

## **ENERGY DEMAND IN INDIA: SPECIAL REFERENCE TO ELECTRICITY**

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### **ABSTRACT**

Indian policy-makers are making strenuous efforts to remove obstacles to investment in energy supply, while moving ahead with complementary policies on efficiency and energy pricing that can constrain growth in consumption. India is in the midst of a profound transformation that is moving the country to centre stage in many areas of global interaction. A vibrant democracy that is home to over one-sixth of the world's population and its third-largest economy, India's modernization has been gathering speed and new policies have been introduced to unleash further growth. The increasing demand for energy specially electricity is the centre of problems before the policy makers of the Indian economy. The key indicator for the rapidly increasing demand for power has also been explained.

**Keywords:** Energy demand, Energy supply, Electricity, Urbanization, Bioenergy, Purchasing power parity (PPP)

### **INTRODUCTION**

India is in the midst of a profound transformation that is moving the country to centre stage in many areas of global interaction. A vibrant democracy that is home to over one-sixth of the world's population and its third-largest economy, India's modernisation has been gathering speed and new policies have been introduced to unleash further growth. The opportunities are huge, but so is the size of the remaining challenges: although incomes and corresponding standards of living are on the rise, India is still home to a third of the world's poor and gross domestic product (GDP) per capita is well below the international average.

India's energy sector has grown tremendously in recent years. Further economic and population growth, allied to structural trends such as urbanisation and the nature of the envisioned industrialisation, point unmistakably to a trend of continued rapid expansion in demand for energy. Recognising this challenge, Indian policy-makers are making strenuous efforts to remove obstacles to investment in energy supply, while moving ahead with complementary policies on efficiency and energy pricing that can constrain growth in consumption. The analysis and

findings in this special focus on India disclose these multiple pressures and show how policies can affect the evolution of the Indian energy sector so as to realise the huge benefits that a well-managed expansion of energy provision will bring. No effort is made here to prescribe a path for India; our intention is, rather, to provide a coherent framework to contribute to the policy choices that India itself will make, drawing out the possible implications of these choices for India’s development, energy security and environment, as well as for the global energy system.

**KEY ENERGY TRENDS IN INDIA**

*Demand*

India has been responsible for almost 10% of the increase in global energy demand since 2000. Its energy demand in this period has almost doubled, pushing the country’s share in global demand up to 5.7% in 2013 from 4.4% at the beginning of the century. While impressive, this proportion is still well below India’s near 18% current share of global population, a strong indicator of the potential for further growth. Expressed on a per-capita basis, energy demand in India has grown by a more modest 46% since 2000 and remains only around one-third of the world average, slightly lower than the average for the African continent. One reason is that a significant part of the Indian population remains without modern and reliable energy: despite a rapid extension of the reach of the power system in recent years, around 240 million people in India lack access to electricity.

**Table: Demand and supply pattern of Indian power sector:**

Year	Energy				Peak			
	Requirement	Availability	Surplus(+)/Deficts(-)		Peak Demand	Peak Met	Surplus(+)/ Deficts(-)	
	(MU)	(MU)	(MU)	(%)	(MW)	(MW)	(MW)	(%)
2009-10	8,30,594	7,46,644	-83,950	-10.1	1,19,166	1,04,009	-15,157	-12.7
2010-11	8,61,591	7,88,355	-73,236	-8.5	1,22,287	1,10,256	-12,031	-9.8
2011-12	9,37,199	8,57,886	-79,313	-8.5	1,30,006	1,16,191	-13,815	-10.6
2012-13	9,95,557	9,08,652	-86,905	-8.7	1,35,453	1,23,294	-12,159	-9.0

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<b>2013-14</b>	10,02,257	9,59,829	-42,428	-4.2	1,35,918	1,29,815	-6,103	-4.5
<b>2014-15</b>	10,68,923	10,30,785	-38,138	-3.6	1,48,166	1,41,160	-7,006	-4.7
<b>2015-16</b>	11,14,408	10,90,850	-23,558	-2.1	1,53,366	1,48,463	-4,903	-3.2
<b>2016-17</b>	11,42,929	11,35,334	-7,595	-0.7	1,59,542	1,56,934	-2,608	-1.6
<b>2017-18*</b>	9,15,123	9,08,650	-6,473	-0.7	1,64,066	1,60,752	-3,314	-2.0

Source: CEA.

