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An Analysis of Power Supply and Demand in India during 2011-2021

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ABSTRACT

Power sector plays an important role in overall development of an economy as well individuals. Over the past few decades, there has been concerted efforts by the policymakers and the governments to improve the power consumption in India. In the period from 2011-2021, there has been continuous decline in power deficit in the country, led by improvement in energy intensity, reduction in transmission and distribution losses and growth in contribution from renewable sources. In this paper, I have shown the trends in power requirements and availability in India and how these two things are growing over the last decade. I have also shown the trends in power deficit and tried to analyse the factors that have led to near convergence in demand-supply of power in India.

Keywords: Power consumption, Energy Intensity, renewable sources, Convergence

INTRODUCTION

With India poised for rapid industrialization and urbanization over the next three decades, the country's power demand is expected to rise. The power generation situation has seen improvements in recent years. In June 2017, the Minister of Power announced that India had achieved power surplus status, with no shortages of electricity or coal. Currently, a significant portion of India's energy production comes from thermal sources. However, in line with its commitment to the Paris Agreement on climate change, there has been a concerted effort to increase the country's renewable energy generation capacity. The affordability and cleanliness of solar and wind power have played a pivotal role in this shift.

India's power sector has undergone a remarkable transformation with the goal of providing reliable, affordable, and sustainable energy to its citizens. Over the past decade, there have been substantial advancements in increasing power generation capacity, expanding access to electricity, promoting renewable energy, and implementing innovative policies. India has added over 175 GW of generation capacity in the last nine years, transitioning from a power-deficient nation to a power surplus one. The country's commitment to renewable energy has been a driving force behind this achievement.

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India's substantial growth in solar and wind energy capacity has solidified its position as a global leader in adopting renewable energy. Currently, India ranks fourth globally in Renewable Energy Installed Capacity, with non-fossil energy sources accounting for nearly 43% of its total installed electricity capacity. India's dedication to power generation and universal electrification has been a driving force behind its transformation.

The Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA) initiative is a shining example of success, achieving universal household electrification, covering every village and district in the country. This ambitious program has provided electricity connections to 2.86 crore unelectrified households since September 25, 2017, in both rural and urban areas. The International Energy Agency (IEA) has recognized this as the fastest expansion of access to electricity anywhere in the world. Power availability has significantly increased in both rural
and urban areas, with rural areas going from around 12 hours per day in 2014 to 22.5 hours per day presently and urban areas enjoying nearly 24 hours of power availability.

To enhance the quality and reliability of power supply in rural areas, the Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) was launched in 2014. The DDUGJY program achieved 100% village electrification on April 28, 2018, by electrifying 18,374 previously unelectrified villages, strengthening the distribution network, and ensuring electricity reaches every corner of rural India.

Government efforts to promote energy efficiency have also yielded significant results. Under the Unnat Jyoti by Affordable LEDs for All (UJALA) scheme, the cost of LED bulbs decreased by nearly 90% between 2014 and 2019, from Rs. 310 to Rs. 39.90. So far, over 36.86 crore LED bulbs have been distributed under this scheme. This initiative not only reduced electricity costs for households but also encouraged domestic manufacturing of LED bulbs, supporting the "Make in India" campaign. As a result, India has witnessed widespread adoption of energy-efficient lighting solutions, contributing to reduced energy consumption and a more environmentally friendly outlook.

To enhance power distribution efficiency, the government has implemented initiatives like the Restructured Distribution Sector Scheme (RDSS). The RDSS has significantly reduced distribution losses of DISCOMs, from 21.5% in FY 2020-21 to 16.5% in FY 2021-22. These initiatives focus on reducing technical and commercial losses, improving metering and billing systems, and promoting energy efficiency. The integration of smart grids, advanced metering infrastructure, and demand response mechanisms has enhanced grid stability and allowed consumers to actively manage their energy consumption.

