Confederation of Indian Industry

Contents

Round-the-clock power supply: A key milestone for the Indian power sector

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Introduction

Rapid economic growth in India has led to a surge in energy demand in the country. India, the fourth largest producer of electricity in the world, has witnessed a transformational change in the energy sector, with supportive policy interventions as well as sector reforms. Despite the phenomenal growth in generation capacity over the past years, India is grappling with a power deficit situation. Over 15.5 million below poverty line (BPL) households and 9,500 villages are still devoid of electricity. The per capita electricity consumption in India is much below the global average. This necessitates a review of actions by the sector stakeholders and better planning for achieving key performance indicators (KPIs).

Energy is one of the key elements necessary for the socio-economic development of any country. The success of key initiatives such as 'Make in India', along with growing urbanisation and social upliftment of rural India, will depend on the availability of uninterrupted quality electricity supply to consumers. In June 2014, the Government of India (GoI) launched the 'Power for All' programme with the objective of providing electricity supply to the un-electrified population of the country, and providing uninterrupted quality power to all consumer categories and adequate electricity to agricultural consumers. Availability, affordability, reliability and quality of electricity supply are recognised as the key pillars for successfully achieving the programme objectives.

One of the priorities for the success of the 'Power for All' programme is the availability of adequate electricity to the grid. Availability of power will depend on two factors—adequate electricity generated and development of supporting infrastructure for the supply of electricity. By 2019, more than 67,780 crore INR will be set aside for investment in the Indian electricity sector, and installed generation capacity is expected to increase to 372 gigawatts (GW). Coal- and hydro-based power generation, two major contributors to the country's generation mix and having great potential, shall dominate the generation mix apart from renewables.

Investment in the generation sector shall be followed by the development of a supporting transmission and distribution (T&D) system. India's losses are above 20%, resulting in a significant loss of energy resources and revenue realisation. Reduction in losses will improve the power availability and financial health of distribution companies (DISCOMs). Improvement in financial health will increase the power purchasing capacity of DISCOMs, thereby encouraging higher generation. Availability of power in the rural areas will be another key area of focus for achieving round-the-clock power supply. However, the country has already achieved 92.3% of village electrification, as household electrification numbers as of May 2016 are quite low. Therefore, the effective implementation of a GoI scheme like Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) and Integrated Power Development Scheme (IPDS) will remain the focus of DISCOMs.

The success of the 'Power for All' programme will depend on managing effective sector investment, continuing technological improvements and efficiently managing the sector programmes.

In this context, the Confederation of Indian Industry (CII), along with PricewaterhouseCoopers Private Limited (PwC) as the knowledge partner, is bringing together policymakers, thought leaders, investors, utilities, regulators, funding agencies and private players to discuss and debate the interventions required to achieve round-the-clock power supply and propose directions for stakeholders in the Indian power and energy sectors.

Trends in power generation

Growing environmental concern about fossil fuel based electricity generation has turned the tide in favour of cleaner electricity generation sources worldwide. The United Nations Climate Change Conference, COP 21 and formation of the International Solar Alliances bear testimony to this development. Despite the low price of coal, oil and gas, the percentage of fossil fuel based electricity generation in the generation mix is in constant decline. Leading coal-based power consuming countries, including China, have planned to phase out their coal-based generation fleet in order to control the increasing level of air pollution.

In line with the global trend, India, a major coal-based electricity generator, has planned to increase its renewable generation capacity to 175 GW by 2022. Despite these massive planned renewable energy installations, the share of coal-based power generation in India's generation mix is not expected to decline sharply. Electricity demand in India is growing at higher than 5%—a growth which cannot be effectively met by renewable energy installations alone, and hence coal-based power sources will continue to dominate the mix.

Global outlook

- According to the 'New Energy Outlook 2016', by 2040, zero-emission energy sources are expected to account for 60% of the global installed generation base.
- Wind and solar are set to lead renewable energy installations.
- Natural gas, the relatively cleaner fossil fuel, will enable the transition from fossil to zero-emission energy resources.
- Despite the focus on zero-emission energy resources, the share of fossil fuel resources, particularly coal, is not expected to register a steep fall in the next 25 years.

Key concerns of the Indian power sector

The Indian power sector is facing key challenges in the form of lower output from generation units and higher losses. As of May 2016, the all-India average plant load factor (PLF) was 62.24%, which has significant scope for improvement.

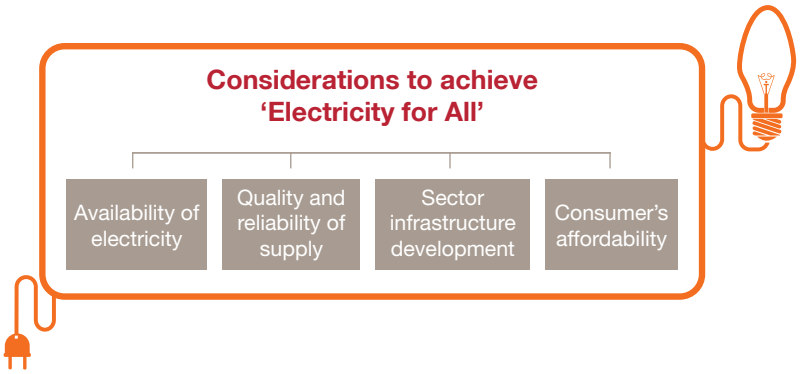
Concerns of Indian power sector

- Low PLF/capacity utilisation factor (CUF)
- High transmission and distribution loss level: 20.83 (estimated)
- Aggregate losses (without accounting for subsidies) for all utilities increased from 64,463 crore INR in FY10 to 1,00,188 crore INR in FY14. (State Power Utilities Performance Report, PFC)
- The gap between ACS and ARR (on subsidy received basis) has increased from 0.61 INR/kWh in FY10 to 0.73 INR/kWh in FY14. (State Power Utilities Performance Report, PFC)

T&D and aggregate technical and commercial (AT&C) losses of the country are above 20%, resulting in huge losses, both in terms of energy and revenue realisation. The financial condition of DISCOMs in India has severely deteriorated as a result of these high loss levels. Subsidised power supply is further increasing the gap between the average cost of supply (ACS) and average revenue realised (ARR).