The above table shows that the demand of electricity in India is increasing in trend and this is the root problem of our country.

The widespread differences between regions and states within India necessitate looking beyond national figures to fully understand the country's energy dynamics. This is true of all countries, but it is particularly important in India, both because of its size and heterogeneity, in terms of demographics, income levels and resource endowments, and also because of a federal structure that leaves many important responsibilities for energy with individual states. For example, figures for residential electricity consumption per capita (for those with access to electricity) show a broad range between the area with the highest levels, in Delhi – the only part of India with consumption higher than the non- OECD average – and other states. Residential electricity consumption (for those with access) remains far below the world average and is ten-times lower than OECD levels. Average residential consumption in Bihar, at around 50 kilowatt-hours (kWh) per capita per year, is consistent with an average household use of a fan, a mobile telephone and two compact fluorescent light bulbs for less than five hours per day.

Energy demand has almost doubled since 2000, but this is slower than the rate of economic growth over the same period. This is due in part to the shift away from bioenergy<sup>3</sup> consumption in the residential sector, the rising importance of the services sector in the Indian economy and increased policy efforts directed at end-use energy efficiency. As a result, it took 12% less energy to create a unit of Indian GDP (calculated on the basis of purchasing power parity [PPP]) in 2013 than was required in 1990. The amount of energy required to generate a unit of GDP (PPP basis) in India is slightly lower than the global average. Even so, much energy is lost or used inefficiently, notably in the power sector because of the generation technologies used, the poor state of the transmission and distribution infrastructure and the relatively low efficiency of

end-use equipment. Significant untapped energy efficiency potential remains across the entire energy system, which could help temper the further growth in energy consumption.

Almost three-quarters of Indian energy demand is met by fossil fuels, a share that has increased since 2000 because of a rapid rise in coal consumption and a decreasing role for bioenergy, as households move away from the traditional use of solid biomass for cooking. Coal now accounts for 44% of the primary energy mix (compared with under a third globally) – mainly because of the expansion of the coal-fired power generation fleet, although increased use of coking coal in India's steel industry has also played a part. The availability and affordability of coal relative to other fossil fuels has contributed to its rise, especially in the power sector. Demand for bioenergy (consisting overwhelmingly of solid biomass, i.e. fuelwood, straw, charcoal or dung) has grown in absolute terms, but its share in the primary energy mix has declined by almost ten percentage points since 2000, as households moved to other fuels for cooking, notably liquefied petroleum gas (LPG).

Oil consumption in 2014 stood at 3.8 million barrels per day (mb/d), 40% of which is used in the transportation sector. Demand for diesel has been particularly strong, now accounting for some 70% of road transport fuel use. This is due to the high share of road freight traffic, which tends to be diesel-powered, in the total transport use and also to government subsidies that kept the price of diesel relatively low (this diesel subsidy was removed at the end of 2014; gasoline prices were deregulated in 2010). LPG use has increased rapidly since 2000, reaching over 0.5 mb/d in 2013 (LPG is second only to diesel among the oil products, pushing gasoline down into an unusually low third place). The rise in LPG consumption also reflects growing urbanisation, as well as continued subsidies. Natural gas makes up a relatively small share of the energy mix (6% in 2013 compared with 21% globally). It is used mainly for power generation and as a feedstock and fuel for the production of fertilisers, although it also has a small, but growing role in the residential sector and as a transportation fuel. Hydropower, nuclear and modern renewables (solar, wind and geothermal) are used predominantly in the power sector but play a relatively small role in the total energy mix.

Energy demand had traditionally been dominated by the buildings sector (which includes residential and services) although demand in industry has grown more rapidly since 2000, overtaking buildings as the main energy user in 2013. In the buildings sector, a key driver of consumption in both rural and urban areas has been rising levels of appliance ownership, especially of fans and televisions, and an increase in refrigerators and airconditioners in urban areas over the latter part of the 2000s. As a result, electricity demand in the buildings sector grew at an average rate of 8% per year over 2000-2013. The share of bioenergy in the buildings sector (mostly the traditional use of biomass for cooking and heating) has declined from 75% of the

sector's total consumption in 2000 to two-thirds in 2013, as electricity and oil products have gained ground.

