International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

# Is Having Access to Electricity Enough to Address Energy Poverty in India?

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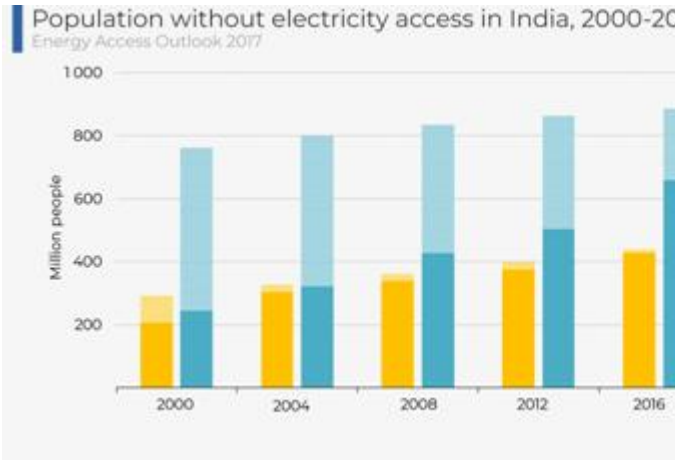
**Abstract:** ***The research paper talks about the concept of energy poverty. The different methods of its measurement and shortcoming of different approaches. It also reviews the energy poverty situation of India and discusses whether having access to electricity enough to address the issue of energy poverty in India.***

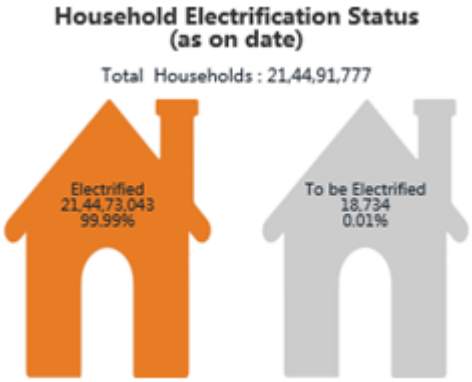
**Keywords:** Energy Poverty

## 1. Introduction

Energy poverty is the inability to access modern energy services, which include electricity, clean cooking facilities (e.g. fuels and stoves that don't contribute to air pollution in houses.) In India, the condition of energy poverty is substantial. As per available data up to 400 million people in India didn't have access to reliable electricity in 2016, which accounted for one third of the Indian population. The situation was worse in rural areas as 44.7 percent of rural population did not have access to electricity, while the figure for urban areas was 7.3 percent.




As shown in the above figure, India has access to electricity situation has improved over the years. According to statistics of the web portal (www.saubhagya.gov.in) of Pradhan Mantri Sahaj Bijli Har Ghar Yojana –'Saubhagya', launched by the Indian Prime Minister in 2017 to provide access to electricity to 100 percent of our population by March2019, India has been able to achieve access to electricity for 99.99 percent of its population as on April 2019.




But is providing only access to electricity enough to overcome the energy poverty of our country, which definitely is a hindrance to accelerated development of the country. Hence understanding the underlying reasons for energy poverty and addressing it is the need of the hour.

In simple terms, Energy poverty is having no or little access to electricity and having to heavily rely on fossil fuels like kerosene and biomass for basic daily activities like lighting or cooking. It's villagers whose children use kerosene lamps to study after dark and mother's who use briquettes made from cow dung as cooking fuel. Consequently our people are breathing in a dangerous cocktail of chemicals that is the equivalent of smoking two packs of cigarettes per day. Millions of people are dying every year from breathing in these pollutants and developing lower respiratory infections like pneumonia We canal levitate energy poverty in both rural and urban India by replacing kerosene lamps with modern solar powered lights. Even though solar power is not going to solve India's energy poverty, it's a step in the right direction and the step in getting the word out, since awareness is half the battle and it might just spark an idea that it is possible to end this. The topic we have chosen although very appropriate and relevant, but it is extremely vast and hence for the current project we are limiting our activities within literature search and analysis based on some published secondary data. In order to discuss energy poverty, we are starting with various definitions or approach towards measuring energy poverty, followed by review and analysis of available secondary data on the energy poverty situation of India. Based on the review and analysis we'll then try to propose some approaches to accelerate addressing the energy poverty situation of India.