Despite these achievements, the power sector still faces various challenges. Access to power and the quality of supplied electricity remain suboptimal and India experienced power deficits of 0.5% and peak deficits of 4% in the year 2022-23.

LITERATURE REVIEW

A large pool of literatures is available related to the power sector. In this study, I have mainly reviewed some of the studies that have emphasised on the importance of electricity consumption.

Bose & Shukla (1999) have estimated elasticities of electricity demand in India. They have shown that changes in income affects electricity consumption and agricultural electricity consumers most affected by the higher tariff rates.

Rao (2013) in his paper found that access to electricity increases the earnings of non-farm entities and better electricity supply (till 16 hours of supply) leads to higher income.

The direction of causation between energy consumption and economic growth has significant implications. If, for example, there exists unidirectional causality running from economic growth to energy consumption, it may be implied that energy conservation policies may be implemented with little adverse or no effects on economic growth. On the other hand, if unidirectional causality runs from energy consumption to income, reducing energy consumption could lead to fall in income. The finding of no causality in either direction, the so-called 'neutrality-hypothesis', would imply that energy conservation policies do not affect economic growth (Asafu-Adjaye, 2000).

Paul & Bhattacharya (2004) and Sahu (2008) are of the view that energy consumption has been universally recognized as one of the most important inputs for economic growth and human development. There is a strong two-way relationship between economic development and energy consumption. On one hand, growth of an economy, with its global competitiveness, rely on the availability of cost-effective and environment friendly energy sources and on the other hand, the level of economic development has been observed to be depended on the energy demand.

DATA & ANALYSIS

Trends in power requirements and availability

Power requirements (demand) in India has shown rising trends since 2011-12. It rose to 129101 crore units in 2019-20 from 93720 crore units in 2011-12 (increased by 37.75%). Average growth rate of power requirement during the period 2011-12 to 2020-21 was 3.52 per cent per year. With lockdowns and restrictions on economic activities with the outbreak of Covid-19, demand for power declined by 1.2 per cent in 2020-21 when compared with 2019-20 level. Similarly, the power availability (supply) in India kept on rising from its 2011-12 level with average growth rate of 4.49 per cent per year during 2011-12 to 2020-21. Same as power demand, supply also

declined in 2020-21 by 1.07 per cent in comparison to 2019-20 level mainly due to Covid-19 related hurdles. Table 1 below shows all the above-mentioned trends.

Table 1

Power requirements and availability in India during 2011-2021				
Year	Requirements (in crore units)	Growth rate (in per cent)	Availability (in crore units)	Growth rate (in per cent)
2011-12	93720	-	85789	-
2012-13	99811	6.50	91121	6.22
2013-14	100226	0.42	95983	5.34
2014-15	106892	6.65	103079	7.39
2015-16	111441	4.26	109085	5.83
2016-17	114293	2.56	113533	4.08
2017-18	119215	4.31	120470	6.11
2018-19	127456	6.91	126753	5.22
2019-20	129101	1.29	128444	1.33
2020-21	127553	-1.20	127066	-1.07

