country, since, according to the World Coal Association, "analysis shows that if all coal plants built from 2020 onwards were ultra-supercritical, total capital expenditure would reach $500 billion by 2040 compared to around $387 billion, if all coal plants built from 2020 onwards were subcritical."[73]

Oil and natural gas

Alarmed by the size of India's trade deficit and the prospect that energy imports will skyrocket in the future, Prime Minister Modi has called for a "fresh" look at the petroleum sector. Modi's attention has focused on new policies to reduce rapidly rising consumption, which in the past has been fueled by heavily subsidized petroleum products and tightly regulated natural gas prices that have discouraged private sector interest in petroleum exploration, especially offshore. India has about 5.7 billion barrels of proven crude oil reserves.[74] The majority of India's domestic oil production is from western offshore fields, most notably the Mumbai High Basin, which in 2015, accounted for roughly 40 percent of India's total crude oil production.[75] Oil production also occurs in significant amounts in the onshore Cambay Basin in India's northwest and the Assam-Arakan Basin in the northeast of the country. Despite efforts over the past two decades through various licensing rounds to encourage foreign investment, oil production has not kept pace with skyrocketing energy demand.

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[68] IEA, *India Energy Outlook*, p. 39.
[69] Ailun Yang and Yiyun Cui, "Global Coal Risk Assessment: Data Analysis and Market Research," *World Resources Institute (WRI)*, November 2012, http://www.wri.org/sites/default/files/pdf/global_coal_risk_assessment.pdf.
[70] IEA, *India Energy Outlook,* p. 39.
[71] GoI, *India's INDC*, p. 31; N.b. While these growth projections have been scaled back, especially since the collapse in global commodity prices and falling global energy demand, India's *INDC* submission shows the degree to which India's shift away from fossil fuels will require capital formation, mobilization and investment both from within India and from foreign investors on a scale not previously ever achieved since the enactment of the 1991 economic reforms.
[72] GoI, *India's INDC*, p. 10.
[73] "The Case for Coal: India's Energy Trilemma," World Coal Association, November 2015, http://www.worldcoal.org/sites/default/files/WCA%20report%20-%20India%27s%20Energy%20Trilemma.pdf.
[74] IEA, *India Energy Outlook*, p. 32.
[75] Promit Mukherjee, "ONGC finds major crude reservoir in Mumbai High: Govt," *Livemint*, 16 May 2015, http://www.livemint.com/Companies/VzdUzJLMcu4IHj3qE3uw2H/ONGC-finds-major-crude-reservoir-in-Mumbai-High-oil-ministe.html.

According to the EIA, petroleum and other liquids in 2012 accounted for about 22 percent of India's total energy consumption while natural gas comprised about 7 percent.[76] India is one of the world's fastest expanding oil and gas markets necessitating large scale imports of oil, gas and coal. In 2013, India produced less than 1 mmbd of oil while consuming 3.7 mmbd, nearly 4 times India's production.[77] In sharp contrast, natural gas production in 2014 was 850 billion cubic meters (bcm) and while shale gas recoverable resources are estimated to be plentiful (with IEA estimates at about 96 trillion cubic feet), there is currently no commercial production.[78]

Recognizing that India's oil and natural gas usage is expected to accelerate over the next several decades, the Indian government has commenced policies to accelerate domestic oil and gas exploration. While still very controversial in some segments of the Indian body politique, the GoI recognizes that to achieve this goal, it must modify its historic nationalistic attitude and adopt policies to attract the technological expertise and financial capacity of the international oil and gas industry. As part of this process, Indian authorities are preparing a new more transparent exploration policy that will make it easier for companies to participate in the auction of hydrocarbon blocks with promising reserves.

In addition, the Indian government has adopted a plan to "reassess" the hydrocarbon potential of all its sedimentary basins by the end of 2016, giving special attention to basins that have never been assessed.[79] To facilitate this process, the GoI has inaugurated changes in its production sharing contracts to win the confidence and interest of investors. The GoI plans to raise its price for domestic undeveloped gas discoveries by 60 percent.[80] The GoI is moving to establish a national gas grid and plans to add another 15,000 km of gas pipelines in order to better connect sources to areas with high demand.[81]

After procrastinating for many years, the Indian government, in the fall of 2014, finally deregulated the price of diesel fuel. However, as Rahul Tongia argues, owing to differential taxes and other market distortions, diesel is cheaper at the pump than gasoline despite diesel fuel having about 15 percent more energy per liter.[82] While one policy prescription might be to raise diesel taxes or prices, it could make sense to levy a national consumer diesel tax on the registration of all diesel vehicles (both personal and commercial), generating major air pollution benefits.

In addition, the government of India inaugurated a new pricing regime for LPG effective January 1, 2015.[83] While LPG remains subsidized under the new program, the subsidy is sent directly to consumers, reducing the diversion of subsidized LPG canisters for household cooking to the commercial and industrial sectors. The introduction of smaller 5 kg canisters on a cash and carry

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[76] EIA, "India," p. 3.

[77] *BP Statistical Review of World Energy 2015*, 64th edition, British Petroleum, June 2015, p. 8-9, http://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2015/bp-statistical-review-of-world-energy-2015-full-report.pdf.

[78] IEA, *India Energy Outlook*, pp. 115, 122.

[79] Sujay Mehdudia, "Moily sets up team to reassess hydrocarbon resources," *The Hindu*, 21 January 2014, http://www.thehindu.com/news/national/moily-sets-up-team-to-reassess-hydrocarbon-resources/article5597663.ece.

[80] PTI, "Government to hike natural gas price for ONGC, Reliance Industries by 60%," *Economic Times*, 3 March 2016, http://economictimes.indiatimes.com/industry/energy/oil-gas/government-to-hike-natural-gas-price-for-ongc-reliance-industries-by-60/articleshow/51236911.cms.

[81] Government of India, "AIMS and Objectives of National Gas Grid," Ministry of Petroleum & Natural Gas, 13 May 2015, http://pib.nic.in/newsite/PrintRelease.aspx?relid=121645.

[82] Rahul Tongia, "Budget 2016: Reduce & refocus power & diesel subsidies," *The Economic Times,* 23 February 2016, http://economictimes.indiatimes.com/industry/energy/power/budget-2016-reduce-refocus-power-diesel-subsidies/articleshow/51105956.cms.

[83] Ministry of Petroleum and Natural Gas, *Annual Report 2014-15*, Government of India, p. 5, http://petroleum.nic.in/docs/Annual_Report/AR14-15.pdf.

basis has also helped disseminate LPG as an affordable and cleaner fuel to segments of the population that use charcoal, kerosene, and fuelwood. As part of the reform package, the GoI has also designated the transport sector as the highest priority both for piped gas and compressed natural gas (CNG) and outlined a plan to establish 35,000 retail outlets and 7,000 LPG distributors to ensure that LPG can be delivered to the most remote regions of the nation.[84]

India's natural gas sector is potentially very promising. Domestic natural gas production has increased steadily, and with India post Paris under pressure from the international community to curtail its rising CO_2 emissions, expansion of natural gas consumption along with renewables, including hydro and nuclear, can provide a low carbon bridge to a clean energy future. In 2014, India produced 31.7 bcm of natural gas far below its domestic demand of 50.6 bcm, despite having proved reserves at 1.4 trillion cubic meters (50.4 trillion cubic feet).[85] The remainder was imported via liquefied natural gas (LNG), since India currently has no pipeline connections to other countries, though a number of projects have been talked about for years (Turkmenistan-Afghanistan-Pakistan-India pipeline, Iran-Pakistan-India pipeline, undersea from Oman, and gas from Myanmar via Bangladesh). Currently, domestic production is concentrated offshore with the Mumbai High Field and the Krishna-Godavari Basins as the primary domestic production zones. The production of onshore gas is mostly in Gujarat, Andhra Pradesh, and Assam. Some analysts believe that natural gas consumption could grow dramatically if discoveries off India's southeastern coast prove to be as prolific as forecast, and projects for expanding LNG, pipeline gas and India's substantial reserves of shale gas materialize.[86] Another unknown is whether the Modi government's decision to raise gas prices for producers and the terms of production sharing contracts discussed above will lead to greater interest in new gas exploration, especially given the depressed nature of the international LNG market in Asia.

Despite these caveats, demand for gas has exploded in recent years and is expected to increase dramatically over the coming decades. Demand for gas has risen owing to its greater availability, development of a transmission and distribution infrastructure, the pricing of gas in comparison to alternative fuels, natural gas's environmental benefits in comparison to oil and coal, and the favorable economics of supplying gas to consumers at reasonable prices. Projections for the future of natural gas in India vary with the IEA estimating a share of only 8 percent of the fuel mix by 2040, to India's Petroleum and Natural Gas Regulatory Board's estimate of 20 percent by 2025.[87] The variations depend on whether gas supplies are used in electricity generation or diverted elsewhere in the economy. Given Prime Minister Modi's greater interest than his predecessors in renewables and domestic coal in comparison to oil and gas, it remains to be seen whether concern over rising oil and gas import bills galvanizes Modi into changing his pricing policies to encourage greater domestic production. While electricity is the largest consumer of natural gas in India, the fertilizer sector comes in second, representing 31 percent of total gas consumption.[88] However, while gas

[84] Ibid.
[85] *BP Statistical Review of World Energy 2015*, p. 20-23.
[86] CSO, Energy Statistics 2015, p. 40; Anupama Sen, *Gas Pricing Reform in India: Implications for the Indian gas landscape*, The Oxford Institute for Energy Studies, April 2015, http://www.oxfordenergy.org/wpcms/wp-content/uploads/2015/04/NG-96.pdf.
[87] IEA, *India Energy Outlook*, p. 57; "Vision 2030" *Natural Gas Infrastructure in India*, Industry Group for Petroleum & Natural Gas Regulatory Board, 2013, p. 8, http://www.pngrb.gov.in/Hindi-Website/pdf/vision-NGPV-2030-06092013.pdf.
[88] "Vision 2030," pp. 18, 23.

demand in power generation is rising it is falling in fertilizer production owing to higher growth in other sectors. Gas demand is also rising as a result of better pipeline connectivity to regions of the country not previously connected to gas supplies.

Demand is also expected to be robust in India's transportation sector. While natural gas vehicles are a small percentage of the national automobile fleet with a little over 1,500,000 vehicles, India has the sixth-largest natural gas vehicle fleet in the world behind China, Brazil, Argentina, Pakistan, and Iran.[89] In addition, following a 1998 Supreme Court ruling which required all commercial vehicles in Delhi to use natural gas by 2001, an effort to reduce air and groundwater pollution, there has been an explosion in demand for gas-powered vehicles.[90] While the law may not always be fully adhered to, it has provided a catalyst for further development of CNG technology.

As a result of disappointing developments in domestic gas supplies, commencing in 2004, India began to be a significant importer of LNG and is expected to import nearly 80 bmc of natural gas in 2040, with LNG representing 85 percent of the total.[91] However, one of the major obstacles to greater LNG usage (in addition to the high cost of receiving and regasification terminals) has been the high cost of imported LNG, which until the collapse of LNG prices in 2015, has been a serious drain on the Indian economy, especially since the government has attempted to shield consumers by keeping domestic prices down leading to large foreign exchange costs on the Indian government's budget. Nonetheless, in the view of many analysts, India remains one of the potential large growth markets for LNG in Asia, and with LNG, imported coal and oil prices at current depressed levels, India may get some breathing room from what had previously been financially dangerous energy import bills.

The Collapse in Global Commodity Prices

The impact on the Indian energy sector and economy unleashed by the fall in global commodity prices in 2015 cannot be overstated. Even though in 2015, the nation experienced a major shortfall in hydroelectric capacity (the result of a bad monsoon), India found itself with a huge volume of idled electric generation capacity, which some observers placed over 10,000 MW, consisting mainly of coal-fired generation.[92] The reason for these market developments was a major collapse in energy demand, lower tariffs, and the debt burden of many coal mining companies which had to give up their mining licenses following a court verdict on illegal allocation of coal fields. In other instances, power generation companies were nearly insolvent and could not pay their suppliers, because they, in turn, were not being paid by the distribution companies, which could not collect from end-use consumers as the result of subsidized prices. Coal demand was also affected by declines for coal in the steel and cement industries. In late 2015 and on into early 2016, there was a precipitous fall in the prices of oil, coal, diesel fuel, naphtha, bunker fuel and LPG, which India utilizes in electricity generation. Before the price collapse, many power stations using fuels other than coal had been unable to operate because of the high costs of LNG and petroleum products. When the prices fell, the drop was so significant that these fuels suddenly became less

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[89] Fazal Ali Khan, "ACT Expo/NGV Global 2014," *Emirates Gas*, Presented 7 May 2014, slide 4, http://www.gladstein.org/pdfs/ACTE2014Presentations/InternationalMarketUpdate/3FazalAliKhan.pdf.

[90] Malini Goyal with Supriya Bezbaruah, "Out of steam," India Today, 20 August 2001, http://indiatoday.intoday.in/story/delhi-switches-to-cng-but-problem-of-implementation-raises-doubts/1/230992.html.

[91] IEA, *India Energy Outlook*, p. 123.

[92] Anil Sasi, "Slowdown signal? Heat is on, but power demand flat," *The Indian Express*, 26 May 2015, http://indianexpress.com/article/india/india-others/slowdown-signal-heat-is-on-but-power-demand-flat/.

expensive, providing stiff competition for pit head coal-based power generation. In addition, stranded gas assets and liquid-based fuels were more competitive than coal. The financial pain extended beyond generation to all segments of the electricity sector, including: fuel suppliers and fuel transporters (railways, harbors, pipelines, etc.). As the crisis intensified, electricity generators, transmission companies, and distribution companies came under severe pressure from their customers in the final consumer market to cut prices and improve their operational efficiencies in an effort to survive the crisis. While some distribution companies (Discoms) tried not to cut prices by charging high tariffs to their bulk consumers, they found that these customers moved to solar and wind facilities or took over existing power plants in financial trouble to meet their captive consumption. With electricity demand at best tepid, coal stocks built up at power plants, leading to a near-term coal surplus and bolstering arguments of critics who believe that India's future coal needs may be vastly inflated.

Infrastructure

As the INDC report reminds us, while India has a nominal per capita GDP of $1,408 per annum, "around 363 million people (30 percent of the population) live in poverty, about 1.77 million people are houseless and 4.9 percent of the population (aged 15 years and above) are unemployed," illustrating the harsh nature of the economic disparity in Indian society both among people and regions.[93] Many of those who are employed do not have stable sources of income. In rural regions of the country, nearly 48 percent of households are fraught with having to survive on little or no basic socio-economic services.[94]

In short, India is on a collision course with modernity. This is not to suggest that India cannot meet the challenge, but merely recognizes for the radical transformation of the energy sector and the economy envisaged by Prime Minister Modi to occur, India must not fail to meet any of its major components, because if it does, there needs to be a backup plan on how to meet the shortfall. For example, if, as I argue later in the paper, nuclear energy fails to meet its targets (which it always has), which fuel will replace it? Similarly, if coal production targets fall short, which fuels will make up for the shortfall? Given the realities of peak electricity demand in the country, how does one avoid having backup thermal power when renewables cannot meet the load? Given that the goals in a number of India's past Five Year Plans often fall short of the forecasts, what happens if Modi's goals for renewable development don't meet his administration's targets?

Furthermore, India's INDC projects that perhaps India's biggest challenge will be a growing urbanization of the population, which is expected to rise from 30 percent today to 40 percent by 2030.[95] This urbanization, which also includes the development of 100 new Smart Cities, will raise the demand for housing and, as a consequence, demand for metals and other building blocks that go into constructing them, including prodigious volumes of steel, cement, electricity and primary fossil fuels. Indeed, it is estimated that more than 50 percent of the buildings, factories, homes etc. that India will need by 2030 have yet to be built, and the manner in which they are constructed will contribute dramatically to India's future energy consumption levels.[96]

Railways

For Prime Minister Modi to reach his goal of tripling domestic coal production, nothing is more

[93] GoI, *India's INDC*, p. 5.
[94] Ibid.
[95] Ibid, p. 6.
[96] Ibid.

important than improving the efficiency of coal production and the coal logistics system that transports it. This is a multi-front problem and involves massive investments in railroad infrastructure; coal mining efficiencies; guaranteed delivery of coal when it is needed at power and other industrial processing plants; greater efficiencies in railway dispatch by lifting freight-utilization rates through enhanced coal washing; lowering the tonnage of coal that has to be transported; and raising the thermal efficiency of coal-fired power plants to reduce the energy intensity of the electricity sector.