## 2. Energy Poverty Measurements

### 2.1 Economic approach

This approach to energy poverty is associated with economic parameters. Here most commonly energy poverty is mapped to income (or expenditure) poverty. In this approach, energy poverty line is considered as the average energy consumption of the households whose consumption expenditure is at same level as income poverty line. The other two differing measures of economic approach are based on the share of household expenditure spent on energy fuels and on the effective price which is the price paid by the household per unit of energy service used. For example the average energy consumption of households falling within 10 percent range of official economic poverty line have been considered to determine energy or fuel poverty line. The poor lack of access to affordable modern energy services and so tend to use more inefficient fuel or device by spending more time and effort in availing the same and they land up paying more price per unit of useful energy. It is worthwhile to note that in 'poverty line' approach, an energy-poor lies below the cut-off, whereas in 'budget share' approach and 'effective price' approach, an energy-poor would lie above the cut-offs.

### 2.2 Shortcomings of Economic Approach

Firstly, the economic parameters on which the energy poverty measurement is based, such as income or price are continuous variables and having discrete cut-offs for identification of poor is arbitrary in the context of income poverty line. Poverty is not really a discrete condition. One does not immediately acquire or shed the afflictions we associate with the notion of poverty by crossing any particular income line. Hence, categorizing households adjacent to a cut-off on either side into two different groups, viz., energy-poor and energy-non-poor is unreasonable given the similarities of their energy use. For example, if we consider the Govt. of UK definition which identifies a household to be energy-poor when it has to spend more than 10 percent of its income on energy to heat its home to an adequate standard, categorizing two households spending a little less and a little more than the cut-off, say 9.9 percent and 10.1 percent of their income for the same purpose, as non- poor and poor, respectively, is nothing but arbitrary. Also, by exclusive relying on income would make income poverty a proxy for energy poverty and vice-versa, thereby making energy poverty measure mostly redundant.

Secondly, another important limitation of the economic approach is that the measure may not be indicative of the actual poverty situation. In the poverty line approach, lower energy consumption may be a result of use of higher efficient devices. Hence, as argued earlier, quantity of energy consumption is less meaningful. Also the larger budget share on energy may not be because of energy poverty but may be due to luxurious and wasteful consumption or larger household size. And a higher effective price per unit energy may indicate that the household's consumption is at a higher level: for instance, per unit electricity price is greater at higher consumptions labs.

### 2.3 Engineering Approach

This approach of assessing energy poverty is an approach that estimates directly the energy requirement of households based on normative basic needs of different energy services and specifications of different energy carriers (calorific value of fuels) and energy appliances (size, efficiency, etc.) used to getthoseservices.Forinstance,usingthisapproach,assumingsafe,clean, and efficient cooking with liquefied petroleum gas (LPG) or LPG-like fuel, and electricity for lighting, space comfort, food preservation, and entertainment, estimated that the basic final energy requirements was 100 watts per capita. This approach has the flexibility of finding energy thresholds for different needs in different geographical and socio-cultural settings.

### 2.4 Shortcomings of this approach

Firstly, this method is computationally intensive requiring complex and inter-related data on household dwelling units, occupants, fuels, ad appliances. In addition, the basic needs are subjective to the consumers and also can vary with season, region, and climate. Hence, these data are extremely dynamic and availability of such data always remains an issue. Also, comprehensive and expensive surveys conducted to collect such data can become obsolete with changing technologies, preferences, and practices. Secondly this approach also suffers from the limitation of cut-offs, and in this sense, is not free from arbitrariness. Also here the focus is on quantity of energy, which is not a very useful parameter as discussed earlier. Lastly the engineering approach fails to account for individual socio-economic characteristics or consumer behavior.