Round-the-clock electricity for all

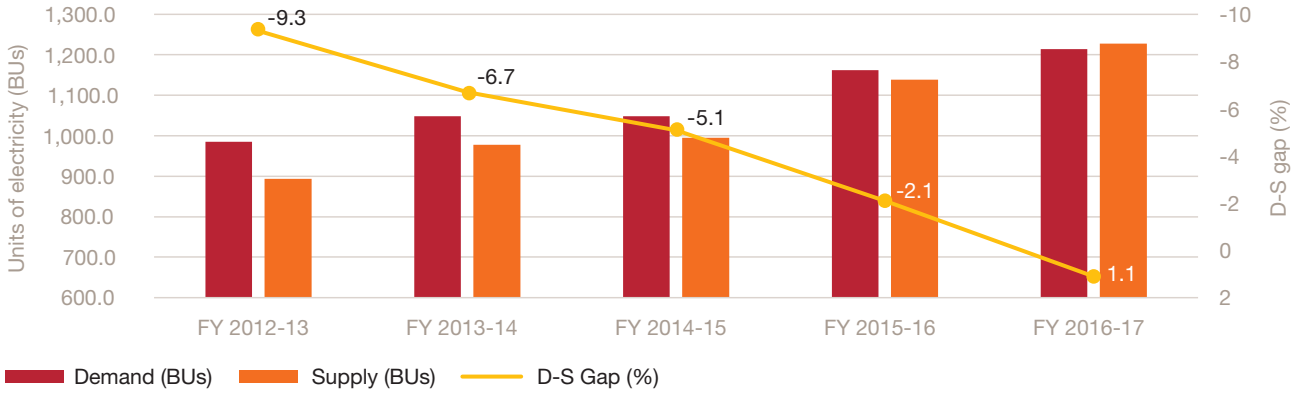
Electricity is vital for the socio-economic development of any country. India, which aims to be one of the economic superpowers of the twenty-first century, needs to invest in the sector infrastructure for sustainable development. Uninterrupted supply of power is one of the prerequisites for any advanced economy. India, on the other hand, is facing challenges in providing continuous power to its citizens. Recognising this need in June 2014, GoI launched the 'Power for All' programme to address this problem. The objective of this programme is to provide round-the-clock uninterrupted quality power to all consumer categories, except agricultural consumers. The objective will be achieved through joint initiatives with individual states and union territories.



Availability of adequate electricity

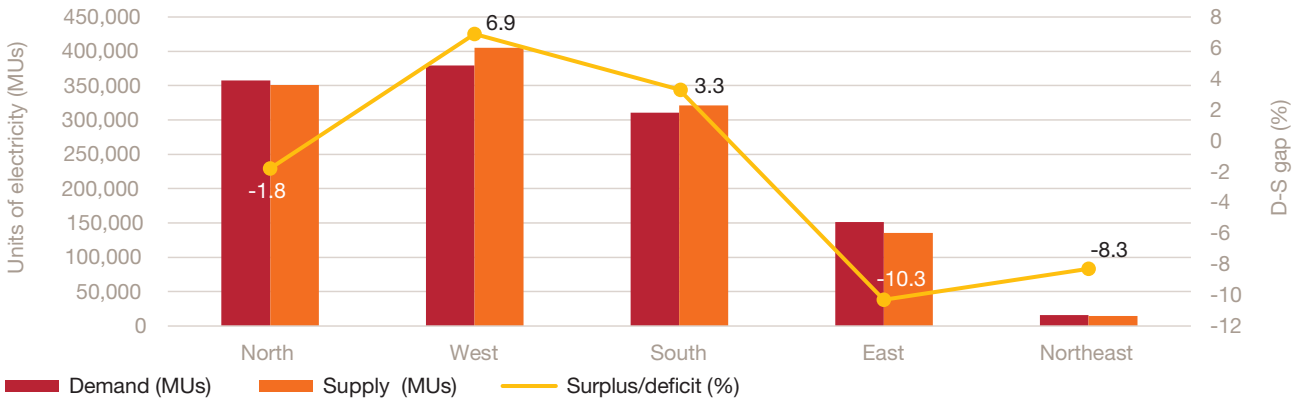
Availability of electricity to meet requirements is the key priority of the 'Power for All' programme. In the last few years, India has consistently improved its power supply position. The demand-supply mismatch declined from -9.3% to -2.1% between FY 2012–13 and FY 2015–16, and it is expected to decline further.

Power supply position, India



According to Load Generation Balance Report (LGBR) 2016-17, ***India is expected to have a power surplus in FY2016–17,*** although northern, eastern and northeastern states will continue to face a power deficit.

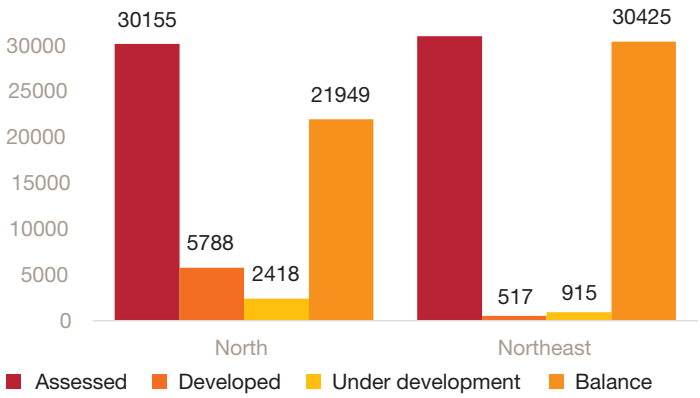
Region-wise projected power supply position, India, FY 2016-17



Source: Load Generation Balance Report 2016-17, CEA

The eastern states of India, such as Odisha, Jharkhand and West Bengal, are rich in coal reserves, but are reeling under a power deficiency. Development of coal mines, improvement in coal logistics and other similar initiatives can help these states to overcome their power deficit situation. Northern and northeastern states are endowed with rich hydro resources. According to the LGBR 2016-17 report, the projected peak deficit in the northern and northeastern region in FY 2016–17 will be 900 MW and 106 MW respectively, which can be met by developing unexploited hydro potential of these two regions.

Hydro potential (MW) at 60% LF



Source: User Guide for India's 2047 Energy Calculator, large hydro sector, CEA

Affordability of electricity supply

Affordability of electricity shall be another key priority of the programme. A large percentage of un-electrified rural households are unable to apply for an electricity connection due to the high cost. High tariff poses a further burden. Dependence on imported fuel such as coal and natural gas exposes the cost to the uncertain global market. The alternative is to develop domestic coal mines and invest in renewable energy development. This will help not only in securing sustainable tariff but also in increasing energy security. India ranks fifth in the world both in terms of proved coal reserves as well as hydro potential.

