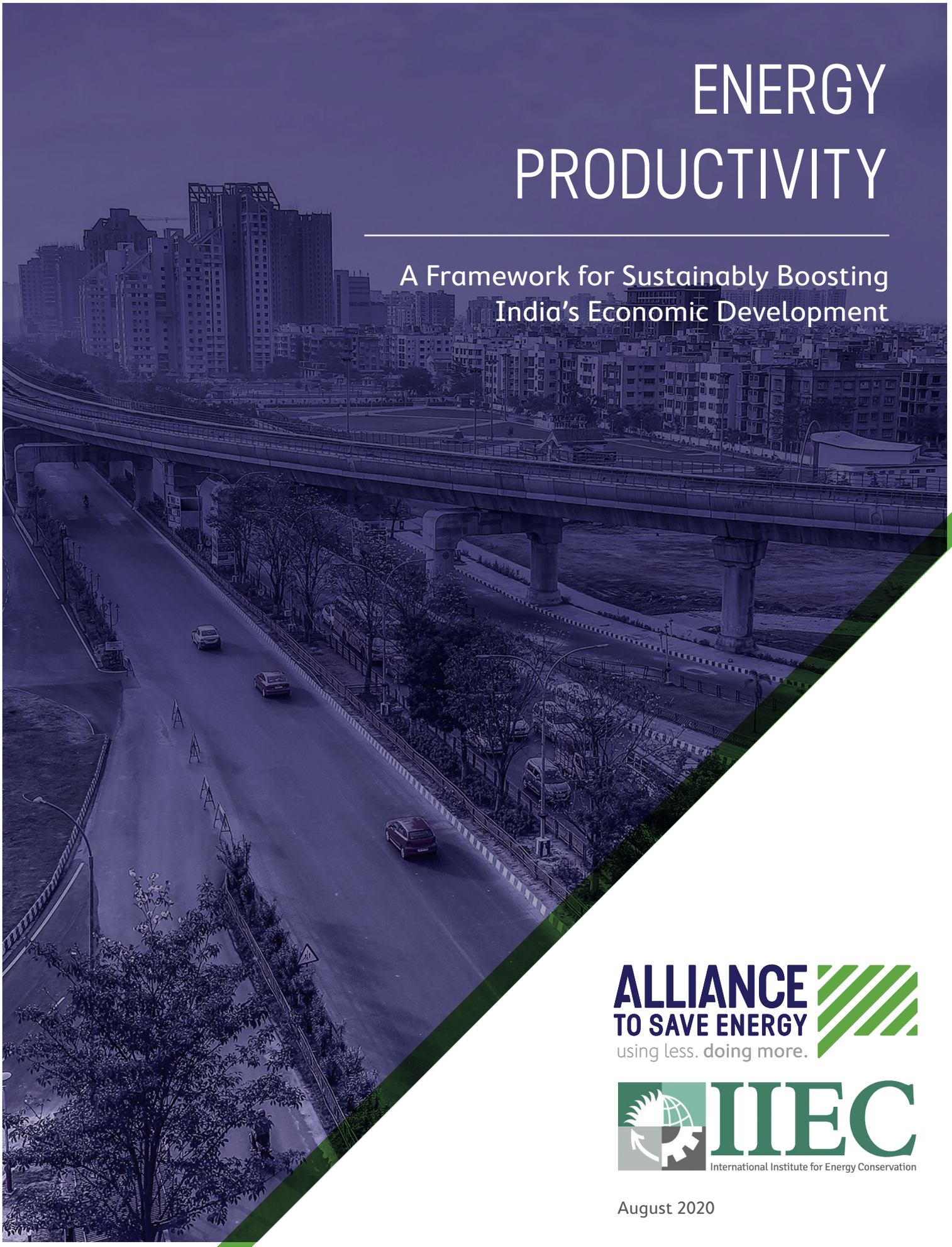
ENERGY PRODUCTIVITY

A Framework for Sustainably Boosting India's Economic Development



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IIEC
International Institute for Energy Conservation

August 2020

FOREWORD

We are pleased to present this report, Energy Productivity: A Framework for Sustainably Boosting India's Economic Development, which offers energy productivity as a new paradigm with which to frame and pursue India's twin goals of economic development and environmental sustainability.

Modeled after similar exercises conducted in the United States and Australia, the idea for this report began when we asked the question: How would India benefit if we doubled the amount of economic benefit accrued from every unit of energy we consume? We partnered with technical experts to model potential scenarios and found that it is feasible to double India's energy productivity by 2041 and that the benefits to the country—including energy savings, reduced greenhouse gas emissions, and job creation—would be enormous.

Over the past year, the International Institute for Energy Conservation (IIEC) and the Alliance to Save Energy (ASE) worked in India with different public and private sector stakeholders to identify programs and policies that could set India on a path to doubling the energy productivity. A high-level Review Committee led by the Bureau of Energy Efficiency (BEE) reviewed the progress of the roadmap and provided guidance on the analysis conducted and the development of the recommendations. This resulting roadmap outlines proven energy efficiency and renewable energy policies that India's central, state, and local governments and other public, private, and non-governmental stakeholders can pursue to achieve this potential.

We look forward to continuing to work with public and private sector stakeholders in India to explore the potential for implementing these recommendations.

The honorable Review Committee Members who provided the valuable contribution to this roadmap are listed below. In addition, the Committee acknowledges with gratitude the valuable comments provided by reviewer Ashok Sarkar of the World Bank's Energy and Extractives Global Practice.

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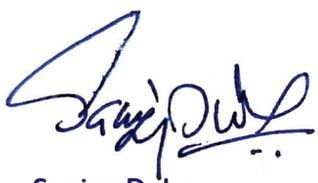

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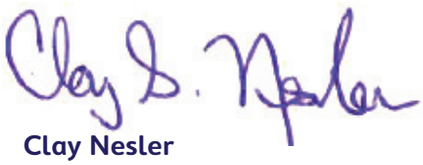

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INTRODUCTION

India, like all nations, faces the "formidable and complex challenge" of balancing economic development and mitigating climate change.[1] India's rapid development and the structural economic trends that are transforming almost every sector pose particular challenges—but also provide unique opportunities—for India to achieve both of these goals.

Economic growth and development have historically been positively correlated with rising energy demand.[2] However, by improving the efficiency of its energy supply and use, India has begun to decouple its gross domestic product (GDP) growth from energy consumption. This achievement offers the key to improving India's ***energy productivity***—obtaining more economic output from every unit of energy consumed. Seizing opportunities to improve the efficiency of energy use throughout the economy—in buildings, industry, transportation, power generation, and services—as these sectors grow and transform can enable India to rapidly grow its economy while curbing the rise in energy use and related greenhouse gas (GHG) emissions.

An analysis of the International Energy Agency (IEA)'s New Policies Scenario (NPS) finds that, by aggressively carrying out energy efficiency policies and programs, alongside continued efforts to shift from fossil fuel generation to renewable energy, India could double its energy productivity by 2041.[3] In addition to reducing the amount of energy required to produce each unit of India's GDP, this would result in significant emissions reductions, increased energy security, and job creation.

This report discusses these results and provides a rationale for using energy productivity as a framework for making energy policy decisions. It also provides a roadmap for near- and long-term actions that the Government of India can take, in collaboration with its private sector, civil society, and international partners, to maximize the energy productivity of India's economy.

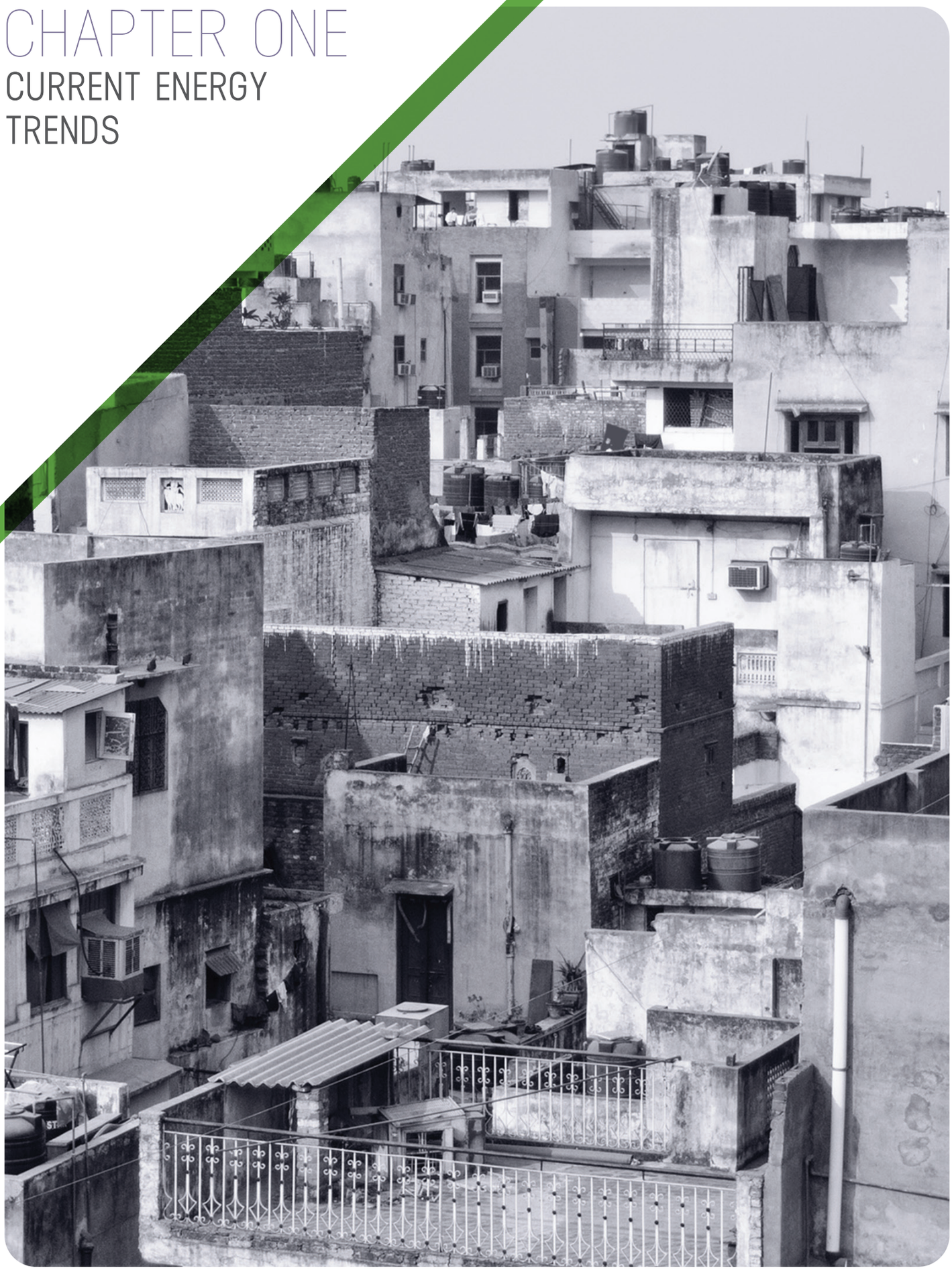
Chapter 1 provides background on India's energy consumption and trends in its high GDP-producing sectors, Chapter 2 makes the case for energy productivity as a framework, and Chapter 3 provides more detail on the scenario analysis underlying this report. Chapter 4 contains 48 policy and program recommendations targeting various actors and focused on four key themes: stimulating investment in energy productivity, modernizing standards and infrastructure, facilitating the transition to renewable energy sources, and educating stakeholders about energy productivity.

1 India's Intended Nationally Determined Contribution: Working Towards Climate Justice. (n.d.). Government of India. Retrieved from: http://nmhs.org.in/pdf/INDIA%20INDC%20TO%20UNFCCC.pdf.

2 Sharma, N., Smeets, B., & Tryggestad, C. (2019, April). The Decoupling of GDP and Energy Growth: A CEO Guide. *McKinsey & Company*. Retrieved from: https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/the-decoupling-of-gdp-and-energy-growth-a-ceo-guide#:~:targetText=It's%20long%20been%20axiomatic%20that,growth%20pulls%20back%20in%20turn.

3 Renewable power consumes less primary energy to generate the same amount of electricity that would have been generated by fossil fuels. In other words, a unit of renewable energy will generate more energy output than the same unit of fossil fuel energy, enabling higher energy productivity.

CHAPTER ONE
CURRENT ENERGY TRENDS



CURRENT ENERGY TRENDS

India is home to nearly 18% of the global population, but currently consumes only 6% of the world's total primary energy.[4,5] However, India's overall energy consumption is increasing—energy demand in the country doubled between 2000 and 2017—and its share of total global energy consumption also is rising. India's energy use has accounted for almost 10% of the increase in global energy demand since 2000, and its share of total global primary energy demand is projected to reach 11% by 2040.[6,7]

India's high population and urbanization growth rates are two of the key drivers of this increasing energy demand, since accommodating the rapid rise in urban populations requires significant expansion in infrastructure and services.[8] Currently, about one-third of India's 1.35 billion people (460 million people) live in cities, and an additional 315 million people are expected to live in India's cities by 2040.[9] Based on these trends as well as increasing living standards and purchasing power, India's economy is expected to grow fivefold by 2040, with an average annual GDP growth of 7.5% until 2020, followed by 5.3% growth until 2040.[10]

More than three-quarters of India's energy demand is currently met by fossil fuels (Figure 1). This poses numerous challenges: The combustion of fossil fuels contributes heavily to chronic pollution in India's cities, presenting a serious public health burden. In addition, these fuels are primarily imported, making India one of the most import-dependent countries in the world. Demand for bioenergy has grown, but its share in India's primary energy mix has declined by almost 10% since 2000, as households shift to other fuels (notably liquefied petroleum gas) for cooking.[11] Natural gas, which is mainly used for power generation and feedstock, accounts for 7% of the energy mix, but has a growing role in transportation and cooking.[12] Hydropower, nuclear and renewable sources currently play a relatively small role in India's energy supply.

4 World Energy Outlook Special Report: India Energy Outlook. (2015). *International Energy Agency*. Retrieved from: https://webstore.iea.org/weo-2015-special-report-india-energy-outlook.

5 World Energy Outlook Special Report: India Energy Outlook. (2015). *International Energy Agency*. Retrieved from: https://webstore.iea.org/weo-2015-special-report-india-energy-outlook.

6 Energy Efficiency in India. (2018, Nov 15). *International Energy Agency*. Retrieved from: https://www.iea.org/articles/energy-efficiency-in-india.

7 BP Energy Outlook - 2019. (2019). *BP*. Retrieved from: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2019-country-insight-india.pdf.

8 World Energy Outlook Special Report: India Energy Outlook. (2015). *International Energy Agency*. Retrieved from: https://webstore.iea.org/weo-2015-special-report-india-energy-outlook.

9 World Energy Outlook Special Report: India Energy Outlook. (2015). *International Energy Agency*. Retrieved from: https://webstore.iea.org/weo-2015-special-report-india-energy-outlook.

10 World Energy Outlook Special Report: India Energy Outlook. (2015). *International Energy Agency*. Retrieved from: https://webstore.iea.org/weo-2015-special-report-india-energy-outlook.

11 World Energy Outlook Special Report: India Energy Outlook. (2015). *International Energy Agency*. Retrieved from: https://webstore.iea.org/weo-2015-special-report-india-energy-outlook.

12 World Energy Outlook Special Report: India Energy Outlook. (2015). *International Energy Agency*. Retrieved from: https://webstore.iea.org/weo-2015-special-report-india-energy-outlook.

India Energy Mix 2015-2016

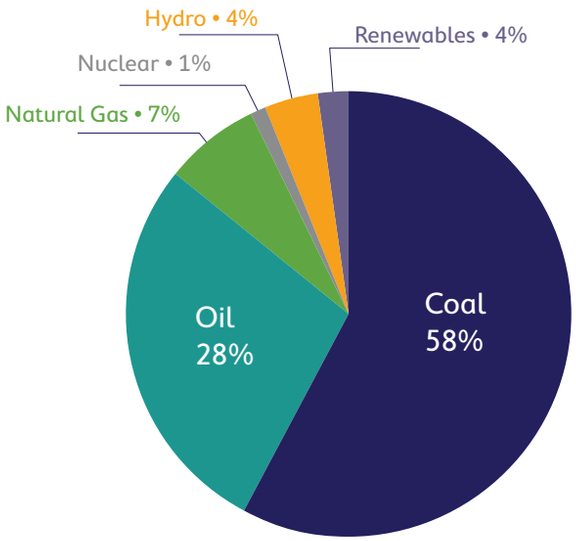


Figure 1: India Energy Mix (2015-2016)

Source: Energizing India, 2016, https://niti.gov.in/writereaddata/files/Energising-India.pdf

Energy use trends in key end-use sectors are described below:

- **Buildings:** To accommodate rapid urbanization, building construction in India has been increasing by almost 6% annually since 2015, and this trend is expected to continue: [13] About 70% of India's anticipated building stock in 2040 has yet to be constructed.[14] The corresponding increase in energy demand is driven not just by population growth and movement, but also by improved living standards and purchasing power, which has contributed to a spike in levels of appliance ownership. India's heating, ventilation, and air conditioning (HVAC) market, for example, is projected to increase by 30% between 2018 and 2024.[15]

- **Industry**: The industrial sector currently consumes about 45% of India's total energy,[16] and micro, small, and medium enterprises (MSMEs) account for about a quarter of this energy use.[17] The massive amount of new infrastructure needed to accommodate India's growing urban population will translate into significantly higher demand for energy-intensive materials, such as steel and cement. These materials are increasingly likely to be manufactured in India, due in part to the Government of India's Make in India initiative, which promotes an increase in domestic manufacturing. This includes India's more than 44 million MSMEs, which constitute 45% of India's manufacturing output.[18] The IEA estimates that the sector's energy demand will increase by 4.4% annually until 2040 and will account for more than 50% of the country's final energy consumption by 2040.[19]

13 Growth Rate of Construction Industry Across India from FY 2010 to FY 2020. (2019, Sept 23). *Statista Research Department*. Retrieved from: https://www.statista.com/statistics/878482/india-growth-rate-of-construction-industry/.

14 Zia, H. & Majumdar, M. (2015). Green Growth and Buildings Sector in India. *TERI*. Retrieved from: https://www.teriin.org/projects/green/pdf/National-Buildings.pdf.

15 India HVAC Market by Type (Heating, Ventilation, Cooling), End-User (Commercial, Industrial, Residential), Geographical Outlook – Industry Size, Share and Growth Forecast to 2024. (2019, March). *PS Market Research Private Limited*. Retrieved from: https://www.psmarketresearch.com/market-analysis/india-hvac-market.

16 Sethi, G. (23 Feb 2017). Industrial Energy Efficiency: Workshop on SDG7: Affordable and Clean Energy. *TERI*. Retrieved from: https://www.niti.gov.in/writereaddata/files/Girish%20Sethi.pdf.

17 Retrieved from https://beeindia.gov.in/content/small-medium-scale-enterprises-sme.

18 Retrieved from https://beeindia.gov.in/content/small-medium-scale-enterprises-sme.

19 World Energy Outlook Special Report: India Energy Outlook. (2015). *International Energy Agency*. Retrieved from: https://webstore.iea.org/weo-2015-special-report-india-energy-outlook.