### 2.5 Access based Approach

It is a way of measuring energy poverty based on the household has access to desirable energy services. The IEA uses access-based approach to assess worldwide energy poverty by calculating number of people lacking access to electricity and modern cooking fuel.

### 2.6 Shortcomings of this approach

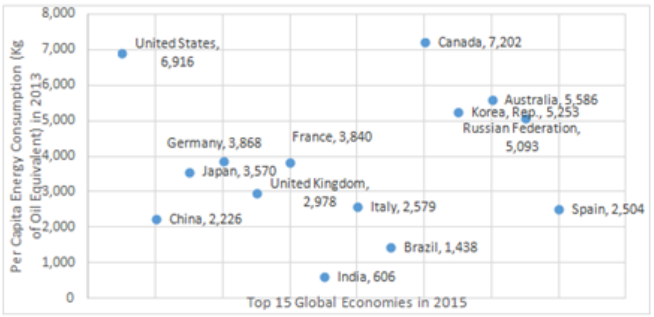
Though this approach seems like a simple one of identifying households with and without access to energy services, it has been described as a complicated method with difficulty in data finding. The reason being that the definition of access in these literature is limited to physical access. For instance, in case of households' access to electricity, data on physical coverage of electricity need to be supplemented with market prices of electricity and electrical equipment, households purchasing capacity, quality of supply. One way to overcome this is to define access in such a way that includes utilization aspect of energy services. When a household uses certain energy services, it automatically accounts for affordability and all other factors that make the use possible. In this way one overcomes the data limitation as some of these data on utilization of energy services are readily available. For example, in the Indian context, the national sample surveys data include household's primary source of energy for cooking and lighting. When a household uses modern fuel, such as LPG or electricity, as prime source of energy for

cooking, it implies not only physical access, but also, quality and reliability of supply, access to market, and affordability of households for both the fuel and device. It is important to note that energy poverty based on households' primary source for certain energy services better fits to the notion of poverty line. When a household substitutes an inefficient fuel by an efficient one as the prime energy source for certain purpose (such as from kerosene to electricity for lighting) there is a definite jump in the energy ladder. Hence, suits better to the discreteness requirement in categorizing people as poor and non-poor.

## 3. Review of Energy Poverty situation in India

Energy use per capita in India lags far behind that of other countries around the world. The acuteness of energy poverty in India is visible from the fact that among the top 15 economies based on GDP, India's per capita energy consumption was the lowest in 2015 with a per capita electricity consumption of 765 kWh which was almost one-fourth of global average. The relative situation has not changed too much even in recent time. The sharp difference between energy consumption of developing countries like India and developed countries like United States can be attributed to low levels of electrification and other forms of networked energy provision as well as low household incomes.

*Figure 1: Per capita energy consumption of top 15 economies in the world*




Source: Prepared by the author based on World Bank data

Based on the following definitions given by Lakshmmikanth Hari in his paper 'Measuring Energy Poverty: A household level analysis of India', an analysis of rural energy poverty in India can be made from the given data.

1) Energy-poor: An energy-poor is one who belongs to the household which does not use modern fuels as the prime source of energy. Among the energy-poor, those who belong to the households that are deprived of modern fuels are considered as extreme energy-poor.
2) Energy-nonpoor: Energy nonpoor is one who belongs to the household which uses modern fuels as the prime source of energy, and has no dependency on any energy inefficient fuels for any purpose whatsoever.
3) Energy-transitional: Energy-transitional is one who belongs to a house- hold which uses modern fuels as the prime source of energy, but has dependency on energy inefficient fuels for some purpose.