However, the problems listed above are only the tip of the iceberg of those confronting India's transportation infrastructure. Given the prodigious growth in transportation fuel demand and the campaign to increase current coal production within the next five years, the Prime Minister has led the charge to build a low carbon transportation infrastructure and public transportation system. As part of this effort, a dedicated freight corridor (DFC) plan and a major expansion in energy efficient railways serve as cornerstones.

Under India's INDC, "the share of railways in total land transportation [will increase] from 36 percent to 45 percent, thereby decreasing the load on less efficient diesel operated road traffic."[97] However, given the antiquated and dilapidated nature of the Indian rail network, this will require a herculean effort and a major budget with no sure sign of success. Previous attempts at upgrading India's railroads have required massive land acquisitions that generated political and social backlash, causing significant project delays.[98]

As a component of the plan, two DFCs (the 1520 km Mumbai-Delhi and the 1856 km Ludhiana-Dankuni) are currently under construction and, over a 30-year time horizon, are projected to reduce CO_2 emissions by 457 million tons.[99] Furthermore, with actions already underway at Indian railways, there have been significant emission reductions on specific routes.

Clearly, if the railroad logistics capacities are not enhanced, it will place severe constraints on coal transport from the mines to major consumption centers. This could make imported coal more financially attractive, especially at power plants located near India's coastal areas, further reducing the demand for domestic coal.

Ports and Waterways

For India to meet its forecasted energy future, based on large volumes of natural gas, oil, and coal imports, the upgrading and expansion of the nation's ports and waterways will have to play a major role in moving these resources to major consuming sectors. To deal with this issue, Modi, in conjunction with the dramatic efforts in railway development and modernization discussed above, has embarked on a major effort to expand coastal shipping and inland water transport. As part of this plan, the Indian government has announced the establishment of a National Water Way as well as the implementation of an integrated waterway transportation grid connecting all existing and proposed national waterways with rail, roads, and ports, which, once constructed, will allow the greater flow of energy commodities throughout the country.[100] While developing robust port infrastructure is key to increasing seaborne imports, it is also vitally

[97] Ibid, p. 14.
[98] Mamuni Das, "Freight corridor may have to take route diversion," *The Hindu*, 22 March 2010, http://www.thehindubusinessline.com/todays-paper/freight-corridor-may-have-to-take-route-diversion/article987153.ece.
[99] GoI, *India's INDC*, p 14.
[100] Ibid.

important to transport these commodities throughout the country. India's INDC accounts for this necessity by calling for the construction of 5,000 km of new roads along the coast.[101] The construction of these roads will require large amounts of cement, which is likely to increase the demand for coal outside the power sector.

Road Transportation

A further component of the government's ambitious transportation and environmental policies is a major expansion in mass transit in major metropolitan regions to reduce reliance on diesel vehicles. According to the IEA:

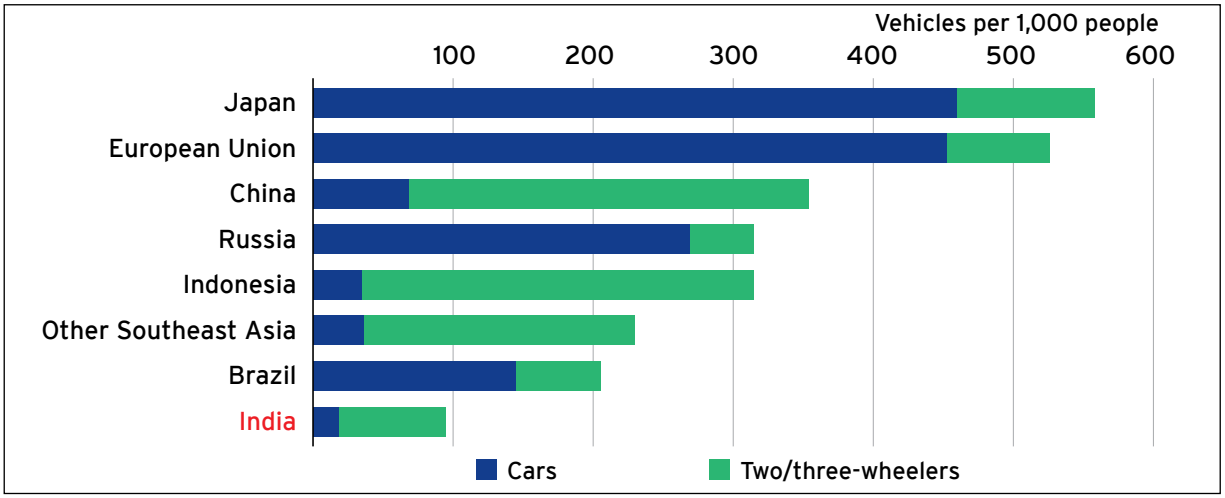
> "Over 90 percent of energy demand in the transportation sector in India is for road transport. The country's passenger light-duty vehicle (PLDVs) stock has increased by an average of 19 percent per year since 2000, rising to an estimated 22.5 million in 2013, with an additional 95 million motorbikes and scooters (two/three-wheelers)."[102]

It is also important to note that despite this explosive growth in vehicle ownership, vehicle levels are still significantly below other emerging market nations as well as developed ones (see Figure 2), suggesting the prospect of much greater energy demand in the future.

The Indian government has a major program to increase fuel efficiency standards in automobiles and is enacting policies to accelerate the development of hybrids and electric vehicles. It hopes over time to adopt a 20 percent biofuel blending requirement in petrol (with *Jatropha curcas* as the most likely feedstock for biodiesel production), but the development of such a large volume may intensify local pollution as well as urban environmental degradation from farms near major urban areas.[103]

Despite the government's keen interest in CNG, it also began a major shift towards electric vehicles in March 2016, with a highly unrealistic goal of 100 percent vehicle penetration by 2030.[104] While I believe this plan is utopian, given the problems

Figure 2: 2013 Vehicle Ownership in India compared to other regions



Source: *IEA, India Energy Outlook, p. 24.*

[101] Ibid, p 15.
[102] IEA, *India Energy Outlook*, p.24.
[103] GoI, *India's INDC*, p 16.
[104] Milafel Dacanay, "India wants to become the first country with 100 percent electric vehicles," *Tech Times*, 28 March 2016, http://www.techtimes.com/articles/144670/20160328/india-wants-to-become-first-country-with-100-percent-electric-vehicles.htm.

in the power sector, which would make the setting up of recharging stations all over the country at best difficult, the goal of Minister Piyush Goyal in pushing the scheme is to alleviate the oil import bill, which otherwise could represent a huge drain on government resources. The Minister wants this conversion to be self-financing, though he was loathed to present any proposals on how this might be achieved.

Electricity grid

Energy Minister Goyal has proposed a $50 billion program to upgrade the efficiency and capacity of the Indian electricity transmission and distribution grid.[105] A critical component of the investment plan is to slash the staggeringly high technical, commercial, and non-technical losses (theft), which officially totals around 25 percent on average but in reality is often much higher throughout the country.[106] The loss of nearly one quarter of the electricity generated is in the words of IEEFA, "financial suicide particularly when coupled with subsidized retail electricity prices."[107] In March 2015, the government proposed an amendment to the Federal Electricity Act of 2003, which would allow demand to dictate how the electricity market operates.[108] The amendments unbundled electricity distribution and supply, allowing customer choice and thereby fostering market competition. However, results have been mixed since, under Indian law, electric power produced and sold in a state is the state's regulatory responsibility. For political and social reasons, many states have been reluctant to raise tariffs, creating a situation where many Discoms are in difficult financial straits. This perilous state of affairs led Minister Goyal in a May 2015 address to state that the electricity sector was in crisis. Minister Goyal noted that in some states, the utilities "have T&D losses, with power theft upward of 40-50 percent" and that one state has losses of 70 percent, while many other states are in the region of 30-50 percent. The minister concluded that "if you run your operations inefficiently, you can't expect your consumer to pay for your inefficiencies."[109]

Institutions

While seldom noted by Indian energy specialists, the plethora of institutions (see Appendix A) involved across the electricity sector, often creates major problems for Indian energy policy. It is not uncommon for institutions in the power sector to conduct forecasts using different base numbers leading to widely different projections both of power supply and power demand as well as technical and non-technical losses. The formation of these various institutions began with India's shift away from British colonial power and its evolution toward democracy and the need for liberal economic policy.

Establishment of private power companies

By the mid-1980s, India's power sector was in crisis as a result of underpriced electricity and lack of investment in transmission and distribution (T&D), with most thermal plants running at an average of 23.5 percent efficiency, the lowest in Asia at that time.[110] By 1990, the state electricity boards (SEBs) owed more than INR 8 billion to the National Thermal Power Corporation, one of many of India's state-owned power companies.[111]

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[105] Tim Buckley, "India's Electricity-Sector Transformation," p 5.
[106] Ibid.
[107] Ibid, p. 19.
[108] Ibid.
[109] Sanjay Dutta interview with Energy Minister Piyush Goyal, "We got honest value of coal through auctions, says Piyush Goyal," *Times of India*, 18 May 2015, http://timesofindia.indiatimes.com/business/india-business/We-got-honest-value-of-coal-through-auctions-says-Piyush-Goyal/articleshow/47322786.cms.
[110] Ebinger, *Energy and Security in South Asia*, p. 25
[111] Ibid.

With the country on the brink of a major energy crisis, Prime Minister Narasimha Rao, supported by his Finance Minister Man Mohan Singh in 1991and 1992, launched a series of reforms across the energy sector designed to bring private investment into the country.[112]

While the implementation of reforms across the energy sector since 1991 has been uneven, the private sector has become ever more important in the Indian energy economy over time. Today the private sector is deeply involved in all aspects of electricity generation, transmission, and distribution, though it still accounts for only a small share of total generation capacity. The largest company is Adani Power with plants totaling about 10,480 MW.[113] Right behind is Tata Power which is India's largest integrated power company with a diverse portfolio (8,750 MW) of thermal, hydro, solar, and wind facilities.[114]

As in the case of the public sector utilities, electricity tariffs for independent power producers that sell power to more than one state are regulated by the Central Electricity Regulatory Commission (CERC), which also issues licenses for companies transmitting electricity across states. The CERC also arbitrates disputes between companies. As noted, State Electricity Regulatory Commissions have jurisdiction for establishing tariffs for state-owned utilities involved in the power sector in a single state.

[112] Ibid, p. 26-28.
[113] Adani Power Limited, *Sustainability Report 2014-15*, Ahmedabad, 2015, p. 6, http://www.adanipower.com/wps/wcm/connect/www.adanipower.com27944/d911db6f-4ef0-4dea-bbee-f9891c8e464a/43_FFReport_APL_Sustainability_Report_2014_15.pdf?MOD=AJPERES&CACHEID=d911db6f-4ef0-4dea-bbee-f9891c8e464a.
[114] "Pioneers in Power," *Tata Power Limited*, accessed 16 December 2015, http://www.tatapower.com/aboutus/pioneers-power.aspx.

3. India's Energy and Climate Policies

Energy stands at the forefront of the many challenges facing India today. As noted, despite being one of the largest consumers of fossil fuels in the world, India's per capita primary energy consumption is far below major emitters such as the United States and China. Furthermore, India is extremely vulnerable to climate change, with the majority of India's farms dependent on rain-fed agriculture and with nearly 175 million people who live along India's 7500 km coastline facing a high risk of sea level rise and extreme weather events.[115] In addition, a large proportion of India's glaciers, as well as those in Nepal and Bhutan feeding India's water supply, are receding at an accelerating rate, threatening millions of people in low-lying communities at the base of the Himalayas.[116] Deforestation continues throughout India, threatening critical human and wildlife habitats—especially in large forest reserves set aside for tribal populations where large-scale coal mining, much of it illegal, continues apace.[117]

Innumerable challenges in the energy and climate arena confront Prime Minister Modi and his government. With India's population projected to surpass China by 2022, energy demand and increasing climate vulnerability will only accelerate. Adding to this crucible is the need to meet global obligations to curb greenhouse gas emissions. Given these challenges, the success of Prime Minister Modi's energy and climate policy becomes essential, not only for India, but also for the success of the Paris climate agreement writ large.

In the next section, I first discuss the framework of India's future climate and energy policy as highlighted in its INDC plan, presented in October 2015 ahead of COP21. After discussing the plan's highlights (See Box 1) and key priorities, I turn to the likely impact of the INDC on India's emissions and the intersection of climate change mitigation and economic development within India's policy.

Formation of India's INDC

The INDC built upon India's existing environmental policy. Rooted in India's constitution (Article 48-A), the policy states, "The State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the

[115] GoI, *India's INDC*, pp. 20, 23.
[116] Samjwal Ratna Bajracharya, Sudan Bikash Maharajanm Finu Shresth, Om Ratna Bajracharya, and Sarju Baidya, *Glacier Status in Nepal and Decadal Change from 1980 to 2010 Based on Landsat Data*, International Centre for Integrated Mountain Development, May 2014, http://lib.icimod.org/record/29591/files/GSN-RR14-2.pdf.
[117] Ashish Fernandes, *How Coal Mining is Trashing Tigerland*, Greenpeace, 1 August 2012, http://www.greenpeace.org/india/Global/india/report/How-Coal-mining-is-Trashing-Tigerland.pdf.

country."[118] More specifically, India's overarching framework on environment and climate change is enshrined in the National Environmental Policy of 2006, which promotes sustainable development along with ecological constraints and the imperatives of social justice.[119] The National Action Plan on Climate Change (NAPCC), launched in 2007, reiterates the centrality of sustainable development as a policy goal but argues that there are benefits of addressing climate change concerns while promoting economic growth. The NAPCC is promoted through eight "National Missions" that highlight priorities for mitigation and adaptation to fight climate change (see Appendix B).[120] These broad policies are supplemented by the policies of state governments, NGOs, other stakeholders, and the private sector. The INDC highlights that 32 states and union territories have inaugurated State Action Plans on Climate Change that attempt to make sure that climate change issues are integrated into the planning process. The INDC notes that these policies are supplemented by other legislation and guidelines such as the Energy Conservation Act, the National Policy for Farmers, the National Electricity Policy, and the Integrated Energy Policy.[121]

Box 1: Highlights of India's INDC*

Fuel Mix:

- Share of non-fossil resources in installed power capacity to 40 percent by 2030
- Increase the share of renewables (wind, solar, bioenergy) installed power capacity cumulatively from 30 GW currently to 175 GW by 2022
- Raise nuclear capacity from its current 5.8 GW to 63 GW by 2032
- Upgrade the efficiency of 144 thermal coal plants, with the launch of the 13th Five Year Plan require that all new coal plants employ supercritical technology

Infrastructure:

- Under the National Smart Grid Mission: invest $6 billion in Green Energy Corridor projects to evacuate power generated by renewable energy sources
- Increase the share of railways in total land transportation from 36 percent to 45 percent
- Create two DFCs that over 30 years will reduce CO_2 emissions by 57 million tons
- Under the Smart Cities Mission and Atal Mission for Rejuvenation and Urban Transformation projects target infrastructural improvements in 600 cities

Efficiency:

- Under the National Mission for Enhanced Energy Efficiency (NMEEE) obviate the need for 20 GW of capacity additions, corresponding to 23 million tons of CO_2
- Under the forthcoming Vehicle Fuel Efficiency Program to be implemented starting April 2016 save 50 million tons of avoided CO_2 emissions

Finance:

- Implement a carbon tax on coal of INR 200 ($3.20) per ton to contribute to the National Clean Environment Fund
- National Adaptation Fund setup with initial allocation of INR 3,500 million ($55.6 million)
- Subsidies to be disbursed through direct cash transfers

* Information derived from: GoI, *India's INDC,* pp. 20, 23.