- **Transportation:** While personal vehicle ownership per capita is still relatively low in India, transportation energy use is projected to grow at the fastest rate in the world, averaging 5.5% annually, compared with the world average of 1.4% per year. Road transport is the dominant mode of transport and will account for the majority of the increase.[20]
- **Agriculture**: Although agriculture currently employs over half of India's population, it has historically accounted for a small portion of India's energy demand. This is because India's agricultural system has, until recently, been characterized by small family shareholder farms that use little or no machinery. As rural India connects to the power grid and some farmers shift to using harvesting and processing machinery, electricity demand in the sector will increase.[21] Since 2000, electric irrigation pumps have accounted for a 15% increase in India's total electricity demand.[22]

In each of these sectors, opportunities exist to significantly improve the efficiency of energy use, enabling India to realize more economic output from every unit of energy consumed. Seizing these opportunities to improve India's energy productivity will enable the country to maximize the benefits of economic growth and development while reducing the associated growth in energy costs, pollution, energy insecurity, and GHG emissions.

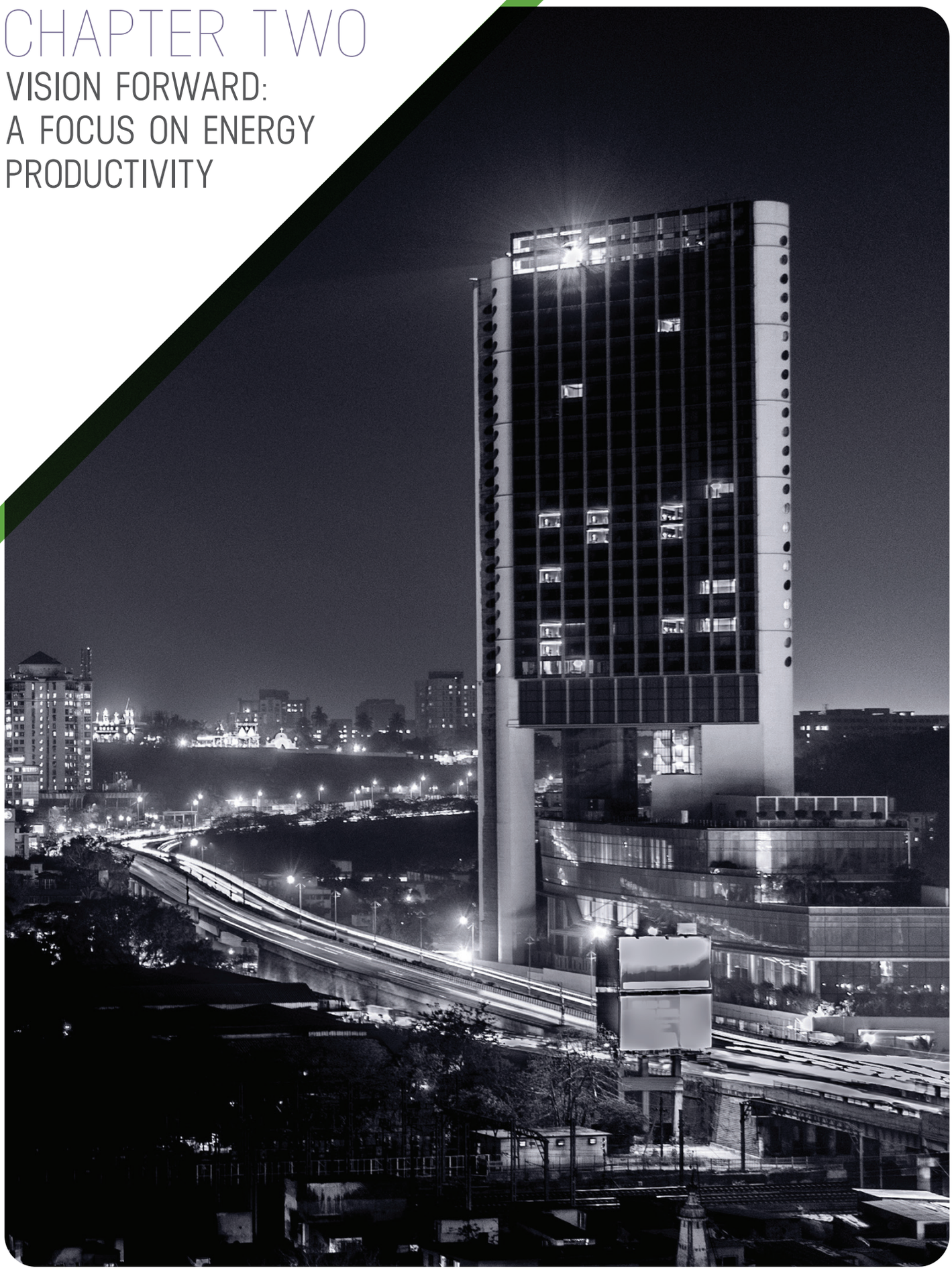
20 Pinna, I., Dalla Chiara, B., & Pant, K. (2014). Energy Used by Transport Systems in India: The Role of the Urban Population, Sources, Alternative Modes and Quantitative Analysis. *Energy Production and Management in the 21st Century*. Retrieved from: https://www.witpress.com/Secure/elibrary/papers/EQ14/EQ14063FU1.pdf.

21 World Energy Outlook Special Report: India Energy Outlook. (2015). *International Energy Agency*. Retrieved from: https://webstore.iea.org/weo-2015-special-report-india-energy-outlook.

22 World Energy Outlook Special Report: India Energy Outlook. (2015). *International Energy Agency*. Retrieved from: https://webstore.iea.org/weo-2015-special-report-india-energy-outlook.

CHAPTER TWO

VISION FORWARD: A FOCUS ON ENERGY PRODUCTIVITY



VISION FORWARD: A FOCUS ON ENERGY PRODUCTIVITY

Decoupling India's GDP growth from energy demand—i.e., increasing its energy productivity—is critical for promoting sustainable energy sector growth, enhancing energy security, and mitigating challenges associated with GHG emissions and local air pollution

Energy productivity is a measure of the economic benefit received from each unit of energy consumed. It is calculated by dividing total economic output (e.g., products, revenue, GDP) by the amount of energy consumed (e.g., kilowatt hours of electricity, barrels of oil equivalent, Gigajoule). At a micro level, the private sector commonly uses this metric to track the relationship between a company's profitability and its energy use. Increasingly, countries (see box below) are also recognizing the value of using energy productivity at the national level, measured as a country's total ***GDP produced per unit of primary energy consumed,*** as a framework for assessing how effectively energy is used to run the economy.[23]

$$EP = \frac{GDP}{\text{Primary Energy Consumed}}$$

Energy productivity integrates the concept of energy efficiency improvements with economic development goals and achievements. It is an effective framework for shaping policy for several reasons:

- **Energy productivity emphasizes the economic outcomes of energy efficiency investments:** By focusing on the economic benefits—such as increased economic competitiveness, energy security, and job creation—that accrue from energy efficiency improvements, the use of this metric can strengthen the rationale for adopting efficiency action. In other words, targeting economy-wide energy productivity improvements empowers decision makers to "set actionable agendas based on the direct and quantifiable benefits of investing in energy-efficient technologies and practices."[24]
- **Energy productivity provides a positive target for policymakers**: Many countries have traditionally used energy intensity, the inverse of energy productivity, as a metric for setting national goals.[25] Shifting to an energy productivity framework provides a more positive connotation and strengthens the message—i.e., aiming to increase economic output per unit of energy rather than aspiring to the "negative" goal of minimizing resource use per unit of output—in a way that can build stakeholder buy-in and inspire action.
- **Energy productivity highlights the important synergies between energy efficiency and renewable energy in meeting national goals**. Energy efficiency directly improves energy productivity (by shrinking the denominator in the energy productivity equation) and also reduces the capacity required for new renewable energy installations. In addition, shifting from fossil fuels to renewable energy resources boosts a country's overall energy productivity by increasing the efficiency of the power grid and reducing conversion losses.

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23 Primary energy consumption refers to total energy demand, which includes losses during energy transformation (e.g., conversion of oil into electricity) and distribution. It excludes secondary energy consumption (in the case of electricity) and energy carriers used for non-energy purposes (such as petroleum used for producing plastics). Primary consumption captures all potential efficiency improvements in the power generation sector, including those from shifting to renewable sources, and presents a more accurate picture (than use of final energy consumption) of the energy carriers consumed as fuel.

24 Energy Productivity Playbook: Roadmaps for an Energy Productive Future. (2016). *Global Alliance for Energy Productivity*. Retrieved from: https://www.ase.org/sites/ase.org/files/gaep_playbook-energy-productivity_alliance-to-save-energy.pdf.

25 Energy intensity is measured by the quantity of energy required per unit output or activity, so that using less energy to produce a product reduces the intensity. See: https://www.energy.gov/eere/analysis/energy-intensity-indicators-efficiency-vs-intensity.

The following chapters of this roadmap outline a scenario analysis that illustrates how India can double its energy productivity by 2041. The roadmap also provides recommendations for actions that policymakers and private sector players in the energy market, supported by development partners, can take to help reach this goal. The recommendations primarily focus on reducing energy demand through end-use energy efficiency, but also include suggestions for facilitating the shift from fossil fuels to renewable energy, and reducing supply side inefficiencies through more efficient power grids. Increasing the share of renewable energy in India's power generation is not only necessary to achieve emissions savings as the economy grows, but it can also significantly improve India's energy productivity by improving the efficiency of the power grid, including through the integration of distributed renewable energy (see box).

Energy productivity benefits of switching to renewable energy

In source/site calculations of primary energy, the generation of renewable power is commonly assumed to be 100% efficient (i.e., source energy consumption for renewables is assumed to be equal to site energy consumption). As a result, renewable power consumes less primary energy to generate the same amount of electricity that would have been generated by fossil fuels. In other words, a unit of renewable energy will generate more energy output than the same unit of fossil fuel energy, enabling higher energy productivity.

Benefits of Energy Productivity – National Case Studies

China[a,b]

In 2006, the Government of China committed to doubling its energy productivity by 40% by 2010 relative to 2005 levels under its Eleventh Five Year Plan. To achieve this goal, the State Council created energy intensity targets for energy-intensive industries and established energy performance standards for industrial products and equipment. China has achieved the following results:

- Nearly 60% of China's final energy use is now covered by mandatory energy efficiency policies.
- Without the energy efficiency improvements made since 2000, China would have used 12% more energy in 2017.

United States[c]

Energy efficiency improvements enabled the United States to double its energy productivity between 1980 and 2014: U.S. GDP increased more than 15 times (from $1.1 trillion to $18.6 trillion) while U.S. energy consumption increased by only 43%. Analysis commissioned by the Alliance Commission on National Energy Efficiency Policy projected that doubling the country's energy productivity again by implementing expanded energy efficiency policies and programs could:

- Save $327 billion annually
- Add 1.3 million jobs
- Decrease CO2 emissions by one-third compared to 2005 levels

Australia[d]

Australia's 2015 "National Energy Productivity Plan 2015-2030" aims to improve the energy productivity of the country by 40% by 2030. Benefits of achieving this goal include:

- The Australian economy is projected to grow by $26 billion by 2030 as a result of a just 1% improvement in energy efficiency every year
- Energy efficiency is expected to be able to deliver half of Australia's target to reduce emissions by 26-28% by 2030.

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a Energy Efficiency: The First Fuel of a Sustainable Global Energy System. (n.d.). *International Energy Agency*.
Retrieved from: https://www.iea.org/topics/energy-efficiency.

b Howarth, N. (2014, Oct 6). Managing China's Energy Productivity Potential: What are the Lessons for Policy Makers? *King Abdullah Petroleum Studies and Research Center.*
Retrieved from: https://www.kapsarc.org/research/publications/managing-chinas-energy-productivity-potential-what-lessons-for-policy-makers/.

c Energy 2030: Doubling U.S. Energy Productivity by 2030. (2013, Feb 7). *Alliance Commission on National Energy Efficiency Policy*.
Retrieved from: https://www.ase.org/sites/ase.org/files/full_commission_report.pdf.

d National Energy Productivity Plan 2015-2030: Boosting Competitiveness, Managing Costs, and Reducing Emissions. (2015, Dec). *Commonwealth of Australia*.
Retrieved from: http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/National%20Energy%20Productivity%20Plan%20release%20version%20FINAL_0.pdf.

CHAPTER THREE

MODELING A PATHWAY TO DOUBLE INDIA'S ENERGY PRODUCTIVITY

MODELING A PATHWAY TO DOUBLE INDIA'S ENERGY PRODUCTIVITY[26]

In its ***2018 World Energy Outlook***, the International Energy Agency (IEA) describes a New Policies Scenario (NPS)[27] for India. The NPS assumes an energy future in which all the energy-related policies announced in India as of mid-2015 are implemented and the energy-related components in India's 2015 Intended Nationally Determined Contribution (INDC) to the UN Framework Convention on Climate Change are adopted and implemented. As such, the scenario represents a balance of ambition and feasibility to meet India's energy and climate goals and provides a coherent framework against which India's energy efficiency policies can be assessed.

To identify a pathway to doubling India's energy productivity and quantify the resulting economic benefits, we carried out an analysis of the NPS.[28] Using publicly available data from the Reserve Bank of India (RBI) and the Ministry of Statistics and Programme Implementation (MoSPI), the analysis established India's 2013 energy productivity as a baseline. The analysis demonstrated that if India realizes its announced and intended energy-related policies, it could double its 2013 level of energy productivity by 2041 (Figure 2). Achieving this target would result in significant energy savings, GHG emissions reductions, and additional benefits in the form of increased energy security and creation of new jobs. The analysis results are summarized below and in Annex 1, and the policies assumed in the scenario are listed in Annex 2.

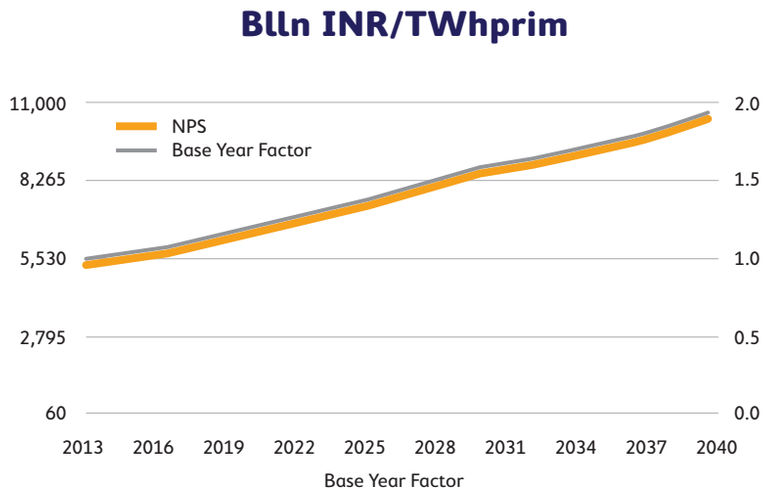

Figure 2: India's Energy Productivity, NPS

It is important to note that, due to a number of data gaps related to energy consumption in India's end-use sectors, there were limitations to the analysis; these limitations are noted in the sections below. The Conclusions section of the roadmap discusses the data gaps in more detail and provides suggestions for data collection to enable a more comprehensive future analysis of opportunities for improving India's energy productivity.

26 Guidehouse (formerly Navigant Consulting Ltd.) analyzed the NPS to identify a pathway to double India's energy's productivity and projected the resulting economic benefits. This Chapter highlights key conclusions from the modeling exercise.

27 World Energy Outlook 2018. (2018, Nov). *International Energy Agency*. Retrieved from: https://www.iea.org/weo2018/scenarios/.

28 World Energy Outlook 2018. (2018, Nov). *International Energy Agency*. Retrieved from: https://www.iea.org/weo2018/scenarios/.

India's Energy Productivity Improvements to Date

Over the last two decades, the Government of India has helped manage energy demand by implementing energy efficiency and energy conservation policies at the state and national level. Under the provisions of the 2001 Energy Conservation Act, the Bureau of Energy Efficiency (BEE) was created in 2002 as the nodal agency for mainstreaming energy efficiency across India's sectors. The BEE initiated the National Mission for Enhanced Energy Efficiency (NMEEE) in 2008, which was one of eight missions under the National Climate Change Mission, and has spearheaded numerous efficiency programs supported by policies, institutional and financing mechanisms, and awareness and technical capacity building programs for promoting energy efficiency across all supply and demand-side sectors. These include energy efficiency building codes, appliance minimum energy performance standards (MEPS) and labeling schemes, an industrial emissions cap-and-trade mechanism for India's heaviest emitters through the Perform, Achieve and Trade (PAT) scheme, certification of energy auditors and managers, support for the energy services company (ESCO) industry and, more recently, e-mobility plans at the national and state level. Efficiency improvements in many sectors of India's economy since 2000 have prevented a 6% rise in additional energy use by 2017.[29]

According to data from MoSPI, these efforts have had a measurable effect on India's energy productivity: While the country's energy demand almost doubled between 2000 and 2015, its rate of economic growth has been even higher.[30] India's energy productivity has thus been gradually rising.

Figure 3 illustrates India's energy productivity between 2011 and 2016. During this period, the country's GDP grew 39.6% while energy consumption increased only 17.2%, resulting in a 10% increase in India's energy productivity (from 20 to 22 billion INR/TWh).

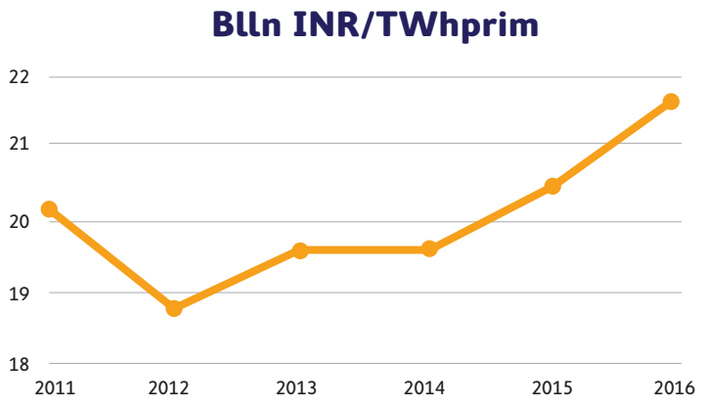

Figure 3: India's energy productivity, 2011-2016

Recent and Future Trends in Energy Productivity by Sector

Policymakers often undertake sector-level analyses of energy intensity in order to prioritize infrastructure and other investments. Similarly, understanding the energy productivity of India's individual economic sectors can help inform policymakers about what types of policies and programs can further increase the overall energy productivity of the economy. To determine sectoral energy productivity, the analysis calculated the ratio of economic output (based on gross value added) in three major sectors of the Indian economy to those sectors' primary energy use. The sectors examined were the major GDP-producing sectors defined by the Reserve Bank of India: Industry, Services, and Agriculture.

29 Energy Efficiency: The First Fuel of a Sustainable Global Energy System. (n.d.). *International Energy Agency*. Retrieved from: https://www.iea.org/topics/energyefficiency/e4/india/.