Generation source	Proved reserves/ potential in India	India's rank in the world
Coal	125.91 BTs	5th
Hydro	148 GW	5th

Source: GSI

Adequate infrastructure

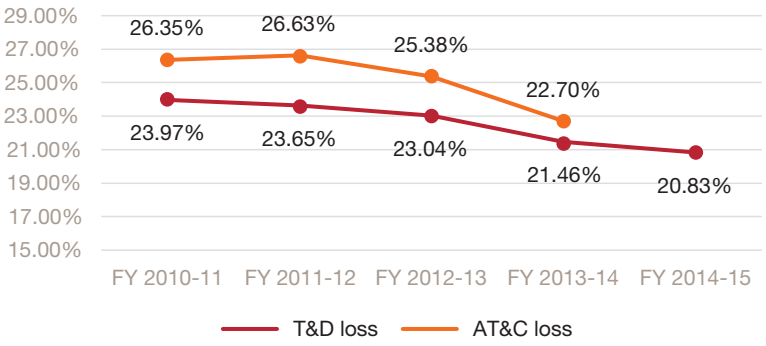
Infrastructure bottlenecks such as an inadequate transmission and distribution network have been a key constraint limiting the power evacuation capacity. Increase in generation capacity requires proportionate growth in the T&D network capacity for the optimum use of resources and the power system.

Segment	Expected investment till FY19 (in thousand crore INR)
Generation	338.7
Transmission	146.3
Distribution	192.9

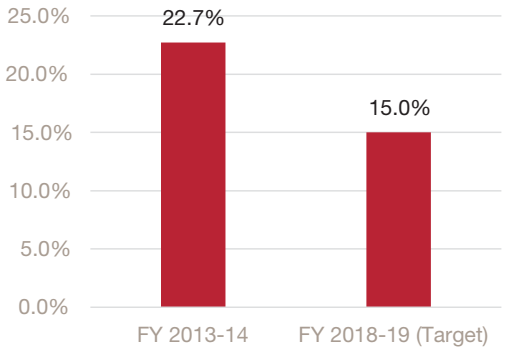
Quality and reliability of supply

Adequate infrastructure development, along with the latest technological interventions in the sector, will result in improved efficiency and the supply of quality power. To improve the efficiency and output of generation stations, PLF and CUF should be improved. The all-India average PLF as of May 2016 was 62.24%, which is significantly low. The AT&C loss levels of India are quite high in comparison to those of advanced economies. In FY 2013–14, the AT&C loss levels of the country were 22.7% (provisional). Though both T&D and AT&C loss levels have declined in the last five years, the present loss levels are still much higher than the targeted loss level for FY 2018–19.

T&D and AT&C loss level trend



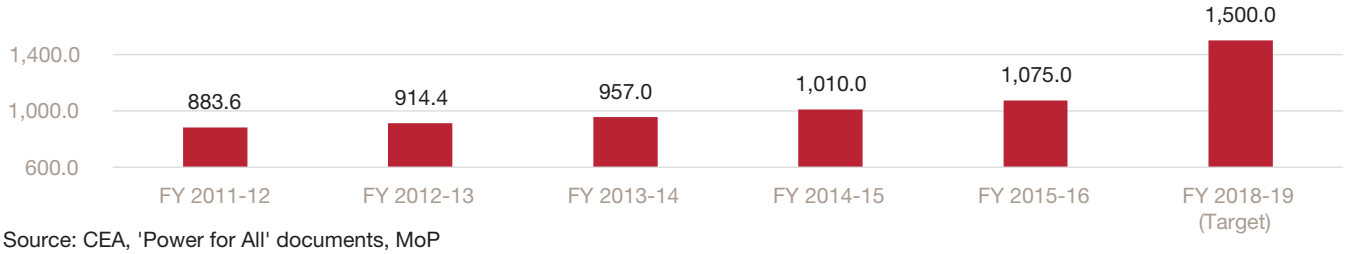
AT&C loss reduction target



Source: CEA, 'Power for All' documents, Ministry of Power (MoP)

According to MoP, the per capita electricity consumption in India during FY 2015–16 was 1,075 kWh (provisional). In the last five years, the per capita electricity consumption in India has witnessed growth at a CAGR of 5.02%.

Per capita consumption (kWh)



Source: CEA, 'Power for All' documents, MoP

Plans to achieve the programme objective

Providing uninterrupted quality power supply to a large country such as India will require focus on some key areas such as:

- Capacity expansion of the power supply chain
- Development of hydro energy resources
- Development of coal resources and improvement of coal logistics
- Adoption of technological intervention
- Effective programme implementation

Capacity expansion of the power supply chain

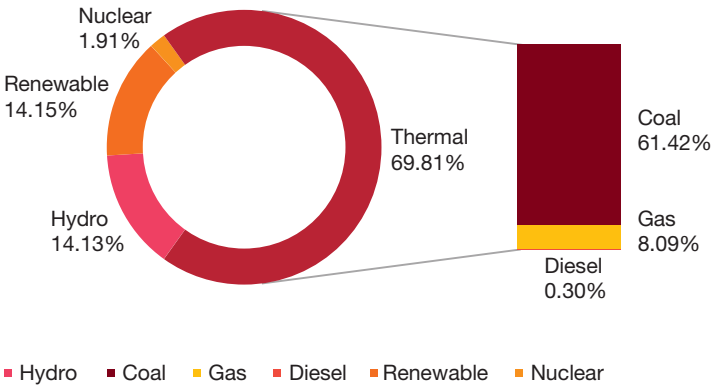
Generation

With growing concern over the environmental impacts of using conventional sources of electricity generation, which mostly comprise fossil fuels, sector stakeholders are compelled to take informed decisions to chart a way forward for the energy sector which involves cleaner, affordable, sustainable and reliable means of energy sourcing.

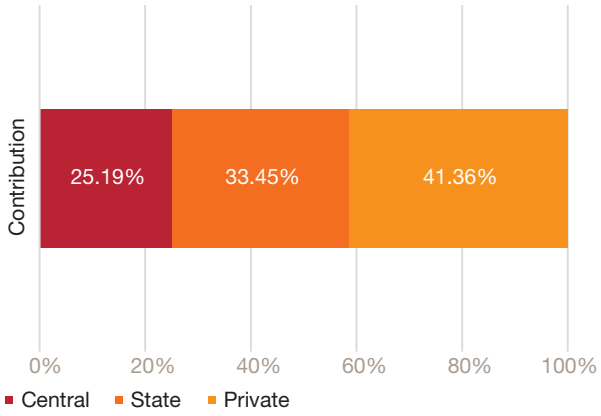
GoI, in collaboration with the state governments, has committed to developing non-conventional sources such as solar, wind, biomass, cogeneration bagasse, and small hydro sources, in addition to policy-level interventions in operational performance, technology implementation and governance. Well-managed expansion of energy supply, if achieved, can considerably improve the quality of life of India's 1.3 billion people, particularly the estimated 240 million that still lack any access to electricity.