[118] Constitution of India, Part IV Directive Principles of State Policy, Article 48A, p. 21, http://lawmin.nic.in/olwing/coi/coi-english/Const.Pock%202Pg.Rom8Fsss(7).pdf.

[119] Ministry of Environment and Forests, National Environment Policy 2006, Government of India, 18 May 2006, http://www.moef.gov.in/sites/default/files/introduction-nep2006e.pdf.

[120] Government of India, Prime Minister's Council on Climate Change, National Action Plan on Climate Change, June 2008, http://www.moef.nic.in/downloads/home/Pg01-52.pdf.

[121] Energy Conservation Act of 2001, 60 Gazette of India § 52 (2001); Government of India Department of Agriculture and Cooperation, National Policy for Farmers, 2007, New Delhi; Government of India Ministry of Power, National Electricity Policy, Pub. No. 23/40/2004-R&R (Vol. II); Government of India Planning Commission, Integrated Energy Policy: Report of the Expert Committee, 2006, New Delhi.

Energy access and economic growth

The Indian government views energy access and gainful employment opportunities for all of India's citizens as two of the country's most critical developmental goals, insisting that they must be kept sacrosanct in any global agreement on climate change. This belief forms the major thrust of Prime Minister Modi's major new policy initiatives: 24X7 Power for All and the Made in India campaign, which seeks to accelerate industrialization rapidly to generate good high-paying jobs.[122] To implement these and other policies, India has embarked on a two track approach. On the generation side, it has made one of the largest capacity expansion plans in the world. Indeed, as part of this effort from 2002 to 2015, the share of renewable capacity was raised nearly six fold from 2 percent (3.9 GW) in 2002 to 13 percent (36 GW) in 2015.[123]

Building climate resilience

The INDC introduces a major program centered on the development of climate resilient urban centers, including the major rejuvenation of existing cities and the development of new ones. In the case of the former, the plan affecting nearly 500 cities will focus on ensuring basic infrastructure services such as adequate clean water supplies, improved sewerage and storm drain facilities, massive urban transport investment, and development of more green spaces.[124] It is anticipated that these developments will be enacted through the adoption of climate resilient and energy efficient policies and regulations at both the central government and state level. In the latter case, the prime minister plans to build 100 new smart cities based largely on renewable energy and state of the art energy efficiency programs as well as smart grids, recycling of wastes and water and other state of the art environmental technologies.[125]

While all the climate resiliency programs highlighted in the INDC appear to have the prospect to produce meaningful results, one has to be careful, because, as noted, there is a great variation in the vulnerability of individual states and regions in India to the threat of climate change. Even within individual states or regions, there can be dramatically different impacts on different groups of people owing to highly diverse, "topography, climatic conditions, and ecosystems as well as diversity in social structures, economic conditions and needs of different communities."[126]

Enhancing energy efficiency

Because the Indian government recognizes that enhancing energy efficiency throughout the Indian economy represents the low hanging fruit for action, it has tasked the Ministry of Power and its Bureau of Energy Efficiency to embark on a number of policy initiatives. First the National Mission for Enhanced Energy Efficiency (NMEEE) is designed to create a favorable regulatory and policy environment and is tasked with effecting nearly 20,000 MW in energy savings through avoided power costs and fuel savings equaling nearly 23 million tons of coal per year when fully implemented.[127] The successful program saved 10,000 MW of new power plant construction from 2005 through 2012.[128] Given the program's success, the government set its INDC target to maximize efficiency for energy consumption at about 10 percent by 2018-2019.[129]

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[122] Ministry of Power, "24X7 Electricity Supply," Press Information Bureau, Government of India, 4 August 2014, http://pib.nic.in/newsite/mbErel.aspx?relid=107956; Ministry of Commerce & Industry, "Prime Minister to Launch 'Make in India' Initiative," Press Information Bureau, Government of India, 24 September 2014, http://pib.nic.in/newsite/PrintRelease.aspx?relid=109953.
[123] GoI, *India's INDC*, p. 9.
[124] Ibid, p 13.
[125] Ibid.
[126] Ibid, p 19.
[127] Ibid, p. 11.
[128] Ibid.
[129] Ibid.

On the demand side management front, the government has enjoyed notable successes through a rapid transformation of efficient lighting in India. NMEEE has launched several programs in order to facilitate widespread adoption of energy efficiency across various sectors, including households. One such initiative, Energy Efficiency Services Limited, has been tasked with replacing old inefficient lightbulbs with LEDs and is providing 150 million LEDs to household consumers at the same cost as traditional incandescent bulbs.[130] There has been marked progress with similar projects, leading India to raise compact fluorescent light bulb sales from 7.8 percent in 2005 to 37 percent in 2014.[131] Lighting standards and labeling programs have seen dramatic results as have financial packages designed to promote energy efficiency. The Indian government has established the Energy Conservation Building Code at the central government level, setting minimum energy standards for new commercial buildings. To date, eight states have followed the central government's lead, announcing that they either have adopted or will adopt similar standards. There are efforts underway to make these standards even stricter by moving to a "near zero" energy efficiency basis.[132]

India has an ambitious program to reduce energy consumption in industry. Perform, Achieve and Trade (PAT) is a policy designed to create a market-based energy efficiency trading mechanism that currently targets the nine most energy-intensive industrial sectors including, "aluminium, cement, chlor-alkali, fertilizers, iron and steel pulp and paper, railways, textiles and thermal power plants."[133] These industries taken together comprise more than half of the total energy consumption in the country.[134] PAT mandates four percent energy reductions targets compared to 2010 levels by 2015.[135] Modi also has ambitious plans to help medium and small scale industries improve their energy efficiency. The plan Zero Effect, Zero Defect initiative is part of the Made in India campaign and centers on a number of programs designed to enhance the energy efficiency of these firms while also reducing pollution, improving waste management, etc. Launched in 2015, the plan when fully implemented is expected to affect about 1 million enterprises.[136]

Tariff reform

As this paper was being written in January 2016, the Cabinet Committee on Economic Affairs (CCEA) approved amendments to the National Tariff Policy of 2005.[137] The purpose of the new policy is to provide guidance to central and state regulators in determining tariffs and other regulations affecting the power sector. It is important to note, however, that these are only guidelines, since, under the Constitution, tariffs in each state are under the jurisdiction of each state. Only wheeling tariffs between two or more states fall under the jurisdiction of the CERC. The areas addressed by the amendments include: efficiency, environment, electricity, and ease of doing business.[138] These categories are intended to bring all of India access to electricity in an affordable and climate prudent manner. Clearly another major goal of the revised tariff policy is to promote

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[130] IEA, *India Energy Outlook*, p. 163.
[131] GoI, *India's INDC*, p. 11.
[132] Ibid, p. 11-12.
[133] Bureau of Energy Efficiency, "PAT," *Government of India, Ministry of Power*, accessed 8 April 2016, https://beeindia.gov.in/content/pat-3.
[134] "India's Climate and Energy Policies," Center for Climate and Energy Solutions, October 2015, p. 2, http://www.c2es.org/docUploads/india-factsheet-formatted-10-2015.pdf.
[135] IEA, *India Energy Outlook*, p. 72.
[136] "Brief History," About ZED, Zero Defect, Zero Effect, accessed 4 April 2016, http://www.zed.org.in/brief-history.php.
[137] Government of India, Ministry of Power, *National Tariff Policy,* 6 January 2006, http://www.aegcl.co.in/National_Tariff_Policy.pdf.
[138] Prime Minister's Office, "Cabinet approves amendments in Power Tariff Policy to ensure 24X7 affordable Power for all," *Press Information Bureau, Government of India*, 20 January 2016, http://pib.nic.in/newsite/PrintRelease.aspx?relid=134631.

renewable energy while ensuring the availability of power, the financial viability of the sector, greater transparency, and more competition.[139] Under the new policy, targets for Renewable Purchase Obligations (RPO) have been raised both by the Ministry of Power and the Ministry of Natural Resources and the Environment. There is also a provision for the pass through of RPO's financial impact on consumers through a regular revision of tariffs. While the amendments require a revised target of 8 percent of electricity consumption to come from solar, by 2022, clearly irrespective of the INDC's target of 100 GW of solar by 2022.[140]

The policy also introduces the concept of a Renewable Generation Obligation for new coal thermal power generators as well as a recension of inter-state transmission charges and losses for solar and wind power—a policy that I believe is not needed given contentions by the wind and solar industry that they are grid parity competitive except of course at peak demand in the evening. If implemented this would have serious ramifications for the solar industry especially for independent power producers using renewable sources of energy.

Challenges of meeting the INDC targets

The policies Prime Minister Modi promulgated at COP21 were certainly not insignificant. Indeed the prime minister promised, as noted earlier, to increase exponentially the deployment of renewable energy and to enact bold energy efficiency and conservation policies, while at the same time, dropping the percentage share of coal in the nation's energy mix, even if missed in the fine print and commentary thereafter was the fact that coal production would more than double volumetrically. Also missed by many commentators was the prime minister's proviso that implementing all India's INDC pledges were contingent on appropriate levels of global financial support. Despite India's demonization for being "coal loving" India emerged from the talks relatively unscathed with the head of the Indian delegation, Environment Minister Prakash Javedkar, praising the final outcome as well as the negotiating process. Now that the international goal of reaching a deal on a framework agreement has been negotiated the question posed to India is what lies ahead in India's path towards the development of a "low-carbon" future?

While India's decision to put forth an INDC was applauded in international circles, its promulgation at Paris was the subject of intense debate among the Indian delegation with supporters cheering the Prime Minister's action and detractors on both sides either chiding the government for not being bold enough or for selling out to foreign interests in ways that would be detrimental to the growth of the Indian economy. Those who argued that the government was too timid in its submission cited an April 2014 report (Final Report of the Expert Group on Low Carbon Strategies for Inclusive Growth) to the Indian Planning Commission found that adoption of a low carbon growth strategy relying on fuel efficient supercritical coal plants and wind and solar electric power generation would lead to a slower growth in emissions than the business as usual policy found in India's Twelfth Five Year Development Plan which made forecasts for the economy out to 2030.[141]

An examination of these claims by my Brookings' colleague, Charles Frank, found using the assumptions of the Expert Group, that by 2030, India's INDC is nearly on the same trajectory as the business-as-usual case presented in the

[139] Ibid.
[140] Ibid.
[141] Planning Commission, "The Final Report of the Expert Group on Low Carbon Strategies for Inclusive Growth," *Government of India*, April 2014, http://planningcommission.nic.in/reports/genrep/rep_carbon2005.pdf.

Expert Group report and that taking a low-carbon strategy could save 1.8 gigatonnes of emissions than the INDC's scenario.[142] The chief reason that the Expert Group argues that emissions can be reduced even lower is that its analysis assumes in addition a much larger development of wind, solar and biomass capacity and larger volumes of nuclear power, hydro and biomass than the baseline projections of the12th Five Year Plan. Interestingly both reports do not see a greater role for combined cycle natural gas. Particularly, in the case of the Expert Group natural gas is not even considered as an option for low-carbon electricity generation, giving it a mere (combined with diesel) 4 percent of India's generation mix by 2030.[143]

What is significant for the purpose of this paper is that both the Expert Group's report and the 12th Five Year Plan place significant reliance on the massive introduction of supercritical coal technology as a cornerstone of their carbon reduction policies, thusly keeping India on the path to vastly accelerated coal production. Likewise neither report seriously addresses how the large sum of money—as per the Expert Group's calculations, an investment of nearly $834 billion—to implement this conversion can be raised.[144] Nor do they address the political realities of a government deciding to build fewer plants because of their higher costs when so many of India's current and future citizens need access to electricity.

Clearly this point of view varies sharply from the orthodox view of many Indian energy specialists both inside and outside the country who believe that the government's INDC submission was too tepid. What is ironic however is that even among this group there is little consensus on how India can best curtail CO_2 emissions. For example, some analysts believe that natural gas combined cycle plants should be pursued arguing that they require much less capital investment per MW than supercritical coal or solar facilities while generating less than half the emissions of supercritical coal plants.[145]

In stark contrast to these analysts who see fossil fuels remaining predominant in the India energy mix for some time, though with dramatic reductions in CO_2 emissions, several of my Brookings India colleagues, as well as leading scholars at Prayas and others believe that India through a diversification strategy focused on distributed generation, including rooftop solar, electrification of water pumps, improved lighting, and cooling systems, demand side management, cost reflective tariffs, and technological improvements in the electricity grid can dramatically reduce the use of fossil fuels and over time move the country to a far less carbon intensive economy.[146]

Both these groups, discussed above, think that India's intent, highlighted in its INDC submission to achieve 40 percent of total electric power installed capacity from non-fossil fuel (not to be confused with renewables) based energy sources can be readily achieved especially since current capacity is around 30 percent.[147] However, based on my sober analysis, it will be unlikely for India to achieve this target due to a significant lack of infrastructure and financing, endemic corruption, labor and environmental issues, as well as lack of coherent political cooperation among key decision makers.

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[142] Charles Frank, "India: Potential for Even Greater Emissions Reductions," Brookings Institution, 11 December 2016, p. 54, http://www.brookings.edu/~/media/Research/Files/Reports/2015/11/16-paris-climate-talks/india-frank.pdf?la=en.

[143] Planning Commission, "The Final Report of the Expert Group," p. 84.

[144] Ibid, p. 1.

[145] Charles Frank, "India: Potential for Even Greater Emissions Reductions," p. 54.

[146] Rahul Tongia (Ed.), "Blowing Hard or Shining Bright?"

[147] Apurba Mitra, Thomas Damassa, Taryn Fransen, Fred Stolle, Kathleen Mogelgaard, "5 Key Takeaways from India's New Climate Plan (INDC)," World Resources Institute, 2 October 2015, http://www.wri.org/blog/2015/10/5-key-takeaways-india%E2%80%99s-new-climate-plan-indc.

Of all the people who have written positively on the prospects for India to meet its INDC commitments, it is my Brookings India colleague, Rahul Tongia, with whom I am in agreement that the major hurdle confronting the energy sector is the need to effect a major transformation in the country's electricity grid. Tongia believes that, "renewables have a bright future, and must play a leading role in India's energy security and growth. They aren't a panacea but are a vital tool in the broader spectrum of India's electricity future. For sustainability, renewables cannot be viewed in isolation, but rather as part of a transition if not transformation of the grid which includes variable and dynamic pricing, distributed generation, storage technologies, smart grids, etc."[148] Dr. Tongia goes on to recognize that India's "energy" or grid problems are not merely technical or economic or financial but go to the core of the political and social dynamics of the country. As he notes, "no discussion of the future of the grid in India can ignore the other elephant in the room, agriculture (pumpset) supply, which itself cannot be solved as an energy problem but a broader challenge spanning land, subsidies, crop-choices, water tables and availability, fertilizers, support prices etc."[149] It is precisely Tongia's prescient analysis of the depth to which energy problems are enmeshed in the Indian body politique that I believe India will be unable to make the vast structural reforms necessary to meet all of its climate goals while extending commercial energy services to those who currently do not have them, meet the energy needs of India's burgeoning middle class, construct India's new cities, and plan for the energy needs of India's growing population over the next 20 years.

While respectful of the views of my colleagues and other scholars in the field, my conclusion based on working in the trenches with many SEBs and the central Indian government for nearly 40 years is that volumetric increases in fossil fuel consumption (perhaps at lower levels of energy intensity) will continue to rise with blips up and down, given domestic and international economic events over the next 25 years. Forecasters at ExxonMobil, in its 2016 Outlook to 2040, agree with my view, projecting that India's electricity usage will soar by 185 percent between 2014 and 2040, with coal-fired electricity more than doubling during this period.[150] Indeed ExxonMobil believes that India's energy demand is "likely to rise" from 34 quadrillion British thermal units (Btu) in 2014 to 47 quadrillion Btus in 2025 and 63 quadrillion Btus in 2040.[151] Finally, ExxonMobil projects that carbon emissions will continue to rise through 2040.[152]

Furthermore, I do not agree with the assessments on how fast all of India's subcritical plants can be replaced by supercritical ones while also meeting new electricity demand and extending service to those either unserved or underserved is realistic. This is especially true when one takes into consideration the myriad challenges confronted by every fuel in the Indian economy that I have discussed throughout this paper. It is also necessary to remember that at the time of the INDC submission that India made clear that all its pledges were contingent on receiving substantial outside financial assistance to make this transformation of the energy sector. As stated, India's INDC estimates costs to make this structural change to be as high as $2.5 trillion dollars by 2030.