Source: RBI's Handbook of Statistics on Indian States

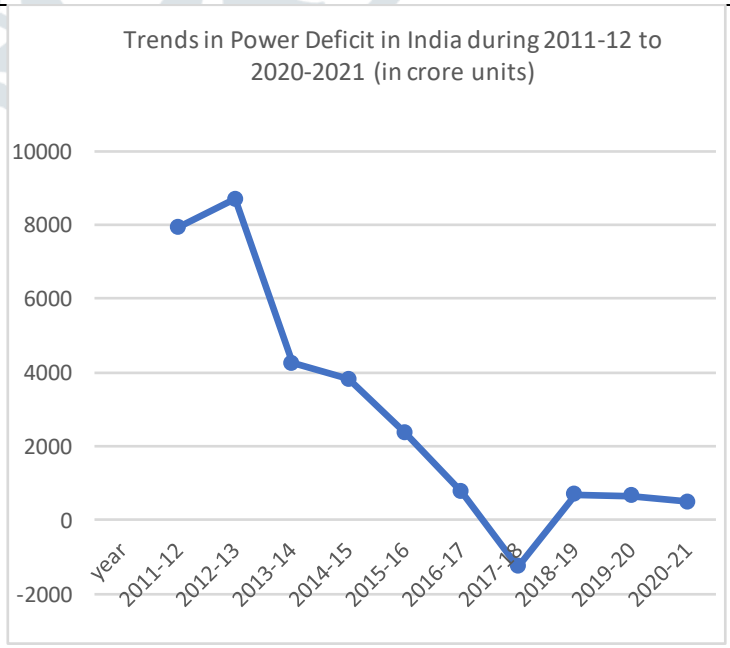
Deficit and Deficit Rate

Power deficit in India (requirements - availability) has been declining since 2012-13. During the period 2011-12 to 2020-21, the deficit was at highest level (8690 crore units) in 2012-13. But since then, there has been a consistent decline in deficit and it fell down to less than 1000 crore units since 2016-17 and there was a surplus of 1255 crore units in 2017-18. Deficit rate which measures the proportion of power requirement that remains unfulfilled, has also declined over the decade. The deficit rate was 8.71% in 2012-13 and fell to 0.38% in 2020=21. The decline in deficit rate and deficit (in crore units) can be seen in table 2 and figure 1 below respectively.

Table 2

Year	Deficit@ (in crore units)	Deficit rate# (in per cent)
2011-12	7931	8.46
2012-13	8690	8.71
2013-14	4243	4.23
2014-15	3813	3.57
2015-16	2356	2.11
2016-17	760	0.66
2017-18	-1255	-1.05
2018-19	703	0.55
2019-20	657	0.51
2020-21	487	0.38

Figure 1

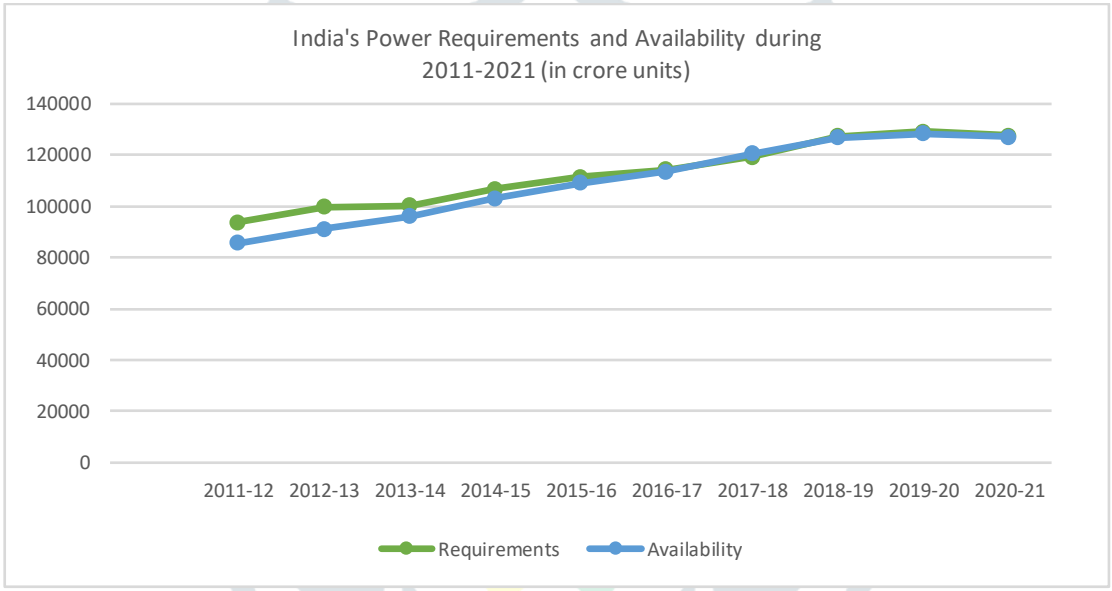


@Deficit = requirements – availability and Surplus (-)/ Deficit (+) #Deficit rate = Deficit/Requirements*(100) Source: Compiled from RBI's Handbook of Statistics on Indian States 2021-22	Source: Compiled from RBI's Handbook of Statistics on Indian States 2021-22

