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# Performance analysis and initiative policies: a study of Indian power sector

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**Abstract:** The aim of the study is to discuss the trend of Transmission and Distribution Losses (T&D), Plant Load Factor (PLF), Deficit in power supply position, and policy initiatives government can take which will assist policy makers to take decisions. The per capita consumption has additionally increased from 15 kWh in 1950 to around 1,181 kWh in the year 2018-19. Among different modes established for gathering the consistently increasing demand of power to accomplish the focused on growth rate, generation capacity enlargement is the most imperative segment. Availability of required power is a parameter of economic growth and the economic growth leads to growth in demand for power. The real challenging task to the power sector is to minimize and eventually wipe out generation deficit, to make available a reliable and financially savvy supply of power to the customers, and to accomplish it in an ecological manner with least impact on nature. It is exceptionally important to take up with all reality measures to increase capacity addition to expand generation of power into uninterrupted supply and increasing demand of power by consumers falling under different groups.

**Keywords:** Power Sector, Transmission and Distribution Losses (T&D), Plant Load Factor, Power supply Position, Initiative Policies.

## Introduction

Power sector's development is key empowering for accomplishing economic growth of the nation as it encourage growth over a several segments of the economy, for example, manufacturing, agriculture, commercial, and railways. In any case, the enactment of Electricity Act, 2003, has acquired progressive changes in every areas

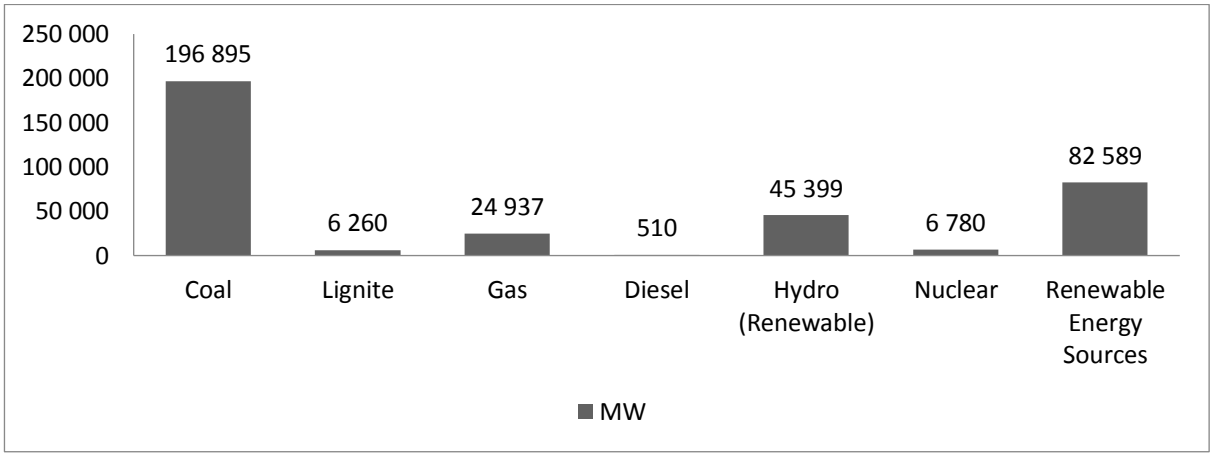
of the sector. Through this Act, a helpful domain has been made to advance private sector interest and rivalry in the sector by giving a level playing field. The private sector has now a predominant position in power generation with the most elevated 46.44 percent of total capacity in comparison with central and state sectors. Throughout the years the introduced limit of power plants (Utilities) has increased from a pitiful 1,713 MW in 1950 to 3, 57,875 MW (Megawatt) as on 30.6.2019. Similarly, the power generation increased from about 5.1 BU (Billion units) in 1950 to 1249.3 Billion units in the year 2018-19(CEA, 2019). The power consumption in the nation at present has 1,196,309 GWh (Gigawatt Hour) and the per capita consumption has additionally increased from 15 kWh in 1950 to around 1,181 kWh (Kilowatt Hour) in the year 2018-19 (Ministry of Power). Let's have a discussion about current scenario of power sector in India.