Policymakers are looking to remove obstacles to investment in energy supply while also focussing on energy efficiency and pricing reform. By far, coal is the most critical fuel in the energy mix, but India's recent climate pledge underlined the country's commitment to a growing role for greener, low-carbon sources of energy, led by solar and wind power.

Generation mix of India, FY-2016



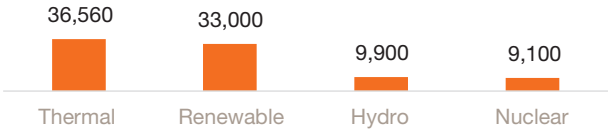
Sector-wise contribution to installed generation capacity, FY 2016



Source: CEA–Executive Summary,16 April

Generation capacity addition of 36.6 GW of thermal, 33 GW of renewable, 9.9 GW of hydro and 9.1 GW of nuclear are envisaged to be added to the grid. Introduction of the renewable energy generation obligation (RGO) and removal of a cross-subsidy for power procured from renewable sources, on account of the proposed amendments to the Electricity Act, 2003, are some of the major headways providing a huge spur to the expansion of the Indian renewable energy space.

Generation capacity addition target from FY 2016-17 to FY 2018-19 (MW)

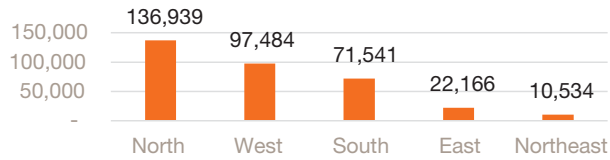


Source: Strategy for Providing 24X7 Power Supply, FOR

Renewable-based generation:

As per the MoP policies set for ensuring 24x7 power to all states by FY 2019, there is a planned investment in the generation segment of 338,664.1 crore INR, including an investment of 156,644 crore INR in renewable capacity addition. The maximum share of investment is planned for the northern region, which has huge potential for hydro-based generation. The north-eastern region, which has an equally large potential of hydropower, can be considered for tapping energy to facilitate the mission of expanding the green energy base.

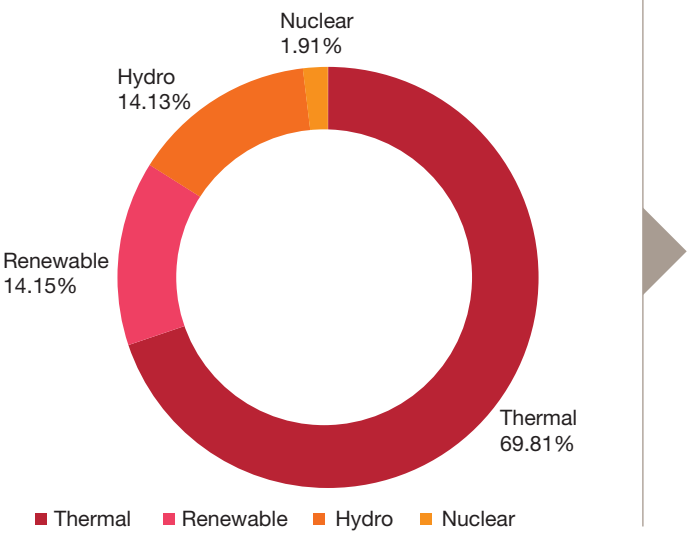
Region-wise investment planned in generation segment till FY 2019 (crore INR)



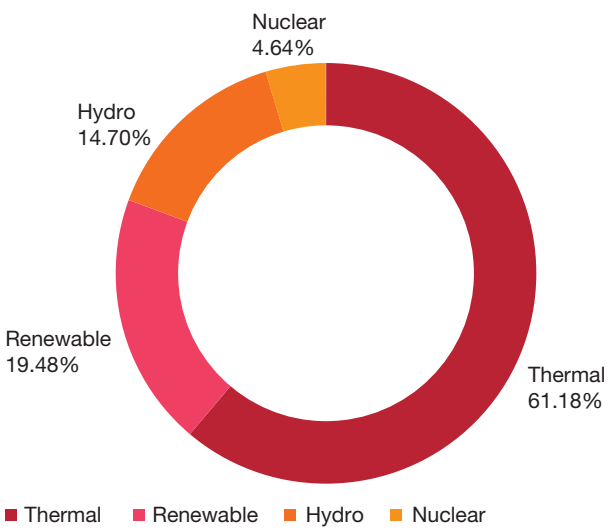
Source: PFA Documents, MoP

More emphasis should be laid on the renewable capacity augmentation, particularly solar and wind, as they have short gestation cycles. The alteration of the generation mix as envisaged for the next three years is shown below.

Generation mix -2016



Generation mix -2019



Source: Strategy for Providing 24X7 power supply, Forum of Regulatory (FOR)

Key enabler in the area of renewable energy sources to achieve 24X7 power supply

A planned capacity addition of 15GW for 2016–17 to augment the renewable installed capacity of 39.5 GW in 2015. The subsequent capacity additions envisaged as per FOR are 9,000MW each year for FY 2017–18 and FY 2018–19.

The introduction of the mechanism for renewable energy certificates has led to the mandate of renewable purchase obligations (RPO), resulting in an increase in the market for renewable energy.

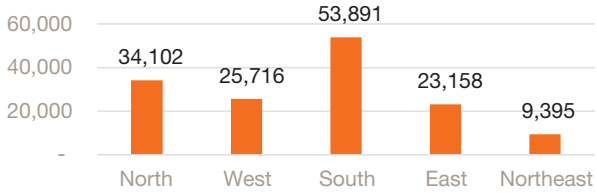
Implementation of renewable energy in the off-grid and distributed generation mode has emerged as a solution to provide green energy to power deficit rural areas.

The Proposed Electricity Amendment Bill, 2014, has provisions for segregation of carriage and content to renewable energy and open access to tariff rationalisation along with removal of cross-subsidy if procured from renewable sources.