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[148] Rahul Tongia (Ed.), "Blowing Hard or Shining Bright?" p. 11.
[149] Ibid.
[150] "The Outlook for Energy: A View to 2040," ExxonMobil, 2016, p. 72, http://cdn.exxonmobil.com/~/media/global/files/outlook-for-energy/2016/2016-outlook-for-energy.pdf.
[151] Ibid, p. 45, 47.
[152] Ibid, p. 52.

Pursuing climate-conscious growth

The INDC combines exhortations for climate justice arguing that nations at a lower level of economic development cannot and should not be denied the opportunity for economic growth with an equal recognition that something must be done to stem climate change, though clearly India believes that this must be done under the UNFCCC's principles of Equity and Common but Differentiated Responsibilities and Respective Capabilities. India's INDC submission is also one of the few to note that although conservation of the earth's natural resources is an imperative so too are a mélange of competing demands for resources. These include the "challenges of poverty eradication, food security and nutrition, universal access to education and health, gender equity and women empowerment, water and sanitation, energy, employment, sustainable urbanization and new human settlements."[153] In short India has laid down the gauntlet, albeit in diplomatic language, stating that improvement in the lives of its citizens cannot be ignored while addressing concerns about climate change.

In the wake of COP21, India's Minister for Power, Coal and Renewable Energy Piyush Goyal has continued to argue that India still plans to increase coal production to 1.5 billion tons by 2020 and will rely on this resource for decades.[154] He has stated categorically that a country that emits around 3 percent of global GHG emissions while having 17 percent of the world's population has no intention to sacrifice economic development on the back of climate change.

As noted, there have been dramatic developments in India both in renewable power generation as well as in an enhanced commitment by the government to demand side management and energy efficiency. India has embarked on these new initiatives because Indian policy makers are cognizant that uneven access to energy has a direct impact on economic growth and represses efforts at poverty alleviation. For India to achieve this growth it must free a large percentage of its citizens from the cycle of endemic poverty (of its roughly 1.3 billion people, according to 2011 data, approximately 700 million live on less than $3.10 per day; of those roughly 250 million live on less than $1.90 per day).[155] To effect this change, the National Institution for Transformation India Aayog (NITI) expects the economy to grow at a sustained rate of at least 8-10 percent per year over the next 15 years—a prodigious and unprecedented goal.[156] Above all else, Indian policymakers realize that, even with high sustained growth in its GDP and rapid expansion of its power-generating capacity, India will not meet its broad energy and social policy goals unless it insures that wherever possible India delivers its energy in all forms as efficiently as possible. This is especially true of the power and transportation sectors.

Nowhere is the challenge of meeting this sustained economic growth target starker than in the power sector. The challenges confronting the sector were dramatically highlighted in a World Bank report that noted not only that there are 100,000 un-electrified villages but also that India's per capita consumption of 639 kWh, gives it one of the lowest electricity consumption rates

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[153] GoI, *India's INDC*, p. 4.

[154] Krishna Das and Tommy Wilkes, "India says Paris climate won't affect plans to double coal output," *Reuters*, 14 December 2015, http://www.reuters.com/article/us-climatechange-summit-india-coal-idUSKBN0TX15F20151214.

[155] "County Dashboard: India, Poverty Trend (by International Standards)" *The World Bank*, accessed 19 April 2016, http://povertydata.worldbank.org/poverty/country/IND.

[156] "India will grow at 8-10% for next 15 yrs," *The Times of India*, 14 April 2015, http://timesofindia.indiatimes.com/business/india-business/India-will-grow-at-8-10-for-next-15-yrs/articleshow/46913116.cms.

in the world.[157] While the World Bank's assessment that, by 2050, India's installed power generation capacity requirements might reach one terawatt, a six-fold increase from the level prevailing at this time, the Bank's sanguine view that this target can be reached through a low carbon strategy, providing thousands of jobs and new economic opportunities seems unduly optimistic given the real constraints (institutional, financial, social, political economic) plaguing almost every part of the energy sector.[158] This is especially true given that it has become déclassé in global climate change circles to suggest that any aspect of current global energy policy cannot be modified or changed despite the profound challenges and real financial costs.

[157] Gevorg Sargsyan, et al., "Unleashing the Potential of Renewable Energy in India", p. x.
[158] "World Bank study outlines options for India's renewable energy future," *The World Bank*, accessed 11 April 2016, http://go.worldbank.org/2Q4N6MM610.

4. The Future of India's Power Sector

It is because of the critical importance of the electric power sector that I now examine in greater depth the myriad constraints affecting each component of the electricity sector. My purpose in doing so is to point out how the failure of any single fuel in contributing to forecasted electricity supply will reverberate on other fuel choices in terms of raising the contribution that they must make to offset the shortfall. Few people would take exception to the bold vision of Prime Minister Modi to embark India on a "Saffron Revolution," based on renewable energy that will wean the country off its nearly 70 percent dependency on fossil fuels in the power sector, much of which has to be imported. Nevertheless, to date, the country remains far short of his goal despite a number of polices such as: accelerated depreciation tax policies for wind power, the use of feed-in tariffs, renewable portfolio obligations, preferential grid access, the waiver of transmission fees for renewables, the adoption of tradeable renewable energy certificates, and generation based incentives to encourage renewable energy projects.[159]

While these policy initiatives will help accelerate a market for renewable power, India has not been successful in creating a major manufacturing capacity for wind and solar to date. The failure to do so risks exchanging import dependence on coal, oil and increasingly natural gas, for import dependence on wind and solar as countries such as China through their subsidized export policies move into the Indian market. Furthermore, there are already concerns regarding whether the pace of India's solar development may not be sustainable as the result of a shortage of skilled labor in the solar market. Finally, for those who believe that given the current surplus of electricity capacity that few new coal plants will be needed, as I have noted the government has already approved over 200 GW of new coal generation capacity and still plans to raise coal production to 1.5 billion tons annually by 2020.[160] While I doubt that this much capacity will be built, and with supercritical technology, clearly a significant portion of the approved plants will be constructed with more to follow after 2020.

India's future energy mix

Coal

More than any other fuel source, coal has been and is likely to remain critical to India's energy future and its development trajectory. In 2014, coal-fired

[159] Rahul Tongia (Ed.), "Blowing Hard or Shining Bright?" p. 109.
[160] Government of Australia, Office of Chief Economist, "Coal in India 2015," *Department of Industry and Science*, June 2015, p. 12, http://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/Coal-in-India.pdf.

power generation provided over 50 percent of India's electricity making India one of the most coal dependent nations. Demand for metallurgical coal, most of which India has to import, is also expected to rise dramatically. In 2014, as previously noted, the government of India embarked on policies designed to transform the country's electricity sector, including not only its commitment to add 175 MW of renewable energy by 2022 but also a $50 billion modernization of the electricity grid as well as an increase in India's domestic coal production to 1.5 billion metric tons per annum up from just above 600 MT in 2015.

To bring about such a transformation of the coal sector, the government will encounter a host of challenges requiring it to overcome numerous institutional, political and economic constraints. These include but are not limited to: (1) major improvements in the mining and transport of coal; (2) improved efficiencies in railway dispatch by raising freight utilization rates through policies such as the requirement to wash all coal to lower the tonnage of freight required to be moved; (3) efficiency improvements throughout the electric grid to reduce T&D losses averaging 25 percent which are among the highest in the world; and (4) improvements in the balance sheets of all the electricity distribution companies from their current unsustainable operating loss positions. This will facilitate power purchase agreements with generators that are bankable. There is also the need for stringent cash-flow security. The government also needs to reduce the GDP/electricity co-efficient; to raise the thermal efficiency of coal-fired plants, thereby reducing the tonnage of coal required per kWh of electricity produced; to lower the electricity sector's emissions though higher regulatory standards and strict regulatory enforcement and to improve financial-market efficiency to reduce the cost of capital and access to it.

Given the Indian government's lofty goals for expanding access to electricity, coal's role in the expansion of the electricity sector will be pivotal as it was under the previous Congress government's policy of bringing Power for All by 2012. This policy, in effect under the 11th Five Year plan, called for rising power generation from 164 GW in 2010 to 242 GW by the end of the plan.[161] Needless to say the policy fell woefully short. While there are many shortcomings in Indian coal policy, one of the major problems is that for too long, the coal sector has been sheltered from competition, hamstrung by entrenched interests, distorted pricing signals, operational inefficiencies, and lack of investment. Coal India Limited's (CIL) dominant market share and powerful lobby have made reform of the coal sector politically difficult as has the fact that CIL pays out a large dividend to the government given the huge amount of cash that it generates. With the Indian government in charge of supply (through CIL) and demand (through its ownership of power companies), coal pricing has been kept artificially below the world price. The restrictions on foreign ownership and the perception that coal deposits are nearly limitless have also installed a sense of complacency.

While the government embarked on "apparent" reform in its 2006 Integrated Energy Policy report by announcing that coal blocks held by CIL but not brought into production by 2016 to 2017 should be made available to "other eligible candidates" for development, with a restriction on foreign ownership, this limited any new market entrants to Indian companies needing coal for their own use.[162] Further reform efforts occurred in May 2009, when following its strong mandate in the general election, the Indian National Congress Party directed the Coal Ministry to begin negotiations to amend the Coal Mines Nationalization Act in order to sell 10 percent of CIL, thereby

[161] Ebinger, *Energy and Security in South Asia,* p. 34.
[162] Ibid, p. xiv.

injecting much-needed private capital into the state-run behemoth. The result was a successful IPO on the Bombay Stock exchange which raised nearly $3.5 billion.[163] In the aftermath of the IPO, there were calls for further reforms including mandatory coal washing to reduce pollution, the introduction of an independent regulatory body to oversee the competitiveness of auctions and the construction of mega coal power generation facilities close to the coast to put competitive pricing pressure on domestic coal producers.

While reformers believed that this change in policy would bring international investors into the Indian coal sector allowing the introduction of new mining techniques, to date this has not occurred. Furthermore, although nearly 26 percent of mining revenue is supposed to go to the communities directly affected, this does not often occur with the irony that such a formal requirement makes it an even more difficult market for international investors.[164] The failure to dispense a portion of the revenue to where the coal is produced has led to industrial unrest and work stoppages in Jharkhand, Bihar, and West Bengal driving up transaction costs and hobbling productivity. In addition, the blatant seizure of private land from villages and tribal forestry preserves have generated near class warfare in several major coal producing areas leading to a number of endemic insurgencies in the coal producing regions.

The Indian domestic coal market has the further anomaly that the mismatch between domestic supply and demand creates the situation whereby imported coal is often more cost competitive in India's western and southern coastal regions because the country's railroad logistics system is so antiquated that it is often difficult to get coal to end-use markets on a timely basis. Indeed, until the current surplus, it was not unusual for many power plants to have no more than a few days' supply of coal on hand making the risk of major brownouts and blackouts endemic such as occurred through much of India in 2012.[165] India's coal and lignite are also plagued by their very low calorific value and their high levels of ash which make cleaner coal imports attractive. Nonetheless, despite these shortcomings, PM Modi's government is deeply committed to reducing coal imports and raising India's domestic consumption.

As if these problems are not telling enough about the challenges posed to India to do anything serious about climate change as long as the economy remains so thoroughly dependent on coal, the legacy of how coal blocks are allocated and the scandals involved raise serious questions about India's institutional capacity to transform itself to a modern energy economy. In March 2012, the Comptroller and Auditor General of India (CAG) issued a draft report accusing the government of "insufficient" allocation of coal blocks between 2004 and 2009, estimating that sweetheart deals rather than competitive bidding had given allotters a windfall profit of Rs. 10.7 lakh crore ($161 billion as converted 19 April 2016). As the scandal unfolded in May 2012 under pressure from the Bharatiya Janata Party (BJP), Prime Minister Manmohan Singh volunteered to retire from public life if he were found guilty in the scam and ordered a full Central Bureau of Investigation (CBI) enquiry.[166]

As a result of this political furor, in June 2012, the Coal Ministry formed an inter-ministerial panel to review the process for the allocation of coal blocks and gave it the mandate to either deallocate the

[163] Ibid, p. 35.
[164] Ibid, p. 36.
[165] Jim Yardley and Gardiner Harris, "2nd Day of Power Failures Cripples Wide Swath of India," *The New York Times*, 31 July 2012, http://www.nytimes.com/2012/08/01/world/asia/power-outages-hit-600-million-in-india.html?_r=0.
[166] "Coal Scam: Chronology of Events," *The Hindu*, updated 14 October 2015, http://www.thehindu.com/news/national/coal-scam-chronology-of-events/article6350481.ece.

blocks or to seize bank guarantees for any company proved to be involved in the scandal. As a result of the enquiry, 214 blocks were deallocated due to fraud in the selection process while bank guarantees in 42 cases were forfeited.[167]

The scandal continued into August. While the CAG's final report to the Parliament scaled down the loss to the Exchequer to about Rs. 1.86 lakh crore (approximately $28 billion, as converted 19 April 2016) the new figures were immediately challenged by the government as based on flawed economics. The scandal widened in late August 2012, when the prime minister stated that, "The observations of the CAG are clearly disputable."[168] By September, 194 coal block allotments under investigation by the CBI began to be reviewed by the Supreme Court. In March 2013, the Court asked the CBI not to share any of the details of its investigation with the government. Then, in April the scandal widened as the Standing Committee on Coal and Steel in a report to the Parliament concluded that all but four of the coal blocks distributed from 1993 to 2008 had been done in an unauthorized manner and that any block that had not yet commenced production should be cancelled.[169] Three days after the release of the report the CBI Director Ranjit Sinha in an affidavit stated that he had shared the investigation report with Law Minister Ashwani Kumar leading to Ashwani's resignation. As charges were filed against select individuals during the second half of 2013 and 2014, including the former Coal Secretary P.C. Parakh, the scandal reached ever larger proportions leading to the Supreme Court's decision to overturn the allocation of 214 coal blocks.[170]

It is against this background of rampant corruption in the coal sector with the collusion of high level members of the Congress Party as well as strident community resistance against coal mining owing to its effect on water and air pollution that Prime Minister Modi's government has now staked a significant amount of India's energy future on the basket of coal.

Energy Minister Goyal has established a target for Coal India of 1 billon tons per annum by 2019 which for comparison, production in FY2014 was just under 600 Mt.[171] Additionally, the scope of the plan is breathtaking since according to Cornerstone, it projects a compound annual growth rate of 18 percent, when production has only grown by 1.68 percent from 2013 to 2014 over 2012-2013 rates.[172] Despite the naysayers, including myself, Coal India at its current rate under the prime minister's prodding is on track with production now rising to about a 12 percent increase from the previous year, crossing the 2015-2016 target of 550 Mt.[173]

Although, it appears that the 1.5 billion metric tons/year is still a far off target; in May 2015, Goyal projected that over the next five years that Coal India will invest $25 billion in new investments to reach its goals and will introduce more modern equipment and technology.[174] Few analysts believe the GoI will not be able to raise the req-

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[167] Ibid.

[168] Manmohan Singh, "PM's statement in Parliament on the Performance Audit Report on Allocation of Coal Blocks and Augmentation of Coal Production," Government of India, 27 August 2012, http://archivepmo.nic.in/drmanmohansingh/pmsinparliament.php?nodeid=62.

[169] Krishnadas Rajagopal, "Supreme Court quashes allocation of 214 coal blocks," The Hindu, 25 September 2014, http://www.thehindu.com/news/national/supreme-court-quashes-allocation-of-all-but-four-of-218-coal-blocks/article6441855.ece.

[170] "Coal Scam: Chronology of Events."