**1.1 Power Scenario**

Among different modes established for gathering the consistently increasing demand of power to accomplish the focused on growth rate, Generation capacity enlargement is the most imperative segment. The economic development prompts development in demand for power. To satisfy this need, in perspective on the constrained accessible resources (fuel) for generation, capacity expansion must be arranged in all respects ideally. "The production of electricity is a basic indicator of a country's size and level of development in all spheres. Some countries are exporting electricity on a massive scale and others are importing it on a large scale (Dasaraju, H., & Murthy, K. S. (2011)". Fuel Options accessible for Generation of power are: (I) conventional sources i.e. coal and lignite, natural gas, nuclear, hydro, and (ii) Renewable Energy (Green Energy) Sources (RES) i.e. solar, wind, biomass, little hydro, Geothermal, tidal, Hydrogen/energy components, waste to energy , fuel cells, and so on. The

Installed Capacity of power in the nation as on 30.6.2019 was 3, 57,875 MW containing 2, 26,324 MW thermal, 6,780 MW Nuclear, 45,399 MW hydro and 79,372 MW RES and is delineated in the table given below.

**Figure:-1.1 Total Installed Capacity of the country as on 30.6.2019**




Source: Central Electricity Authority (CEA), as on 30.09.2019.

The portion of power generation from thermal, particularly from coal is more in contrast with Hydro, Nuclear, and Renewable Energy Resources. The normal nature of the Indian coal isn't extremely high and this requires the import of astounding coal to meet the pre-requisites. Import of coal has consistently increased from 59.00 MTs (Metric Ton) during 2008-09 to 208.27 MTs during 2017-18 (Energy Statistics, 2019). The power generation focus of conventional sources for the year 2019-20 has been fixed as 1330 Billion Unit (BU) i.e. development of around 6.46 percent over actual conventional generation of 1249.337 BU for the earlier year (2018-19).

The major problem is to run the power station at a maximum plant load factor (PLF), which is a proportion of the generated power of a power plant compared with the maximum power (output) it could generate. Maximum load factor for the mainly implies maximum output and a minimum cost for every unit of power generated. The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efficiency of the power plant is estimated based on plant load factor and Station Heat Rate. Nonetheless, the PLF of the thermal power stations in the nation has been diminishing gradually throughout the years. More than 20% of the electricity generated in India is lost to widespread thefts. "On 31st July, 2012, India faced the biggest power outage in the history, when the complete northern grid collapsed and plunged most of north India in darkness, affecting around 700 million people. A better understanding of the vital theft determinants in distribution of electricity is important for policy makers to address the challenge of reducing the size of the existing power shortages" (Gaur, V., & Gupta, E. (2016). So, check-on T&D losses are need of the time to meet the demand-supply gap of electricity. The deficit in availability of energy for meeting energy requirement and peak demand met has also a serious matter of concern since it influences development as well as an effect on economy of the nation. So, In this paper the trend in Transmission and Distribution Losses (T&D), Plant Load Factor (PLF), Deficit in power supply position (Required/ Available, Peak Demand/ Met), and policy initiatives government can take which will assist policy makers to take decisions.

## Literature review

In this section we go through the literature related to above-discussed problems under the themes; (a) Reforms in power sector, (b) Transmission & Distribution (T&D) Losses, (c) Plant Load Factor (PLF), and (d) Requirement/ Availability of Power and try to find out research gap for our study.

### (a) Reforms in power sector

**Bhattacharyya (1994)** examined the issues and outline of the Indian power sector in the post- independence period. Author concluded that demand for electricity is


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outstripping supply, which was widespread power shortage. **Arun and Nixon (1998)** discussed the recent reforms in Indian power sector and concluded that the fulfilment of reforms was depending mostly on how governments of state perceived themselves in the reform process and their understanding of the major problems involved. **Tongia (2003)** discussed the political economy of Indian power sector since 1991 and remarked that reforms had improved the normal costs at the State Electricity Boards at a higher rate than the increased profits. **Thakur et al. (2005)** investigated the impacts of main strategic reforms were taken by the Indian Government and raised a question on issues like network policy complexities, open access, financial, transmission bottlenecks environmental concerns, etc., which were not resolved in the act. **Singh (2006)** discussed the issues involved in the Indian power sector after reforms and regulatory and policy changes accepted since the 1990s. **Yadav et al. (2011)** evaluated the performance of electricity distribution divisions of Uttarakhand by applying Data Envelopment Analysis (DEA). In results, the divisions were in need to improve operational efficiency and researchers suggested the potential for cost reduction and possible reduction in the number of employees.