Transmission

The surge in demand for power necessitates the development of a robust and non-collapsible transmission infrastructure. With an ambitious target set for achieving a generation capacity addition of over 85 GW by the end of FY 2018–19, corresponding strengthening of transmission capacity is required to ascertain the availability of power to the load centre. The presence of a single interconnected transmission network, which was achieved with the linking of the southern region with the rest of the grid in December 2013, has not been fully successful in ensuring reliable power to the nation mainly because of corridor bottlenecks and congestion issues. Some of the issues faced during the two phases of implementation of transmission projects which need immediate attention are as follows:

Region-wise investment planned in the transmission segment till FY 2019 (crore INR)

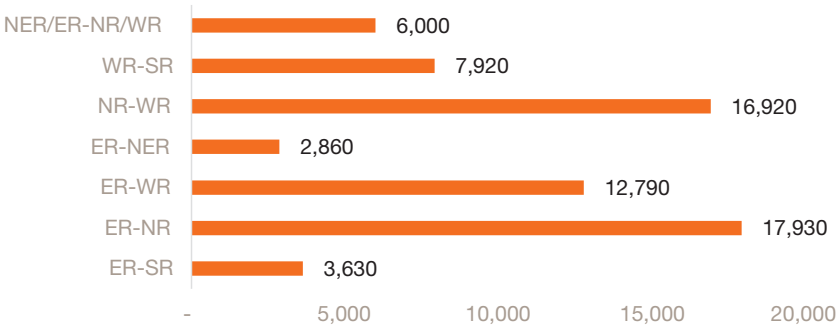


Source: PFA Documents, MoP

Implementation phases	Issues
Planning and award	• Micromanagement of specifications in the tender leave the developer with no room to innovate • Participation of inexperienced players in the bidding process and further submission of unviable and aggressive bids due to lack of due diligence at the bidding stage • Lengthy concept-to-commissioning time with suboptimal planning process
Execution and commissioning	• Delay in execution of major transmission projects pertaining to resistance from landowners on account of inadequate compensations, resulting in cost escalations and right of way (ROW) acquisition • Less focus on technology and innovation

The life cycle of the transmission project demands proper attention for ensuring round-the-clock power supply. In view of this, appropriate measures need to be taken to tackle the issues which are dampening the growth of the transmission sector, thereby highlighting the need to focus on the transmission infrastructure. More than 46% of the total investment required (in excess of 2 lakh crore INR) has to come from the private sector. Evidently, public private partnerships (PPPs) in transmission will provide a fillip to massive investment as well as capacity augmentation targets.

Projected growth of inter-regional transmission capacity by FY 2018-19 (MVA)



- Transmission capacity expansion of almost three times by 2020
- 25% of the annual target of 23,384 ckm planned for 2016–17 commissioned till date and capacity addition of 37% of targeted value, i.e. 45,188 MVA

In order to keep pace with the progress in generation capacity addition, inter-regional transmission links (either associated with generation projects or as system strengthening schemes) need to be established to tackle persisting problems of corridor bottlenecks and congestion issues.

Distribution

With the growing demand for power, necessary steps need to be taken to ensure the bottlenecks that impede the expansion of the power sector are addressed properly. Complex regulatory processes and high costs of financing upcoming projects lead to cost overruns, resulting in high tariffs. Populist tariff schemes exacerbated by operational inefficiencies and aggregate technical and commercial (AT&C) losses estimated at 22.70% (in FY14) affect the financial viability of state DISCOMs, which are grappling with huge debts.

The distribution networks need immediate expansion in order to ensure electricity supply to the un-electrified BPL households numbering over 15.7 million, along with 9,529 un-electrified villages. The distribution sector accounts for nearly 20% of the losses. A 10% reduction in distribution losses per annum can augment the supply of electricity by nearly 100 BU per year.

In order to facilitate the strategic goal of ensuring round-the-clock power for the entire nation, the government has taken several initiatives such as smart grid, IT enablement and process automation, high-voltage distribution system (HVDS), demand side management (DSM), PPPs, power trading, and various energy efficiency (EE) initiatives.

Some of the key factors to be considered as impetus to the distribution infrastructure growth in India are mentioned below:

- The technological advancement needs to be supplemented by concomitant policy and regulatory provisions that would provide a clear roadmap for implementing smart technologies.
- Currently, initiatives in outage management systems, power quality managements, demand response, renewable energy integration, energy storage, electrical vehicle, cyber security and the communication system are being explored.
- A smart grid will be an inevitable requirement to manage large numbers of on-grid and off-grid renewable generators and distributed direct generation (DDG) sources.

Key initiatives for distribution infrastructure development

Integrated Power Development Scheme (IPDS)

Strengthening of sub-T&D network: Augmentation of existing substations, creation of new substations, installation of new distribution transformers and capacitors, high voltage distribution system, aerial bunched cables, enterprise resource planning (ERP), implementation etc.

Metering: Replacement of faulty meters and electro-mechanical meters, installation of suitable static meters for feeders and existing un-metered connections, boundary meters for ring fencing of non-RAPDRP towns with a population above 5,000

IT enablement of distribution sector and distribution network strengthening

Completion of optical fibre missing links to connect all distribution grid substations under the establishment of the National Optical Fibre Network (NOFN)

Carriage and content segregation

Initiative for creation of separate distribution licensees and multiple supply licensees to boost competition in the retail segment

Ample options for the consumer in terms of choosing a supplier, as more than one supply licensee can share space within a particular distribution area

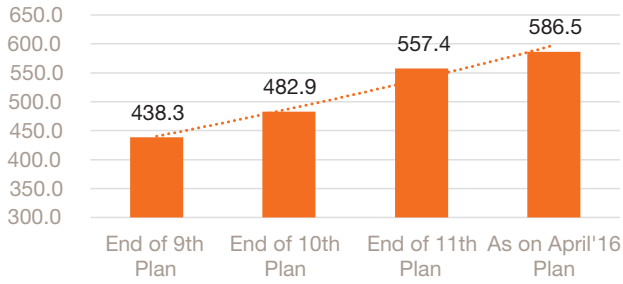
A transfer scheme needs to be in place so as to facilitate the takeover of existing power purchase agreements and procurement arrangements of relevant distribution licensees by an intermediary company

Rural electrification

GoI, under the flagship scheme of DDUGJY, has an estimated outlay of 43,033 crore INR, including budgetary support of 33,453 crore INR. The RGGVY scheme, as approved by CCEA for continuation in the 12th and 13th plans, has been embodied in this scheme as a separate rural electrification component for which CCEA has already approved the scheme cost of 39,275 crore INR, including budgetary support of 35,447 crore INR. This outlay will be carried forward to the new scheme of DDUGJY in addition to the outlay of 43,033 crore INR.

The state governments are supporting the DISCOMs by funding a part of the project cost towards agency charges, additional cost towards bid premium and increase in scope of work, electrical inspections by DISCOM engineers to avoid delays, dedicated nodal officers for each package to assist in RoW forest clearance, site selection, etc.