[171] A.M. Shah, "Navigating India's Coal Maze," Cornerstone Magazine, 28 July 2014, http://cornerstonemag.net/tag/1-billion-tonnes-coal-per-year/; CSO, *Energy Statistics 2015,* p. 25.

[172] A.M. Shah, "Navigating India's Coal Maze;" CSO, *Energy Statistics 2015,* p. 25.

[173] CSO, *Energy Statistics 2015,* p. 25.

[174] Sumit Moitra, "Coal India to invest $25 billion in 5 years," *Daily News and Analysis*, 16 May 2015, http://www.dnaindia.com/money/report-coal-india-to-invest-25-billion-in-5-years-2086245.

uisite capital to come near its coal production target, though the implications for local pollution and enhanced GHG emissions are potentially perilous.

Nonetheless despite the obstacles, the government is bulldozing its way forward with a policy based on the following principles, as highlighted in IEEFA's 2015 report:

1. Dramatically enhancing labor productivity, which will be a prolonged process without allowing foreign coal companies to be involved;
2. Gaining better control over the coal logistical system; both in terms of land acquisitions as well as reducing transportation bottlenecks, particularly by rail;
3. Increase coal washing to increase the energy content of coal per ton shipped;
4. Encouraging the Indian private sector to raise production to reduce dependency on imports, as demand continues to grow;
5. Moving away from subcritical plants to supercritical plants in the 12th Five Year Plan.[175]

One of the difficulties in assessing the actual state of the Indian energy economy is that while India has had huge growth in coal- and gas-fired electricity capacity since 2012, many existing plants including some fully commissioned new ones operate well below design capacity owing to their huge financial leveraging as well as power purchase agreements that have pricing terms below the level where the plants have any profit margin.[176] Despite the government's policy to bring electric power to every village, there are significant logistical issues in delivering the electricity to consumers. On the supply end it has been particularly difficult to source domestic coal from reliable supplies. On the other hand, imported coal is either too expensive relative to the highly subsidized wholesale tariff or the bottlenecks in the coal logistics system make having adequate supplies at times problematic.[177]

These obstacles have created a situation for coal-fired capacity where while many plants receive preliminary approval from the Ministry of Environment, Forests and Climate Change, a large number of these plants are never built owing to land acquisition delays (which the PM is attempting to overcome though often through controversial policies) and concerns about water scarcity. Critics of the prime minister's energy policies argue that too often the government in its headlong obsession for economic development ignores the social and environmental impact of developing coal under irreplaceable tracts of national forests, waterways, and canals where the indigenous population is ill prepared for industrialization and where their livelihoods are directly threatened. These critics note that the government's rough-shod policies often lead to major project delays and sometimes outright stranded assets, the costs of which are neither calculated in the government's budget or in assessments about how other energy policy choices (renewables and efficiency) might have proven substantially cheaper if they had been taken into account. Critics note that it is not only coal projects that run into problems and opposition from affected residents, but also large scale hydro and nuclear power projects both of which uproot native populations while using huge volumes of water and creating ancillary environmental problems.

[175] Tim Buckley, "India's Electricity Sector Transformation," p. 24-25.
[176] Ibid, p 25.
[177] Ibid.

While the prime minister ardently believes that devolving more power and decision making to the states will shake up the inertia of the Indian federal bureaucracy, one has to withhold judgement whether the recent decision by the CCEA to end the central government's 41-year-old monopoly on the allocation of coal mines and to pass it to the states will prove to have been a wise reform.[178] Under the new policy, the states will have the authority to allocate coal mines for sale to medium, small, and cottage industries in their state.[179] While the final ramifications of the policy remain to be seen, under previous policy the states were allocated coal blocks by the central government but with specified end uses such as electricity production, steel and iron production, etc.

The Cabinet's decision will benefit the coal-rich states allowing them to earn surplus revenue which up to now they had been earning from royalties from private companies mining coal for their captive use under the 2014 Coal Ordinance (Special Provisions).[180] As a result of the Cabinet's decision, coal blocks can be allocated without having any specified use, allowing the states to allot coal to any industry. The government has justified the change under the rubric that the new policy will increase domestic coal production (at the risk of exacerbating climate change) thereby reducing imports (of cleaner coal) while providing additional revenues to the states. The government argues that the policy will also make coal available to smaller users that currently are unable to obtain coal from Coal India.

In another move to expand coal use, the CCEA approved a policy framework for developing underground coal gasification in coal and lignite bearing formations in the country.[181] The government intends to adopt a policy based on revenue sharing and the offering of blocks through competitive bidding. The government's policy is designed to develop reserves of coal and lignite that are considered to be uneconomic for conventional mining techniques.

Furthermore the government has promoted under the ninth National Mission on Clean Coal Technologies a cost effective ultra-supercritical technology to increase the efficiency of coal combustion while reducing emissions in future coal-based thermal power plants. An 800 MW supercritical boiler has been designed by Bharat Heavy Electrical (BHEL), an equipment manufacturer, which when completed will serve as a demonstration project to validate the use of the technology.[182] The plant will use Indian grade coal to avoid dependence on expensive imports of high grade coal. While the success of the plant has not been proven, it represents a demonstration of the seriousness the PM places on policies that will help address climate change and allow the continued use of coal in power generation.

Solar

On the solar energy front, the prime minister has achieved dramatic gains with solar capacity growing to just over 5 GW as of January 2016.[183] While a long way from the PM's 2022 solar target

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[178] BS Reporter, "Cabinet allows states to mine & sell coal, ends monopoly of Centre," Business Standard, 17 December 2015, http://www.business-standard.com/article/economy-policy/cabinet-allows-states-to-mine-sell-coal-ends-monopoly-of-centre-115121601219_1.html.

[179] "Government working on coal allotment procedure for commercial mining," *Economic Times,* 17 December 2015, http://articles.economictimes.indiatimes.com/2015-12-17/news/69119483_1_coal-sector-commercial-mining-coal-blocks.

[180] Prachee Mishra, "Bill Summary: Coal Mines (Special Provisions) Bill, 2014," PRS Legislative Research, 19 December 2014, http://www.prsindia.org/uploads/media/Coal%20Mines/Bill%20Summary-%20Coal%20Mines.pdf.

[181] "Government prepares draft policy on underground coal gasification," *Economic Times*, 14 December 2015, http://articles.economictimes.indiatimes.com/2015-12-14/news/69033428_1_coal-gasification-two-coal-blocks-ucg.

[182] "BHEL readies design for 800 MW plant with ultra supercritical parameters," The Hindu, 20 April 2013, http://www.thehindu.com/todays-paper/tp-national/tp-tamilnadu/bhel-readies-design-for-800-mw-plant-with-ultra-supercritical-parameters/article4636067.ece.

[183] Ministry of New and Renewable Energy, "Solar Power Capacity Crosses Milestone of 5,000 MW," Press Information Bureau, Government of India, 15 January 2016, http://pib.nic.in/newsite/printrelease.aspx?relid=134497.

of 100 GW of installed capacity, with new utility-scale solar projects coming on line in 2016, solar's contribution is expected to rise by 4.8 GW, clearly demonstrating that India is making great progress.[184] Interestingly, most of this new capacity expansion will be driven by state governments. While India received 263 GW of renewable investment commitments in 2015 from private investors and new developers continue to enter the market resulting in oversubscriptions for power and dramatic reductions in tariffs, there are some storm clouds on the horizon.[185] Indeed, the solar market according to Bridge to India is in "uncharted territory" as none of the projects offered at $7.50/kWh have yet reached financial close. Apparently developers are hoping for a fall in equipment costs even though there is growing concern that prices might actually rise over the next six to nine months as a result of burgeoning demand.[186] The end result of this situation is that over the next year a number of projects are likely to be delayed or cancelled while tariffs may rise marginally. Furthermore, there have been delays in the commissioning of new plants both by the National Thermal Power Corporation (NTPC), India's largest government-owned utility, and the Solar Energy Corporation of India (SECI). Because of these developments, it appears that over the next several years while solar capacity additions will remain robust, they may be lower than the Ministry of New and Renewable Energy's (MNRE) 12 GW growth projection for 2017.[187]

While the allocation of coal blocks has been the most controversial, a recent report by the CAG has raised questions concerning the allocation of land to six solar companies wishing to build solar thermal plants in the Jodhpur and Jaisalmer regions of Rajasthan.[188] According to the report, the state government provided preferential treatment to private developers allocating government land at below normal rates while at the same time changing the land's status without going through normal legal procedures. The scandal in Rajasthan should not surprise any long-term observer of the rampant corruption that goes on in far too many of India's state governments.

Another potential storm cloud on the horizon is the fact that changes in the parliamentary composition of India's upper house might accelerate passage of a Goods and Services Tax (GST), which by centralizing a number of existing taxes and rescinding others might lead to the abolition of some current tax urgent exemptions that benefit the solar industry with the net effect of raising the costs of solar energy. Key provisions of the bill if enacted would raise the tariff for solar projects by 12 to 20 percent potentially leading to the financial collapse of some projects.[189] The cost increase would occur because under the current policy no import duty or indirect taxes are applied on solar projects whereas under the GST, as proposed, such taxes combined with state excise taxes and levies would be imposed. The MNRE is lobbying heavily against the proposed changes with the outcome still in doubt.

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[184] "India adds 2 GW of utility scale solar capacity in 2015; to install 4.8 GW in 2016," Bridge to India, 11 January 2016, http://www.bridgetoindia.com/blog/india-adds-2-gw-of-utility-scale-solar-capacity-in-2015-to-install-4-8-gw-in-2016/.

[185] "Indian solar market running on fumes?" Bridge to India, 11 April 2016, http://www.bridgetoindia.com/blog/indian-solar-market-running-on-fumes/#more-4002.

[186] Ibid.

[187] "About Us," National Thermal Power Corporation, accessed 12 April 2016, http://www.ntpcindia.com/?q=en/about-us; MNRE, "Solar Power Capacity Crosses Milestone of 5,000 MW."

[188] Hamza Khan, "CAG report on renewable energy: Rajasthan utilizing only 0.51 per cent of its solar energy potential," *The Indian Express*, 9 December 2015, http://indianexpress.com/article/cities/jaipur/cag-report-on-renewable-energy-rajasthan-utilising-only-0-51-per-cent-of-its-solar-energy-potential/.

[189] Debjoy Sengupta, "GST poses a big risk for Indian solar Industry: Report," The Economic Times, 14 March 2016, http://articles.economictimes.indiatimes.com/2016-03-14/news/71509542_1_gst-solar-sector-goods-and-service-tax.

Despite the above developments, in 2016, it is anticipated that 80 percent of all new solar capacity will be in the southern states of Tamil Nadu, Andhra Pradesh, Telangana, and Karnataka. With these new projected capacity additions, India will become one of the key global markets for solar power. Given its success, to date it appears very likely that even though the GoI's target of 12 GW of installed capacity for 2017 may fall a bit short, India will still remain a robust solar market. However, after this target is achieved it will become more difficult to sustain momentum as the states alone are responsible for further sector expansion. Unless there is a dramatic improvement in the grid and in the institutional and financial capacity of the SEBs, it appears likely that the evacuation of power and grid stability will become major policy issues given the huge intermittent renewable capacity in the southern states which will have to be able to be moved to other parts of the country while maintaining overall system stability. Clearly the central policy issues will center upon the speed of construction of inter-state evacuation corridors which in turn will be affected directly by the resolution of the land use issue, discussed above.

Wind

One of the greatest success stories for renewables in India has been the skyrocketing growth of wind energy which at the end of 2011 totaled 16,084 MW in installed renewable capacity.[190] Although tapering off slightly, wind has continued to grow to just under 24,000 MW at the end of 2015, accounting for nearly 65.2 percent of India's renewable installed capacity.[191] This surge in wind capacity which made India the fifth largest wind producer in the world occurred largely as the result of very generous accelerated depreciation tax provisions. With this favorable tax treatment capped at 40 percent starting in 2022 (down from 80 percent) in the recently announced new federal budget, it is likely, given past investments that are now sunk costs, that wind energy will nearly double from its 2011 level by the end of FY2016-2017 and then level off while continuing to grow on a modest basis.[192] Given ongoing concerns about how to integrate renewable power into the grid and its limited ability to meet peak evening electricity demand, there seems to be a clear political preference by the prime minister for solar over wind especially as a cornerstone of the PM's distributed generation policy despite the fact that solar also as an intermittent resource cannot currently help meet peak demand. I believe Modi's solar targets will not be met as the realities of the limitations of the electrical grid become manifest.

Hydropower

Perhaps no form of energy in the Indian energy mix is more vexing than hydroelectricity. Although capacity has continued to rise, the overall contribution of hydro in power generation has fallen from almost 40 percent during the Sixth Five Year Plan (1980-1985) to around 12 percent in 2013, despite the fact that India has developed only about 25 percent of its domestic potential, not to mention the huge export potential of its neighbors in Nepal and Bhutan.[193] Hydropower is also seen as vital since it provides operational advantages such as providing renewable baseload capacity allowing it to help balance an electricity system that is trying to integrate much larger volumes of intermittent wind and solar capacity into the grid.

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[190] Danish Wind Industry Association, "Wind Energy Industry in India (2012-2013)," WindPower, 18 February 2011, p. 2, http://www.windpower.org/download/2243/vindenergirapport_2012-2013pdf.

[191] GoI, *India's INDC*, p. 9.

[192] Shreya Jai, "Budget 2016: Wind sector to take a hit as accelerated depreciation tax benefit capped at 40%," Business Standard, 2 March 2016, http://www.business-standard.com/budget/article/budget-2016-wind-sector-to-take-a-hit-as-accelerated-depreciation-tax-benefit-capped-at-40-116022900591_1.html.

[193] IEA, *India Energy Outlook*, p. 132.

Yet despite its potential, hydropower development has a myriad of pitfalls ranging from regulatory setbacks to environmental opposition, concerns about seismicity and territorial disputes, as well as water scarcity considerations. These contentious issues discussed in greater detail earlier in the paper, present enormous obstacles for the expansion of hydroelectricity within India.

One possible option for India's electricity planners is enhanced trade with India's hydro-rich neighbors in Bhutan and Nepal. In the case of Bhutan, there is already nearly 1.5 GW of installed capacity leading to major trade between the two countries with another 10 facilities under review or in the early stages of construction. The case of Nepal is far more complex. While the issue of electricity trade with India looms large in the minds of Nepali energy planners, as stated, the 43,000 MW of economically viable potential projects have never come to fruition for a myriad of complex political, social, environmental, and economic reasons, though Nepal imports a small amount of power from India.

From the Nepali perspective, the development of its vast hydroelectric potential against an internal demand of only 700 MW could be the cornerstone of Nepal's economic growth.[194] Discussion of Nepal's potential importance in helping to meet India's burgeoning electricity demand is not a new topic but one that has raged for nearly five decades. The inability to develop this potential reflects largely technical but surmountable obstacles; however, it also has been hindered by a mutual suspicion stemming from decades of minor conflicts. Furthermore, for years Nepal has been wary of Indian interference in its foreign policy and domestic political affairs.[195]

Despite these very real concerns, trade between the two countries continues on most occasions unobstructed by anything other than technical and institutional barriers. For instance, different voltages in the transmission lines connecting the two countries limits the exchange of electricity to only one-third of the agreed 150 MW of capacity, though clearly given the small size of the interconnection this could be replaced with an integrated system if India saw such an investment as in its national interest.[196] Also, the dilapidated state of Nepal's hydropower and electricity sector mandates that it actually imports electricity in the south to supply demand unmet by domestic generation. While I believe that there is great opportunity for enhanced cooperation between the two countries and that the 1.8 GW of planned projects could prove a viable starting point for enhanced trade, it appears unlikely for the following reasons that such trade will occur: (1) the severe mistrust between the two nations and the ongoing political instability in Nepal, (2) the financial insolvency of the Indian SEBs immediately adjoining Nepal and in those that would have to be crossed with large power lines en route to major Indian load centers, (3) the massive resettlement of people in northern India and particularly in Bihar and Jharkhand that would be necessary for large scale high voltage power lines to cross their territories and (4) the fact that India has huge domestic hydro potential in its Northern region that has not been developed.