| States | Deprived of modern cooking fuel (%) | Deprived of modern lighting fuel (%) | Energy poor (P) (%) | Extreme energy-poor (E) (%) | Energy transitional (T) (%) | Energy nonpoor (N) (%) | Rank P | Rank E | Rank T | Rank N |
|---|---|---|---|---|---|---|---|---|---|---|
| Chhattisgarh | 98.1 | 14.0 | 98.1 | 14.0 | 1.6 | 0.4 | 1 | 12 | 35 | 34 |
| Jharkhand | 97.5 | 37.5 | 97.5 | 37.4 | 2.0 | 0.5 | 2 | 4 | 34 | 31 |
| Orissa | 96.4 | 31.7 | 96.4 | 31.7 | 2.9 | 0.7 | 3 | 6 | 32 | 28 |
| Bihar | 94.7 | 73.9 | 96.1 | 72.5 | 3.7 | 0.2 | 4 | 1 | 31 | 35 |
| Uttar Pradesh | 94.3 | 58.2 | 95.1 | 57.5 | 4.4 | 0.5 | 5 | 2 | 30 | 32 |
| Tripura | 95.0 | 15.9 | 95.0 | 15.9 | 4.5 | 0.5 | 6 | 10 | 29 | 30 |
| Lakshadweep | 94.0 | 0.0 | 94.0 | 0.0 | 5.4 | 0.6 | 7 | 32 | 26 | 29 |
| Madhya Pradesh | 93.8 | 15.8 | 93.9 | 15.7 | 5.1 | 1.0 | 8 | 11 | 28 | 27 |
| West Bengal | 93.7 | 28.7 | 93.9 | 28.6 | 5.7 | 0.5 | 9 | 7 | 25 | 33 |
| Meghalaya | 92.7 | 18.4 | 92.7 | 18.4 | 5.3 | 1.9 | 10 | 9 | 27 | 22 |
| D & N Haveli | 91.9 | 3.6 | 91.9 | 3.6 | 6.3 | 1.8 | 11 | 20 | 23 | 24 |
| Rajasthan | 91.2 | 21.2 | 91.4 | 21.0 | 6.1 | 2.5 | 12 | 8 | 24 | 20 |
| Karnataka | 85.3 | 2.8 | 85.3 | 2.8 | 12.7 | 2.0 | 13 | 24 | 19 | 21 |
| Gujarat | 84.0 | 4.3 | 84.1 | 4.2 | 9.0 | 6.8 | 14 | 19 | 21 | 15 |
| Assam | 82.4 | 42.0 | 82.8 | 41.5 | 15.3 | 1.9 | 15 | 3 | 15 | 23 |
| Haryana | 78.3 | 5.0 | 78.7 | 4.6 | 10.1 | 11.3 | 16 | 18 | 20 | 11 |
| Himachal Pradesh | 76.7 | 1.8 | 77.4 | 1.1 | 15.4 | 7.2 | 17 | 25 | 14 | 14 |
| Uttaranchal | 75.1 | 6.0 | 75.2 | 5.9 | 13.0 | 11.8 | 18 | 17 | 18 | 10 |
| Maharashtra | 74.3 | 8.8 | 74.6 | 8.5 | 21.1 | 4.3 | 19 | 16 | 12 | 19 |
| Jammu & Kashmir | 73.7 | 3.2 | 74.0 | 2.9 | 17.3 | 8.7 | 20 | 22 | 13 | 13 |
| Arunachal Pradesh | 70.5 | 33.0 | 71.4 | 32.0 | 22.4 | 6.2 | 21 | 5 | 11 | 17 |
| Punjab | 70.8 | 2.0 | 71.0 | 1.8 | 15.3 | 13.7 | 22 | 27 | 16 | 7 |
| Kerala | 69.3 | 3.9 | 69.9 | 3.4 | 28.9 | 1.2 | 23 | 21 | 8 | 26 |
| Andhra Pradesh | 67.5 | 2.1 | 67.5 | 2.1 | 25.7 | 6.8 | 24 | 26 | 9 | 16 |
| A & N Islands | 64.8 | 10.5 | 64.8 | 10.5 | 8.9 | 26.3 | 25 | 15 | 22 | 5 |
| Mizoram | 63.7 | 14.0 | 64.4 | 13.4 | 23.0 | 12.6 | 26 | 14 | 10 | 8 |
| Manipur | 63.3 | 13.6 | 63.5 | 13.4 | 32.2 | 4.3 | 27 | 13 | 6 | 18 |
| Tamil Nadu | 61.2 | 2.8 | 61.3 | 2.8 | 30.0 | 8.8 | 28 | 23 | 7 | 12 |
| Nagaland | 46.8 | 2.4 | 48.7 | 0.5 | 49.6 | 1.8 | 29 | 30 | 1 | 25 |
| Sikkim | 44.8 | 0.1 | 44.9 | 0.0 | 38.5 | 16.6 | 30 | 31 | 4 | 6 |
| Daman & Diu | 40.5 | 0.0 | 40.5 | 0.0 | 47.3 | 12.2 | 31 | 33 | 2 | 9 |
| Pondicherry | 25.1 | 2.1 | 27.2 | 0.0 | 36.6 | 36.2 | 32 | 34 | 5 | 3 |
| Goa | 25.2 | 2.2 | 25.2 | 2.2 | 47.2 | 27.6 | 33 | 25 | 3 | 4 |
| Chandigarh | 13.4 | 0.0 | 13.4 | 0.0 | 15.1 | 71.5 | 34 | 35 | 17 | 2 |
| Delhi | 9.6 | 1.2 | 9.6 | 1.2 | 2.6 | 87.8 | 35 | 28 | 33 | 1 |
| **India** | **85.8** | **28.8** | **86.2** | **28.4** | **10.7** | **3.0** | | | | |