**(b) Transmission & Distribution Losses**

**Ranganathan (2005)** investigated the components of power sector reforms for reducing Transmission & Distribution losses and concluded that since there was no competition, fixing the initial loss levels and the loss trajectory correctly is very crucial. **Navani et al. (2012)** analyzed the technical & non- technical losses and their impact on the Indian economy and concluded that the reasons behind such high losses were lack of proper Transmission & Distribution limits, complexities in transformation levels, inappropriate load distribution and widespread village electrification. **Gaur & Gupta (2016)** investigated the determinants of power theft

in states of India using econometric techniques and concluded that more than 20 percent generated electricity was lost due to rampant thefts. **Sadovskaia et al. (2019)** described the Transmission & Distribution losses of all countries based on different parameters data and concluded that the main parameters which were needed to define T&D power loss were the area of a nation, GDP per capita, CPI, and the level of urbanization.

**(c) Plant Load Factor**

**Kannan and Pillai (2001)** investigated the physical performance of SEBs of India and inefficiency costs included in the functioning of SEB's and commented that transmission & Distribution losses, technical efficiency, institutional and organizational inefficiencies were major reasons for the negative growth of the power sector. **Sharma et al. (2005)** studied the power sector's performance from 1991 to 2001 during the restructuring process and how that restructure had been effective in realization of its objective & benefitted the nation in social development. **Dasaraju and Murthy (2011)** explained the efficiency of the Indian power sector, Plant Load Factor (PLF), distribution of power, and resources of power generation since 2002-03 to 2007-08. **Motghare and Cham (2015)** concluded that to improve the power plants performance through interventions targeted at strengthening Operation & Management practices, combined with necessary rehabilitation and life extension interventions were maybe the fastest and minimum cost options for augmenting the availability of power. **Reddy (2001)** investigated a case study of Karnataka and concluded that unbundling of power utilities, inefficiency in generation, removal of all subsidies and privatization was not because of ground results but from the global trend.

**(d) Requirement/ Availability of Power**

**Bajpai and Sachs (1999)** investigated and concluded lack of freedom in decision making at the state level was affecting the competition, higher efficiencies and productivity at the state level which was the main reason for not meeting demand with the requirement. **Boss and Shukla (1999)** analyzed the elasticity's of income, price, and deficits of power consumption in India for five important consumer groups and concluded that total electricity deficit from public-owned utilities affects most of the commercial sector followed by the residential sector. **Ghosh (2002)** examined the existence and direction of Granger causality among electricity consumption and economic development in India using the yearly data covering the period 1950–51 to 1996–97 and concluded that there was the absence of long-run equilibrium relationship between the variables. **Reddy et al. (2012)** reviewed the power generation scenario of India and commented that to meet the requirement of electricity in comparison to availability India must increase the awareness and scope of renewable energy sources. **Garg (2012)** discussed energy requirement & deficit, different resources of renewable energy and commented that because of the immense population and scarcity of resources to meet energy requirement India must use the best possible energy options available with one strong policy implications.

From the above-discussed literature, we can make an inference that most of the studies are on power sector reforms and a very few discuss Plant Load Factor, Transmission & Distribution losses, power supply position, and demand forecast of power for a future period in the current scenario. The literature that exists related to above-said issues was before more than 10 to 15 years later. So, there is a sufficient gap to study current situation of power sector, Plant Load Factor (PLF), Transmission & Distribution losses, power supply position, and demand forecast of power for future


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period which helps to understand the implications of power policies and efforts Government of India make till the date to recover power sector from the serious issues which were cause unbundling of power utilities , elimination of all subsidies and privatization and solutions assumed to be work to diagnose power sector from these hazardous problems. In the next section, we are going to make a discussion on the present situation of the Indian power sector on the basis of available data.