As a result of the above obstacles, one should scrutinize any future energy or climate emission reduction scheme that counts on hydro expansion to account for any meaningful contribution to the carbon free generation of electricity with a healthy dose of skepticism. After nearly 35 years

[194] Ebinger, *Energy and Security in South Asia,* p. 113.
[195] Ibid, p. 165.
[196] Ibid.

of working on this issue for the World Bank, the Asian Development Bank and USAID, I project that by 2040 hydropower's contribution to India's energy mix will account for little more than 4 to 5 percent of the generation mix—significantly below the IEA's projection of 8 percent.[197]

Nuclear

One of the major issues that has bedeviled India's nuclear aspirations since the dawn of its program has been the fact that India has very little uranium. Consequently, the early architects of the program formulated the controversial "three stage program" consisting of uranium in the first stage, then the reprocessing of the spent fuel to extract plutonium to fuel a large number of breeder reactors that would utilize uranium-233, and then the development of a thorium fuel cycle using India's large reserves, bypassing the need for large volumes of imported uranium either in its raw or enriched form. The problem, however, that India has encountered is that the breeder reactor has never proven itself anywhere in the world to be either commercially or technologically easy to build and operate. As a result of these problems and after huge investments, India has little to show for its efforts despite grandiose claims over the years by many Indian politicians of a bright nuclear energy future.[198]

Despite these realities and serious political opposition to major nuclear expansion following the Fukushima nuclear disaster in Japan, Prime Minster Modi continues to see the rapid expansion of atomic energy as a serious pillar in his drive to move India towards a sustainable energy future based to the greatest degree possible on carbon free sources of energy.

To best understand the complexities of why one should remain skeptical about the future of nuclear energy in the country's energy mix, one has only to look at past goals for the expansion of nuclear energy against what was actually achieved. As stated, India currently has 21 operational nuclear reactors at seven plants with an installed capacity of 5,302 MW. Six additional reactors are under construction and once finished will generate an additional 4,300 MW. In addition, the French company, AREVA, contractually replaced in January 2016 by Electricity de France plans to build six reactors at Jaitapur with a total capacity of 9,600 MW.[199] Ever since the deal was first struck with AREVA, it has been under attack on a number of fronts: (1) the selected reactor type (EPR) has never been built and operated anywhere in the world; (2) no technical or economic assessment of the project has ever been done; (3) the EPR reactors being built in Finland and France are years behind schedule and have had massive cost overruns with no completion dates in sight; and (4) the French regulator, the Nuclear Safety Authority, is threatening to deny certification of the design owing to problems with the plants' forgings.[200] Furthermore, India has also experienced massive technical problems with its VVER reactor at Kudankulam purchased from Russia which is not operational 80 percent of the time.[201]

Despite these problems and massive serious public demonstrations at a number of nuclear sites,

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[197] IEA, *India Energy Outlook*, p. 132.

[198] M V Ramana, "Flunking the Atomic Audits: CAG Reports and Nuclear Power," *Economic & Political Weekly*, vol. 47, no. 39, 29 September 2012, http://www.epw.in/journal/2012/39/commentary/flunking-atomic-audits.html.

[199] Huma Siddiqui, "India, France fail to announce final deal for nuclear reactors," The Financial Express, 26 January 2016, http://www.financialexpress.com/article/economy/india-france-fail-to-announce-final-deal-for-nuclear-reactors/202114/.

[200] Huma Siddiqui, "Fate of Areva deal for nuclear reactors hangs in the balance," The Financial Express, 23 January 2016, http://www.financialexpress.com/article/economy/fate-of-areva-deal-for-nuclear-reactors-hangs-in-balance/200596/.

[201] "Kudankulam Atomic Power Project," Nuclear Power Corporation of India Ltd, accessed 12 April 2016, http://www.npcil.nic.in/main/ProjectOperationDisplay.aspx?ReactorID=77.

the proposed power generation program, fully supported by the PM, surges ahead with plans for an additional 30 reactors "planned" to be built by 2032 at an estimated cost of $85 billion, raising nuclear capacity to an astounding 63,000 MW.[202]

When pushed hard on where this 63,000 MW forecast, often cited by NITI Aayog, comes from, it is difficult to obtain an answer though even more outlandish forecasts have been made with some as high as 470,000 MW to 650,000 MW by 2050.[203] In January 2014, then PM Manmohan Singh, in laying a cornerstone for a new nuclear project in Haryana, stated that within 10 years (2024) India would have a nuclear capacity of 27,000 MW.[204]

As part of his drive to expand nuclear energy, Prime Minister Modi has traveled the globe and invited high level officials to Delhi signing MOUs with France, Australia, Russia, Canada, the United States, Japan, and China. While bold moves have been announced, such as creation of an insurance pool to help get over the liability issues that have held back any meaningful investment by foreign nuclear vendors besides Russia, in reality, few of the economic obstacles have been overcome. While the prime minster asserts that in the case of the United States the two governments have done all that they can do to move a sale forward and that it is now up to the suppliers to cement a deal. The reality is that the goal of 63,000 MW or even 20,000 MW will remain elusive, putting pressure on other energy alternatives—most notably coal for baseload electricity to offset nuclear energy's slower than forecast growth.

Natural Gas

When it comes to expanding India's natural gas sector, difficult challenges remain. First and foremost is the question of when the global markets stabilize how power prices produced from LNG will compare to power produced from both domestic and imported coal and perhaps even oil. Additionally, will consumers be willing to pay more for cleaner sources of energy such as imported LNG and pipeline gas? Of course, as long as many state governments continue to subsidize retail prices below the cost of production and the government remains committed to the rapid expansion of domestic coal reserves, this may keep gas imports from capturing as large a market share as they might if the government actually put a price on carbon or raised retail tariffs.

Three other critical issues center on whether the government will (1) raise incentives to encourage upstream oil and gas production, (2) reduce the subsidies it pays for fertilizer produced from natural gas feedstock, and (3) raise consumer prices for natural gas. While it was hoped that the direction of government policy would be clarified in the new budget, this was not the case. On the exploration and production (E&P) side, the finance minister announced the price of "newly discovered" gas would be determined by the market and linked to the price of alternative fuels. What was not addressed was whether "newly discovered" referred to fields already discovered but not developed or to completely new discoveries.[205] It was also not clear whether alternative fuels referred to the price of Indian coals, imported coal, imported LNG, imported oil, or to some basket of all of them.

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[202] Krista Mahr, "China joins nations eyeing India's civil nuclear sector," Reuters Africa, 18 September 2014, http://af.reuters.com/article/worldNews/idAFKBN0HD0ZK20140918.

[203] Praful Bidwai, "Between Ambition and Reality: India's Nuclear Power Programme," *The Green Political Foundation*, 7 April 2014, https://www.boell.de/en/2014/03/21/between-ambition-and-reality-indias-nuclear-power-programme.

[204] P. Sunderarajan, "India Committed to Safety of Nuclear Plants: PM," *The Hindu*, 14 January 2014, http://www.thehindu.com/news/national/india-committed-to-safety-of-nuclear-plants-pm/article5573879.ece.

[205] Vikram S. Mehta, "Oil slip," The Indian Express, 7 March 2016, http://indianexpress.com/article/opinion/columns/union-budget-2016-oil-price-petroleum-industry/.

On the domestic pricing of gas, while in the past it looked as if the government might learn from its past mistakes and raise prices, in March 2016 for the third time, the GoI announced that commencing April 1, it would for a period of six months reduce the price of domestically produced gas from $3.82 to $3.15 per million Btu, moving the country in the wrong direction.[206]

Furthermore on the E&P side, the government announced a major change in the way the tax would be calculated. Whereas, previously the calculation of the government's cess (tax on oil production) was based on a fixed rupee rate per barrel, the collapse in the price of oil has led the industry to lobby for a change to an ad valorem tax (percentage of value tax). The previous tax of $9.10 per barrel (bbl) was perhaps justified when oil prices were in excess of $100/bbl, but is highly injurious to the industry when prices are at $35/bbl.[207] While the industry initially applauded the change, it was appalled when the ad valorem tax was set at 20 percent, effectively only reducing the tax burden by $2/bbl. As my Brookings India colleague, Vikram Mehta, notes even if prices rise to $45/bbl, the effective tax would revert back to $9/bbl—the same level paid when oil was at $100/bbl. The decision if left in place, will have a negative impact on natural gas exploration companies such as Reliance Industries Ltd and state-owned Oil and Natural Gas Corp (ONGC) and may well set back its plans for a $5 billion investment in the Bay of Bengal. It is estimated that every $1 reduction in the gas price leads to a decline of INR 40 billion in ONGC's revenue on an annual basis.[208]

Another issue is what policy the government may adopt towards fertilizer production if domestic gas exploration and production fail to prove up significant additional gas supplies. While currently fertilizer consumes the largest amount of domestically produced gas, a reduction in prices could have the perverse effect of increasing demand, putting additional pressure on gas supplies.[209] A critical question confronting the government will be what policy should it adopt towards incremental demand for fertilizer? Will it import LNG to meet this demand? Or if LNG prices are too high relative to the direct importation of fertilizer, what impact will this have on overall LNG demand?

A final dual challenge the government needs to meet is keeping LNG and pipeline transportation infrastructure networks expanding as fast as demand but also assuring that there is enough imported gas to supply the infrastructure once it is built to avoid having stranded assets. Currently, only about 42 percent of the pipeline network is actually supplied by gas.[210] While market dynamics may change with the falling price of LNG, clearly Prime Minister Modi is well aware that over time demand for LNG and oil imports will soar, creating major stresses for the Indian economy once the market turns and currently distressed prices for oil and gas resume their upward track. It is this prospect that makes the PM so committed to increasing the domestic production of coal to 1.5 billion tons—both to provide India's citizens who currently have no electricity with energy allowing them to have work at home and not forced to migrate overseas to find a job. Given

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[206] "Government to hike natural gas price for ONGC, Reliance Industries by 60%," Economic Times, 3 March 2016, http://economictimes.indiatimes.com/industry/energy/oil-gas/government-to-hike-natural-gas-price-for-ongc-reliance-industries-by-60/articleshow/51236911.cms.

[207] Vikram S. Mehta, "Oil slip."

[208] Saket Sundria, "India Cuts Domestic Gas Prices 20% Amid Falling Global Rates," Bloomberg, 31 March 2016, http://www.bloomberg.com/news/articles/2016-03-31/india-cuts-domestic-gas-prices-20-amid-falling-global-rates.

[209] Anupama Sen, *Gas Pricing Reform in India, p. 23*.

[210] Ministry of Petroleum & Natural Gas Economics and Statistics Division, *Indian Petroleum and Natural Gas Statistics 2014-2015*, Government of India, p. 35, http://www.petroleum.nic.in/docs/pngstat.pdf.

his political choices, it appears that prime minister has made the Faustian bargain that developing coal rather than going all out on climate change will prove the wiser political choice.

Institutionalized paralysis

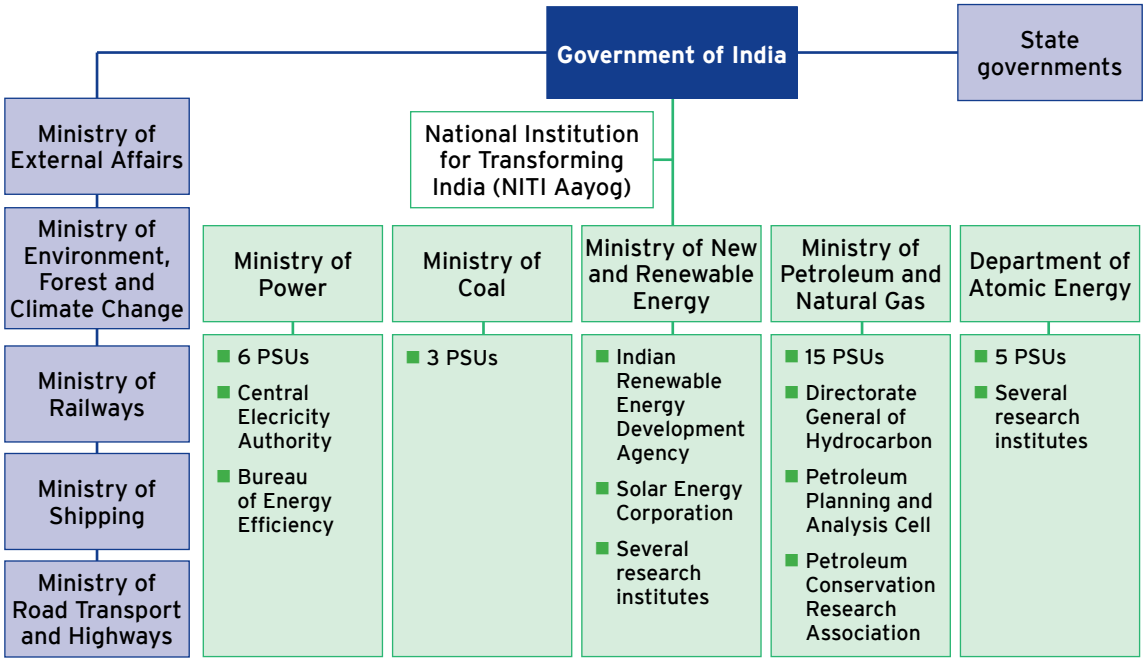
As noted, India's energy sector is characterized by a byzantine network of ministries, advisory agencies, and regulatory bodies. Until 1992, the country's entire energy apparatus was run under the purview of the Power Ministry. Subsequent sector restructuring led to the formation of the Ministry of Power responsible for formulating and implementing national policy for the electricity sector, including thermal and hydropower generation, transmission and distribution. The ministry is responsible for the administration of the Central Electricity Authority (CEA), an institution tasked with broad planning oversight and forecasting and the implementation of India's power sector legislation. In addition to its oversight of the CEA, the Ministry of Power has authority over the National Thermal Power Corporation; the National Hydroelectric Power Corporation; the Rural Electrification Corporation, which provides financial assistance to villages and agriculture-based industries; the North Eastern Electric Power Corporation Limited (dedicated to the development of northeast India's hydro and natural gas resources); the Power Finance Corporation; the Ministry of Petroleum and Natural Gas; the Ministry of Coal; and the Ministry of New and Renewable Energy (formerly the Ministry of Non-Conventional Energy). Nuclear power is administered by the Department of Atomic Energy which acts as a separate ministry but often does its forecasting of future power demand in isolation from other entities leading to very different forecasts.[211]

The structure of India's energy sector is complex and is based on the assumption that there will be a high level of coordination among the five major ministries responsible for policymaking. Overseeing the ministries is NITI Aayog (Figure 3) which replaced the Planning Commission in early 2015. Also in May 2014, shortly after Prime Minister Modi came into office, he appointed Piyush Goyal as a union minister of state (an independent charge) responsible for overseeing the Ministries of Power, Coal, and New and Renewable Energy. This consolidation of ministerial authority was designed to de-bottleneck the system and to make government more accountable for the delivery of energy services.

In the Indian Constitution, power is a joint responsibility between the central and state governments. Through the Ministry of Power, Delhi has a critical role in the formulation and implementation of electricity policy. It does this through two subsidiary statutory bodies (Central Electricity Authority and the Bureau of Energy Efficiency) as well as six state-owned utilities. These institutions are responsible for thermal and hydro power generation, transmission, and distribution and financing.[212] However, the state governments also play a role in the siting and approval of power plants and in overseeing all aspects of their transmission and distribution networks. The states also have with only a few exceptions a State Regulatory Commission responsible for tariff setting and broad oversight of the sector. In addition to the utilities in each state, there are also State Area Electricity Boards responsible for overseeing the state's utilities. Most of these state electricity companies are either bankrupt or on the edge of solvency usually because tariffs are held below the cost of providing service. Similarly, many of

[211] Ebinger, *Energy and Security in South Asia,* p. 28.
[212] Sun-Joo Ahn and Dagmar Graczyk, *Understanding Energy Challenges in India: Policies, Players and Issues*, p. 31, Paris, 2012, OECD/IEA, https://www.iea.org/publications/freepublications/publication/India_study_FINAL_WEB.pdf.