Overall in rural India, 86.2 percent people are energy-poor that is they depend on inefficient fuels such as coal, coke, charcoal, firewood and chips, dung cake, and kerosene instead of modern sources of energy such as LPG, electricity, and biogas.

Chhattisgarh, Jharkhand, Odisha, Bihar, and Uttar Pradesh are five states with more than 95 percent of their rural population being energy poor. Not surprisingly these states also figure among the poorest states in India where over 40 per cent of people are below the poverty line, indicating that their energy poverty status can be attributed to unaffordability of modern energy sources.

Bihar has the highest proportion of extremely energy poor rural population, a whopping 72.5 percent followed by Uttar Pradesh and Jharkhand where the proportion of rural population with extreme energy poverty are 57.5 percent and 37.4 percent respectively. In contrast to this Chandigarh, Pondicherry, Sikkim, Daman and Diu, and Lakshadweep have no rural population who can be categorized as extreme energy-poor.

**Analyzing overall trends**

Trends in Consumption of Energy Sources in India

| Year | Coal # (Million Tonnes) | Lignite (Million Tonnes) | Crude Oil** MMT | Natural Gas (Billion Cubic Metres) | Electricity (GWh) |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 2007-08 | 502.82 | 34.65 | 156.10 | 39.80 | 5,01,977.00 |
| 2008-09 | 549.57 | 31.85 | 160.77 | 39.81 | 5,53,994.71 |
| 2009-10 | 585.30 | 34.41 | 186.55 | 48.34 | 6,12,644.99 |
| 2010-11 | 589.87 | 37.69 | 196.99 | 52.02 | 6,94,392.00 |
| 2011-12 | 642.64 | 41.89 | 204.12 | 60.68 | 7,85,194.00 |
| 2012-13 | 688.75 | 46.01 | 219.21 | 53.91 | 8,24,300.99 |
| 2013-14 | 724.18 | 43.90 | 222.50 | 48.99 | 8,74,208.57 |
| 2014-15 | 821.85 | 46.94 | 223.24 | 46.95 | 9,48,521.82 |
| 2015-16 | 836.73 | 42.21 | 232.86 | 47.85 | 10,01,190.68 |
| 2016-17 | 841.56 | 43.16 | 245.36 | 50.78 | 10,66,268.00 |
| **% Increase from 2007 to 2017** | **67.37** | **24.53** | **57.18** | **27.58** | **112.41** |