30 Energy Statistics 2017. (2017). *Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India*. Retrieved from: http://www.mospi.nic.in/sites/default/files/publication_reports/Energy_Statistics_2017r.pdf.pdf

As shown in Figures 4 and 5, the energy productivity of each sector rose during 2013-2016 and is expected to continue to rise under the NPS, but at very different rates:

- **Industry**: Industry, which includes power generation under RBI's categorization, is currently India's largest energy consuming sector and is expected to remain the largest end-use energy consumer, accounting for 50% of final consumption by 2040. This is due to strong domestic demand for intensive materials such as steel and cement, spurred by increasing urbanization and the Government of India's efforts to strengthen India as a global manufacturing hub. The sector's energy productivity is expected to rise from 1,276,000 Million INR /TWh in 2013 to around 2,411,000 Million INR/TWh by 2040 – which represents a relatively smaller increase compared to other sectors; the industry sector is not expected to double its energy productivity until after 2045. One likely reason for this is that the sector includes energy-intensive activities (including power generation for other sectors) that do not generate a high contribution to GDP.

- **Services**: The Services sector has a high energy productivity, due to a very high GVA relative to the sector's energy consumption. This is likely the case because the analysis only considered primary energy and final electricity consumption in the Services sector is captured in the power generation sector (and thus is considered in the Industry sector).[31] For the Services sector, energy productivity is expected to rise sharply and double its 2013 level by around 2028. By 2040 its energy productivity is expected to have grown from 54,833 to 172,515 INR / GJ. Expected improvements in energy efficiency in the buildings and transport sectors will drive these changes, along with the shift to modern fuels. In addition, the high energy productivity in this sector is due to its expected high economic output as the economy grows, coupled with its low energy intensity—on average only around 555-833 TWh per year.

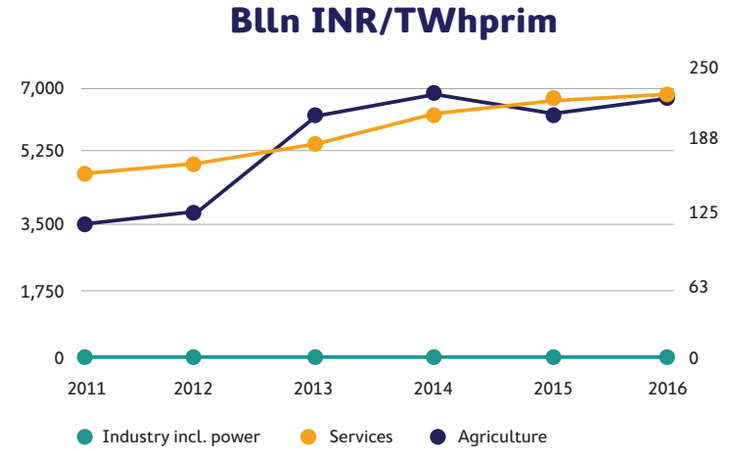

Figure 4: Energy Productivity of India's Industry and Agriculture Sectors, 2011-2016

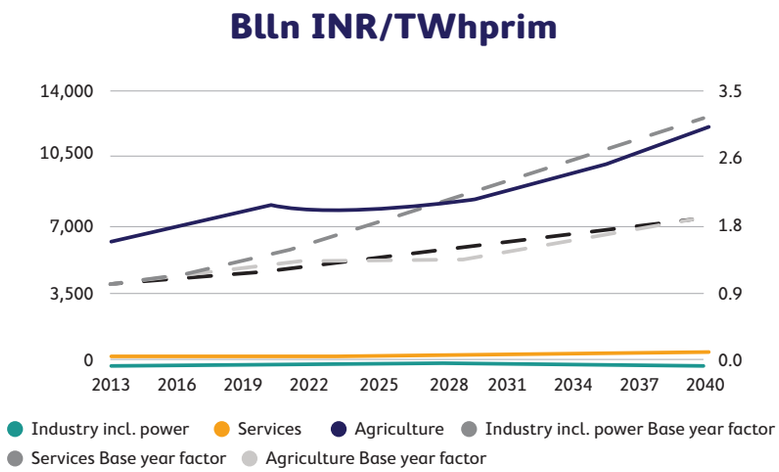

Figure 5: India's Sectoral Energy Productivity, 2013-2040

- **Agriculture**: Agriculture has the highest sectoral energy productivity at 3475 billion INR/TWh; this is likely because the sector has low energy input requirements relative to its GVA. The NPS projects that energy consumption in this sector will nearly double by 2040, with electricity accounting for 68% of the 2040 share and diesel and other oil products accounting for 30%. The NPS assumes a shift toward metered electricity in the agricultural sector, continued reforms to energy pricing, a 25% improvement in the average efficiency of electric pumps as well as widespread adoption of solar-powered pumps, and the promotion of micro-irrigation, groundwater management and crop diversification.

31 For the sectors, GVA value was used as the economic output instead of GDP as only GVA value was available on a sectoral level.

Benefits of Doubling Energy Productivity

The NPS finds that India will reap significant economic and environmental benefits if it doubles its energy productivity. These benefits include energy savings, carbon emissions reductions, increased energy security, and job creation in the clean energy sector.

- **Energy Savings:** Doubling India's energy productivity is projected to result in significant net energy savings of about 8.3 EJprim by 2040. As shown in Figure 6, this will likely result from a combination of efficiency improvements and a shift away from fossil fuel power generation and toward the use of bioenergy and renewable energy sources (additional 1.5 EJ) and nuclear energy (additional 0.6 EJ). However, these changes will not translate into a dramatic shift in the primary energy mix: Coal and oil will still dominate India's energy supply. In the NPS, bioenergy consumption remains constant in absolute terms, but as India's overall energy consumption grows from 2013 to 2040, the share of bioenergy used in end-use sectors is expected to decrease from 25% to 11%. The reduction in bioenergy's share of the energy mix is primarily due to a shift from solid biomass toward electricity (and liquefied petroleum gas in the services sector).32 Details of the energy and emissions savings under the NPS across India's end-use sectors are provided in Annex 1.

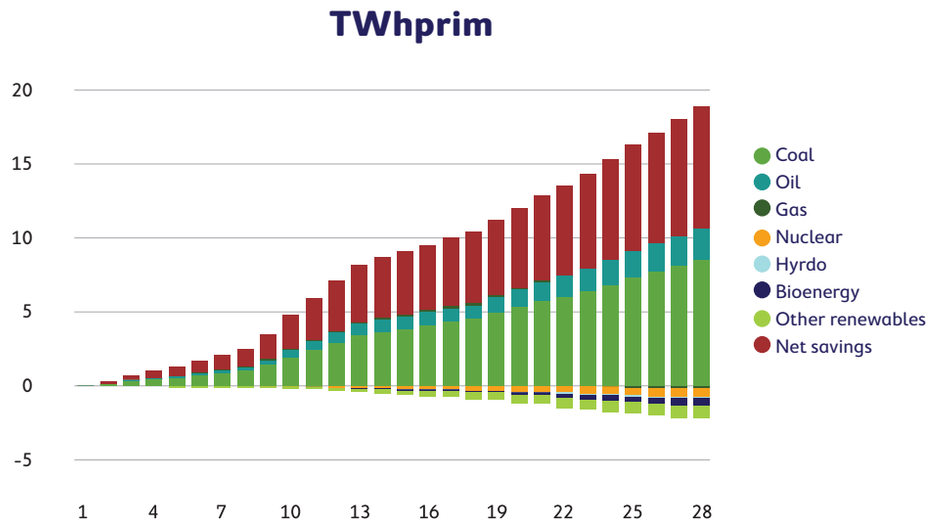

Figure 6: National energy savings, NPS

- **Emissions Reductions:** The emissions reductions projected by the analysis represent about 2.2 gigatons of CO2 equivalent per year by 2040, compared to business as usual. Most emissions savings will come from changing coal utilization practices, reducing overall consumption due to fuel switching, and improved efficiency of end uses.

- **Energy Security:** The NPS analysis projects that the energy savings related to doubling India's energy productivity would improve the energy security of the country by decreasing India's future reliance on energy imports. Even as India increases deployment of domestic sources of energy, it it still expected to face a growing gap between supply and demand for power to meet all of India's energy needs. To the extent the increased demand cannot be met by renewable energy development, the gap will need to be filled by imported fuels. Figure 7 shows the expected development of the fossil fuel trade balance under the NPS. In 2030, net imports are expected to cover more than 50% of fossil energy consumption, representing a large burden for the economy. As a result of energy efficiency and renewable energy policies and programs modelled in the NPS, the net import share of fossil fuels could decrease by up to 12% in 2030.

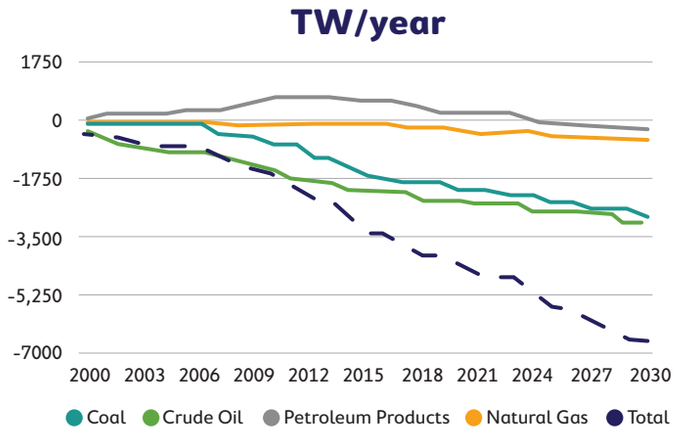

Figure 7: Fossil-fuel trade balance in India, NPS, total and by fuel

- **Job Creation:** The NPS analysis projects that India's energy productivity will create a market shift within the energy sector toward jobs in renewable energy (Figure A-1.3 in Annex 1); as overall energy sector employment rises, these jobs are expected to account for more than 30% of total energy supply jobs in 2040 (up from 15% in 2014). In addition, although this analysis was not able to break out data on job growth in the energy efficiency sector, analyses from other countries have shown that energy efficiency investments often add even more jobs than renewable energy investments, particularly factoring in both direct and indirect job creation (e.g., jobs related to the manufacturing, installation, and servicing of energy-efficient equipment and related products). In the United States, for example, energy efficiency businesses lead the nation's energy economy in creating jobs—accounting for about half (76,000) of the energy sector's entire job growth in 2018 (151,700).[32] Factoring these types jobs into the analysis would show even higher economic benefits of doubling India's energy productivity.

32 Energy Efficiency Jobs in America. (2019, Sept). *E4theFuture*. Retrieved from: https://e4thefuture.org/wp-content/uploads/2019/09/Energy-Efficiency-Jobs-in-America-2019-National-Summary.pdf.

CHAPTER FOUR
POLICY AND PROGRAM RECOMMENDATIONS

POLICY AND PROGRAM RECOMMENDATIONS

As indicated in the analysis outlined above, fully implementing the Government of India's announced and intended energy-related policies could double the country's energy productivity—from a 2013 baseline—by the year 2041. To arrive at this outcome, the NPS scenario analysis assumed that India will fully realize the energy supply and end-use efficiency improvement policies in its INDC and will carry out its planned measures to shift from fossil fuels to centralized and distributed renewable energy sources as well.

The recommendations in this section identify specific actions that the Government of India can take, in collaboration with the private sector and supported by civil society and international partners, to accelerate India's path toward doubled energy productivity. The recommended actions were not specifically modeled by the NPS analysis, but they build on the policy and program assumptions in the NPS and identify opportunities for fully implementing—and in some cases strengthening or expanding—these policies and programs to accelerate India's energy productivity gains. The recommendations target a range of Government of India stakeholders as well as public and private sector partners who can take action to boost India's energy productivity. Where relevant, the recommendations reference examples of relevant measures from around the world.

These recommendations are divided into four sections, focusing on: I) stimulating investment in energy productivity, II) modernizing standards and infrastructure, III) facilitating a transition to renewable energy sources, and IV) enhancing awareness among stakeholders. Each section summarizes the status of relevant policies and programs in India and provides a series of ***Findings*** that describe key opportunities for increasing energy productivity as well as ***Recommendations*** for specific actions different stakeholders can take to seize these opportunities and accelerate progress toward energy productivity.

Table 1 in the Conclusions section provides a breakdown of the recommendations by targeted actor as well as by implementation timeframe.

I. Stimulate Investment in Energy Productivity

Doubling India's energy productivity will require significant public and private sector investment. There is a wealth of evidence demonstrating that energy productivity investments are cost-effective: returns on investment through energy savings alone can exceed the amount invested by up to three times.[33] As with all governments, however, the Government of India faces choices regarding how to distribute limited public funds across a range of priorities, and how to use these funds to leverage and unlock private capital mobilization for energy efficiency investments. Mobilizing significant investment will require effective coordination among multiple levels of government and between the public and private sectors, including through entering public-private partnerships (PPPs).

The Government of India also will need to address existing barriers to private investment. The recommendations in this section focus on how to encourage both private and public investment in energy productivity by making energy efficiency financing more accessible, empowering ESCOs, and stimulating more research and development into cutting edge technologies.

Scale up access to finance for energy efficiency projects

While investments in energy efficiency are proven to be cost-effective, the high cost of upfront capital, risk perception of financiers, and lack of experience with delivery institutions like private ESCOs are often

33 World Energy Outlook Special Report: India Energy Outlook. (2015). *International Energy Agency*. Retrieved from: https://webstore.iea.org/weo-2015-special-report-india-energy-outlook.

prohibitive barriers to converting the technical potential into investments. To reduce this burden, government agencies can work with the private sector to creatively finance energy efficiency investments. Two strategies for improving the accessibility of financing for energy efficiency projects are: a) supporting the development of a robust energy service company (ESCO) market, and b) supporting banks and other financing institutions in developing energy efficiency lending strategies.

1A
Support private ESCOs.

- **Finding:** A robust ESCO market is a critical ingredient for widespread use of performance contracting, through which energy efficiency upgrades are paid for with the revenues generated by the accrued energy savings. Energy Efficiency Services Limited (EESL), the Government of India's public super-ESCO, has played a significant role in advancing India's energy productivity through its bulk procurement model, which drives economies of scale in supply and encourages demand for energy-efficient products through competitive pricing schemes. While EESL has distributed millions of energy-efficient appliances and equipment components to public sector end users such as municipalities across the country, a broader private sector ESCO market could increase the scale of investment and innovative solutions—that go beyond EESL's equipment-based energy efficiency focus—to the level needed to double India's energy productivity and expand the scope and range of efficient solutions and services available to customers.

- **Recommendation:** EESL, as a public super-ESCO, should support private ESCOs in developing viable business plans and implementing energy efficiency projects in the public sector. EESL also should support private ESCOs in accessing financing, including through the Government of India's Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE) or the World Bank-SIDBI's Partial Risk Sharing Facility.[34]

1B
Collect detailed data on end-use energy consumption across sectors to justify investment in efficiency projects.

- **Finding:** Investors seek detailed accounts of energy use before and after proposed efficiency measures to assess the value of a project. However, there is not currently a comprehensive energy consumption data survey in India except for large consumers e.g., through the PAT scheme; energy data generally are collected as components of surveys conducted by various ministries and agencies. This can make it difficult to assess projects and may contribute to the stalled growth in energy efficiency financing beyond large industries covered under the PAT scheme.

- **Recommendation:** BEE should scale up its current energy use data collection program—which is limited to designated energy-intensive consumers under the PAT scheme and to buildings under the Energy Conservation Building Code (ECBC)—to cover additional industrial and commercial end users, including MSMEs and commercial buildings that are not covered by the ECBC. In addition, BEE should work with other ministries that collect energy-related data to establish a comprehensive energy database that includes energy consumption data from all end-use sectors as well as cost and energy savings resulting from a broad range of energy efficiency measures. Data should be published publicly and be accessible to investors (see box on collecting energy data).

1C
Create uniform contract structures that consider energy savings as a key outcome.

- **Finding:** An energy savings performance contract (ESPC) is a legal framework between an ESCO and a customer. While ESCOs have full control over their contracts, the central government can create a "gold standard" contract that serves as a template for India's ESCOs. Uniformity in ESPCs across the nation can help alleviate perceived risk among investors, and widespread use of consistent contracting language can encourage the scaling up of financing

34 Partial Risk Sharing Facility for Energy Efficiency (PRSF). (n.d.). Small Industries Development Bank of India. Retrieved from: http://prsf.sidbi.in.

opportunities to interest investors in energy efficiency measures. The United States Department of Energy, for example, curates a resource webpage of model contract templates and companion documents intended for ESCOs on its website.[35] The documents are developed by public and private-sector stakeholders and undergo an extensive three-phase review process to ensure their applicability to a range of users.

The standard ESPCs for India—which use a shared savings approach or a guaranteed savings approach—have been developed by the Small Industries Development Bank of India (SIDBI) under the World Bank's Partial Risk Sharing Facility (PRSF) project. They have been tested in 25 ESCO projects worth $45 million during 2018-2019 and have been accepted by 10 local banks across India. The ESPC resources have been made available to the ESCO industry through the PRSF Portal. A Deemed Savings ESPC is under preparation and will be added to the PRSF Portal by mid-2020.

- **Recommendation:** As the agency responsible for accrediting ESCOs and co-chair of the PRSF Advisory Committee, BEE should build on the ESPC standardization work of the PRSF to convene a consortium of state energy offices, other financial institutions, rating agencies, energy efficiency program evaluators, M&V professionals, and ESCOs to design and implement a plan to make the ESPC and M&V templates available to the larger ESCO community.

1D
Create awareness and build capacity of financial institutions on the value proposition of energy efficiency.

- **Finding:** The banking and financial sector can play a major role in reducing barriers to investment in energy productivity as well as in marketing the value proposition of energy productivity to significant market segments, including small and medium enterprises (SMEs), large corporations, and households. However, many banks and financial institutions lack foundational knowledge on how to value energy productivity investments. Providing training and support to these institutions on energy efficiency business models and security structures can help expand access to funding on attractive terms.[36] Toward this goal, BEE created the Energy Efficiency Financing Platform (EEFP), through which the capacity of the Indian banks and project developers interested in developing energy efficiency and ESCO projects can be enhanced. To date, however, few banks have participated in the EEFP.[37] Additional training is available through the SIDBI PRSF's capacity building program and training e-modules.

- **Recommendation:** BEE should strengthen its ongoing partnership with multilateral institutions such as the World Bank's PRSF, the Asian Development Bank, and the UN Environment Programme's Finance Initiative—as well as with EESL and other domestic agencies—to develop and deliver a results-oriented capacity building program for Indian banks on energy efficiency and ESCO project appraisal systems.

1E
Encourage banks and financial institutions to designate efficiency as a priority lending sector.

- **Finding:** Energy efficiency is not designated as a formal priority sector by the Reserve Bank of India (RBI). Once a sector is designated as a priority, RBI sets percentage targets for lending to ensure a higher credit flow to such sectors. Renewable energy already has been denoted as a priority sector for lending, but it is critical to increase awareness of the importance of energy efficiency—as a lucrative investment on its own, as well as a prerequisite to achieving the full potential of shifting to renewable sources.

35 About Energy Savings Performance Contracting Models. (n.d.). *United States Department of Energy*. Retrieved from: https://www.energy.gov/eere/slsc/about-energy-savings-performance-contracting-model-documents.

36 International Energy Efficiency Financing Protocol: Standardized Concepts. (2009, April). *Efficiency Valuation Organization*. Retrieved from: http://www.eeperformance.org/uploads/8/6/5/0/8650231/ieefp_2009.pdf.