### **ENERGY DEMAND BY FUEL IN SELECTED END-USE SECTORS IN INDIA**

Industrial energy demand has almost doubled over the 2000-2013 period, with strong growth from coal and electricity. Large expansion in the energy-intensive sectors, including a tripling in steel production, is one component. Nonetheless, consumption levels of cement and steel are still relatively low for a country of India's size and income levels: consumption of cement is around 220 kilograms (kg) per capita, well behind the levels seen in other fast-growing economies and a long way behind the elevated levels seen in China in recent years (up to 1 770 kg per capita). The agricultural sector, though a small part of energy demand, is a key source of employment and since 2000 has accounted for roughly 15% of the increase in total final electricity demand as more farmers obtained electric pumps for irrigation purposes.

Over 90% of energy demand in the transport sector in India is from road transport. The country's passenger light-duty vehicle (PLDVs) stock has increased by an average of 19% per year since 2000, rising to an estimated 22.5 million in 2013, with an additional 95 million motorbikes and scooters (two/three-wheelers). Yet ownership levels per capita are still very low compared with other emerging economies and well below ownership levels of developed countries. Poor road infrastructure is a major constraint to broader vehicle ownership; according to the World Bank, one-third of the rural population lacks access to an all-weather road, making car ownership impractical – even in cases where it is affordable (World Bank, 2014).

#### ***Electricity***

The provision of electricity is critical to India's energy and economic outlook and is a major area of uncertainty for the future. The country's electricity demand in 2013 was 897 terawatt-hours (TWh)<sup>4</sup>, up from 376 TWh in 2000, having risen over this period at an average annual rate of 6.9%. Electricity now constitutes some 15% of final energy consumption, an increase of around four percentage points since 2000. As with all other demand sectors, further rapid growth is to be expected: around one-sixth of the world's population in India consumes about one-twentieth of global power output. With continued economic expansion, expanding access to electricity, urbanisation, an ever-larger stock of electrical appliances and a rising share of electricity in final consumption, pressures on the power system will persist and increase.

The situation varies from state to state, but higher tariffs paid by commercial and industrial consumers are typically not enough to offset the losses arising from subsidies to residential and agricultural consumers, despite efforts to raise retail rates in recent years (see section on energy prices below). The consequent financial problems faced by local distribution companies are often

exacerbated by shortfalls in subsidy compensation payments due from state governments and by poor metering and inefficient billing and collection, creating a spiral of poor performance, inadequate investment, high transmission and distribution losses and regular power outages. This is a key structural weakness for the energy sector as a whole.

On the supply side, India has some 290 gigawatts<sup>5</sup> (GW) of power generation capacity, of which coal (60%) makes up by far the largest share, followed by hydropower (15%) and natural gas (8%). The mix has become gradually more diverse: since 2000, almost 40% of the change in installed capacity was non-coal. This is reflected also in the figures for generation, which show how renewables are playing an increasingly important role. But, despite the increase in generation, India faces a structural shortage of power. For residential consumers, this constraint is most evident during periods of peak demand, typically in the early evenings as demand for lighting, cooling and other appliances surges (with the result that, where they can afford it, households often invest in small diesel generators or batteries and inverters<sup>6</sup> as back-up).

### **POWER FLUCTUATIONS, FROM STATE TO STATE**

The provision of electricity is a shared responsibility between the central and state authorities in India: states have significant freedom to set electricity prices, the average subsidy level and the beneficiaries of the cross-subsidisation. In practice, there are large differences in circumstances between the various states and a wide range of performance across various indicators, such as progress towards universal access, success in reducing losses from theft, non-billing and non-payment, and electricity losses in transmission and distribution (for which six states registered total losses of less than 15% of available supply in 2012-2013, while four had losses greater than 40% [CEA, 2014a]). Steps to narrow or even to close the gap between end-user tariffs and the cost of supply also vary widely.