Trends in Availability of Energy Sources for Supply in India

| Year | Coal (Million Tonnes) | Lignite (Million Tonnes) | Crude Petroleum (Million Tonnes) | Natural Gas (Billion Cubic Metres) | Electricity (GWh) |
|---|---|---|---|---|---|
| 2007-08 | 507.68 | 33.31 | 155.79 | 39.80 | 6,89,780 |
| 2008-09 | 550.64 | 33.00 | 166.28 | 40.90 | 7,07,945 |
| 2009-10 | 620.39 | 33.73 | 192.95 | 56.65 | 7,63,519 |
| 2010-11 | 604.53 | 37.78 | 201.28 | 62.15 | 8,11,635 |
| 2011-12 | 642.64 | 42.77 | 209.82 | 60.77 | 8,81,466 |
| 2012-13 | 680.14 | 46.89 | 222.66 | 53.81 | 9,21,229 |
| 2013-14 | 724.19 | 44.64 | 227.03 | 48.40 | 9,74,436 |
| 2014-15 | 824.26 | 49.57 | 226.90 | 47.75 | 10,54,355 |
| 2015-16 | 847.58 | 45.47 | 239.79 | 48.39 | 11,04,228 |
| 2016-17 | 863.90 | 47.30 | 249.94 | 50.53 | 11,68,317 |
| % Increase from 2007 to 2016 | 70.17 | 42.03 | 60.43 | 26.95 | 69.38 |

From the above data it is evident that while consumption as well as availability of energy has increased over the 10 years from 2007 to 2017, the availability of all the primary energy sources for supply has exceeded their respective consumption demand in absolute terms. This indicates that the issue of energy poverty in India is not due to inability to meet energy demands by the households. Rather there is excess supply of energy sources which either due to lack of affordability or lack of access because of poor distribution infrastructure has been unable to reach the masses, especially in rural India where many still depend on inefficient sources of energy. This is especially true for electricity since in recent years India is facing a problem of higher supply of electricity as compared to demand as highlighted by NITI Aayog CEO Amitabh Kant. With the successful push for tapping the renewable energy, India, which once faced electricity shortage, now has too much of it. However the data reveals that the Compounded annual growth rate of availability of electricity which is 5.41 percent is lower than the compounded annual growth rate of consumption of electricity (7.82 percent), implying that supply and demand for electricity can converge in the future. This is however not true for primary energy sources such as coal lignite crude oil and natural gas where the annual growth rate of availability exceeds the annual growth rate of consumption, which can lead to further divergence.