37 Energy Efficiency Financing Platform (EEFP). (n.d.). *Bureau of Energy Efficiency*. Retrieved from: https://www.beeindia.gov.in/content/eefp.

- **Recommendation:** BEE should work with RBI to recognize energy efficiency as a priority lending sector and formal economic sector to ensure that ESCOs and other energy efficiency project developers can access finance more easily.

1F
Scale up risk sharing mechanisms for energy efficiency and clean energy investments.

- **Finding:** Governments can help alleviate perceived risk of energy efficiency and clean energy investments by offering risk guarantees to commercial institutions and investors. The Partial Risk Sharing Facility for Energy Efficiency (PRSF) is a successful risk-sharing mechanism that provides guarantees for participating financial institutions to provide loans to energy efficiency projects.[38] It is delivered through the Small Industries Development Bank of India.
- **Recommendation:** SIDBI should work with multilateral development banks to scale up the PRSF and develop a more extensive pipeline of energy efficiency/ESCO projects.

Facilitate energy productivity through tax reform

Tax policy is a powerful instrument that governments can use to influence behavior. India's tax code can be used to promote its energy policy goals, including increasing its energy productivity. Tax incentives, for example, can encourage broader adoption of energy-efficient and clean energy technologies.

1G
Integrate energy efficiency as a prerequisite to receiving tax-free infrastructure bonds for renewable energy.

- **Finding:** To incent progress on the Government of India's national renewable energy target—which aims to onload 225 GW of renewable energy capacity by 2022—the Ministry of Finance issues tax-free infrastructure bonds for eligible renewable energy projects.[39,40] Because energy efficiency will enable renewable energy to capture a larger share of energy demand, there is an important opportunity to integrate energy efficiency goals into the national renewable energy target incentives.

Data enables energy productivity:

Consistent collection and management of energy data can provide investors with confidence in the profitability of energy efficiency investments. Best practices for collecting, processing, and disseminating energy data include:

- **Relevance:** Data should account for all major end-use consumption sectors and trends in energy use, including analysis of energy and cost savings where applicable and feasible. Data analysts should identify major gaps through consultations with stakeholders to help prioritize the direction of data collection.
- **Timeliness:** Effective and timely data dissemination is crucial to inform the development of energy and economic policies. Long delays between data collection and data dissemination lead to the creation of energy policies using obsolete information.
- **Access:** Data should be free, publicly accessible, and presented in a user-friendly format.
- **Coordination:** Agencies responsible for collecting data should coordinate to avoid redundancy.

38 What is PRSF? (n.d.). Partial Risk Sharing Facility for Energy Efficiency (PRSF). Retrieved from: http://prsf.sidbi.in/user/pages/viewpage/p_whatis_prsf.

39 Energy Management (n.d.). *National Productivity Council*. Retrieved from: http://www.npcindia.gov.in/competencies/energy-management/.

40 Tax Free Infrastructure Bonds for Renewable Energy. (n.d.). *Government of India*. Retrieved from: https://biomasspower.gov.in/document/news-headlines/Tax%20Free%20Infrastructure%20Bonds%20for%20Renewable%20Energy.pdf.

- **Recommendation:** The Ministry of Finance should coordinate with BEE to restructure eligibility for its infrastructure bonds by integrating energy efficiency requirements. The two agencies should coordinate with the Ministry of New and Renewable Energy to determine energy efficiency criteria, best practices in energy management, and a list of government-approved vendors.

1H
Establish an energy productivity-specific R&D tax credit for corporations.

- **Finding:** The private sector continually innovates to remain competitive, but private R&D budgets for energy efficiency and energy productivity improvements are often limited. Tax credits can be strategic tools for encouraging enhanced private sector investment in R&D.

- **Recommendation:** The Ministry of Science and Technology, with support from the Ministry of Finance, should establish an RDD&D tax credit to reward businesses that undertake energy productivity-related research and development.

Increase Research, Development, Demonstration, and Deployment (RDD&D) to bring energy-efficient technologies to scale to advance energy productivity

RDD&D is the seed of innovation and a key ingredient to unlocking unrealized gains in a nation's energy productivity. Investments in RDD&D will be critical for introducing next-generation technologies to the market and will need to span a host of sectors and technologies, including smart energy systems, buildings, transportation, water infrastructure, and manufacturing. Because energy and infrastructure projects are highly capital intensive and often require long development cycles, the private sector often cannot make investments in RDD&D for energy productivity on its own.

India has a long history of successful RDD&D through its research institutes—including the Indian Institutes of Technology (IIT) and other leading universities and laboratories—and private sector leaders, but there is opportunity to significantly scale up these efforts. While the NPS does not assume that any new energy-related technologies are introduced to India between 2015 and 2040, increased RDD&D in energy-productive technologies can help boost India's energy productivity at a faster rate. The recommendations in this section aim to catalyze additional government and private sector RDD&D.

1I
Increase government investment in basic and applied RDD&D and technical assistance for energy-productive technologies and practices.

- **Finding:** For the past two decades, India's spending on RDD&D has remained at 0.6-0.7% of GDP—lower than the proportional RDD&D rates of the U.S., China, South Korea, and other R&D-focused economies.[41]

- **Recommendation:** The Ministry of Science and Technology should increase support for RDD&D related to technologies and practices proven to increase energy productivity, such as demand response, smart appliances, battery storage, load flexibility, efficient agricultural technologies, and digital technologies that facilitate energy optimization.

41 India's R&D Spend Stagnant for 20 Years at 0.7% of GDP. (2018, Jan 29). *Economic Times*. Retrieved from: https://economictimes.indiatimes.com/news/economy/finance/indias-rd-spend-stagnant-for-20-years-at-0-7-of-gdp/articleshow/62697271.cms.

1J
Strengthen inter-agency collaboration on RDD&D.

- **Finding:** Because energy productivity involves all sectors, multiple ministries should collaborate on RDD&D. BEE and the Ministry of Power; the Ministry of Science and Technology; the Ministry of Road Transport and Highways; the Ministry of Environment, Forest, and Climate Change; the Ministry of Agriculture & Farmers' Welfare; the Ministry of New and Renewable Energy; the Ministry of Jal Shakti (Water Power); and the Ministry of Statistics and Programme Implementation all provide research functions that could be amplified through greater coordination, including with IITs, universities, and the private sector.

- **Recommendation:** Wherever possible, India's central ministries should perform collaborative projects to leverage the specific RDD&D capabilities and expertise of each ministry, and should collaborate with academic/research institutions and the private sector to identify robust, cross-cutting solutions.

1K
Launch competitive grants, innovation challenges, or contests that encourage RDD&D that leads to commercialization of new energy efficiency technologies and business models.

- **Finding:** Competitive grant competitions and innovation challenges—allowing state, local, private sector and research entities to compete for funds earmarked for specific activities by the central government in collaboration with development partners and foundations—can facilitate a "race to the top" by encouraging innovation in energy productivity-related technologies and associated business models for scale up. Such competitions also can result in new public-private partnerships, and partnerships between states and the central government. These could possibly be modelled after Rocky Mountain Institute's Global Cooling Challenge Prize, which is stimulating international innovation in residential air conditioning technologies.[42]

- **Recommendation:** BEE, in collaboration with MoST and other relevant ministries and state level entities and research institutes should create a race-to-the-top style energy productivity competition for states and communities. Grants could be awarded to states and localities that develop energy savings goals and initiatives that produce gains in energy productivity, such as stricter energy codes and programs or innovative investments in public transportation. The contest should take geographic diversity and demographic factors into consideration when allocating the grants.

Lead by Example

As a large energy user with significant purchasing power—public procurement is estimated to constitute about 20% of India's GDP[43]—the Government of India can stimulate and expand markets for efficient products and practices by increasing the energy productivity of its vast portfolio of assets, including buildings and vehicle fleets. The central government also serves as a highly visible test bed and early adopter of technologies and practices that are proven to increase energy productivity. The Government of India has demonstrated its commitment to energy productivity by mandating that public, commercial buildings are Energy Conservation Building Code (ECBC)-compliant and participate in the Star Labelling Program.

In addition, the Government of India's 2013 mandate that all government departments and ministries – as well as subordinate offices – must procure projects that have a threshold or higher BEE star rating is a notable case of government leadership by example. EESL's bulk procurement programs, such as the electric

42 "About the Global Cooling Prize." (n.d.). Global Cooling Prize. Retrieved from: https://globalcoolingprize.org/about-the-global-cooling-prize/.

43 Djankov, S., Saliola, F. & Islam, A. (2016, Dec 1). Is public procurement a rich country's policy? The World Bank. Retrieved from: https://blogs.worldbank.org/governance/public-procurement-rich-country-s-policy.

vehicle (EV) and municipal LED street lighting programs, also have significantly expanded the markets for these products. The recommendations in this section suggest opportunities for the Government of India to expand these types of programs. The additional energy productivity investments can in turn save taxpayers money, helping citizens and consumers realize the benefits of increased energy productivity.

1L
Demonstrate energy management best practices in all government buildings.

- **Finding:** As a large owner and operator of buildings, the central government can influence the market by demonstrating best practices in building construction and management. Currently all new construction of central government buildings is required to be ECBC-compliant and to be certified through either the Green Rating for Integrated Habitat Assessment (GRIHA), Leadership in Energy and Environment Design (LEED), or Indian Green Building Council (IGBC) program. EESL also is working with the Government of India to retrofit Central Public Works Department buildings. However, further opportunities remain for reducing energy waste from the government's building portfolio, including by mandating the adoption of energy management systems and setting energy performance goals.

- **Recommendation:** The Department of Central Public Works should require adoption of an energy management standard (e.g., ISO 50001) and establish energy and water savings reduction goals in all public buildings. Buildings should be audited on an annual basis, and energy savings should be tracked in a central location that is publicly accessible.

1M
Encourage government contractors and vendors to improve energy management practices.

- **Finding:** The central government has an enormous supply chain. Governments can leverage their purchasing power by encouraging their vendors to take steps to improve their own energy productivity. In the United States, for example, the Obama Administration enacted a provision to its Federal Acquisition Regulations that required companies bidding on government contracts worth $7.5 million or more to indicate if and where they report their carbon footprint, emissions-reductions goals, and climate change-related risks.[44]

- **Recommendation:** The Department of Central Public Works should encourage its contractors and vendors to report to CDP, the best-known energy and environmental disclosure program. The Department could also encourage corporations to use the World Resources Institute's India GHG Program, a voluntary hub through which Indian corporations share best practices in sustainability, including energy management.[45]

1N
Leverage public-private partnerships to reduce risk and costs associated with energy productivity investments.

- **Finding:** Government dollars are stretched among competing demands. Improved public-private coordination can significantly drive investment in energy productivity by enabling the public and private sectors to share project costs. In particular, public-private partnerships are effective at bolstering the types of risk-sharing mechanisms discussed in recommendations 1.A, 1.C, and 1.F.

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44 Rumsey, A. & Sherwood, A. (2016, Nov 21). New Rule Required Federal Contractor Disclosure of Existing Greenhouse Gas Emissions Reporting. *Arnold Porter*.
Retrieved from: https://www.arnoldporter.com/en/perspectives/publications/2016/11/new-rule-requires-federal-contractor.

45 The India GHG Program is a voluntary framework that industry can follow to measure and manage GHG emissions led by WRI India, the Confederation of India Industry (CII), and The Energy and Resources Institute (TERI) "About." (n.d.). *India GHG Program*.
Retrieved from: https://www.indiaghgp.org/

- **Recommendation:** To encourage PPPs for energy-productive infrastructure, the Ministry of Power and Ministry of Urban Development should provide guidance for special purpose vehicles, a mechanism that enlists the private sector to help cities with their climate plans.

10
Assess life-cycle cost-effectiveness and impacts on energy productivity when planning new construction and retrofit infrastructure projects.

- **Finding:** Because infrastructure lasts for decades, any inefficiencies in its design have decades-long consequences. Governments that miss the opportunity to invest in energy efficiency can increase costs in the long-term for future generations of taxpayers.

- **Recommendation:** When investing in new infrastructure development or repairing existing assets, the Central Public Works Department and its private contractors should use best practices from existing programs (e.g., ESCO procurement requirements in public facilities) to conduct life-cycle and energy productivity analyses on potential outcomes at the outset of projects.

II. Modernize Standards and Infrastructure

The use of space cooling, personal vehicles, electronic devices, and other energy-using equipment is expanding rapidly in India. Optimizing the efficiency of these devices and equipment through progressively stringent efficiency standards and codes is critical for mitigating increases in energy demand and boosting India's energy productivity.

In addition, the global energy market is undergoing a massive transformation with the advent of disruptive technologies and business model innovations, including distributed renewable energy, battery storage, EVs, connected devices, demand response, and smart grids. Integrating these technologies into India's next generation of infrastructure can enable significant system-level efficiency increases. In particular, using data from connected and smart buildings to optimize energy supply and use in an integrated manner can significantly improve energy productivity across the transportation, power, and water sectors.

Encourage energy productivity through stringent energy efficiency standards for appliances and equipment, building codes, and other regulations

India's appliance and electronics market is projected to more than double between 2017 and 2022.[46] India is also constructing new buildings faster than ever to meet the needs of the country's rapidly urbanizing population. Residential and commercial buildings account for nearly 30% of total electricity consumption in India today. This share is expected to increase to 48%—nearly half of the country's electricity consumption—by 2042.[47] Experience in both OECD and developing economies has demonstrated the effectiveness of building energy codes, minimum energy performance standards (MEPS), and appliance labeling as cost-effective cornerstone programs to improve energy productivity. Through a combination of Energy Conservation Building Code (ECBC) compliance and voluntary rating programs, India could potentially save more than 3,000 TWh of energy in its buildings by 2030.[48]

46 Growth of Consumer Durable Industry in India – Infographic. (2019, June). *India Brand Equity Foundation*. Retrieved from: https://www.ibef.org/industry/indian-consumer-market/infographic.

47 Towering Possibility in India: Scaling Up the Implementation of Energy Conservation Building Code Across States. (2019, Sept.). *Natural Resources Defense Council & Administrative Staff College of India*. Retrieved from: https://www.nrdc.org/sites/default/files/towering-possibilities-in-india-20190910.pdf.

48 Towering Possibility in India: Scaling Up the Implementation of Energy Conservation Building Code Across States. (2019, Sept.). *Natural Resources Defense Council & Administrative Staff College of India*. Retrieved from: https://www.nrdc.org/sites/default/files/towering-possibilities-in-india-20190910.pdf.

India's first ECBC, which BEE developed in 2007, created a minimum standard for energy use in new commercial buildings; the latest update to the ECBC was in 2017. BEE is also developing an ECBC-compliant program for residential buildings. In addition, BEE's Standards and Labeling Programme contributed to energy savings of 121 billion kWh from 2011 to 2018[49] with coverage of 26 appliances (10 mandatory and 16 voluntary), and it has since added four new voluntary standards. However, significant potential remains for additional energy savings through the expansion and enforcement of building codes and appliance standards: The ECBC is not widely enforced, and Indian consumers still overwhelmingly purchase inefficient appliances.[50,51] The NPS assumes that India will strengthen its MEPS levels and its enforcement regime, shift to fully mandatory appliance efficiency labels, and fully implement the ECBC. The recommendations in this section suggest specific actions to support stronger MEPS implementation systems and building code compliance to help enhance energy savings from appliance and equipment standards.

2A
Raise consumer awareness of appliance standards programs.

- **Finding:** Awareness of the cost-effectiveness and other benefits of more efficient appliances remains low in India, especially in rural areas. As a result, market uptake of appliances with higher levels of energy efficiency (i.e., products that receive a 4 or 5 star rating) has been slower than uptake of less-efficient appliances (2 and 3-star products).[52] Since many households do not prioritize energy efficiency when purchasing products, there is significant opportunity to improve the effectiveness of the standards and labeling program by increasing awareness of the value of energy efficiency.[53]

Addressing the Cold Crunch: India Cooling Action Plan

Access to cooling benefits human development, health, well-being and economic productivity. Rising temperatures and incomes are expected to create a "looming cold crunch" as India's cooling-related energy demand increases 15-fold between 2016 and 2050.

Citation: The Future of Cooling. (2018, May). International Energy Agency. Retrieved from: https://www.iea.org/reports/the-future-of-cooling.

India is proactively addressing this issue through the formulation of its India Cooling Action Plan (ICAP). The Plan, which provides an outlook of India's 20-year cooling demand from 2018 to 2037 and a blueprint for action, was published by the Ministry of Environment, Forest, and Climate Change in 2019. ICAP targets multiple stakeholders, including government ministries, industry, R&D institutions, and NGOs. Its broad objectives are to assess India's cooling requirements for the next 20 years across sectors, map available technologies, suggest interventions in each sector, develop an R&D "innovation ecosystem" for new technologies, and train the next generation of cooling service technicians.

Citation: India Cooling Action Plan. (2019, March). Ministry of Environment, Forest and Climate Change. Retrieved from: http://ozonecell.in/wp-content/uploads/2019/03/INDIA-COOLING-ACTION-PLAN-e-circulation-version080319.pdf

49 Thambi, S., Bhatacharya, A., & Fricko, O. (2019, July). India's Energy and Emissions Outlook: Results from India Energy Model. *NITI Aayog*.
Retrieved from: https://niti.gov.in/sites/default/files/2019-07/India%E2%80%99s-Energy-and-Emissions-Outlook.pdf.

50 Agarwal, A. & Martin, S. (2016, April 27). What's Holding Up the Efficient Appliance Market in India? *World Resources Institute*.
Retrieved from: https://www.wri.org/blog/2016/04/whats-holding-efficient-appliance-market-india.

51 Levine, M., et al. (2012). Building Energy-Efficiency Best Practice Policies and Policy Packages. *Lawrence Berkeley National Laboratory, American Council for an Energy-Efficiency Economy, & Sustainability Consulting Ltd*.
Retrieved from: https://eetd.lbl.gov/sites/all/files/publications/gbpn-finaloct-2012.pdf.

52 Jairaj, B., et al. (2016, Jan). Strengthening Governance of India's Appliance Efficiency Standards and Labelling Program. *World Resources Institute*.
Retrieved from: https://wriorg.s3.amazonaws.com/s3fs-public/Strengthening_Governance_of_Indias_Appliance_Efficiency_Standards_and_Labeling_Program.pdf.

53 Chunekar, A., Kulkarni, S., & Sreenivas, A. (2019, April 7). Managing India's Household Energy Challenge. *The Hindu BusinessLine*.
Retrieved from: https://www.thehindubusinessline.com/opinion/managing-indias-household-energy-challenge/article26762887.ece.

Efforts to raise consumer awareness of appliance energy efficiency in many countries have resulted in quantifiable energy savings. In China, since the compulsory informational labeling scheme – the China Energy Label – was launched in 2005, consumer awareness of energy efficiency has risen: Over 75% of surveyed consumers can distinguish between efficient and inefficient products and 63% take the efficiency rating into account when making a purchase.[54] In the United States, the ENERGY STAR endorsement labeling program enjoys brand recognition from over 90% of American households and more than 16,000 companies and organizations have chosen to participate, making energy-efficient products available throughout the U.S. market.[55] The program estimates that buying Energy Star-qualified products saves U.S. households $12 billion on utility bills annually.[56]

- **Recommendation:** BEE, in collaboration with product manufacturers and retailers, should develop and fund a proactive, coordinated approach to raising consumer awareness of the Standards and Labelling Programme, with a focus on educating consumers about newer product and appliance categories. Based on best practices from consumer awareness programs globally and the findings of BEE's Unlocking National Energy Efficiency Potential (UNNATEE) strategy plan,[57] the awareness campaign should include the following strategies: retailer and product manufacturer education, multi-media coverage of the tangible benefits of owning energy-efficient appliances, and prime location of efficient products on retailers' shelves. Other recommended strategies for public awareness campaigns on energy efficiency are highlighted in BEE's 2015 Strategy for Energy Efficiency Campaign report.[58]

2B
Develop a standard compliance approach for the commercial and residential ECBC.