Part of the explanation is related to variations in income levels and population density, with low-income, densely-inhabited states tending to perform worse than average. States also differ in their resource endowments, both fossil fuel and renewables, as well as in their geographical proximity to coal mining areas and ports. All of these factors have a significant impact on how the local electricity sector is structured and performs. But policy formulation and efficacy of implementation are also important variables. Research by the World Bank has measured a series of outcome-based indicators for the different states against an index that assessed the actions taken by the respective governments, regulatory commissions and utilities to implement electricity sector reforms (in line with the objectives of the 2003 Electricity Act, a milestone in India's power regulation. <sup>7</sup> Gujarat state was among the best in both policy formulation and implementation and overall there was a strong correlation between reforms and outcomes, with

states either exhibiting a high commitment to reform alongside strong performance indicators, or the reverse.

Industrial consumers are also affected by unreliable and unpredictable power supply: around half of the industrial firms in India have experienced power cuts of more than five hours each week (FICCI, 2012). Elevated end-use industrial tariffs, allied to unreliable supply, lead many industrial and commercial consumers to produce their own electricity, using back-up diesel generators or larger plants (albeit not utility-scale). Energy-intensive industries, such as steel, cement, chemicals, sugar, fertilisers and textiles are key auto-producers, with cement producers, for example, estimated to produce around 60% of the electricity that they consume. This capacity has been growing steadily and is often coal-fired, relatively inefficient compared with utility-scale generation units and under-utilised (many companies need less electricity than their captive plants can produce, but there are obstacles to feeding this excess power into the grid). The increased use of captive generators, both at household and industrial levels, often worsens local air pollution.

The solution to India's electricity dilemma is not only to raise average tariffs and add more capacity (although both will be essential over time), but also to deal with inefficiencies and bottlenecks. Although there is an overall shortage of power, utilisation rates in coal-fired plants have actually fallen considerably in recent years, down from a peak of almost 80% in 2007 to around 64% in 2014. The decline has been even more dramatic in the case of gas-fired power plants, which ran less than a fourth of the time on average in 2014 (CEA). In some instances, particularly for gas plants supplying periods of peak demand, the financial situation of the distribution companies has meant that plants are not being called upon when needed. Another reason for low load factors lies with fuel supply problems, including shortages and quality issues in the case of coal (although the situation has improved in 2015, due to efforts to fast-track the approval of mines and increase oversight of production) and lower than anticipated domestic gas production, for which comparatively expensive liquefied natural gas (LNG) has not been a substitute in most cases (though the recent decline in the price of LNG has made imports more attractive).

The situation is not helped by the low efficiency generation technologies that prevail across much of India's existing fleet (meaning that more fuel is required to generate a unit of power). Over 85% of India's coal plants use subcritical generation technology, and the average efficiency of India's coal-fired fleet is just under 35%, below that of China or the United States. Poor coal quality (high ash content) and the relatively high ambient temperatures in India also play a role in lower efficiency levels. In some cases, generation has also run below capacity due to a lack of available transmission capacity. The creation of a national grid (the five regional grids were interconnected by end-2013) and continued progress in inter-state and inter-regional links has

been and remains critical, given that resources and capacity for power generation are often not located close to the main centres of demand. Despite steps to encourage investment, including private investment, in transmission projects, expansion of the network has generally lagged behind that of generation; projects face numerous obstacles, notably over clearances. In 2011, the Central Electricity Authority (CEA) estimated that over 120 transmission projects were held up because the developer was unable to secure the necessary land and rights-of-way.

## **CONCLUSION**

India has made great strides in improving access to modern energy in recent years. Since 2000, India has more than halved the number of people without access to electricity and doubled rural electrification rates. The population without access is concentrated in a relatively small number of states: almost two-thirds are in two populous northern and north-eastern states, Uttar Pradesh and Bihar. In large swathes of India, including the majority of southern states, electrification rates are already well above 90%. Of the total without access, the large majority – some 220 million people – live in rural areas where extending access is a greater technical and economic challenge. In urban areas, electrification rates are much higher, but the quality of service remains very uneven, especially in India's large peri-urban<sup>9</sup> slum areas that are home to around 8.8 million households.

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