## 4. Energy poverty - is access to electricity enough to overcome it?

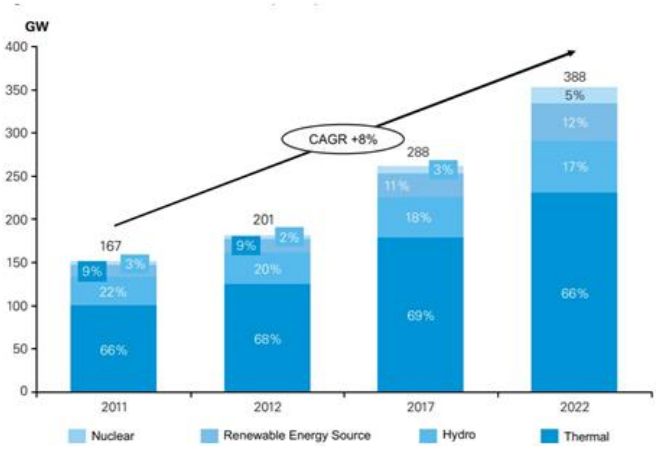
### 4.1 Introduction

As per web portal of Saubhagya (www.saubhagya.gov.in) India has now achieved 100 percent village electrification and almost 99.99 percent access to electricity of all 'willing households'. In 2018 India also claimed to be a net surplus and exporter of electricity (a scenario projected to continue for at least a decade). But do these developments mark an end to India's energy poverty? Although we have taken steps in the right direction, it is far from over. The inadequate access electricity lean energy source has become a defining feature of urban poverty. By 2050, two out of every three people will live in cities, and yet according to the world bank, urban electrification poses a serious problem to achieving human development goals. Blackouts and brownouts leave millions in the dark for an average of 20 hours every month. In India despite a year's long "power for all" campaign, official fig- ures from 2018 show that millions of people live in cities without electricity, in spite of theoretically having access to it. For the world's urban poor, electricity is often literally out of reach. In many slums, high voltage power lines run overhead but cannot be legally accessed because of steep connection costs, theft, and corruption. And yet, the biggest obstacle may simply be a dearth of affordable supply. Closing the urban-energy gap is a growing priority for human development specialists, but there is no silver bullet solution. As analyzed in the previous section, the adequate generation of energy is not the main problem that needs to be targeted, nor only providing one time access to electricity. Instead, it's the affordability and thereby demand for energy and under-utilization of our capacity through effective distribution that needs to be addressed in order to mitigate energy poverty in India.

### 4.2 Affordability

While electricity may have reached all villages, but at the same time, a significant portion of connected rural households is yet to get adequate quantity and quality of supply. Also concurrence between economic poverty and en- ergy poverty is a barrier to the goal of 100 percent access. Cost of electricity supply is definitely a barrier. For the economically poor section of Indian population, even the existing subsidised electricity tariffs appear unafford- able. Had it been otherwise, households would have started consuming as soon as they got connected and consumption would have significantly in- creased. Given the context, it is uncertain whether the goal of electrifying all 'willing households' under the Saubhagya initiative would translate into universal access to electricity. The assumption that a waiver of the connection charge and easing the connection process, but with no further rebate on consumption, will make poor households willing to take up electricity connection or start consuming is questionable. As analyzed in the previous section, the supply of energy is not the main problem that needs to be targeted. In- stead, it's the demand for energy and under-utilization of our capacity that needs to be addressed in order to mitigate energy poverty in India.

### 4.3 Infrastructural Constraints




Apart from providing access to electricity, so far our governments have paid attention mostly towards generation. The generation capacity projection is as shown in the figure below:

While the generation capacity is growing, India lacks basic transmission infrastructure and distribution facilities because of which the energy generating sources remain under-utilized. Electrification in India has followed an approach of expansion, mostly driven by political agenda, without much importance on capacity augmentation of the grid to make it future ready. As a result, today the distribution infrastructure is overburdened, as the demand has grown; it is causing a high level of technical losses and frequent breakdowns. The transmission and distribution network capacity in several parts of our country is inadequate to carry available electricity. Subsequently, distributing companies have been resorting to load shedding while their contracted generation capacities are also underutilized. Adding new load to the existing distribution network will only compromise the quality and reliability of supply. It could result in continued blackouts for the rural or urban poor during peak hours. The other issue is so far very little attention has been given in India from a policy perspective towards distributed generation which is nothing but generating near the consumers and thereby reducing requirement of vast transmission and distribution infrastructure. It is high time we pay adequate attention towards it. Delay in transmission and distribution projects also leads to reduced efficiency. Untimely completion of projects stymies the development of the overall industry. Right of Way (ROW) is a major impediment for on-time completion of the projects. Empowered redressal councils which can ensure speedy approval of land acquisition and other permits are essential for timely completion of projects. Such councils can also act as a dispassionate body during disputes and suggest pragmatic solutions which avoid abandoning the project or reinitiating the whole project from the start.

### 4.4 Inapt funding and lack of private Investment

The current distribution of funding for future project is inapposite. The current plan only focuses primarily on investing in power generation and providing initial access which will only take care of half the problem. For every 1 dollar invested in power generation, the plan requires an investment of 50 cents into the transmission project. Currently the ratio is very low. Also the sourcing of finance is ideally supposed to come from the government as well as from private. However, due to inefficiencies in the system the private investment has been inadequate. The challenges with tariff setting and adjustments, regulatory disputes, ambiguous contracts, hasty allotment of contracts leading to re-negotiations, and unequal risk sharing exacerbate the situation. In order to mitigate this, the first step that must be under- taken is redoing the investment plan and allocate more funds to transmission infrastructure. Secondly, despite previous attempts, reforms concerning PPP (public private partnership) must be brought about in order to ensure greater private participation.

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