- **Finding:** India's Energy Conservation Building Code, which sets minimum energy standards for new commercial buildings with a load of 120kVA and above, has been operational for over a decade.[59] While ECBC-compliant buildings deliver 20-25% energy savings compared to non-compliant buildings, less than half of India's states have mandated and incorporated the code into municipal bylaws.[60] The slow rate of adoption is due, in part, to the fact that State Designated Agencies (SDAs), State Energy Regulatory Commissions (SERCs), and Urban Local Bodies (ULBs) lack knowledge, tools and resources for enforcing these building energy codes.

- **Recommendation:** To increase local implementation of and compliance with the ECBC, BEE should support SDAs, SERCs and ULB-based entities by creating guides for the adoption of ECBC into building bylaws and facilitating capacity-building workshops to train local officials involved in compliance strategies.

54 China Press Publicizes CLASP's Assessment of the China Energy Label. (2014, July 22). *CLASP*. Retrieved from: https://clasp.ngo/updates/2014/chinese-press-publicizes-clasps-assessment-of-china-energy-label.

55 About Energy Star – 2018. (2019, April). *ENERGY STAR*. Retrieved from: https://www.energystar.gov/sites/default/files/asset/document/Energy%20Star_factsheets_About%20EnergyStar_190403%20original.pdf.

56 Energy Star Products: 20 Years of Helping American Save Energy. (n.d.). *ENERGY STAR*. Retrieved from: https://www.energystar.gov/ia/products/downloads/es_anniv_book_030712_508compliant_v2.pdf

57 Unlocking National Energy Efficiency Potential (UNNATEE): Strategy Plan Towards Developing an Energy Efficient Nation (2017-2031). (2019, Feb). *Bureau of Energy Efficiency*. Retrieved from: https://beeindia.gov.in/sites/default/files/press_releases/UNNATEE%20Report.pdf.

58 Retrieved from: https://cdkn.org/wp-content/uploads/2017/07/Up-EE-communications-campaign-strategy-1.pdf.

59 Buildings. (n.d.). *Bureau of Energy Efficiency*. Retrieved from: https://beeindia.gov.in/content/buildings.

60 Unlocking National Energy Efficiency Potential (UNNATEE): Strategy Plan Towards Developing an Energy Efficient Nation (2017-2031). (2019, Feb). *Bureau of Energy Efficiency*. Retrieved from: https://beeindia.gov.in/sites/default/files/press_releases/UNNATEE%20Report.pdf.

2C

Integrate ECBC compliance into affordable and public housing programs.

- **Finding:** Low-income households are disproportionately affected by energy costs, since they often must spend a higher percentage of household income on meeting their energy needs. However, low-income communities also face barriers in obtaining information and technologies that can bring down their energy costs; these barriers include a lack of access to financing for efficiency upgrades and the fact that many low-income residents do not own their own homes.[61] Developing and enforcing energy efficiency codes that apply to affordable and public housing can save significant energy and lower bills for low-income communities. BEE's current efforts to develop a residential ECBC, which currently focuses on private residential construction, provides an opportunity to incorporate efficiency measures in affordable/public housing developments.
- **Recommendation:** BEE should develop a version of the ECBC that applies to affordable and public housing, and should work with the Public Works Department, SDAs, SERCs, and Municipal Corporations, along with domestic banks, to integrate the code into public housing and other affordable housing programs.

Buildings: Other actions for improving energy productivity

- Develop plans for the use of locally sourced and sustainable building materials as drafted in the Energy Conservation Building Code. The plan should include the development and publication of guidelines for developers and architects.
- Support financial incentive-based programs from the National Housing Bank and other domestic banks to encourage construction of energy-efficient homes.
- Increase the number of easily accessible building retrofit program toolkits and guidelines for near- and net-zero energy building construction for dissemination through engineering and architectural associations, in collaboration with IGBC, GRIHA and other platforms.
- Design and build materials testing laboratories and develop a national certification system body to assess performance levels and certify new building materials and products.
- Provide tax incentives and technical assistance to encourage deployment of innovative energy-efficient surface heating and cooling technologies such as tri-generation, district cooling, and heat pumps in commercial buildings and facilities.

Transition to an efficient and electrified transport system

India's demand for transportation of both people and goods is rapidly increasing. Considering that four-wheeled passenger vehicles currently make up only 2% of India's total annual vehicle sales, India has the potential to partially leapfrog the energy intensive transport system found in many countries—characterized by high personal vehicle ownership, congestion, and carbon intensity—to one that is shared, electrified, connected, and inherently cleaner and more energy efficient.[62,63] EESL estimates that shifting to a shared, electric, and connected transportation paradigm could reduce India's energy demand by 64% and cut carbon emissions by 37% by 2030.[64]

61 Low Income Community Energy Solutions. (n.d.). *United States Department of Energy*. Retrieved from: https://www.energy.gov/eere/slsc/low-income-community-energy-solutions.

62 Zero Emission Vehicles (ZEVs): Towards a Policy Framework. (2018). *NITI Aayog*. Retrieved from https://niti.gov.in/writereaddata/files/document_publication/EV_report.pdf.

63 India's Electric Mobility Transformation: Progress to Data and Future Opportunities. (2019). *NITI Aayog & Rocky Mountain Institute*. Retrieved from https://rmi.org/wp-content/uploads/2019/04/rmi-niti-ev-report.pdf.

64 E-Vehicle. (n.d.). *Energy Efficiency Services Limited*. Retrieved from: https://www.eeslindia.org/content/raj/eesl/en/Programmes/ElectricVehicles/e-Vehicles.html.

Efficient transportation policies in the NPS scenario include maintenance of India's fuel economy standards program and policy support for the development of electric vehicles (EVs). Opportunities for even greater efficiency gains include the expansion of reliable public transport, an emphasis on mixed-use development in urban environments to reduce the need for personal vehicle ownership, and building widespread charging infrastructure to support large scale deployment of EVs.

2D
Increase stringency of fuel economy standards.

- **Finding:** Fuel economy standards for vehicles significantly increase national energy productivity by decreasing (or limiting the increase in) the volume of fuel used for surface transportation. These savings benefit many sectors of the economy, since most sectors use surface transportation. In 2016, the Ministry of Road Transport and Highways developed a draft for India's first fuel economy standards—the Bharat Stage Emissions Standards IV—for all major on-road vehicle categories. This brought Indian vehicles into alignment with the emissions standards imposed in the European Union.[65] The Ministry of Power requires that the average fuel consumption of passenger cars be less than 5.49 or 4.77 liters/100 km, depending on their weight.[66] NPS assumes that India strengthens the Bharat Stage Emission Standards to increase the fuel efficiency of all cars and light-trucks manufactured after 2016.

- **Recommendation:** The Ministry of Road Transport and Highways should improve the Bharat Stage Emissions Standards to target a mandatory average reduction of 5g/km of carbon dioxide annually, and caps should be introduced to encourage automakers to manufacture low-emission passenger cars. Additionally, the Ministry of Power should strengthen its corporate average fuel consumption standards so that its 2022-2023 standards match the EU 2021 standard. In the future, this standard should be indexed to the EU level, as with the Bharat Stage Emissions standards.

2E
Increase investment in the development and maintenance of efficient public transport systems.

- **Finding:** The energy productivity of a transportation system increases as the number of passengers per vehicle increases or as the fuel economy increases for each mode of transport. A society organized around strong, multi-modal public transport networks is typically more energy productive than one defined by high personal vehicle ownership.[67] As personal vehicle ownership in India rises along with per capita income, it will be a challenge to promote the expansion of public transport services. A key to encouraging and retaining widespread use of public transit services is embracing the 'mobility as a service' model that seamlessly integrates energy-productive transport modes such as transit, walking, biking, e-scooters, and ridesharing.

- **Recommendation:** The Ministry of Road Transport and Highways and the Ministry of Housing and Urban Affairs should invest in the development and maintenance of public transit systems and infrastructure designed to encourage active modes of mobility, including safe bike lanes and pedestrian walkways.

65 India Bharat Stage VI Emission Standards. (2016, April). *International Council on Clean Transportation*. Retrieved from https://theicct.org/sites/default/files/publications/India%20BS%20VI%20Policy%20Update%20vF.pdf.

66 Fuel Efficiency. (n.d.). *Bureau of Energy Efficiency*. Retrieved from: https://beeindia.gov.in/content/fuel-efficiency.

67 Walker, J. (2018, Oct 31). The Bus is Still Best. *The Atlantic*. Retrieved from https://www.theatlantic.com/technology/archive/2018/10/bus-best-public-transit-cities/574399/.

2F
Encourage mixed-use development in urban planning.

- **Finding:** Land use and transport energy use are deeply intertwined. Developing higher residential and employment densities through compact, mixed-use development reduces vehicle miles traveled, thereby reducing transportation energy use. Three of the eight criteria of the Smart Cities Mission, an urban renewal program implemented by the Ministry of Housing and Urban Affairs, are related to mixed-use development. To encourage mixed-use development, Austria passed the "Austrian Federal Road Traffic Act," which excludes motorways from being incorporated into a mixed-use zone and allows municipalities and city administrations to determine which streets can be designated as a mixed-use zone.[68]

- **Recommendation:** The Ministry of Housing and Urban Affairs should encourage cities to create mixed-use development plans that include public transit, making communities more walkable, and building affordable housing near jobs and other amenities.

2G
Plan and invest in widespread charging infrastructure and equipment for EVs.

- **Finding:** One of the biggest barriers to widespread EV deployment is range anxiety – fear that the battery will die before reaching a charging station. This can be addressed by making charging infrastructure more widespread and accessible.

- **Recommendation:** The Ministry of Housing and Urban Affairs should work with the Central Public Works Department to create comprehensive plans for mapping and meeting charging infrastructure needs, including in rural areas. Prioritization should be given to mass transit and the most highly congested and polluted ports, cities, and highway corridors.[69] ULBs should work with private third parties to install chargers in public locations through public-private partnerships (PPPs). State governments also can expedite permitting processes and should work to engage utilities and eliminate regulatory barriers that may hinder investment in charging stations.[70]

2H
Maintain incentives until EVs hit cost parity with conventional vehicles.

- **Finding:** Although the price of lithium ion batteries is falling, EVs are not expected to reach cost parity with conventional private passenger vehicles in India until at least the mid-2020s.[71] While prices of EVs will eventually fall due to economies of scale, incentives are a proven tool to accelerate their deployment. The government of India's Faster Adoption and Manufacturing of Electric Vehicles II (FAME II) incentives give those who purchase EVs up to INR 250,000 per car in benefits.

- **Recommendation:** To avoid locking in generations of internal combustion vehicles, the Ministry of Heavy Industry & Public Enterprises should maintain the FAME incentives. The Ministry of Finance should maintain its low taxation rate on EVs (a 5% tax on EVs rather than the 20+% tax charged on internal combustion vehicles) until cost parity is reached.[72]

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68 1.7: Mixed-Use Zones. (n.d.). Mobility and Transport. *European Commission*. Retrieved from: https://ec.europa.eu/transport/themes/urban/cycling/guidance-cycling-projects-eu/cycling-measure/mixed-use-zones_en.

69 Anupam, S. (2019, May 19). Will India's Charging Infrastructure Framework be the Shot in the Arm for EV Industry? *Inc 42*. Retrieved from https://inc42.com/features/india-ev-industry-awaits-charging-infrastructure-framework/.

70 Anupam, S. (2019, May 19). Will India's Charging Infrastructure Framework be the Shot in the Arm for EV Industry? *Inc 42*. Retrieved from https://inc42.com/features/india-ev-industry-awaits-charging-infrastructure-framework/.

71 Juyal, S., et al., (2018). Zero Emission Vehicles (ZEVs): Towards a Policy Framework. *NITI Aayog & World Energy Council*. Retrieved from https://niti.gov.in/writereaddata/files/document_publication/EV_report.pdf.

72 Choudhury, S.R. (2019, July 8). India Hopes Making Electric Vehicles Cheaper Will Get More People to Buy Them. *CNBC*. Retrieved from https://www.cnbc.com/2019/07/08/india-hopes-making-electric-vehicles-cheaper-will-spur-demand.html.

2I
Incorporate charging infrastructure requirements to the ECBC.

- **Finding:** It costs about half as much to install the electrical equipment needed to support an EV charger in a commercial building during the building's construction as it does to retrofit an existing building to accommodate the charging equipment. In China, the city of Beijing requires that 20% of new parking spots in commercial buildings and 100% of new parking spots in residential buildings be equipped with chargers.[73]

- **Recommendation:** To avoid difficult and costly future retrofits of existing buildings, the Ministry of Power and BEE should include mandatory provisions for EV-ready charging spaces in all new construction in the next versions of the commercial and residential ECBC.

2J
Explore potential to reduce energy use through shared mobility (ride-hailing and ridesharing).

- **Finding:** The proliferation of smart phones equipped with global positioning systems (GPS) has led to the explosion of ride-hailing services offered by transportation network companies (TNCs). TNCs such as Ola and Uber have become a fixture in India's cities, with analysts predicting that India could soon become one of the world's largest markets for ridesharing.[74] While this new business model can dramatically change how Indians move, the way that ride-hailing is deployed will have significant impacts on the country's energy use. Depending on whether the rides are shared with other passengers, ride-hailing has the capacity to either complement or compete with public transit.

- **Recommendation:** The Ministry of Housing and Urban Affairs should perform analytical modelling on the effects of ride-hailing and ridesharing on energy use, and policy pathways that India could take to address unintended consequences on energy demand. The study should consider strategies such as per-ride taxes directed toward encouraging public transport.[75]

2K
Study impacts of last-mile delivery services on energy demand.

- **Finding:** E-commerce, or the purchase of goods online, is expected to be worth more than $100 billion in India by 2022.[76] This has enormous implications for energy demand, as transportation energy use increases due to last-mile deliveries—the package's journey from a warehouse to the customer's door—and vehicle idling during deliveries.[77] Governments around the world are working to devise solutions appropriate to their local circumstances. For example, the Government of Santiago, Chile, dedicates parking spots for freight vehicles during certain hours to avoid wasteful idling.[78]

- **Recommendation:** The Ministry of Road Transport and Highways should study the impact that last mile deliveries have on energy use and explore policies to help mitigate energy waste.

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73 Hall, D., Cui, H., & Lutsey, N. (2018, Oct). Electric Vehicle Capitals: Accelerating the Global Transition to Electric Drive. *The International Council on Clean Transportation*.
Retrieved from: https://theicct.org/sites/default/files/publications/EV_Capitals_2018_final_20181029.pdf.

74 Shared Mobility on the Road of the Future. (2016, June 15). *Morgan Stanley*.
Retrieved from: https://www.morganstanley.com/ideas/car-of-future-is-autonomous-electric-shared-mobility.

75 Well, B., Petzhold, G., & Minella Pasqual, F. (2018, Aug 8). Cities are Taxing Ride-Hailing Services like Uber and Lyft. Is This a Good Thing? *World Resources Institute*.
Retrieved from: https://www.wri.org/blog/2018/08/cities-are-taxing-ride-hailing-services-uber-and-lyft-good-thing.

76 Propelling India Towards Global Leadership in E-Commerce. (n.d.). *PWC India*.
Retrieved from: https://www.pwc.in/research-insights/2018/propelling-india-towards-global-leadership-in-e-commerce.html.

77 Dolan, S. (2018, May 10). The Challenges of Last Mile Logistics & Delivery Technology Solutions. *Business Insider*. Retrieved from https://www.businessinsider.com/last-mile-delivery-shipping-explained.

78 Brown, E. (2018, Sept 4). E-commerce Spurs Innovations in Last-Mile Logistics. *MIT News*. Retrieved from http://news.mit.edu/2018/mit-e-commerce-spurs-innovations-last-mile-logistics-0904.

2L

Plan for the introduction of automated vehicles.

- **Finding:** While the widespread commercialization of automated vehicles (AVs) is still likely decades away, preliminary studies have suggested that in some countries their adoption could result in energy savings of 60%—or energy increases as high as 200% or more—depending on technological, policy, and behavioral variables.[79] Given the high level of uncertainty about how AVs will affect energy demand, governments should begin considering policies to ensure that the introduction of AVs to the transport system is carried out in a way that promotes more efficient, sustainable and accessible mobility.

- **Recommendation:** The Ministry of Road Transport and Highways should convene critical stakeholders—including NITI Aayog, auto manufacturers, technology providers, urban planners, transit agencies, utilities, infrastructure developers, and central, state, and local governments—to study the possible implications of vehicle automation and clarify a regulatory framework for India that ensures AVs are introduced in an energy-productive manner. Stakeholders should consider policy interventions that promote and facilitate shared mobility.

Address the energy productivity of water infrastructure

Providing universal access to potable water is a pressing challenge that also has enormous implications for energy demand in India. Investments in water supply infrastructure aimed at improving access also represent important opportunities for improving the energy efficiency of municipal water and agricultural systems. According to a baseline study of global progress toward achieving UN Sustainable Development Goal 6 (on Clean Water and Sanitation), India is among the least water-efficient countries in the world.[80] Its water infrastructure is in need of maintenance and monitoring: up to 50% of the country's water supply may be lost to leaks and theft.[81] Improving the efficiency of India's water supply can significantly boost the country's energy productivity, since every liter of water saved is a liter that does not use energy for pumping, treatment, or delivery.

2M

Create a strategic national plan for efficient water management.

- **Finding:** Prime Minister Modi's government recently merged the Ministry of Water Resources, River Development, and Ganga Rejuvenation with the Ministry of Drinking Water and Sanitation to form the Ministry of Jal Shakti.[82]

- **Recommendation:** The Ministry of Jal Shakti should include energy productivity measures into its strategic plan for managing India's water supply system and the energy-water nexus.

79 Stephens, T.S. et al. (2016, Nov). Estimated Bounds and Important Factors for Fuel Use and Consumer Costs of Connected and Automated Vehicles. *National Renewable Energy Laboratory*. Retrieved from: https://www.nrel.gov/docs/fy17osti/67216.pdf.

80 Progress on Water-use Efficiency: Global Baseline for SDG Indicator 6.4.1. (2018). *Food and Agriculture Organization of the United Nations*.

81 FAQS. (n.d.). *Atal Mission for Rejuvenation and Urban Transformation*. Retrieved from http://amrut.gov.in/content/innerpage/faqs.php.

82 FAQS. (n.d.). *Atal Mission for Rejuvenation and Urban Transformation*. Retrieved from http://amrut.gov.in/content/innerpage/faqs.php.

2N
Adopt a nationwide policy that mandates the reuse of treated wastewater.

- **Finding:** Reusing water is inherently energy productive because every liter of water reused does not have to be extracted and transported from its source.[83] India currently lacks a national policy that addresses wastewater reuse.