## Discussion

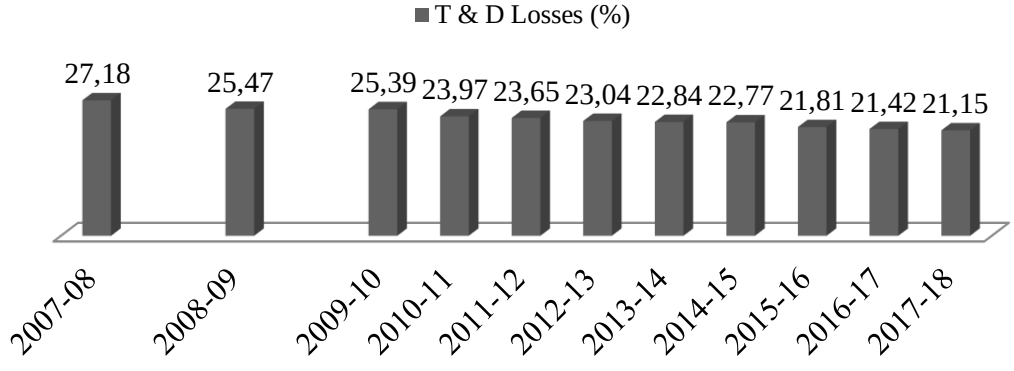
In this section, we discuss the efficiency performance of Indian power sector through Transmission and Distribution losses (T&D), Plant Load Factor (PLF), Power supply position and also the causes of low performance.

### 3.1Transmission and Distribution Losses

**T& D Losses= {1-(Total Energy Billed/ Total Energy Input in the system)}x100**

Transmission and Distribution Losses are power losses that happen in the process of supplying electricity to consumers because of some technical and commercial reasons. The technical losses are because of power dispersed in the conductors, transformers and other equipment's used for transmission and distribution of electricity.

**Fig. 3.1 All India Transmission and Distribution Losses**





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Source: Report of Central Electricity Authority (CEA), MoP, 2018

These technical losses are intrinsic in a system and can be minimised to a specific level. The T&D losses in 2017-18 were 21.15 percent which is more than enough the international standards as China has only 6.21percent in 2018 (World Bank, 2018) despite the most populated country in the world. The principal causes for the commercial losses are pilferage by hooking, bypassing meters, flawed meters, blunders in meter reading and in evaluating the un-metered supply of energy. These increasing T&D losses have made the power sector an unprofitable endeavour. So, these losses must be kept at a low level to bridge the demand-supply gap.

**3.2 Plant Load Factor (PLF)**

In terms of power, PLF is the proportion of average power provided for a given time span to the power that could have been provided at maximum loading condition for the similar timeframe. In other words, Plant Load Factor (PLF) is a proportion of the generated power of a power plant compared with the maximum power (output) it could generate. Thus, mathematically we can write it as,

**$PLF = P_{Average} / P_{Maximum}$(Average Energy Supplied / Energy Supplied at maximum demand)**

This is another most significant factor in the generation of power as it manages the production at each centre and their set targets achieved.

**Table: - 3.2 The PLF (Coal and Lignite based) from 2009-10 to 2019-20:**

| Year | Sector-wise PLF (%) | | | Average PLF |
|---|---|---|---|---|
| | Central | State | Private | |