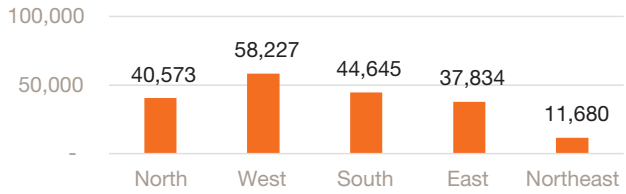
Villages electrified at the end of a plan



Source: Power for All, MoP

Highest investment in distribution segment has been planned in western region, whereas northeastern region will see the least investment. The smart grid initiatives are given due focus in the northern and southern regions as compared to other regions.

Investment planned in distribution till FY 2019



Source: Power for All, MoP

Hydropower development in the northeast region

Currently, India's power requirement has largely been dominated by coal-based generation, accounting for approximately 70% of the total installed capacity. As power generation from coal poses a threat to energy security, India needs to focus more on a sustainable method of power generation capacity development.

Given its abundance (potential of around 148 GW), hydropower can substantially contribute towards meeting the energy needs of the country. Regional assessment of hydropower development shows that almost 40% of the total potential for hydropower development mainly rests in the northeastern region. However, only 2% of this potential has been developed till now, which is one of the key reasons for low share of hydropower in the total electricity mix.

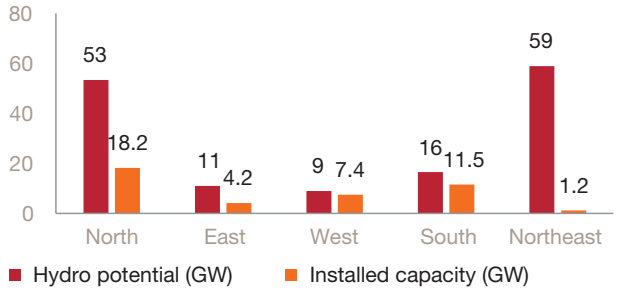
Exploitation of the large hydro potential in the northeast region would contribute significantly in meeting the country's power needs in the future. The region would also benefit from the development of associated social benefits such as roads, schools and electricity supply to remote areas, which would further improve the quality of life. With only 7% of the tapped potential (installed capacity and project under construction), the northeast region provides enormous opportunities to the state governments and hydro developers to harness the rest of the potential.

States	Identified potential (MW)	Percentage of capacity under operation and construction
Arunachal Pradesh	50328	6%
Meghalaya	2394	13%
Mizoram	2196	3%
Manipur	1784	6%
Nagaland	1574	5%
Assam	680	55%
Tripura	15	Nil

Status of hydropower development

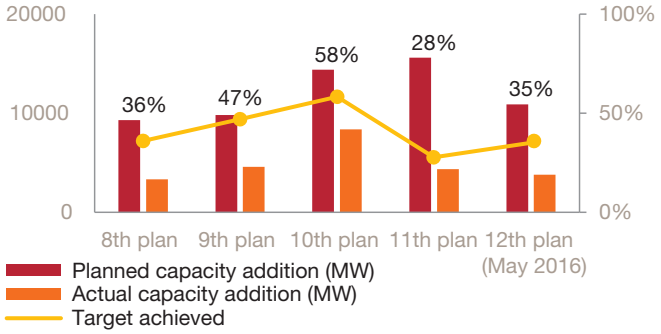
India is blessed with significant hydropower potential and can cater to a demand of around 85 GW at 60% load factor. But till date, only 41 GW of hydropower capacity has been installed, which is 28% of the total potential. On the other hand, countries like Canada and Brazil had harnessed around 69% and 48% of the economically feasible potential back in 2009. In order to increase the hydropower capacity, GoI has planned 10,897 MW in the 12th Five Year plan, which is almost 25% of the total hydro installed capacity. This is due to various issues such as rehabilitation and resettlement (R&R) and local agitation.

Status of hydropower development in India



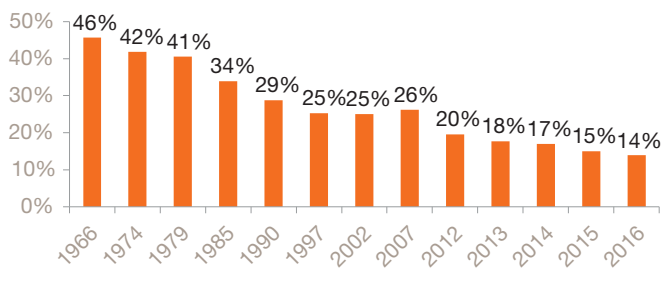
Source: CEA

Planned vs actual capacity addition



Source: CEA

Hydro proportion of total installed capacity



Source: CEA

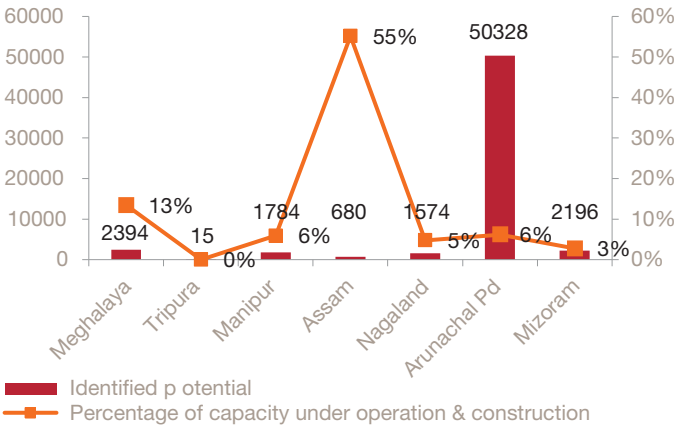
The actual capacity added till May 2015 was only 2,660 MW. The same trend can also be observed in the previous five year plan periods too—for example, in the 11th Five Year Plan, only 40% of the target was met. This was due to various issues in the form of water-sharing disputes, environmental concerns, R&R issues, land acquisition problems, delay in procuring clearance and approvals, inadequate technical and financial capability of developers, etc., which also resulted in a declining share of hydropower in India's electricity mix (e.g. the share of hydropower in electricity mix has decreased by more than 30% in the last 50 years).

Overview of hydropower development in the northeast

The northeastern part of India is enriched with bountiful water resources, mainly the mighty River Brahmaputra, which provides the region with a huge hydropower potential comprising 40% of the country's total potential. However, till now, only 7% of the total potential of the region has been tapped and this provides enormous opportunities to developers to harness rest of the potential.