- **Recommendation:** The Ministry of Jal Shakti should develop a nationwide policy that promotes the reuse of treated wastewater where it is feasible and cost effective. The State of Gujarat's policy can pose as a blueprint: In 2018, the state announced its target to reuse 70% of treated wastewater by 2025, and 100% by 2030.[84] To help meet these targets, Gujarat's government also has made it mandatory for thermal power plants and large industrial units to use treated wastewater in their operations.[85]

2O
Encourage state distribution companies (DISCOMs) to implement and enforce the Agriculture DSM (Ag-DSM) Programme.

- **Finding:** The agricultural sector faces numerous challenges, such as the widespread use of inefficient pump sets, overconsumption of electricity, and poor irrigation practices. To address energy and water waste in this sector, BEE launched the Ag-DSM Programme to replace inefficient irrigation pumps with BEE-accredited five-star pumps outfitted with timers and other mechanisms to control water consumption.[86] BEE collaborated with 11 DISCOMs to pilot projects in eight states, replacing around 20,000 pumps. An analysis of the pilot found that the average energy savings potential of the new pumps was about 40%, with a payback period between three and four years.[87] Yet despite the successful pilot, AgDSM has not been replicated on a large scale.[88]

- **Recommendation:** The Ministry of Power, Ministry of Agriculture, and Jal Shakti should engage in policy dialogues with DISCOMs and state governments to develop a comprehensive energy-water nexus framework for agriculture. State governments should incentivize DISCOMs to implement an AgDSM program, either with support from ESCOs or using one of the Ministry of Power's three suggested public-private partnership business models: the DISCOM model (where the DISCOM invests its own funds to replace the pump sets with support from pump manufacturers and project contractors); the ESCO model (where an ESCO enters a contract with a DISCOM and earns money back from the DISCOM through energy savings obtained or estimated); or the hybrid model (where the project is jointly funded by both a DISCOM and an ESCO and the ESCO earns back a portion of the energy savings per the contract).[89]

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83 Water Reuse and Recycling: Community and Environmental Benefits. (n.d.). *United States Environmental Protection Agency*. Retrieved from https://www3.epa.gov/region9/water/recycling/#energy.

84 Policy for Reusing Waste Water: Gujarat Government. (2018, May 29). *DNA*. Retrieved from https://www.dnaindia.com/ahmedabad/report-policy-for-reusing-waste-water-gujarat-government-2619850.

85 Policy for Reusing Waste Water: Gujarat Government. (2018, May 29). *DNA*. Retrieved from https://www.dnaindia.com/ahmedabad/report-policy-for-reusing-waste-water-gujarat-government-2619850.

86 Agriculture DSM. (n.d.). *Bureau of Energy Efficiency.* Retrieved from https://beeindia.gov.in/content/agriculture-dsm-0.

87 Agricultural Demand Side Management (Ag-DSM) Program in India: Adopting Technologies to Boost Efficiencies. (n.d.). *Federation of Indian Chambers of Commerce and Industry & ICF International*. Retrieved from http://ficci.in/spdocument/20804/White-Paper-AgDSM-Workshop.pdf.

88 Sarkar, A. et al. (2016). Utility Scale DSM Opportunities and Business Models in India. *The World Bank Group, Energy Efficiency Services Limited, Energy Sector Management Assistance Program, & PWC.* Retrieved from https://www.esmap.org/sites/default/files/esmap-files/113214-WP-P147807-Utility-Scale-Opportunities-PUBLIC_2.pdf.

89 Agricultural Demand Side Management (Ag-DSM) Program in India: Adopting Technologies to Boost Efficiencies. (n.d.). *Federation of Indian Chambers of Commerce and Industry & ICF International*. Retrieved from http://ficci.in/spdocument/20804/White-Paper-AgDSM-Workshop.pdf.

2P
Support farmers' adoption of efficient irrigation techniques.

- **Finding:** Because India subsidizes agricultural water use, farmers have traditionally had little incentive to monitor or measure the amount of water—and by extension the related energy—that they use. Workshops to educate farmers on the benefits of efficient irrigation pumps (e.g., one held by the Maharashtra Energy Development Agency and BEE[90]) are an effective mechanism for disseminating best practices for energy-efficient agricultural practices.
- **Recommendation:** BEE should collaborate with DISCOMs and local leaders in farming communities to organize training workshops and programs for farmers on energy- and water-saving opportunities in agriculture.

2Q
Develop best practices for energy management at water utilities and wastewater treatment facilities.

- **Finding:** To achieve the National Water Mission's goal of increasing India's water efficiency by 20%, India will need to improve the operational efficiency of water utilities and wastewater treatment plants.[91] NITI Aayog compiles best practices for water management in India's states through the Composite Water Management Index (in collaboration with the Ministry of Jal Shakti and the Ministry of Rural Development,)[92] and the National Productivity Council has experience developing best practices for energy management in other sectors and industries.[93]
- **Recommendation:** NITI Aayog and the National Productivity Council should collaborate on the development of guidelines for energy management at water and wastewater utilities. The final guide should be disseminated to ULBs, which control water supply in cities.

2R
Monitor and report progress on energy-water savings.

- **Finding:** Reliable public information about energy and water use in water supply and treatment facilities is a prerequisite for tracking progress and stimulating investment in infrastructure upgrades. In 2018, NITI Aayog released the first edition of its Composite Water Management Index, which assesses states' ability to efficiently manage water resources.
- **Recommendation:** NITI Aayog should work with state agencies to develop an M&V framework for tracking and reporting energy-water savings and provide training to ULBs on using the framework.

Develop and leverage digital infrastructure

Digital technologies are transforming India. In addition to enabling both urban and rural Indians to access a wealth of information, digitalization is also changing the way energy is used in virtually every end-use sector—from connected vehicles in the transportation sector, to smart thermostats in buildings. If developed and leveraged with strategic policies in place, digitalization can enable India to reap even deeper energy savings and dramatically increase its energy productivity. As one of the world's leading information

90 One Day Training Programme for Farmers on 'Energy and Water Conservation' in Agriculture Pumping. (2015). *Maharashtra Energy Development Agency*. Retrieved from https://beeindia.gov.in/sites/default/files/ctools/Pune%20AgDSM%20Training%20Report%202015.pdf

91 Objective of National Water Mission. (n.d.). *National Water Mission, Government of India*. Retrieved from http://nwm.gov.in/?q=objective-national-water-mission.

92 Composite Water Management Index 2019. (2019). NITI Aayog. Retrieved from : https://niti.gov.in/sites/default/files/2019-08/CWMI-2.0-latest.pdf.

93 About Us. (n.d.). *National Productivity Council*. Retrieved from: https://www.npcindia.gov.in/NPC/User/index.

technology (IT) hubs and a growing manufacturing hub, India is well positioned to take advantage of this digital revolution.[94,95] As it updates its infrastructure to accommodate a mass influx of new urban residents, India should ensure that any new physical infrastructure is outfitted with digital infrastructure.

The phrase 'digital infrastructure' is used throughout this section to refer to the myriad technologies—including sensors, automated controls, and metering—that underpin physical infrastructure. Often characterized as "smart," these devices network to a centralized system and have two-way connectivity and logic, allowing the devices to address energy inefficiencies. These devices can allow homeowners and building managers to adjust energy usage on their smart phones, helping to cut wasted energy. Grid operators also can benefit, as these devices can provide flexibility for demand-response and allow operators to adjust energy use during peak periods.

Because the efficacy of digital infrastructure depends on the existence of reliable, high-speed internet connection, the recommendations in this section assume that India achieves its goal of universal Internet access and its Digital India Programme, an initiative that aims to transform India into a digitally empowered society and knowledge economy. These types of changes can help India move beyond the energy productivity improvements projected by the NPS: The NPS does not account for many of the digital technologies that have emerged since 2015, many of which could help India dramatically increase its energy productivity.

2S
Incorporate connectivity and controls criteria in building codes and appliance and equipment standards programs.

- **Finding:** Connected and smart devices have the potential to revolutionize the energy management of homes and buildings by allowing owners and operators to see and adjust energy usage, including on their smart phones.
- **Recommendation:** BEE should update the ECBC to require new construction to include connections for Internet access, including those that would allow submeters to connect to the Internet.[96] BEE also should pursue updates to its voluntary appliance and equipment standards to incorporate the value added by smart features, such as automatic controls or grid connectivity.

2T
Train DISCOMs on the energy savings potential of digital infrastructure.

- **Finding:** A more flexible grid will enable India to better integrate distributed energy resources, including renewable energy and battery storage, into its power system. A 2019 Climate Policy Initiative report projected that load flexibility could help India integrate 40% more wind and solar generation into its grid by 2030 than otherwise projected in a baseline scenario.[97] Furthermore, transmission and distribution losses in the electric grid are currently greater than 15% of total generation in India (for comparison, losses are about 5% in the U.S.), so improving efficiency in the power grid is particularly critical considering that India's electricity demand for buildings has grown

94 IT & ITeS Industry in India. (2019, July). *India Brand Equity Foundation*. Retrieved from https://www.ibef.org/industry/information-technology-india.aspx.

95 Ayres, A. (2018, Jan 4). Can Indian Manufacturing Be the Next Chinese Manufacturing? *The Atlantic*. Retrieved from https://www.theatlantic.com/business/archive/2018/01/india-manufacturing-tata-alyssa-ayres/549263/.

96 Wireless Submetering and Utilities – What are the Benefits? (2017, March 15). *Engerati*. Retrieved from: https://www.engerati.com/article/wireless-submetering-and-utilities-benefits.

97 Pierpont, B., Khurana, S., & Nelson, D. (2019, Feb). Developing a Roadmap to a Flexible Low-Carbon Indian Electricity System: Interim Findings. *Climate Policy Initiative*. Retrieved from: https://climatepolicyinitiative.org/wp-content/uploads/2019/02/CPI-India-Flexibility-WEB.pdf.

by more than 8% per year in the last 10 years.[98] The IEA estimates that India could save about 4 PWh in its power system from widespread digitalization by 2040.[99]

- **Recommendation:** The Ministry of Power should compile lessons learned about advanced metering infrastructure—and other connectivity technology relevant to supporting load flexibility or reducing transmission and distribution losses demonstrated through the Smart Grids projects—and share them with power utilities and the Central Electric Regulatory Commission (CERC) to demonstrate the value of leveraging digital infrastructure.[100] CERC should provide incentives for power utilities to deploy smart metering, develop demand response programs, and use remote monitoring to improve operational efficiency.

2U
Develop best practices for energy management at data centers.

- **Finding:** The information accrued from smart devices is stored in data centers. While data centers have existed since the advent of the computer, they have become increasingly large energy consumers due to the proliferation of smart devices. The IEA reports that India's data center market is projected to grow by more than 20% per year for several years.[101]

- **Recommendation:** NITI Aayog and BEE should collaborate to develop guidance for efficient energy management at data centers.[102]

98 Frequently Asked Questions: How Much Electricity is Lost in Electricity Transmission and Distribution in the United States? (n.d.). *United States Energy Information Administration*. Retrieved from: https://www.eia.gov/tools/faqs/faq.php?id=105&t=3.

99 Digitalization & Energy. (2017). *International Energy Agency*. Retrieved from: https://www.iea.org/reports/digitalisation-and-energy.

100 SG Projects: Smart Grid Projects Under NSGM. (n.d.). *Ministry of Power*. Retrieved from: https://www.nsgm.gov.in/en/sg-projects.

101 Digitalization & Energy. (2017). *International Energy Agency*. Retrieved from: *https://www.iea.org/reports/digitalisation-and-energy*.

102 Energy Management. (n.d.). *National Productivity Council*. Retrieved from: http://www.npcindia.gov.in/competencies/energy-management/.

Expand and Modernize the Electrical Grid

At current rates of development and population growth, India will need to add about 870 gigawatts of power to its grid—triple the amount of installed generation capacity today—to keep up with energy demand over the next 20 years.[103] To accommodate the dramatic increase in energy demand, India will need to expand and modernize its electrical grid.

2V
Expand and strengthen the DISCOM Capacity-Building Programme to mainstream utility DSM.

- **Finding:** BEE's Capacity-Building Programme for DISCOMs is designed to improve load management, manage load growth, and promote energy conservation. Thirty-four DISCOMs are already designated as beneficiaries of the programme, but some states still do not have DISCOMs included in the programme. There are varying levels of engagement among the current programme beneficiaries. Some, for example, do not have a utility demand-side management (DSM) action plan or notice of DSM regulation.[104] While DSM regulations exist in 17 Indian states and seven Union Territories, enforcement is limited.[105]

- **Recommendation:** DISCOMs from all states should be added to BEE's DISCOM Capacity-Building Programme to maximize the benefit of planned capacity management and conservation.[106] BEE should strengthen the regulatory framework of the programme to improve cost-effectiveness evaluations, cost-recovery mechanisms, incentive frameworks, the establishment of DSM targets, and the capacity and authority of DSM teams or cells.[107]

2W
Encourage DISCOMs to establish peak demand reduction goals.

- **Finding:** Power grid capacity is typically built to accommodate peak demand conditions, so peak demand reduction is critical to improving the overall energy productivity of the grid.[108,109] DISCOM-led DSM programs can use a variety of strategies to encourage customers to be more energy efficient, such as subsidizing upgrades to efficient equipment or offering monetary rewards for saving energy during certain times of day through dynamic and time-of-use based electricity tariffs.

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103 Agarwal, A. & Martin, S. (2016, April 27). What's Holding up the Efficient Appliance Market in India? *World Resources Institute*. Retrieved from: https://www.wri.org/blog/2016/04/whats-holding-efficient-appliance-market-india.

104 Capacity Building of DISCOMs. (n.d.). *Bureau of Energy Efficiency*. Retrieved from: https://beeindia.gov.in/content/capacity-building-discoms.

105 Sarkar, A., et al. (2016). Utility Scale DSM Opportunities and Business Models in India. The World Bank Group, Energy Efficiency Services Limited, Energy Sector Management Assistance Program, & PWC. Retrieved from: https://www.esmap.org/sites/default/files/esmap-files/113214-WP-P147807-Utility-Scale-Opportunities-PUBLIC_2.pdf.

106 Capacity Building of DISCOMs. (n.d.). *Bureau of Energy Efficiency*. Retrieved from: https://beeindia.gov.in/content/capacity-building-discoms.

107 Sarkar, A. et al. (2016). Utility Scale DSM Opportunities and Business Models in India. *The World Bank Group*. Retrieved from: http://documents.worldbank.org/curated/en/422921488948129217/Utility-scale-DSM-opportunities-and-business-models-in-India-prepared-for-the-WorldBank-energy-and-extractives-global-practice-South-Asia-Region.

108 Peak demand for electricity occurs when more generation capacity is needed to meet high demand, leading to high energy prices and/or stress on the grid. Because power generation systems are built to serve peak demand, the grid often has more capacity than it needs during most periods. Reducing peak demand reduces the need for resources to maintain the extra power grid capacity, i.e. the infrequently used generation equipment that is activated only during peak demand periods. The energy productivity of the grid increases when the amount of resources/primary energy consumed (to maintain grid capacity) decreases relative to the power provided.

109 Feldman, B., Tanner, M. & Rose, C. Peak Demand Reduction Strategy. *Advanced Energy Economy*. Retrieved from: https://info.aee.net/peak-demand-reduction-report.

- **Recommendation:** State Energy Regulatory Commissions should partner with DISCOMs in their territories to establish peak demand reduction goals, develop DSM programs to meet those goals, and incentivize the participation of key high-energy consuming customers.

2X Deploy advanced metering infrastructure.

- **Finding:** Consumers who have an easy and secure means of accessing their energy use data are more likely to implement energy efficiency measures. Smart grids—electrical grids with automation, communication, and internet technology systems—can monitor and control power flows or curtail loads to match generation in real time.[110] The technologies that enable the grid to be multi-directional can reduce inefficiencies and are inherently more compatible with power sources generated outside of plants, such as rooftop solar panels. Effective use of smart grids, however, requires advanced metering systems, which enable the measurement of real-time information. EESL and the Asian Development Bank have implemented a program to install smart meters in municipal areas of several states.
- **Recommendation:** The Ministry of Power should develop a model mechanism for deploying metering infrastructure throughout all Indian states. Once meters reach cost parity, the Ministry of Power should work with EESL to train DISCOMs to scale the model to a national level.

III. Facilitate the Transition to Renewable Energy Sources

The NPS assumes that renewables will account for more than 40% of India's power generation capacity by 2040 and will account for a significant portion of energy productivity improvements. This large displacement of fossil fuel energy consumption has significant implications for avoided emissions as well as increased energy productivity, especially when combined with energy efficiency strategies.

Switching to renewable energy can lead to productivity gains for India in several ways. Distributed energy resources (DERs)—such as onsite renewables, battery storage, and EVs—can reduce the stress of peak demand on the grid and thereby improve the efficiency of power generation for the grid.[111,112] Furthermore, the benefits of demand response/load flexibility and renewable energy reinforce each other. Since the availability of many types of renewable energy (e.g., solar, wind) is inherently dynamic, greater demand response capacity enhances opportunities to incorporate renewable energy into the grid. In turn, renewable energy provides a low-cost and low-carbon lever for demand response to help smooth the load profile of a power plant when renewable energy is abundant.[113] Smoothing the load profile can have enormous energy saving impacts. Analysis by the Rocky Mountain Institute found that demand flexibility in the U.S. has the potential to save 56% of the power that would normally be required to ramp power generation up and down to accommodate the steeper and more frequent changes in demand that occur in the absence of flexibility.[114] Finally, onsite renewable energy eliminates transmission and distribution losses found within power distribution from the grid, further reducing electricity wastage and therefore enhancing energy productivity.

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110 Smart Grid. (n.d.). *Ministry of Power.*
Retrieved from: http://www.nsgm.gov.in/en/content/smart-grid.

111 Shah, M. et al. (2018). Valuing Energy Efficiency and Distributed Energy Resources in the Built Environment: Preprint. *National Renewable Energy Laboratory*.
Retrieved from: https://www.nrel.gov/docs/fy18osti/71701.pdf.

112 Grid-interactive Efficient Buildings. (n.d.). *United States Department of Energy*.
Retrieved from: https://www.energy.gov/sites/prod/files/2019/04/f62/bto-geb-factsheet-41119.pdf.

113 Nelder, C. (2018, Jan 17). Demand Flexibility. *Resilience.org*.
Retrieved from: https://www.resilience.org/stories/2018-01-17/demand-flexibility/.

114 The analysis modelled a market with "significant renewable growth potential," the wholesale electricity market in Texas, ERCOT, which was assumed to power eight end-use loads in the residential and commercial sectors. See: http://rmi.org/wp-content/uploads/2018/02/Insight_Brief_Demand_Flexibility_2018.pdf.

3A
Integrate EE and DSM measures with renewable energy deployments.

- **Finding:** As renewable energy installations become more affordable and are scaled up at an accelerated rate, more opportunities will arise to integrate renewable energy measures with deployment of EE, DSM, and demand response (DR) technologies to maximize the efficiency benefits of renewable energy.

- **Recommendation:** The Ministry of Power and the Ministry of New and Renewable Energy should collaborate to develop joint initiatives, at both project and strategic levels, that enable load aggregators to aggregate the demand of distributed renewables used by domestic consumers—particularly relevant in the context of technologies like rooftop solar PV and solar water heaters—along with integration of digitalization technologies, such as advanced metering infrastructure, to enable demand response.[115]

3B
Integrate energy storage with EE, DSM and renewable energy systems.