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| | | | | |
|---|---|---|---|---|
| 2009-10 | 85.5 | 70.9 | 77.97 | 77.5 |
| 2010-11 | 85.1 | 66.7 | 75.63 | 75.1 |
| 2011-12 | 82.1 | 68 | 74.47 | 73.3 |
| 2012-13 | 79.2 | 65.6 | 71.57 | 69.9 |
| 2013-14 | 76.1 | 59.1 | 66.93 | 65.6 |
| 2014-15 | 73.96 | 59.83 | 66.08 | 64.46 |
| 2015-16 | 72.52 | 55.41 | 63.41 | 62.29 |
| 2016-17 | 71.98 | 54.35 | 62.07 | 59.88 |
| 2017-18 | 72.35 | 56.83 | 63.28 | 60.67 |
| 2018-19 | 72.64 | 57.81 | 63.84 | 61.07 |
| 2019-20* | 64.49 | 53.28 | 58.48 | 57.67 |

Source: Central Electricity Authority (CEA), ***** Up to September 2019 (Provisional)

Despite the way that huge numbers of the Thermal Power Stations (TSPs) are very old, that is the reason the plant load factors have demonstrated a decrease throughout the years from 2009-10 to 2016-17. The national average Plant Load Factor (Coal/Lignite based) of power generating stations has been consistently diminishing as shown in table during the twelfth plan period from 69.9 percent during 2012-13, to 59.88percent during 2016-17. But it gradually improves from 2017-18 to 2018-19 and 57.67 percent (Up to September 2019). This is an appreciable scenario in power generation. If we look at the sector-wise distribution, the state sector has shown less growth as compared to the central and private sector but it also gradually improving. A main reason behind the low PLF proportion is uncertainty about factors of production, which appears to be uncontrollable. The high level of vulnerability in the

resources for power generation and the expense of vitality would deflect venture, which is exceptionally subject to the contributions of vitality.

**3.3 Scenario of Power Supply Position in Country**

The retirement of inefficient and old units of thermal producing stations and supplanting them with new and progressively proficient units is one of the significant initiatives taken by the Government of India. The peak demand not met was around 12,159 MW (9 percent) and the average energy not supplied in the nation was around 87 Billion kWh (8.7percent) as shown in table during the first year of twelfth plan i.e. 2012-13. The peak demand not met and energy not supplied of the country has generously declined to 2,608 MW (1.6percent) and 7.6 Billion Units (0.7 percent) respectively by the end of twelfth Plan (2016-17) and gradually declining in 2018-19 also. The scenario of power supply position in the nation during 2009-10 to 2019-20 is summarized in Table.

**Table: - 3.3 Scenario of power supply position from 2009-10 to 2019-20:**

| | **Energy** | | | | **Peak** | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **Required** | **Available** | **Excess(+) / Deficiency (-)** | | **Demand** | **Met** | **Excess(+) / Deficiency (-)** | |
| | **(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 |


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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 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 |
| 2013-14 | 10,02,257 | 9,59,829 | -42,428 | -4.2 | 1,35,918 | 1,29,815 | -6,103 | -4.5 |
| 2014-15 | 10,68,923 | 10,30,785 | -38,138 | -3.6 | 1,48,166 | 1,41,160 | -7,006 | -4.7 |
| 2015-16 | 11,14,408 | 10,90,850 | -23,558 | -2.1 | 1,53,366 | 1,48,463 | -4,903 | -3.2 |
| 2016-17 | 11,42,929 | 11,35,334 | -7,595 | -0.7 | 1,59,542 | 1,56,934 | -2,608 | -1.6 |
| 2017-18 | 12,13,326 | 12,04,697 | -8,629 | -0.7 | 1,64,066 | 1,60,752 | -3,314 | -2 |
| 2018-19 | 12,74,595 | 12,67,526 | -7,070 | -0.6 | 1,77,022 | 1,75,528 | -1,494 | -0.8 |
| 2019-20* | 6,87,107 | 6,83,389 | -3,719 | -0.5 | 1,83,804 | 1,82,533 | -1,271 | -0.7 |

Source: Central Electricity Authority (CEA), ***** Up to September 2019 (Provisional)

The distinguished units are to be replaced in a phased manner along with the coordinating capacity addition in the concerned State, in order to have no effect of retirement on the power supply position in the States/nation. In eleventh Plan time period a capacity of 2398 MW has been retired. In the twelfth Plan, the capacity of 5,082 MW was retired. Unfortunately, the power circumstance in our nation in


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general and in the states has not been good. Power cuts are common, the power supply is deficient and sporadic and high voltage changes are normal. So, on the basis of the current situation of the Indian power sector in the next section, we try to give some valuable initiatives which assist policymakers.