Among the northeastern states, Arunachal Pradesh has the highest hydropower potential, accounting for 80% of the total potential of the region, followed by Sikkim (7%) and Meghalaya (4%). However, in terms of harnessing the hydro potential, Assam ranks first with 56%, followed by Sikkim 16% and Meghalaya 12%. In Arunachal Pradesh, only 405 MW (0.8%) of the total capacity has been developed so far and additional capacity of 2710 MW (5.4%) is under construction. This puts the untapped capacity of Arunachal Pradesh to around 93% of the total potential.

Status of hydropower development in the northeast



Source: CEA

Key issues related to hydropower development in the northeast

Hydropower planning

Hydropower planning and development in India are generally project oriented and not based on any basin development plan. Non-sequential development of a hydropower project may make it unviable and inefficient.

Multiple projects on the same river will reduce the capacity to generate power from each plant and thus the energy demand supply gap will persist.

- Unexpected costs may emerge due to the development of new projects on the same river, e.g. by increasing or reducing the level of silt in the water.
- Owing to a lack of interstate agreements and disputes on water sharing, a large number of hydropower projects with common river systems between adjoining states are delayed.

> The threat felt by Bangladesh due to India's **Tipaimukh Dam** in Manipur and China's alleged plan to divert the Brahmaputra suggest the potential of transboundary conflicts over the use of water resources.

Technical challenges

Hydropower projects are site specific and depend on the geology, topography and hydrology of the site. The unpredictable nature of the geology and climatic conditions impact the accessibility and favourable working conditions of a site. This unpredictable geology is more pronounced in the young fold mountains of the Himalayas, where most of the Indian hydropower potential are situated. Moreover, the availability of experienced engineering, procurement and construction (EPC) contractors and proper equipment to tackle certain geological surprises is limited.

> **Kameng (600 MW) and Pare (110 MW)** projects of Arunachal Pradesh have been delayed due to poor geology.

Financing challenges

Hydropower projects are capital-intensive and require high upfront costs to address greater complexities in design, engineering, environmental mitigation, etc., which leads to time and cost overruns and increases the uncertainty in cash inflows. Moreover, project financing in such a risk-prone environment is a big challenge and leads to higher risk premiums. This increases the cost of financing and deters investors from going on full recourse financing option.

Enabling infrastructure

Most of the hydropower projects are located in remote areas which do not have adequate transmission infrastructure for power evacuation due to various reasons, such as site inaccessibility, absence of integrated generation and transmission plans, and lack of demand.

In northeast India, the construction of a transmission line is very expensive and time-consuming due to the difficult terrain and adverse climatic conditions.

> The cost of the associated transmission system for the evacuation of electricity from the **Kameng Hydroelectric Project (600 MW)** is estimated at 11,000 million INR, which is about 50% of the project's cost of generation, thus making the construction cost high.

Social and environmental impacts

Hydropower projects are site specific and may impact the environment in a variety of ways, such as affecting the natural river system and changing the river course, thereby impacting the flora and fauna. The construction of hydropower dams involves the establishment of large infrastructure, which leads to deforestation and disruption of forest ecosystems and reduction of biodiversity, thus significantly affecting livelihood and increasing the possibility of conflicts.

- **The Tipaimukh High Dam,** located on the border of Manipur and Mizoram, led to displacement and loss of livelihood for a large number of indigenous communities mostly belonging to the Zeliangrong and Hmar peoples.
- The proposed **2,700-MW Lower Siang Hydroelectric Project** has been opposed on grounds of social and ecological destruction, limited sustainable livelihood, increased seismicity in the region, and other major downstream impacts.

Way forward

Hydropower development is challenged by varying risks and uncertainties and needs government support and developers' experience in terms of data availability, financing, technical competence, etc., for the efficient development of the sector. Sustainable growth in the sector can be undertaken by considering the following measures:

Governance framework

- Basin-wide planning needs to be developed to understand the effect of one project on another and to ensure efficient project allocation in a river basin.
- Creation of a single window and defining specific timelines for statutory and non-statutory clearances for facilitating clearances and approvals will help the developers of large infrastructure projects to minimise the time taken for these processes.

Financing options

- Discounted interest rates may be provided on long-term loans during construction and early years of operation along with higher depreciation in early periods to assist the developer in generating sufficient revenue for meeting repayment obligations.
- PPP initiatives like viability gap funding (VGF) can be explored to make hydropower projects price competitive.

Technological aspect

- Hydro projects in the Himalayan region are full of geological surprises, and developers are required to opt for modern machinery and techniques to enhance the capability to deal with contingencies. Development of knowledge and experience and handholding with developers from other territories with successful experience of similar projects may prove beneficial in this aspect.

Associated infrastructure development

- Development of a dedicated transmission corridor along with provisions for building pooling substations in locations having a large concentration of hydro resources to facilitate developers in reducing their cost on account of last mile connectivity

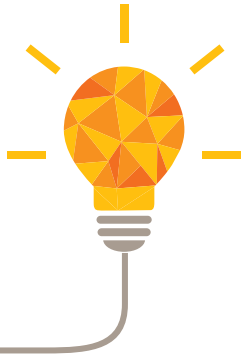
Social and environmental aspect

- Social and environmental impact assessments need to be given due importance and project affected persons (PAPs) need to be involved with the developer and the government in order to eradicate the differences and get legal and social consent. In addition, development of technical training centres, clinics and health centres, schools, etc., can contribute towards improving the socio-economic condition of the region and gaining public acceptance.

R&R

- Non-availability of land ownership records in the northeastern states and the lack of manpower and logistical resources with the district administration delays the land acquisition process. Thus, state governments should generate land ownership records and provide the required manpower and logistical resources to district administration for timely completion of the land acquisition process.
- The local governments must effectively channelise development funds, upfront premium, etc., to invest in such associated infrastructure with the objective of improving the socio-economic condition of the area.

Developments in the coal sector



Close to 70% of existing generation capacity is thermal and thermal power will dominate the generation by more than 62% in 2019. Coal-fired power plants remain a key contributor to electricity supply in India and are expected to dominate the generation mix in near future. For ensuring round-the-clock electricity supply, adequate mining and sourcing of coal shall remain one of the key focus areas for the power sector.

According to government estimates, coal demand is likely to be the range of 1.2 to 1.5 billion tonnes (BT) by FY 2020. This demand will continue to be mainly driven by the power sector, which will account for about 65–70% of the total demand. The government aims to minimise the dependence on imports for catering to the demand. In order to achieve this objective, the government has envisaged producing 1 BT from Coal India Limited (CIL), 100 million tonnes (MT) from the Singareni Collieries Company Limited (SCCL) and 400 MT from other sources by FY 2020. Over the last year, a number of developments have taken place in the coal sector for the improvement of coal supply, rationalisation of linkages, cost optimisation, etc.