Near convergence in power requirements and availability over the decade

From the Figure 2 below, we can clearly see the convergence happening between power requirements and availability in the last one decade. Both, power demand and supply has been rising over all the years except in 2020-21 (covid-19 period). But the availability of power has grown much faster to catch up with the requirements, resulting in partial convergence of the two entities.

Figure 2



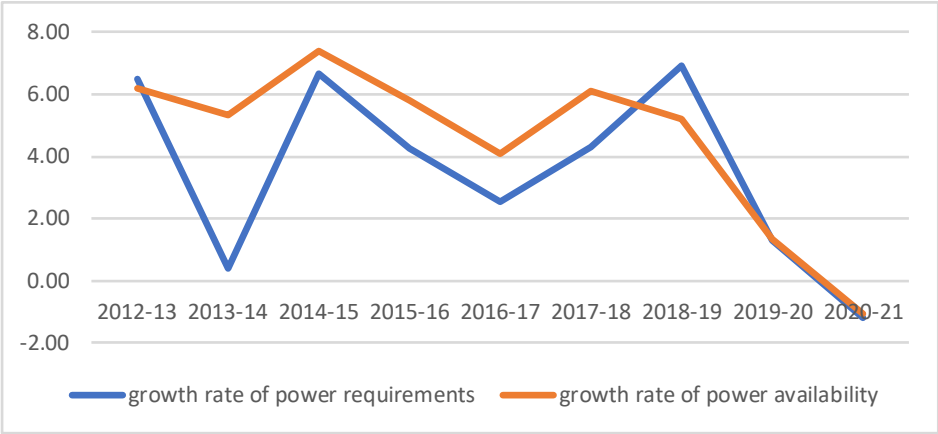
Source: RBI's Handbook of Statistics on Indian States 2021-22

Factors affecting the decline in power deficit.

Higher growth rate of power availability

The most important factor responsible for bridging the gap in power demand and supply is the higher growth rate of power supply over the decade. From figure 3 below, it can be clearly seen that growth rate of power availability has been higher than the growth rate of power requirements for most of the periods. This has resulted in the catching up of power supply with the relatively slower growing demand over the decade. Improving electricity generation from renewable sources and declining losses of electricity during transmission & distribution has improved the power availability.

Figure 3: Growth rates of power requirements and availability



Source: Computed from RBI's Handbook of Statistics on Indian States 2021-22

Role of Renewable Electricity Sources

The table 3 below shows the installed capacity of electricity generation from renewable sources (excluding hydro) in Mega Watts (MW) for various years, along with the growth rate.

Table 3

Installed Capacity of Electricity Generation from Renewable Sources (excluding hydro)				
		(in Mega Watt = 1000 x Kilo Watt)		
Year	RES from Utilities	RES from non-utilities	Total	Growth rate
2011-12	24,503	872	25,376	-
2012-13	27,542	1,124	28,666	12.97
2013-14	34,988	1,259	36,247	26.45
2014-15	38,959	1,301	40,260	11.07
2015-16	45,924	1,368	47,292	17.47
2016-17	57,244	1,433	58,677	24.08
2017-18	69,022	1,726	70,749	20.57
2018-19	77,642	3,067	80,708	14.08
2019-20	87,028	4,475	91,503	13.38
2020-21	94,434	5,694	1,00,128	9.43
				Avg.= 16,61