**POLICY INITIATIVES GOVERNMENT CAN TAKE WHICH WILL ASSIST POLICYMAKERS TO TAKE DECISIONS**

a. **Reduction of Aggregate Technical & Commercial Losses:** There is strict need of implementation of schemes for a decrease of Aggregate Technical & Commercial losses like UDAY, Integrated Power Distribution System, Deen Dayal Upadhyaya Gram Jyoti Yojana, and so on. The decrease of Aggregate Technical &Commercial losses would prompt a decrease in power demand.
b. **Demand Side Management, Energy Conservation & Efficiency improvement programs:** Ministry of Power, Government of India and the State Governments ought to present different projects for incredible DSM, energy proficiency improvement and energy preservation estimates like Standards and Labelling, Perform-Achieve-Trade programs in industries, Energy Efficient Lighting arrangements, Super-Efficient Equipment Program, and so forth.
c. **Initiative of Power for All:** Government of India must start with respective State /UT's for the planning of State/UT explicit documents for giving (24X7) Power to all households, industrial and commercial customers and sufficient power supply to agricultural consumers according to their policy. This initiative will bring about higher development of electrical and guaranteeing continuous quality power supply to present consumers and giving power access to all required consumers in an established way.


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d. **Devoted Freight Corridor:** Electricity demand because of devoted freight corridor must be considered in the demand of electricity in railways according to data given by Ministry of Railways dependent on their project of electrifying railway track and development projects.

e. **Make in India:** Government of India (GoI) started Make in India to energize worldwide, just as national organizations to make their items in India. This activity would prompt development in power demand. The state power distribution companies are requested to incorporate the power demand because of this program in their demand forecast.

f. **Electric Vehicles:** According to the National Electric Mobility Mission Plan (NEMMP) 2012 of Department of Heavy Industries, Government of India (GoI), the quantity of electric vehicles in India is probably going to be six million (four million two- wheelers and two million four-wheelers)constantly 2020. The electric vehicles are probably charge their batteries during day time and therefore, will maintain balance in the peak power demand.

g. **Roof-top solar Projects:** India has set its sustainable energy source capacity expansion target to 175 Gigawatt in the 2022 in perspective on the huge Sustainable Energy opportunities in the nation. This incorporates 5 GW from little hydropower, 10 GW from biomass, 60 GW from wind, and 100 GW from solar. A portion of the power demand will be met through these roof-top solar oriented establishments, prompting fewer pre-requisites from the grid.

Thus, the State Authorities likewise shows that information submitted to Central Electricity Authority (CEA) for the Energy Performance Survey (EPS) Exercise might be touch the base by thinking about the effect of such strategies/schemes on


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the power demand of States/ Discoms/Under Takings. These initiatives may assist policymakers to take decisions for offsetting Electricity demand with requirement.

## Conclusion

The real challenge to the energy and power sector is to minimize and eventually wipe out generation deficit, to provide a reliable and financially savvy power supply to the consumers, and to accomplish it in an effective manner with least impact on nature. The energy sector is in the vicious circles of diverse issues experienced in the production and dissemination of power. Theft of power, unauthorized utilization of power, misuse of power, line spillages are widespread in both provincial and urban sector. Generation part is amidst a change in outlook – one which has never been found in India. Besides, sustainable power source plants have been named 'must run plants. Additionally, mostly part of the fossil-terminated plants is compelled to work at part load for a continued period. India likewise moved progressively from the coal deficiency time to imported coal system and now to excess coal period. All these show that our nation is at the cusp of a new age where India should devise innovations and systems to separate most extreme profit by inexhaustible just as conventional plants in a sustainable way. Consequently, huge opportunities to improve the generation framework, including viewpoints like improved plant configuration, expanding the effectiveness, enhancement in fuel quality and waste heat recovery framework present.


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