- **Finding:** Energy storage measures provide DISCOMs with the flexibility to smoothly integrate intermittent renewable energy resources in order to optimize the power system's ability to closely follow load curves. Affordable energy storage technologies can be used as resources to avoid grid shortages due to high peak loads and steep ramping needs. Due to the intermittent availability of renewable energy (e.g., lack of sun during the day or lack of wind at night), energy storage can serve as an important complement to renewables, filling gaps in power availability, capturing excess renewable energy during peak supply periods, and helping to balance DISCOMs' electricity demand.[116] Electric vehicles can serve as a storage mechanism, supporting peak load leveling both by coordinating charging with off-peak periods and by discharging from the vehicle to the grid during peak periods.[117] Energy storage also can improve a community's resilience by serving as a back-up to the grid and sustaining critical loads in islanding-mode if the grid becomes unavailable.

- **Recommendation:** DISCOMs should leverage battery and other energy storage systems, along with EVs and any other storage technologies at the downstream distribution level, to optimize demand-supply levels and stabilize the grid by load-shifting when appropriate.

3C
Modify electricity rate designs to support demand response and leverage distributed energy resources.

- **Finding:** Demand response measures enable electric utilities to modify their loads, i.e. to shift demand to more optimal periods—e.g., when electricity is cheaper, cleaner, and more abundant—or shave off load that cannot be met. Demand response measures can be supported by effective rate designs. Peak demand charges or time-of-use rates can encourage electricity customers to decrease their energy consumption during periods of peak demand and shift loads to off-peak hours.[118] The Rocky Mountain Institute found that when the ratio of peak to off-peak price was 2:1 in the United States, the peak reduction was typically at least 5%—whereas a 5:1 ratio resulted in a peak reduction of at least 10%.[119]

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115 Defined by the National Renewable Energy Laboratory as traditional load-serving entities or third-party companies focused on providing demand response solutions. See: https://www.nrel.gov/docs/fy19osti/70630.pdf.

116 Investment Creates Long-term Reliability. (n.d.). *Energy Storage Association*. Retrieved from: https://energystorage.org/why-energy-storage/benefits/.

117 Vehicle-to-grid Drive May Power Cars for Free. (23, Jan 2019). *Global Times*. Retrieved from: http://www.globaltimes.cn/content/1136778.shtml.

118 Trabish, H.K. (2016, June 2). Rate Design Roundup: Demand Charges vs. Time-based Rates. *Utility Dive*. Retrieved from: https://www.utilitydive.com/news/rate-design-demand-charges-time-based-rates/419997/.

119 Chitkara, A. et al. (2016). A Review of Alternative Rate Designs. *Rocky Mountain Institute*. Retrieved from: https://rmi.org/insight/review-alternative-rate-designs/.

Renewable Energy: Additional measures that improve energy productivity

Measures that support the integration of renewable energy into the energy system will further improve energy productivity. Additional actions to accelerate renewable energy deployment include:

- Develop collaborative programs engaging DISCOMs, municipal corporations, and citizens in renewable technology implementation programs to raise awareness of the benefits of renewables and create local policies that are conducive to renewable energy installations.
- Provide loan recovery and other financial support to low-income communities to accelerate renewable energy installations. In the long-term, enhancing renewable energy generation in low-income communities may be cost-effective for DISCOMs, which often highly subsidize electricity in these communities.
- Encourage Non-Banking Financial Companies to invest in renewable energy.
- Improve guidelines for operations, maintenance, and performance for Renewable Energy Service Companies (RESCOs).
- Develop model lease agreements and power purchase agreements for contracts between consumers and RESCOs to mitigate risk caused by lack of clarity in expectations.
- Provide assistance to DISCOMs to implement virtual net metering for community solar programs.
- Work with DISCOMs to create an online portal to facilitate management of renewable energy projects and to collect feedback from customers on their renewable energy systems.

- **Recommendation:** The Ministry of Power, in collaboration with BEE, CERC and SERCs, should mandate that electricity customers with DR measures and rooftop solar be subject to time-of-day tariffs for their electricity consumption. In addition, DISCOMs should provide customer incentives through modified rates that leverage vehicle-to-home and vehicle-to-grid capabilities by encouraging EV charging or discharging, as appropriate, to provide grid stability benefits.

IV. Increase Awareness, Educate and Engage Stakeholders

The recommendations outlined thus far have focused on making India's physical infrastructure and systems more energy efficient to enhance energy productivity. Equally important, however, is raising awareness about how energy productivity improvements can benefit individuals, corporations, and the nation to encourage behavior change among energy market stakeholders and consumers.

Encourage corporate energy management, transparency, and reporting

Private sector commitment to energy management is critical for achieving deeper improvements in national energy productivity. Energy productivity is a framework that many companies already use to track energy efficiency improvements, since energy productivity aligns directly with business growth and development objectives. Productivity of energy use—like productivity of capital, labor, and material inputs—is integral to economic competitiveness in the private sector, so efforts to improve energy productivity are recognized as a wise business decision. The Government of India, in collaboration with industry associations, companies, and agencies dealing with manufacturing and commerce, can build on this foundation and promote even stronger and more broad-based private sector efforts by encouraging the corporate community to make energy-productive investments in their facilities, operations, and reporting mechanisms.

4A
Create a resource platform of case studies, best practices, and technical guidance in energy productivity for building operators.

- **Finding:** Lack of information is one of the biggest barriers to the market penetration of energy efficiency in buildings and facilities. While the technologies for making buildings and facilities more energy productive are available, it can be difficult for companies and building owners to justify investments in higher cost options without evidence of proven results and financial viability. The government can encourage corporate uptake of energy efficiency by creating a platform for firms and individuals to share knowledge on best practices. One effective example is the U.S. Department of Energy's Better Buildings Initiative, which was launched to help improve the energy productivity of commercial, public, industrial, and residential buildings. The Initiative hosts a collection of resources and best practice examples in energy and water management, sourced through more than 900 partners that include companies, federal agencies, and state and local governments. As of 2020, more than 2,500 best practice examples, resources, and solutions are available on the Better Buildings website. Participants have collectively saved nearly 1.8 quadrillion Btus of energy and $11 billion USD.[120]

Corporate Commitments to Increase Energy Productivity

The EP100 initiative—led by The Climate Group in partnership with the Alliance to Save Energy—brings together companies committed to improving their energy productivity. EP100 members track their energy productivity by reporting their ratio of economic output to energy consumption through a self-chosen metric (e.g., revenue pre gigajoules of energy). Five Mahindra Group companies—Mahindra & Mahindra Ltd, Mahindra Heavy Engines Ltd, Mahindra Vehicle Manufacturers Ltd, Swaraj Engines Ltd, and Mahindra Holidays & Resorts Ltd—have joined the program and committed to doubling their energy productivity within a 25-year timeframe. As of 2019, Mahindra & Mahindra Automotive had progressed more than 90% of the way toward its goal. Anirban Ghosh, Chief Sustainability Officer at Mahindra Group, noted that "improving energy productivity is the dominant form of [climate] mitigation that a corporation can contribute to… using more energy than required is literally like burning money and environmental resources."

Citation: Smarter Energy Use: Businesses Doing More With Less. (2019, July 24). *The Climate Group.* Retrieved from: https://www.theclimategroup.org/news/smarter-energy-use-businesses-doing-more-less).

- **Recommendation:** To encourage commercial market transformation, BEE should maintain a hub of resources housing information on the successful deployment of efficiency technologies in India. Maintaining a broad offering of detailed case studies can help capture lessons learned and demonstrate proven energy savings for companies, DISCOMs, and building operators interested in improving their energy management practices.

4B
Support the next generation of micro, small, and medium enterprise (MSME) entrepreneurs.

- **Finding:** The NPS assumes that most increases in India's industrial energy productivity will come from large energy-intensive industries, particularly those covered by the PAT program, since implementing energy efficiency measures can be more difficult in MSMEs due to their diverse nature, lack of capital and technical capacity, the perceived risk of some efficiency investments, and relatively high transaction costs.[121] However, an energy productivity strategy for India would not be effective without engaging the MSMEs, which are often considered to be the backbone of India's economy. MSMEs contribute to 45% of India's industrial outputs and 40% of of its imports,

120 DOE Announces $11 Billion in Energy Savings from Better Buildings Partners. (2020). *Better Buildings*. Retrieved from: https://betterbuildingssolutioncenter.energy.gov/news/doe-announces-11-billion-energy-savings-better-buildings-partners.

121 World Energy Outlook Special Report: India Energy Outlook. (2015). *International Energy Agency*. Retrieved from: https://webstore.iea.org/weo-2015-special-report-india-energy-outlook.

and employ approximatively 60 million people.[122] Plans to strengthen India's energy productivity will thus need to prioritize this sector and build on current programs, such as SAMEEKSHA, an energy efficiency knowledge-sharing platform for MSMEs, and Stand-Up India, a program that provides training, mentorship, skill development, and loans for MSMEs (e.g., through SIDBI).[123,124]

- **Recommendation:** To capture efficiency gains in the industrial sector, the Ministry of Micro, Small, and Medium Enterprises should collaborate with SAMEEKSHA, Stand-Up India, SIDBI and any other agencies hosting entrepreneurship and financing programs to design and implement a coordinated strategy for supporting MSMEs' efficiency efforts. The collaboration should ideally provide a platform of services to address needs for information, financing, and technical expertise.

Train the next generation of workers with the needed skills to advance energy productivity

Major investment in increasing India's energy productivity across all sectors can create millions new jobs. However, the energy efficiency market transition may also disrupt established industries, companies, and individuals as new processes or products supersede old ones. A smooth transition will thus require investment in workforce training to ensure that the skills of the future workforce best match the requirements of the emerging job markets.

Implementing Energy Management Systems

An energy management system (EnMS) is a comprehensive plan that tracks a building or facility's energy performance. To be effective tools for reducing building energy waste, energy management systems should include well-defined energy policies and goals, designated staff for implementing the policies, technology that can measure and provide context on energy consumption, and a process for responding to the measured results to improve energy performance.

Best practices for developing energy management systems include:

- Adopt facility-specific energy efficiency targets.
- Prepare an energy management manual.
- Designate a Certified Energy Management Professional or Manager to oversee implementation of the EnMS and to ensure compliance at the facility-level.
- Develop a monitoring and reporting framework to track efficiency improvements.
- Contract ESCOs to identify and implement energy efficiency measures.
- Participate in information-sharing and advisory support to help other industries create and implement energy management systems.

4C
Integrate energy productivity knowledge into primary education.

- **Finding:** Creating a society that understands the importance of energy productivity starts in the classroom. BEE is developing the School Capacity Building Program; when completed, the program will incorporate energy efficiency training into the science curricula for grades 6-10.
- **Recommendation:** BEE should incorporate energy productivity themes into the School Capacity Building Program's curriculum to ensure that students understand the relationship between energy productivity and economic prosperity.

122 Definition of Indians SMEs. (n.d.). *Europe-India SME Business Council*. Retrieved from http://www.eisbc.org/Definition_of_Indian_SMEs.aspx.

123 About Us. (n.d.). *SAMEESKA*. Retrieved from: http://sameeeksha.org/#:~:targetText=SAMEEEKSHA&targetText=SAMEEEKSHA%20is%20a%20collaborative%20platform,in%20the%20Indian%20MSME%20sector.

124 About Us. (n.d.). *Stand Up India*. Retrieved from: https://www.standupmitra.in/.

4D
Increase job training in energy-productive sectors.

- **Finding:** Although India is the world's third largest economy, it still faces a shortage of workers with the skills to match job needs.[125] To better prepare India's workforce, the Ministry of Skill Development & Entrepreneurship created the Skill India Programme, which aims to train more than 400 million people in vocational skills by 2022. Anyone of Indian nationality who is unemployed as well as high school and college dropouts are eligible to apply.

- **Recommendation:** The Ministry of Skill Development & Entrepreneurship should mainstream an energy efficiency job training curriculum within the Skill India Programme.

4E
Train government employees on the importance of energy productivity.

- **Finding:** In its National Training Policy, the Department of Personnel and Training (DoPT) currently requires that each of the Government of India's ministries and departments earmarks 2.5% of its salary budget for skill training.[126] In 2012, DoPT noted that climate change risks and other changes since the policy's inception in 1996 have created "a complex and challenging environment in which the civil service has to function at a time when there are increasing expectations of its performance and ability to respond more efficiently and effectively to the needs of the citizens."[127] This recognition presents an opportunity to restructure the program to put an increased emphasis on training for energy productivity.

- **Recommendation:** The DoPT should ensure that training components dedicated to climate change and sustainable development include discussions on the importance of and opportunities for energy productivity improvement.

125 Saulat, T. (2018, Sept 22). Why Does India Still Face Skill Shortage? *Business World*. Retrieved from: http://www.businessworld.in/article/Why-Does-India-Still-Face-Skill-Shortage-/22-09-2018-160473/.

126 Office Memorandum. (2012, Jan 19). *Department of Personnel & Training, Ministry of Personnel, Public Grievances, and Pensions*. Retrieved from https://dopt.gov.in/sites/default/files/NationalPolicy.pdf.

127 Office Memorandum. (2012, Jan 19). *Department of Personnel & Training, Ministry of Personnel, Public Grievances, and Pensions*. Retrieved from https://dopt.gov.in/sites/default/files/NationalPolicy.pdf.

CONCLUSION

CONCLUSION

The rapid pace of India's economic growth and urbanization offers exciting opportunities for making significant improvements in energy efficiency that would contribute to higher levels of energy productivity. By investing in efficient energy end-use technologies across every sector, India can obtain more economic output from every unit of energy consumed and maximize its economic growth while curbing the rise in energy use and GHG emissions. Putting India on this path will require new levels of coordination across all levels of government and with the private sector, as well as significant investment—but will provide even greater rewards.

This roadmap provides recommendations for near- and long-term actions for various actors—Government of India Ministries and Departments, state agencies, and private sector partners—to help maximize the potential energy productivity gains of India's economy. Table 1 summarizes these recommendations by target audience, and categorizes the recommendations by timeframe:

- Short term: By 2030
- Long term: 2030 and beyond

The analytical work and research conducted to produce the policy recommendations revealed significant gaps in data availability. For future analyses of policy and program opportunities and the benefits of energy productivity improvements, additional data collection will be helpful. The identified data needs are outlined in Annex 3.

Table 1. Recommendation Summaries by Target Audience and Timeframe

Recommendation Summary	Timeframe	Rec. #
Bureau of Energy Efficiency		
Scale up current energy use data collection programs to cover other end users and work with other ministries to establish a comprehensive energy consumption database.	Short Term	1.B
Convene a consortium of stakeholders to design and implement a plan to build on the standardization work of the PRSF to make the ESPC and M&V templates available to the larger ESCO community.	Short Term	1.C
Strengthen partnerships with multilateral institutions to develop and deliver a results-oriented capacity building program for banks on energy efficiency and ESCO project appraisal systems.	Short Term	1.D
Work with RBI to recognize energy efficiency as a priority lending sector and formal economic sector.	Short Term	1.E
Create a race-to-the-top style energy productivity competition for states and communities in collaboration with the Ministry of Science and Technology and other relevant ministries, state-level entities, and research institutes.	Short Term	1.K
Work with product manufacturers and retailers to implement a strategy to raise consumer awareness of the Standards and Labelling Programme.	Short Term	2.A
Support adoption of residential ECBC into local bylaws and train local officials in compliance strategies.	Short Term	2.B
Develop a version of the ECBC that applies to affordable and public housing and work with other agencies to integrate the code into affordable housing programs.	Short Term	2.C
Include mandatory provisions for EV-ready charging spaces in new construction in the next versions of the commercial and residential ECBC (with the Ministry of Power).	Short Term	2.I
Collaborate with DISCOMs to organize training workshops and programs for farmers on the energy- and water-saving opportunities in agriculture.	Short Term	2.P
Update the ECBC to require new construction to include connections for internet access and submeters. Update appliance and equipment standards to incorporate the value of these features.	Short Term	2.S
Collaborate with NITI Aayog to develop guidance for energy management at data centers.	Short Term	2.U
Add DISCOMs from all states to the DISCOM Capacity-Building Programme and strengthen the programme's regulatory framework.	Short Term	2.V

Enhance the resource hub of information on the successful deployment of efficiency technologies.	Short Term	4.A
Incorporate energy productivity themes into the School Capacity Building Program's curriculum.	Short Term	4.C
Central Ministries		
Perform collaborative projects to leverage the RDD&D capabilities of each ministry. Collaborate with academic/research institutions and the private sector.	Short Term	1.J
Central Electric Regulatory Commission		
Provide incentives for DISCOMs to use remote monitoring for operational efficiency, smart metering, and demand response programs.	Short Term	2.U
Department of Central Public Works		
Require the adoption of a recognized energy management standard and establish energy and water savings goals in all public buildings.	Short Term	1.L
Encourage contractors and vendors to report to CDP or the Indian GHG Programme.	Short Term	1.M
Work with the Ministry of Housing and Urban Affairs to create comprehensive plans for mapping and meeting EV charging infrastructure needs.	Short Term	2.H
Department of Personnel and Training		
Ensure that training dedicated to climate change and sustainable development includes discussions on energy productivity.	Short Term	4.E
DISCOMs		
Work with other stakeholders to develop an energy-water nexus framework for agriculture.	Short Term	2.P
Partner with State Energy Regulatory Commissions to establish peak demand reduction goals, develop DSM programs to meet those goals, and incentivize participation for high-energy consuming customers.	Short Term	2.W
Leverage battery energy storage systems to help stabilize the grid through load-shifting.	Short Term	3.B
Provide customer incentives through modified rates that leverage vehicle-to-home and vehicle-to-grid capabilities.	Short Term	3.C
EESL		
Support private ESCOs in developing viable business plans, accessing financing, and implementing energy-efficient projects in the public sector.	Short Term	1.A
ESCOs		
Work with other stakeholders to develop an energy-water nexus framework for agriculture.	Short Term	2.P
Ministry of Agriculture & Farmer's Welfare		
Work with other stakeholders to develop an energy-water nexus framework for the agriculture sector.	Short Term	2.P
Ministry of Finance		
Coordinate with BEE and the Ministry of New and Renewable Energy to restructure eligibility for infrastructure bonds by requiring an energy efficiency audit.	Short Term	1.G
With support from the Ministry of Science and Technology, establish a tax credit to reward businesses that conduct energy productivity RDD&D.	Short Term	1.H
Maintain a low taxation rate on EVs until cost parity with conventional vehicles is reached.	Short Term	2.H
Ministry of Heavy Industry & Public Enterprises		
Maintain the current FAME incentives until EVs hit cost parity with conventional vehicles.	Short Term	2.H
Ministry of Jal Shakti		
Explore implications of the energy-water nexus and integrate energy productivity into any long-term strategic plan for managing water.	Long Term	2.M
Develop a nationwide policy to mandate the reuse of treated water.	Short Term	2.N
Work with other stakeholders to develop an energy-water nexus framework for agriculture (with the Ministry of Power and Ministry of Agriculture).	Short Term	2.O
Ministry of Micro, Small, and Medium Enterprises		
Collaborate with agencies hosting entrepreneurship and financing programs to design a coordinated strategy to support efficiency efforts.	Short Term	4.B