Source: Energy Statistics India - 2022, MoSPI, GOI

In 2011-12, the total installed capacity was 25,376 MW, with 24,503 MW coming from utilities and 872 MW from non-utilities. Over the years, there has been a consistent increase in the total installed capacity from renewable sources. By 2020-21, the total installed capacity had reached 1,00,128 MW, which is a significant growth. The growth rate, shown in the last column, indicates the percentage increase in the total installed capacity from one year to the next. For example, in 2012-13, there was a 12.97% increase compared to 2011-12. The data also shows a growing contribution from non-utilities (private or independent renewable energy projects) in addition to utilities. The capacity added by non-utilities has generally been smaller than that added by utilities, but it has been steadily increasing. This data highlights the increasing adoption of renewable energy sources in the electricity generation sector, reflecting a positive trend towards cleaner and more sustainable

energy generation. It's important for addressing environmental concerns and reducing dependence on fossil fuels. The growth rates indicate the rapid expansion of renewable energy capacity during this period.

From India becoming electricity importing to an electricity exporting country

India's Foreign Trade of Electricity, as depicted in the table 4 below, spanning from 2011-12 to 2020-21, reveals a dynamic evolution in the country's energy landscape. In the early years, notably from 2011-12 to 2015-16, India consistently operated as a net importer of electricity, with majority of its energy needs met through foreign sources.

Table 4

India's Foreign Trade of Electricity (in Gwh)			
year	Gross imports	Exports	Net Imports
2011-12	5253	135	5118
2012-13	4795	154	4641
2013-14	5598	1651	3847
2014-15	5008	4433	575
2015-16	5244	5150	94
2016-17	5617	6710	-1093
2017-18	5072	7203	-2131
2018-19	4396	8469	-4073
2019-20	6351	9491	-3140
2020-21	9547	9573	-26

Source: Energy Statistics India - 2022, MoSPI, GOI

However, a pivotal shift occurred in 2016-17 when India transformed into a net exporter, marked by a surplus of 1093 GWh. This trend continued with varying degrees until 2019-20, reflecting India's capacity not only to fulfil domestic demands but also to contribute significantly to the global energy market. The peak in net exports at -4073 GWh in 2018-19 underscores a substantial surplus in electricity production. The subsequent years saw a moderation in net exports, and in 2020-21, India experienced a minimal net import of electricity (-26 GWh), suggesting a balanced or self-sufficient energy scenario. The observed fluctuations could be attributed to diverse factors, including advancements in domestic energy production, changes in consumption patterns, and alterations in energy policies. This transition from a net importer to a net exporter indicates a maturing energy infrastructure and a potential shift towards energy independence for India on global stage.

Declining losses of electricity in transmission and distribution

The table 4 below shows data on electricity availability from utilities, losses in transmission and distribution (in Giga Watt hours), and the percentage of losses for the years 2011-12 to 2020-21. Electricity availability for supply from utilities increased steadily from 8,81,466 GWh in 2011-12 to 13,14,025 GWh in 2020-21, indicating a growing supply of electricity over the years.

Table 4

Electricity availability (from utilities) and losses in transmission & distribution in Giga Watt hour =10^6 KW hour			
	Net Electricity available for supply	Losses in transmission & distribution	Loss in per cent
2011-12	881466	208398	23.64%
2012-13	9,21,229	2,12,232	23.04%
2013-14	9,74,436	2,22,528	22.84%
2014-15	10,54,355	2,40,105	22.77%
2015-16	11,04,228	2,40,864	21.81%
2016-17	11,63,290	2,49,197	21.42%
2017-18	12,32,505	2,59,375	21.04%
2018-19	13,07,685	2,70,167	20.66%
2019-20	13,23,048	2,70,701	20.46%
2020-21	13,14,025	2,72,369	20.73%