Figure 3: Ministries under central government shaping energy and climate policies in India. Does not include PSUs and Public-Private partnership companies that also influence energy policy.



Notes: PSU = Public sector undertaking (state-owned enterprise). Other ministries with responsibilities relevant to the energy sector include the Ministry of Urban Development, Ministry of Water Resources, Ministry of Agriculture, Ministry of Finance and the Department of Science and Technology.
Source: *IEA, India Energy Outlook, p. 42*

the SEBs are highly politicized and oppose tariff changes even if the State Regulatory Commission approves them. The precarious state of the utilities' finances has also led to underinvestment in T&D resulting in large line losses compounded by widespread electricity theft. Although seldom discussed, the inadequacy of the transmission and distribution networks poses a major challenge to the widespread evacuation of new solar and wind facilities in that the grids are not prepared for the introduction of large volumes of intermittent power. Furthermore, most SEBs also have antiquated billing and collection systems meaning that many bills either do not arrive, are lost, or go to the wrong address. This problem is especially endemic in fast growing urban areas where new communities are being built so quickly that often addresses are unknown. Still another major problem is the paying off of meter readers either to low ball the actual bill in exchange for kickbacks or to slow the meter in return for a bribe.

In addition, at the state level there is also the Office of the Chief Electrical Inspector who has responsibility for overseeing all electricity hookups, certifying that connections are up to code, etc. From personal experience working in a number of Indian states on electricity restructuring projects, this office all too often is open to the highest bidder with payoffs endemic. To take but one example: While working in Kerala for the Asian Development Bank a recently retired chief electricity inspector, in exchange for a bribe, offered to provide a detailed list of 17 ways that power could be stolen in the state.[213]

[213] Personal meeting in Kerala, 15 April 2009.

Financial challenges

Despite the euphoria in September 2012 when under the Financial Restructuring Proposal (FRP) of the central government Indian banks restructured their loans to the SEBs with the explicit financial guarantee of these loans by the central government, many of these SEBs are now bankrupt and have no resources to meet their financial obligations either to pay their own staff or to modernize their transmission and distribution networks.[214] Clearly financially solvent SEBs are the fulcrum of any government policy to effect its vision of Power for All through the integration of huge infusions of renewable power generation into the national energy grid. Under the FRP, Delhi agreed to a moratorium on principal payments from the SEBs for three years. When this deadline was reached in September 2015, most SEBs either had to ask the banks and other financial institutions for time to improve their finances or for restructured loans. To demonstrate the degree to which the reforms had failed to help transform many of the SEBs, Rajasthan alone had to seek additional assistance for nearly 50,000 crore in short term liabilities.[215]

When the FRP was being negotiated, all the SEBs were required as part of the loan package to lift tariffs. However in the ensuing three years, few SEBs lived up to their obligation. At the same time, the SEBs were required to reduce transmission losses (technical and non- technical); nonetheless, after three years few SEBs have made any significant reductions.

Given the realities of this catastrophic situation, in November 2015 the Government announced a new policy—Ujwal Discom Assurance Yojana (UDAY)—designed to help the SEBs effect a financial turnaround. The UDAY scheme involves four major components: (1) improving operational efficiencies, (2) reducing the cost of power, (3) reducing the interest costs of Discoms and (4) enforcing financial discipline on Discoms by aligning their financial interest with state government finances. Under UDAY, the state governments for two years starting September 2015 will assume 75 percent of the electricity Discom's debt reducing the interest on the debt to 8 to 9 percent, far below the 14 to 15 percent paid by the Discoms prior to the change.[216] The remaining debt can also be refinanced by state government-backed Discom bonds issued by the utilities themselves. During the first two years after adoption of the scheme, the state-issued UDAY bonds will not be counted against the state's fiscal borrowing entitlements. Thereafter the debt will count against the state's capacity to borrow. The scheme assumes that if the SEBs acts imprudently the states will have the incentive to rein them in given the impact on the state's own finances and their capacity to borrow for other social priorities. The core of the scheme is to link the finances of the SEBs and the states so closely as to instill financial discipline and to encourage the Discoms into improving their operational efficiencies. Joining the UDAY scheme is optional, but as of 2016, 15 states have joined.[217] While many people want to believe that the UDAY scheme is less onerous for the central government than the FRP, I have severe doubts that the financial health of the Discoms will improve dramatically until (1) all the Discoms sell power at cost-reflective tariffs; (2) special courts backed by police power are set

[214] Shobhana Subramanian, "Column: Cutting SEBs to size," The Financial Express, 26 June 2015, http://www.financialexpress.com/article/fe-columnist/column-cutting-sebs-to-size/90169/.
[215] Vishwanath Nair, "Default fears grow for state electricity boards," Livemint, 16 July 2015, http://www.livemint.com/Industry/BprrJi6qhAqtlanrJBGsvJ/Default-fears-grow-for-state-electricity-boards.html.
[216] "UDAY (Ujwal DISCOM Assurance Yojana," Press Information Bureau Government of India Cabinet, 5 November 2015, http://pib.nic.in/newsite/PrintRelease.aspx?relid=130261.
[217] "15 states have joined UDAY scheme: Piyush Goyal," *The Hindu*, 4 January 2016, http://www.thehindubusinessline.com/news/national/15-states-have-joined-uday-scheme-piyush-goyal/article8065262.ece.

up to go after power theft, meter tampering, and the non-payment of bills especially by powerful industrial and agricultural interests as well as the military and government agencies; (3) state regulatory commissions become truly independent and have complete authority over tariff schedules or if forced to provide service that is uneconomic are compensated by state governments with interest where applicable; and (4) regulators once appointed cannot be removed before the end of their term except for incapacity, malfeasance, or failure to carry out their responsibilities. Finally, I am struck as to why under the UDAY scheme any investor in their right mind would consider investing in bonds held by state governments (often themselves in a precarious financial position) or in any bankrupt utility, minus the introduction of the reforms and codes of conduct highlighted above.

In July 2015 seeing the economic cliff confronting the nation, the chair of the State Bank of India, Arundhati Bhattacharya, met with senior officials in the Finance and Power Ministries to express grave concern over the potential for further increases in bad loans occurring in the power sector and especially among the SEBs.[218] She made it clear that the problem was sector and nationwide and not only with the State Bank of India.

While no one can be sure of the potential size of the unmet financial obligations, estimates from independent sources suggest that there was a combined debt of INR 4.30 trillion.[219] Given this staggering amount, it became apparent that something must give if the system is to avoid a complete collapse. Clearly with this degree of unmet financial obligations, there is no prospect of the SEBs in the aggregate having the resources they need to upgrade their T&D networks to receive tens of thousands of megawatts of intermittent power into their grids.

Furthermore, with the financial exposure of the banks and other financial institutions so high, the government was confronted with the conundrum that it had to do everything possible to avoid letting the SEBs become non-performing assets since under Indian law if they even honored requests to reduce the interest rates on these loans, this would count as a second debt restructuring requiring them under Reserve Bank regulations to turn the SEB accounts into bad loans on their ledgers potentially threatening their own financial viability.[220] By November 2015, the National Democratic Alliance government had no other choice but to offer the Discoms another bailout, the third in nearly 13 years; however, there was renewed hope that this bailout would require states to take over the Discom debt and keep the banks out of any rescue efforts.[221] The other danger from a political perspective is that if the SEBs went under, the banks would have to try to seize SEB assets and sell them for whatever they could raising the question of who would buy them or be allowed to do so. If the private sector were allowed to but could only do so at fire sale prices, they would immediately need to raise tariffs which would bring the entire SEB Ponzi scheme crashing down—not to mention a major national political crisis if state governments tried to stop such sales.

As noted in Mint, the collapse of the restructuring plan occurs against the backdrop of the National Democratic Alliance government's plan to spend 75,600 crore rupees ($12 billion) to provide power through separate feeders for agricultural and

[218] Vishwanath Nair, "Default fears grow for state electricity boards."
[219] Remya Nair and Utpal Bhaskar, "New bailout plan for state power utilities," Live Mint, 6 November 2015, http://www.livemint.com/Politics/ZXS4WqprRv2VlDOz48onkI/New-bailout-plan-for-state-power-utilities.html.
[220] Vishwanath Nair, "Default fears grow for state electricity boards."
[221] Remya Nair and Utpal Bhaskar, "New bailout plan for state power utilities."

rural domestic consumption, a segment of which is to meet its goal of providing round-the-clock power to rural households as well as the government's Integrated Power development Initiative to help strengthen sub-transmission and distribution systems in urban areas.[222]

Perhaps one of the most damaging assessments of the government's entire FRP was made by Abhishek Poddar, a partner at AT Kearney when he said, "The financial restructuring package was like 'old wine in a new bottle' with an underlying intent to prevent an impending financial failure on the distribution end. With limited focus on big-ticket business restructuring, the fundamental issues at the distribution end continue to hurt the industry posing a threat to the long term viability of the power sector itself."[223]

Poddar's assessment however is only the tip of the iceberg. Having been directly involved in attempts to restructure SEBs in a number of Indian states, the problems go far beyond pure financial issues but too often include:

1. Top to bottom corruption from CEOs to meter readers to chief state electricity inspectors;
2. Woefully inadequate billing and collections systems both for technical inadequacies, and poor data management to outright corruption including meter tampering, payoffs for false bills, and outright intimidation to anyone trying to read a meter; in this last regard, I was personally threatened on three occasions in three different SEBs when he tried to inspect a meter;
3. Outright extortion by powerful rural landlords at the expense of their workers making them pay higher rates either for power the landlord received free or at a very low price;
4. Outright power theft in several manifestations;
5. Nonpayment or partial payment by government offices and the military;
6. No ability by many State Electricity Regulatory Commissions or SEBs to take any meaningful actions for nonpayment against powerful economic and political interests, including rich industrialists;
7. Failure by state governments to enact the model State Electricity Distribution Responsibility Bill 2013 on the lines of the fiscal Responsibility and Budget Management Act which was designed to enforce discipline on the states in the operations of the distribution companies; and
8. Failure by the SERCs to enforce the provisions of the Electricity Act 2003 allowing the free flow of power between and among states.

In conclusion, the Indian power sector for many years has been in a state of economic, financial, and political paralysis, and continues to struggle with critical underlying political, social, and economic issues. Without a major transformation of the sector, it is clear that the Discom situation alone may keep Prime Minister Modi from instituting many of the commitments made in India's INDC submission to COP21. Incremental reform of the power sector will no longer work. Institutional reform of the power sector which commenced in 1991, nearly a quarter of a century ago, has had little or no success in putting the sector on a long term sustainable growth path that will meet the requirements of a rapidly expanding

[222] Utpal Bhaskar, "Bailout plan for discoms fizzles out," Live Mint, 9 September 2014, http://www.livemint.com/Politics/xnabMXKPnPSS4VFDAw07zM/Bailout-plan-for-discoms-fizzles-out.html.
[223] Ibid.

population while also providing hope to the large population that lacks any access to modern energy services.

If one takes exception to this evaluation, one has only to examine the Ministry of Power's State Distribution Utilities Third Annual Integrated Rating Report issued in August 2015. In its assessment which has its own critics for what is alleged to be the use of a new methodology less onerous and inconsistent with previous reports, the Ministry of Power ranked only five utilities with a score of A-plus suggesting very high operational and financial performance capability; two utilities ranked an A for their high operational and financial capability; 10 utilities ranked a B-plus for their moderate operational and financial performance capability; 13 utilities ranked a B for their below average operational and financial performance capability; eight utilities ranked a C-plus for their low operational and financial performance capability and two utilities ranked a C for their very low operational and financial performance capability.[224]

Given these realities, it is time for the Modi government to come clean about the formidable challenges it has in the electricity T&D sector as well as in the other sectors of the energy economy highlighted in this paper if it wishes to have any chance to turn the vision for an Indian clean energy economy into reality.

Land rights and the environmental rollback

At the vortex of Prime Minister Modi's new energy policy is the question of land acquisition and environmental regulation. Continuing the preceding government's industrialization agenda, the BJP government in less than two years has diluted environmental regulations and prospects for just land right reforms, significantly endangering not only the future of India's citizens but also the future of its unique biodiversity and wildlife.

What is remarkable is the number of Indian energy analysts who continue to argue either that Prime Minister Modi is the man who can change India and get it onto a sustainable energy path or those that argue that India can meet its INDC commitments through an energy path that reduces coal use and focuses mainly on renewables, end-use efficiency, and conservation. Both sets of analysts in my opinion seem to ignore the reality to the PM's tenure in office.

In September 2014, a parliamentary high-level committee, chaired by T.S.R. Subramanian, a former cabinet secretary and ex-chief secretary of Uttar Pradesh, was assembled to review key environmental statutes (including the Environment Act, 1986; the Water Act 1974; the Air Act 1981; and the Indian Forests Act 1927) to determine their validity and applicability.[225] In its report, the Committee found ample ground for streamlining the process for environmental clearances and that many of the acts often conflicted or overlapped with each other making it onerous for businesses to proceed with projects on a timely basis. However, in July 2015, the Committee's report was rejected by the Parliament on the grounds that some of the critical recommendations "would result in an unacceptable dilution of the existing legal and policy architecture established to protect our [the] environment."[226] Opposition to the bill also arose

[224] Ministry of Power, *State Distribution Utilities Third Annual Integrated Rating*, August 2015, p. 9, https://www.upcl.org/wss/downloads/third_annual_integrated_rating_aug_15.pdf.

[225] "Govt sets up panel to review environment laws," *Live Mint*, 2 September 2014, http://www.livemint.com/Politics/tLX8sssr9OXX3DYnq6hfdP/Govt-sets-up-panel-to-review-environment-laws.html.

[226] Srestha Banerjee, "Parliamentary Standing Committee rejects TSR Subramanian report on environmental laws," *Down to Earth*, 24 July 2015, http://www.downtoearth.org.in/news/parliamentary-standing-committee-rejects-tsr-subramanian-report-on-environmental-laws-50577.

from the fact that affected parties under the new proposed regulations would have little recourse to challenge land acquisitions. The legal validity of the committee itself was challenged owing to the fact that it had been formed on the recommendation of the Environment Ministry when such a high-level panel needs the approval of the prime minister which apparently was not sought even though the PM clearly supported the change in the proposed land acquisition procedures.

In addition to environmental regulation, the Modi government also sought to reform land rights and land acquisition policies. The Right to Fair Compensation and Transparency in the Land Acquisition, Rehabilitation, and Resettlement Bill that was tabled in Parliament during its monsoon session has been one of the most controversial pieces of legislation introduced by the Modi government. In its current draft, the bill exempts five categories of projects (defense, rural infrastructure, affordable housing, industrial corridors, and public-private partnerships) from needing any consent by the affected parties.[227] The bill failed to define the full scope of many of these categories of projects creating room for broad and vague interpretations. This is particularly the case for "industrial corridors" projects that many people fear could allow the coal industry to run roughshod over land acquisitions for railways or mining projects linking up with the railway network leading potentially to a massive increase in railway infrastructure which is one of the primary goals of the Modi administration.

Furthermore while the draft bill proposes to expedite the time required to complete land acquisitions, the change is minimal from 50 to 42 months. In addition, the bill retroactively overturns a previous clause in the regulations that if land remains unused after five years that it returns to the original owner.[228] The political opposition believes that in its proposed new form the bill grossly violates the rights of land owners—particularly farmers and tribal villagers.

On the environmental front, Prime Minster Modi's government has continued to use taxes on coal first introduced in 2010 at a rate of INR 50/ton to encourage a shift away from coal based energy to renewable energy. In 2015, the government raised the tax to INR 200/ton and in the new budget, the PM has proposed raising the tax to INR 400/ton.[229] The revenue generated from the tax finances a Clean Energy Fund which critics argue have sometimes been used for environmental projects outside the power or energy sector, such as cleaning up the Ganges. Nonetheless, according to The Indian Express, the fund is significant, and in 2015, had a cumulative total of INR 17,000 crores available.

Recent Developments

As this paper was being finalized several important developments occurred which are potentially vital for energy sector reform. In late February, the minister of finance presented the union budget for FY2016-2017 (April 2016-March 2017).