Ministry of New and Renewable Energy		
Coordinate with BEE and the Ministry of Finance to restructure eligibility for infrastructure bonds by requiring an energy efficiency audit.	Short Term	1.H
Develop a joint initiative with the Ministry of Power that enables aggregation of the demand of distributed renewables used by domestic consumers.	Short Term	3.A
Ministry of Power		
Provide guidance for special purpose vehicles to enlist the private sector to help cities with their climate plans (with the Ministry of Housing and Urban Affairs).	Short Term	1.N
Include mandatory provisions for EV-ready charging spaces in new construction in the next versions of the commercial and residential ECBC (with BEE).	Short Term	2.I
Work with other stakeholders to develop an energy-water nexus framework for agriculture.	Short Term	2.P
Share lessons learned about advanced metering infrastructure with power utilities and CERC to show the value of digital infrastructure.	Short Term	2.T
Develop a joint initiative with the Ministry of New and Renewable Energy that enables aggregation of the demand of distributed renewables used by domestic consumers.	Short Term	3.A
Collaborate with BEE, CERC, and SERCs to mandate that electricity consumers with DR measures and rooftop solar be subject to time-of-day tariffs for their electricity consumption.	Short Term	3.C
Strengthen the corporate average fuel consumption standards so that the 2022-23 standards match EU 2021 and index the standard to the EU level going forward.	Short Term	2.D
Set up a model mechanism for deploying metering infrastructure throughout all states, and work with EESL to train DISCOMs.	Short Term	2.X
Ministry of Road Transport and Highways		
Improve the Bharat Stage Emissions Standards and introduce caps to encourage automakers to manufacture low emission vehicles.	Short Term	2.D
Collaborate with the Ministry of Housing and Urban Affairs to invest in public transit systems and infrastructure that encourages active modes of mobility.	Long Term	2.E
Study the impact that last mile deliveries have on energy use and explore policies to help mitigate energy waste.	Short Term	2.K
Convene stakeholders to study vehicle automation and clarify a regulatory framework that ensures automated vehicles are deployed in an energy-productive fashion.	Long Term	2.L
Ministry of Science and Technology		
With support from the Ministry of Finance, establish a tax credit to reward businesses that conduct energy productivity RDD&D.	Short Term	1.H
Increase support for RDD&D related to technologies and practices proven to increase energy productivity.	Long Term	1.I
Collaborate with BEE and other relevant ministries, state-level entities, and research institutes to create a race-to-the-top style energy productivity competition for states and communities.	Short Term	1.K
Ministry of Skill Development and Entrepreneurship		
Mainstream an energy efficiency job training curriculum within the Skill India Programme.	Short Term	4.D
Ministry of Housing and Urban Affairs		
Provide guidance for special purpose vehicles to enlist the private sector to help cities with their climate plans (with the Ministry of Power).	Short Term	1.N
Work with the Department of Central Public Works to create comprehensive plans for mapping and meeting charging infrastructure needs.	Short Term	2.G
Collaborate with the Ministry of Road Transport and Highways to invest in public transit systems and infrastructure that encourages active modes of mobility.	Long Term	2.E
Study the potential effects of ridesharing and ride hailing on energy use and develop policy pathways to help mitigate energy waste.	Short Term	2.I
Encourage mixed-use development that includes public transit and build affordable housing near jobs and amenities.	Long Term	2.F
National Productivity Council		
Collaborate with NITI Aayog to develop and disseminate guidelines for energy management at water and wastewater utilities.	Short Term	2.R

NITI Aayog		
Collaborate with the National Productivity Council to develop and disseminate guidelines for energy management at water and wastewater utilities.	Short Term	2.Q
Work with state agencies to develop an M&V framework for tracking and reporting energy-water savings and train Urban Local Bodies to use the framework.	Short Term	2.R
Collaborate with BEE to develop guidance for energy management at data centers.	Short Term	2.U
Small Industries Development Bank of India		
Work with multilateral development banks to scale up the Partial Risk Sharing Facility for Energy Efficiency (PRSF) and develop a more extensive pipeline of energy efficiency/ESCO projects.	Short Term	1.F
State Energy Regulatory Commissions		
Partner with DISCOMs to establish peak demand reduction goals, develop DSM programs to meet those goals, and incentivize participation for high-energy consuming customers.	Short Term	2.X
State Governments		
Expedite EV charging infrastructure permitting.	Short Term	2.H
Work with other stakeholders to develop an energy-water nexus framework for agriculture and incentivize DISCOMs to implement the AgDSM program.	Short Term	2.P

Annex 1

New Policies Scenario: Benefits of Doubling India's Energy Productivity (Detail)

Figure A-1.1 shows the expected energy savings under the NPS across the four sectors. The greatest energy savings will occur in Industry—particularly the power generation subsector—and will amount to around 2057 TWh savings by 2040. The power sector will see a significant uptake of renewables (+350% growth from today) and the bulk of energy savings will arise from the efficiency improvements in the switch from coal-based to lower carbon forms of power generation. Energy consumption across India's end-use activities is expected to increase under the NPS by around 3.3% per year on average until 2040. This represents a doubling of overall consumption. While the largest energy savings are expected to come from the power generation subsector, agriculture, buildings, and transportation will also offer energy savings, particularly from implementation of energy efficiency measures and electrification. [128]

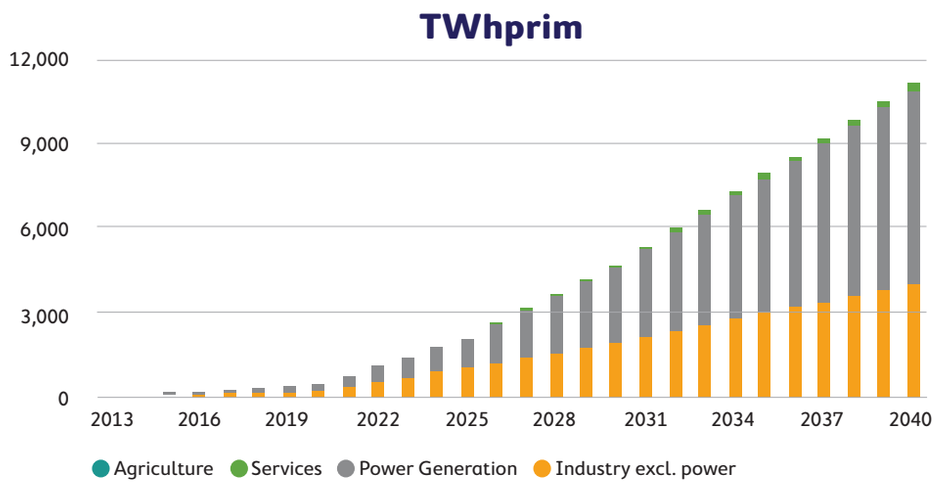

Figure A-1.1: Sectoral energy savings, NPS

128 This is due to a combination of reasons, including the relatively smaller absolute primary energy consumption of other sectors compared to the power generation subsector. In addition, the analysis focuses on primary energy consumption, so efficiency savings on secondary electricity in the end-use sectors is accounted for in the Power Generation sector.

Figure A-1.2 shows sectoral CO_2 emissions reductions, which follow the same trend as the expected energy savings: Most of the reductions result from the Industry sector. Emission reduction benefits from the power generation sector are such that the volume by 2040 is over 90 times that of the Services sector (the sector with the second highest emission reduction benefits). Outside of power generation, scenario data indicate that industry emission reductions will be generated from fuel switching and a shift in production processes.

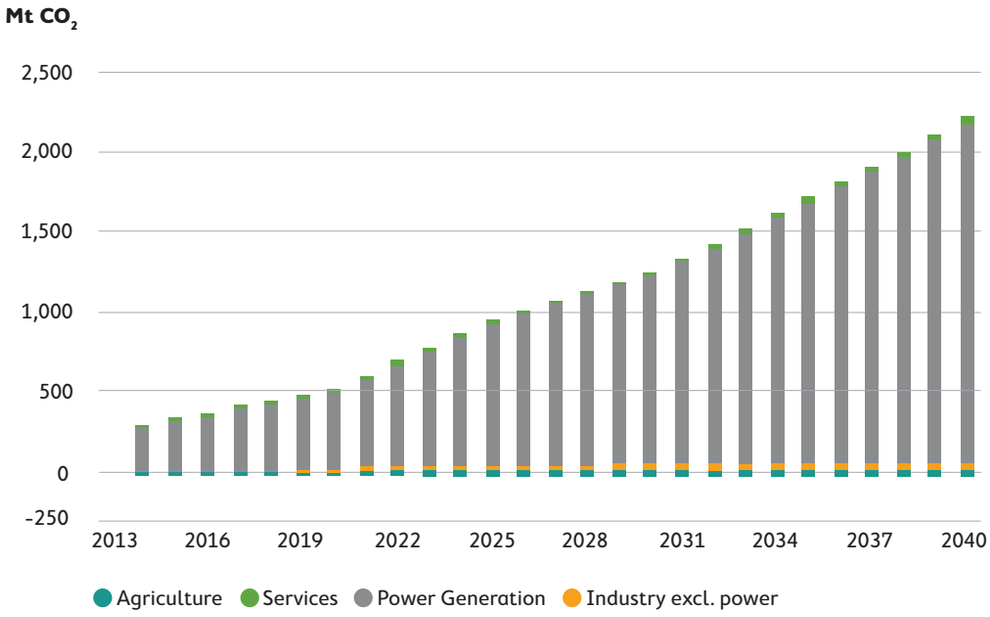

Figure A-1.2. Sectoral CO2 emissions reductions, NPS

Figure A-1.3 illustrates the market shift toward jobs in renewable energy under the NPS, accounting for more than 30% of total energy supply jobs in 2040 (up from 15% in 2014).

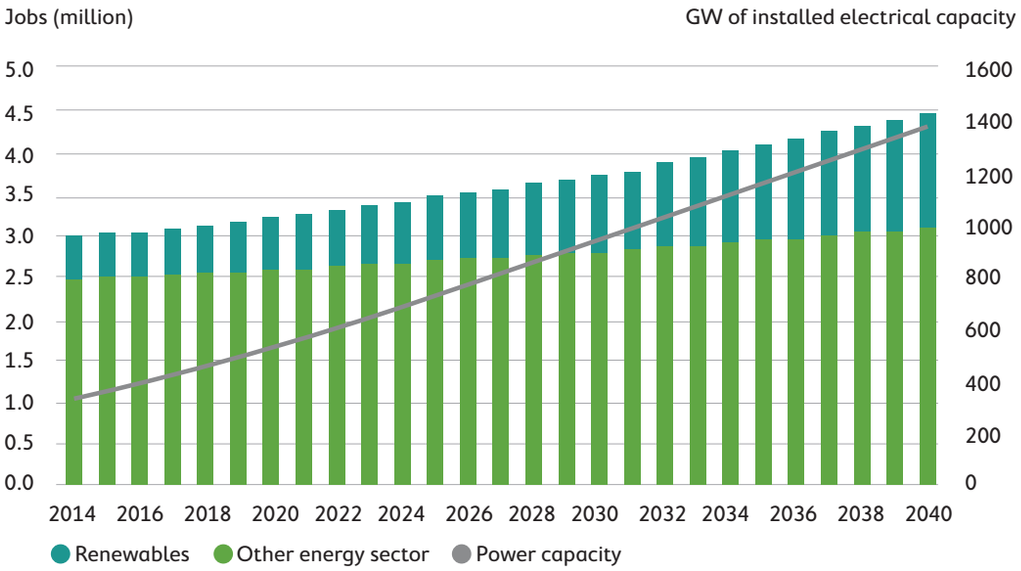

Figure A-1.3: Direct jobs in the energy supply sector, NPS

Annex 2
New Policy Scenario (NPS) Assumptions

The NPS assumes the implementation of energy policies that had been adopted as of mid-2015, the energy-related components of India's INDC, and policies that the Government of India had announced as of mid-2015 but had yet to be implemented. The specific policy drivers, technological developments, and economic conditions are:

Overall economy

- The Indian economy grows to more than five times its current size by 2040 (average yearly GDP growth of +7.5% until 2020, down to +5.3% until 2040), mainly driven by population growth, making it the most populous country in the world, and strong trends toward urbanization.
- Cross-cutting domestic policies considered in the NPS include the National Missions on solar energy and enhanced energy efficiency from the 2008 National Action Plan on Climate Change and wind power targets. In addition, a continued levy on domestic and imported coal is assumed to support the national Clean Energy Fund.

Energy demand and supply

- Energy consumption more than doubles by 2040, with the associated increase in coal use in coal use making India by far the largest source of growth in global coal demand. Coal retains a central position in the country's primary energy mix in this scenario, increasing its overall share to 49% in 2040 (from 44% in 2013) – contrary to global trends where this share is expected to decrease. All fossil fuel sources taken together represent 81% of primary energy in 2040. Strong growth is observed in the deployment of modern renewables technologies, led by solar and wind power, but it does not compensate for the drop in the proportion of solid biomass used mostly in cooking (from 24% to 11%) and hydropower (from 2% to 1%).
- National policies regarding energy supply taken into consideration to shape the NPS include measures to increase fossil fuel supply (mainly coal) with the aim to limit import dependence and a larger encouragement of private investment in energy supply, notably by facilitating the licensing procedures. The NPS also accounts for pushes in environmental clearances and land allocation for large energy projects.

Power sector

- With an increase in electricity demand of 4.9% per year, the power sector will play a pivotable role in the future Indian energy system. Installed power capacity develops from below 300 GW today to over 1,000 GW in 2040, with renewables and nuclear sources accounting for more than 50% of new capacity brought online. In 2040, coal still represents two-thirds of electricity generation (from nearly 80%), assuming plant efficiency improvements from 34% to 38%. Variable renewables (mostly wind and solar) and nuclear represent 9% and 7% of generation, respectively.

Industry

- Industry remains the largest end-use energy consumer (with 50% of final consumption by 2040), based on a strong domestic demand for energy intensive materials for infrastructure (steel and cement) and consumer goods (chemicals, textiles, and transport equipment).
- The NPS includes the aim of the "Make in India" initiative launched in 2014 by the Government of India to increase the share of manufacturing in GDP. It also includes energy efficiency measures according to the Perform, Achieve, and Trade (PAT) Scheme, as well as support for energy audits and new financing mechanisms for energy efficiency improvements.

Services

- Energy used in the buildings sector will be dramatically changed under the influence of population growth, urbanization, growth in access to modern energy, and the impact of rising incomes on the ownership of appliances. Electricity and oil represent more than 60% of energy use in the sector (with 45% and 16% respectively) in 2040. Transport shows the fastest growth of energy consumption, both for freight and for personal mobility, and is expected to still be largely dominated by diesel and gasoline.
- For the buildings sector, the NPS includes further urbanization in line with the "100 Smart Cities" concept as well as a a shift from voluntary to mandatory appliance standards and the application to a wider range of appliances. In addition, the NPS assumes the extension of the building code and efforts to incorporate it into local and municipal laws. The scenario also assumes subsidies for LPG, which constitutes an alternative to solid biomass as cooking fuel.
- For the transport sector, the NPS assumes fuel efficiency standards for new cars and light trucks from 2016 onwards, policy support for biofuels via blending mandates and natural gas, and hybrid and electric vehicles. In addition, the scenario assumes dedicated rail corridors to encourage a move away from road freight.

Agriculture

- In this projection, energy consumption in agriculture nearly doubles by 2040, with electricity accounting for 68% of the 2040 share and oil products (overwhelmingly diesel) a further 30%. Additionally, the NPS assumes that the average efficiency of electric pumps is improved by around 25% and large-scale adoption of drip irrigation techniques leads to efficiency gains for irrigation. By 2040, electricity covers close to 90% of energy use for irrigation needs, with a large share of demand being met by solar-powered pumps.
- The NPS assumes a shift toward metered electricity in the agricultural sector as well as continued gradual reforms to energy pricing, promotion of micro-irrigation, groundwater management, and crop diversification.

Annex 3
Developing Sectoral Energy Productivity – Analytical Process and Data Gaps

Consistently monitoring the energy productivity of India's major sectors will help benchmark progress. To support future efforts on benchmarking sectoral energy productivity, below are details on the NPS analysis and gaps in data that would be helpful to fill.

Data

India's primary energy consumption and economic output data were collected from the Ministry of Statistics, Planning, and Implementation (MOPSI) and the Reserve Bank of India (RBI). GDP was provided in Indian rupees (2011) by RBI and converted to 2017 USD equivalent. RBI's sectoral definitions were used to define sector activities.

Approach

India's national energy productivity was calculated by dividing India's nominal GDP by aggregated sectoral primary energy consumed. The value of standalone national primary energy consumption data is different from the aggregated sectoral data. For sectoral primary energy consumption, fuel consumption data for relevant activities were used and appropriate conversion factors from MoSPI Energy Yearbooks were applied. Sectoral GVA was divided by the sectoral energy consumed to calculate sectoral energy productivity. For sector calculations, GVA was used because GDP data were not available. IIEC provided data that split out the primary energy consumption of the domestic sector; however, as there is no data on economic outputs from this sector, the domestic sector data were only included in the national energy productivity calculations.

These data were used for two purposes:

- Establish the current situation and potential pathways to double India's energy productivity: India's current and historical energy productivity were determined using publicly available data. In addition, credible existing energy use scenarios with existing data sets were examined to identify two possible realistic pathways to double India's energy productivity.
- Estimate benefits of doubling energy productivity: For the two pathways identified, key energy consumption parameters such as future projected sector energy use growth and mix were calculated and applied to India's energy use data. The results were analyzed to identify estimated benefits including energy savings potential, GHG emissions reduction, and job creation.

Key Assumptions

- Sectoral definitions of Agriculture, Services and Industry are assumed to be consistent between energy consumption and economic output values.
- Because sectoral GDP data are unavailable in India, estimates were derived from RBI's GVA data.
- All taxes and duties are the same across the sectors, so the difference between national GVA and GDP also applies at sectoral level.
- Because sectoral energy data are unavailable, estimates are based on aggregated fuel consumption data of various subsectors from MOSPI.
- Mass-to-energy conversion factors such as for petroleum products were missing in the original datasets from the Indian government. Reasonable estimates were based on default values of the various individual products from the IEA.
- Consistency in the definitions of the sectors and their subsectors between energy consumption and economic output accounting is critical to ensure accurate calculation of energy productivity. It is not clear if this is the case, as energy consumption is from MOSPI and economic output is from RBI. Thus, sector and subsector breakdowns for energy consumption and economic output are unlikely to be completely consistent.

Summary of Data Gaps

- Data on sectoral energy consumption or sectoral GDP
- Mass to energy conversion factors for various fuel types
- Electricity
  - Fuel mix per source
  - Power generation efficiency per source
  - Emission intensity per source
  - Total volume
  - Transmission and distribution losses
  - End-use sector breakdown
- Buildings
  - Floor space per capita by type of dwelling
  - Renovation rate

- Energy use per energy services
- Fuel source for both renovated and new buildings
- Electrification rate for each type of energy service
- Fuel mix for direct energy use

- Transportation
  - Transport demand per capita
  - Modal split
  - Share of electrified transport activity
  - Fuel mix for non-electrified type of transport
  - Energy intensity per type of transport