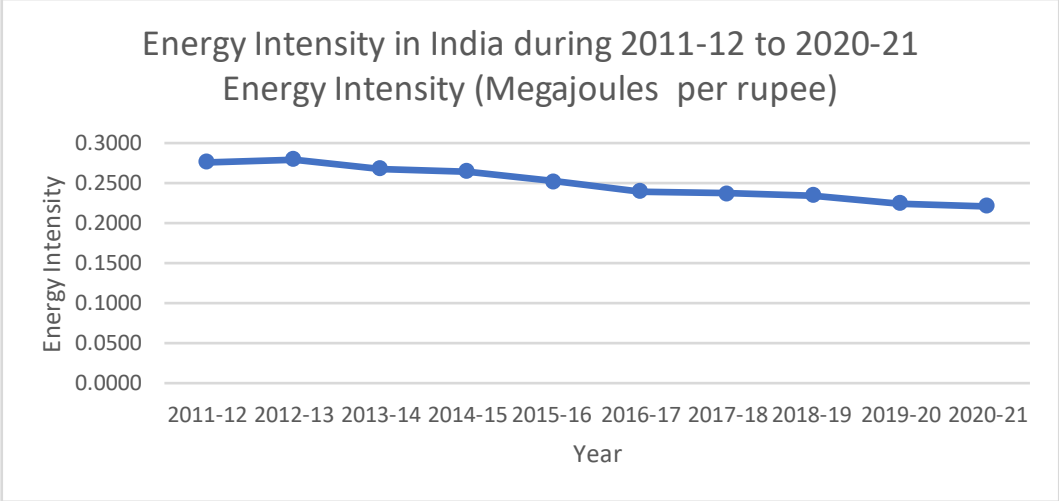
Source: Energy Statistics India - 2022, MoSPI, GOI

Losses in transmission and distribution also increased, but the percentage of losses in relation to the available electricity decreased from 23.64% in 2011-12 to 20.73% in 2020-21. This suggests that the efficiency of the transmission and distribution system improved, resulting in lower losses as a proportion of total electricity availability. The decreasing percentage of losses is a positive trend as it indicates more efficient energy management and reduced wastage in the power distribution process. This can lead to more reliable and sustainable electricity supply. In summary, the data shows an increase in available electricity supply and an improvement in the efficiency of the transmission and distribution system over the decade, leading to a reduction in losses as a percentage of the total electricity supplied

Improvement in Energy Intensity

The figure 4 displays the energy intensity in India from 2011-12 to 2020-21, measured in Megajoules per rupee. Energy intensity is a metric that indicates the amount of energy (in Megajoules) required to produce one unit of economic output (in rupees).

Figure 4



Source: Energy Statistics India - 2023, MoSPI, GOI

In 2011-12, the energy intensity was 0.2761 Megajoules per rupee. Over the years, there has been a consistent decrease in energy intensity, indicating that the country has become more energy-efficient in its economic activities. By 2020-21, the energy intensity had decreased to 0.2218 Megajoules per rupee, reflecting a significant improvement in energy efficiency over the decade. A declining trend in energy intensity is a positive sign as it indicates that the economy is using less energy to produce a given level of economic output, which can be attributed to energy-saving measures and more efficient technology adoption. In summary, the data shows a notable reduction in energy intensity in India over the ten-year period, suggesting that the country has been successful in improving its energy efficiency in economic activities.

CONCLUSION

In India, power deficit has continuously declined over the last decade (2011-12 to 2020-21). There was a deficit of 7931 crore units of electricity in 2011-12 which has come down to 487 crore units in 2020-21. All this has come through the considerable efforts that has been put in to raise the power availability in the country. Renewable Energy Sources (RES) have strengthened the supply capacity. Electricity generation capacity from RES have increased tremendously from 25376 MW in 2011-12 to 100128 MW in 2020-21, which accounts to nearly 35% of the total capacity of electricity generation. The declining losses during power transmission and distribution along with better Energy Intensity have also to some extent contributed to the reduction in demand-supply mismatch of power in the nation. There is a long way to go for the power sector in India. The problem of availability, quality, reliability and affordability of power still remains.

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