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[227] Joyita Ghose, "Bill Summary: The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Second Amendment) Bill, 2015," PRS Legislative Research, 12 May 2015, http://www.prsindia.org/uploads/media/Land%20and%20R%20and%20R/Bill%20Summary-LARR%202nd%20Amendment.pdf.

[228] Mandira Kala and Prachee Mishra, "Legislative Brief: The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Second Amendment) Bill, 2015," PRS Legislative Research, 17 July 2015, http://www.prsindia.org/administrator/uploads/media/Land%20and%20R%20and%20R/Brief%20-%20LARR%20Bill_2015.pdf.

[229] Amitabh Sinha, "Union Budget 2016-17: Coal cess doubled to fund ministries, green drives," *The Indian Express*, 2 March 2016, http://indianexpress.com/article/india/india-news-india/union-budget-2016-17-coal-cess-doubled-to-fund-ministries-green-drives/.

While some of the proposed changes—especially for oil, natural gas, and coal—have been discussed earlier in the paper, perhaps the most significant announcement centered on a proposed investment of INR 91 billion, an increase of INR 37 billion from over the previous year, in the Indian Renewable Development Agency, the government owned renewables dedicated lender.[230] At the same time, the government sent mixed signals by announcing that there would be changes in depreciation, and corporate and service tax schedules for renewable projects. Under the proposed changes, as previously mentioned, the reduction in the rate of accelerated depreciation from 80 percent to 40 percent effective in April 2017, will be felt largely in the market for rooftop solar, where consumers have taken advantage of the existing depreciation schedule leading to a surge in sales. Even though these changes will adversely affect solar projects, it is anticipated that in the near term there will be a surge in investment this fiscal year to take advantage of the higher depreciation rate. Critics of the budget found glaring reasons to attack it. Rahul Tongia, while pleased with several aspects of the budget was disappointed by the lack of provisions to accelerate energy efficiency and demand side management.[231] Nonetheless, while the changes, if enacted will have an impact on the solar and wind sectors and according to Bridge to India, despite these changes, India is expected to add 5 GW of solar projects in 2016 and another 9GW in 2017.[232]

[230] "With a focus on financing, FY 17 budget increases fund allocation to IREDA," Bridge to India, 29 February 2016, http://www.bridgetoindia.com/blog/with-a-focus-on-financing-fy-17-budget-increases-fund-allocation-to-ireda/.
[231] Rahul Tongia, "Uncomplicating the Budget 2016," Brookings India, 3 March 2016, http://www.brookings.in/uncomplicating-the-budget-2016/.
[232] "With a focus on financing, FY 17 budget increases fund allocation to IREDA."

5. Conclusions

The Paris agreement has led to global celebration, providing hopes that with 196 countries in the world now publically committed to fighting climate change, concrete actions will be taken. Going into the talks, India was considered to be one of the major elephants in the room, demanding enhanced financing commitments from the developed world to help the nations of the developing world to adapt and turn back where possible the prospective threats of climate change. India was also in the vanguard of those insisting that countries with the historical responsibilities for creating climate change during their own industrial growth should be expected to do more to curb its effects, allowing India and other fast growing emerging market economies to continue to grow. India also reiterated the view raised in previous COP meetings and especially in Cancun, of the principle of differentiation; whereby, states with the economic and technological capacities to do the most to deal with climate change should do so, while other states should take actions commensurate with their economic and technological capacities.

This is not to say that the policies PM Modi promulgated at COP21 were insignificant. Indeed, the PM promised, as noted earlier, to increase exponentially the deployment of renewable energy and to enact bold energy efficiency and conservation policies while at the same time dropping the percentage share of coal in the nation's energy mix, even if missed in the fine print and commentary thereafter was the fact that coal production would more than double volumetrically. Also missed by many commentators was the PM's proviso that implementing all India's INDC pledges were contingent on appropriate levels of global financial support. Despite India's demonization for being "coal loving," India emerged from the talks relatively unscathed, with the head of the Indian delegation, Environment Minister Prakash Javedkar, praising the final outcome as well as the negotiating process. Now that the international goal of reaching a deal on a framework agreement has been negotiated, the question posed to India is what lies ahead in India's path towards low-carbon future development?

Coming out of Paris, PM Modi faces a number of challenges. When he assumed office in May 2014, he inherited an economy that was ranked 134 (of 189) on the World Bank's ease of doing business index.[233] The prime minister and the Bhartiya Janata Party-led Government began the process of addressing this poor ranking by reforming industry

[233] "Ease of doing business index (1=most business-friendly regulations)," Data, The World Bank, accessed 19 April 2016, http://data.worldbank.org/indicator/IC.BUS.EASE.XQ.

licensing processes, reducing taxes on commercial business ventures, and uncluttering environmental clearing processes. Eighteen months on, India now ranks 130 on the ease of doing business index.

So where does this leave us in our assessment of India's capacity to enact its INDC commitments? Clearly if India could work on all four cylinders, it has the capacity to achieve whatever it wants to on the energy front. Both in India and abroad, corporate leaders such as Sundar Pichai, Binoy Job, Aditya Ghosh, Sachin Pilot, and Chanda Kochar have demonstrated business acumen second to none.[234] If these leaders would now take on the challenge of transforming India's energy sector, there is no doubt that they could go a long way in putting India on a sound long term path for energy using all available forms and new advanced technologies. This is not to argue that even with the best of leadership that there will not be intense debates over the use of certain energy resources and how best to insure the country's long term energy security.

The chief issues that will form the cornerstone of this national discussion will be:

1. The long term role of fossil fuels (oil, gas, and coal) in the economy and the degree to which, if domestic supplies are available they should be imported with attendant economic, security, and environmental ramifications;
2. Transportation bottlenecks including railways, roads, and port infrastructure;
3. Energy and emissions related to the construction of new infrastructure developments, including the 100 smart cities and expanding urban populations;
4. The significant upgrades to the transmission and distribution systems throughout India that require massive investments;
5. The ongoing issues related to rampant corruption throughout the energy sector;
6. Land acquisition policies for generation facilities and transmission corridors for electricity and oil and gas pipelines, as well as their impact on local populations, water supplies for agriculture, and the local and national environment;
7. Tariff policies, with special emphasis on capacity to pay;
8. The security of large scale energy trade with India's neighbors for electricity and natural gas; and
9. How India can begin to make a major diversification away from petroleum for its transportation sector, to avoid what on the basis of current policy looks as if it could lead to staggering levels of oil imports over the next 25 years.

However, despite the challenges confronting each fuel source in the Indian economy and the constraints they put on Prime Minister Modi's ability to turn India's INDC into reality, **it is events outside the energy sector both in the world economy and in India that ultimately will prove the greatest challenge to the prime minister.**

As my colleague at Brookings India, Vikram Singh Mehta, recently wrote in the Indian Express, despite the fact that India is one of the fastest growing economies in the world, the finance minister acting on behalf of the prime minister needs not only to put meat on the bones of the forthcoming Indian budget but also needs "to navigate the economy through the choppy international

[234] Sundar Pichai, CEO, Google; Binoy Job, Director of Communications, Prime Minister's Office; Chanda Kochar, MD and CEO ICICI Bank; Aditya Ghosh, CEO, Indigo Airlines; Sachin Pilot, Former MP, Indian National Congress

waters of collapsing commodity prices, demand recession, rising debt, sectarian strife and terrorist violence."[235] At the same time, he needs to make clear to the Indian people "how he will address the immediate imperatives of poverty alleviation, income generation, skill development, social justice and sustainable development."[236]

Despite the fact that the underlying fundamentals of the Indian economy remain strong, the reality is that **too much of the Indian energy sector as well as the broader economy have not made enough of the fundamental reforms that are vital if India is to not only grow its economy on a sustainable basis but also to do so in a way that meets its INDC goals**. Despite a vigorous renewable energy generation program and great strides in energy efficiency, demand side management and the construction of new "smart cities" centered around smart grids and new digital technologies, the reality is that the Indian economy is not growing fast enough (8 percent or more) to generate enough jobs to lift India out of its slumber. Indeed income inequality is growing as is the number of unemployed and underemployed people.

In addition, as the result of bureaucratic delays; painstakingly lengthy permitting processes; corruption; and power theft, unwillingness by far too many state governments and their SEBs to make meaningful tariff reforms, reduce their own bureaucracies and raise tariffs to levels that will sustain meaningful investments in upgrading electricity transmission and distribution systems, there is little chance that the plans for expansion of tens of thousands of megawatts of renewable power—or, for that matter, for coal, gas, nuclear, and hydro power—will meet the government of India's vison of Power for All.

India is at a critical juncture in its long term future. As noted, it has among the best entrepreneurs in the world, talented business people, top flight engineers, a strong working ethic, and cheap labor. However for its energy sector and economy to thrive it must have an enlightened tax code and regulatory policies that encourage investment in oil and gas production, the development of domestic manufacturing of solar panels and wind turbines, and state of the art energy efficiency and demand side management technologies. If India believes that coal, even for a transition period, must remain a vital part of the energy mix, then it must put tax and other fiscal policies into effect, such as accelerated depreciation, first year expensing on capital equipment, etc. to move away from its subcritical coal plants to ultra-supercritical facilities while investing in R&D for carbon capture and sequestration.

India's success or failure in meeting its future energy needs is not only of concern to India but to the entire world, since if India fails, Paris fails.

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[235] Vikram Singh Mehta, "Over the barrel: Waiting for a big bang," *The Indian Express,* 2 February 2016, http://indianexpress.com/article/opinion/columns/waiting-for-a-big-bang-india-economy-arun-jaitley/.
[236] Ibid.

APPENDIX A: Government-led Utilities and Organizations

Government-owned utilities account for a majority of the country's electric power generation. The following is a brief outline for reference of key ministries and state-run companies.

- The **National Thermal Power Corporation**: accounts for about 27 percent of national electricity capacity. Under Indian law, the NTPC has Maharatna status which gives it large scale autonomy to act without central government direction in areas relating to capital expenditures, joining in strategic alliances or joint ventures with other partners, internal restructuring of the organization, setting up offshore offices, and raising debt in capital markets.[237]
- The **North Eastern Electric Power Cooperation:** has responsibility for developing electric generating capacity in the northeastern region of India with a total installed capacity of 1,251 MW.[238]
- The **National Hydroelectric Power Corporation:** is in charge of developing hydropower, tidal power, and geothermal and wind-based electricity capacity. It currently has 20 plants with a combined capacity of 6,507 MW.[239]
- The government-owned **Power Grid Corporation of India:** is a public sector power transmission utility whose objectives range from the coordination of inter-state transmission systems to ensuring overall reliability and security.[240] Power Grid also transfers and operates a number of dispatch centers around the country.
- The **Power Finance Corporation:** provides term financing for power sector projects and serves as a conduit for overseas investment in the sector. Its clients include State Electricity Boards and power utilities in both the public and private sectors. The Power Finance Corporation has been designated as the "nodal agency" for the development of India's ultra-mega transmission projects which involves setting up a number of special purpose vehicles or shell companies.[241]
- The **PTC India:** formerly known as the Power Trading Corporation of India is a public-private partnership established in 1999 to create greater economic efficiency in India's electricity market by facilitating cross-border power trading between states and quickly adapting to supply surpluses and shortages. There is also extensive power trading by private sector firms since the passage of the Electricity Act in 2003.[242]
- The **National Smart Grid Mission:** as part of its new power generation policy,

[237] "Vision & Mission: Objectives," Power Grid Corporation of India Ltd, accessed 13 April 2016, http://www.powergridindia.com/_layouts/PowerGrid/User/ContentPage.aspx?PId=77&LangID=English.
[238] "Power Potential in North Eastern Region," NEEPCO, last updated 7 July 2015, http://neepco.co.in/neepco/#.
[239] "About Us: Overview", NHPC, accessed 13 April 2016, http://www.nhpcindia.com/about-overview.htm.
[240] Ebinger, *Energy and Security in South Asia,* p. 29.
[241] Ibid.
[242] Ibid.

India has established a design to reduce losses and outages throughout the power network and has set up plans to develop a Green Energy Corridor to ensure that there will be facilities and land allowing green energy to reach major load centers.[243]

[243] GoI, *India's INDC,* p. 10.

APPENDIX B: The National Action Plan on Climate Change and its Missions

The NAPCC outlined eight missions when it was released in 2008. These missions were intended to cut across sectors in a holistic approach to climate change mitigation. The missions and their current status are discussed below:

- **Jawaharlal Nehru National Solar Mission (JNNSM):** Launched in 2010, the JNNSM can be considered the flagship mission of the NAPCC. The mission aims at significantly ambitious targets of 100 GW of grid-connected solar by 2022, an increase of the originally proposed 20 GW.[244]
- **National Mission for Enhanced Energy Efficiency:** This mission seeks to create, strengthen, and sustain a market for energy efficiency in India, across both consumer goods and commercial manufacturing sectors. Using market-based approaches to incentivize savings, such as the PAT initiative, new financing models, and accelerating adoption of efficient appliances.[245] As previously discussed, the NMEEE has made tremendous strides in promoting the use of LED lightbulbs and working towards fuel savings equaling nearly 23 million tons of coal per year.
- **National Mission on Sustainable Habitat:** Broadly, this aims to promote sustainable urban planning through increasing public transport, bettering waste management, and optimizing energy demands (through the use of the Energy Conservation Building Code).[246]
- **National Water Mission:** This mission aims at water conservation, distribution, and optimization. The mission has been tasked with enhancing water use by 20 percent, in accordance with India's INDC.[247]
- **National Mission for Sustaining the Himalayan Ecosystem:** This mission aims to manage the Himalayan mountain ecosystem(s) and mitigate the effects on climate change. Primary concerns include: the Himalayan glaciers, management of natural hazards, floods, protection of wildlife, and utilizing traditional knowledge.[248]
- **National Mission for a "Green India:"** This mission aims to utilize a combination of adaptation and mitigation measures in enhancing carbon sinks in sustainably managed forests and other ecosystems,

[244] "Revision of cumulative targets under National Solar Missions from 20,000 MW by 2021-22 to 1,000,000 MW," Press Information Bureau Government of India Cabinet, 17 June 2015, http://pib.nic.in/newsite/PrintRelease.aspx?relid=122566.
[245] "National Mission for Enhanced Energy Efficiency (NMEEE)," Bureau of Energy Efficiency, accessed 13 April 2016, https://beeindia.gov.in/content/nmeee-1.
[246] Ministry of Urban Development, "National Mission on Sustainable Habitat," Government of India, pp. 13-14, accessed 13 April 2016, http://moud.gov.in/sites/upload_files/moud/files/NMSH_0.pdf.
[247] GoI, *India's INDC,* p. 21.
[248] "Cabinet approves mission to sustain Himalayan ecosystem," The Hindu, 28 February 2014, http://www.thehindu.com/news/national/other-states/cabinet-approves-mission-to-sustain-himalayan-ecosystem/article5736496.ece.

adaptation of vulnerable species/ecosystems, and to increase forest/tree cover. This mission is expected to achieve the sequestration of nearly 100 million tons of carbon emissions on an annual basis.[249]

- **National Mission for Sustainable Agriculture:** This mission aims to "transform agriculture into an ecologically sustainable climate resilient production system while at the same time, exploiting its fullest potential and thereby ensuring food security."[250]
- **National Mission on Strategic Knowledge for Climate Change:** This mission aims to bring together research, technology, and capacity to mitigate and adapt to climate change by building dedicated knowledge centers, networks, and support structures.[251]

[249] GoI, *India's INDC,* p. 16.
[250] "Climate Change Initiatives in India: Convergence of Actions 2015," Ernst & Young LLP, 2015, p. 16, http://www.ey.com/Publication/vwLUAssets/ey-climate-change-initiatives-convergence-of-actions/$FILE/ey-climate-change-initiatives-convergence-of-actions.pdf.
[251] Ministry of Science & Technology, "National Mission on Strategic Knowledge for Climate Change under National Action Plan on Climate Change: Mission Document," Government of India Department of Science & Technology, July 2010, p. 5, http://dst.gov.in/sites/default/files/NMSKCC_July_2010.pdf.

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