Status of blocks allocated to power sector

Of the total 75 coal blocks allocated so far, 49 blocks (40 blocks – allocated, 9 blocks – auctioned) with a combined annual capacity of around 261 MT have been allocated for 'power' end use and the rest for the non-regulated sector.

Three auctioned blocks, namely Amelia North (Madhya Pradesh), Sarisatolli (West Bengal) and Talabira-I (Odisha), have commenced production in FY 16. The production from these three blocks till February 2016 was 5.30 MT, which represents only 2% of the total annual capacity of 267 MTPA.

State	Number of blocks allocated for power end use	Capacity (MTPA)
Jharkhand	13	97
West Bengal	10	18
Chhattisgarh	9	88
Odisha	9	57
Maharashtra	6	2.50
Telangana	1	2.50
Madhya Pradesh	1	3
Total	**49**	**267**

Key areas for augmentation of coal production to meet power sector demand

Selection of mine developer cum operator (MDO) model

Most of these government companies intend to develop and operate their coal blocks through the MDO model.

Of the combined capacity of 231 MT of allotted blocks for the power sector, the MDO selection process for only 29% (66 MTPA) capacity has made substantial progress. With about 58,770 MW of the power sector capacity linked to these 40 blocks, it is critical to accelerate the process of MDO selection and implement an effective project management system to keep the projects on schedule.

MDO selection process	Number of blocks	Peak rated capacity (MTPA)
MDO appointed or in final stages of selection	7 (completed for 4 blocks)	66
Tender for MDO selection has been floated	15	65

Funding requirement for development of coal blocks

Low foreign direct investment (<0.05% of total) inflow in coal production between 2011–15, a large number of stressed assets in banks' balance sheets and the high debt-to-equity ratio of Indian companies are some of the key concerns related to sourcing of capital required for enhancing the coal production. Nearly, 52,000 crore INR will be required for achieving the 267 MT production from 49 blocks allotted, auctioned for power end use. Thus, to source and manage the required investment, the following steps need to be taken by the government and coal mine owners:

- Developing an effective credit risk monitoring and management system for banks
- Development of debt management plan to ensure capital inflow at reasonable rates
- Dynamic management of working capital

Requirement of coal transportation infrastructure in the eastern region

In order to meet India's growing energy demand, CIL has estimated a coal production capacity of 908 MT by FY 2020. MCL, ECL, Bharat Coking Coal Limited (BCCL) and Central Coalfields Limited (CCL), which have mines in Jharkhand, Odisha and West Bengal, are expected to produce 499 MT (56%) of the 908 MT planned production in FY 2020. Also, 31 of the total 48 blocks allocated for 'power' end use are in these three states. Production capacity of these 31 blocks is approximately 64% of the total production capacity of the blocks allocated for power end use. These 31 coal blocks are linked to 45,850 MW of power capacity, of which 53% lies outside Jharkhand, Odisha and West Bengal.

Rail transport has a comparative advantage over road transport in terms of energy consumption, financing costs and CO2 emissions. Thus, rail transport will play a vital role in coal evacuation from coal mines located in these states. However, the major challenge in using rail transport is the overutilisation of the existing system. The percentage of overutilised sections of the East Coast Railways, Eastern Railways and Eastern Central Railways is 48%, 63% and 47%, respectively.

In order to tackle this challenge, CIL has identified two critical railway lines in Jharkhand and Odisha.

- In Jharkhand, 60 MT of CCL's planned production is dependent on the Tori-Shivpur-Kathotia line. The Tori-Shivpur section is expected to be completed by 2016–17, but the Shivpur-Kathotia section has an undecided timeline due to issues pertaining to land acquisition and forest clearance.
- Mines with a total capacity of 72 MT depend on the Jharsuguda-Barpali-Sardega single line in Odisha. Timely completion of this railway line will be critical for coal evacuation from mines located in Odisha. Further, seven new projects have also been identified in Odisha for strengthening the evacuation infrastructure.

Apart from this, availability of wagons will play a critical role in coal evacuation. In FY 2020, CIL will require an additional 115 rakes per day with an investment of 1,744 crore INR and the coal blocks allocated for power end use will require 26 rakes per day with an investment of 394 crore INR. Therefore, strengthening of railway systems for coal evacuation will require huge investments. Availability of funds has been a major bottleneck in this process. Thus, the success of private sector participation through the government's NGRPL model, which tries to properly allocate risk between the private and public sectors can be the possible solution.

Removing the quality constraints

Environment (Protection) Amendment Rules, 2014, state that the coal transported for thermal power plants with a distance greater than 500 km from the pithead must use raw or blended or beneficiated coal with ash content not exceeding 34%. For FY 2020, the government has estimated that 63 MT of coal will be required to be transported beyond 500 km as per the fuel supply agreement. CIL has planned the addition of 94 MT of non-coking coal washing capacity to the existing 101.5 MT capacity, to ensure coal transported beyond 500 km has ash content below 34%.

Coal blocks for commercial mining

On 16 March 2016, the Ministry of Coal (MoC) issued an order directing the nominated authority to carry out the allotment of 16 coal mines earmarked for state public sector units for sale of coal. The sale of coal can be through a coal supply agreement or spot sale. In case the coal is sold to an independent power producer, such sale should not result in an increase in the power tariff. These commercial mining blocks provide an additional fuel source for thermal power stations. The states need to devise a suitable framework and model fuel supply agreement for the sale of coal from such mines.

As per the model allotment document, 25% coal production from mines should be sold to micro, small and medium enterprises (MSMEs), and the remaining to other buyers on pan-India basis in a fair and transparent manner. It has been observed that some of the states may not be in a position to comply with the requirement of 25% sale to MSMEs owing to the low demand from the MSME sector. For example, in Odisha, the estimated allocation from the Baitarani West coal block to MSMEs is nearly 20 times the present coal requirement of MSMEs in the state. Considering this, there may be a risk of no offtake of the complete MSME share. In such scenarios, the central government should provide flexibility to state governments to determine the quantum allocations to the MSME sector.

Focus on reduction of cost of power generation

In November 2015, the Union Cabinet approved the Ujwal DISCOM Assurance Yojana (UDAY) scheme, which aims at improving financial and operation efficiencies of state DISCOMs. One of the four key initiatives of this scheme is the reduction of cost of power generation

On 8 June 2016, the Central Electricity Authority (CEA) released a methodology for flexibility in the utilisation of domestic coal for reducing the cost of power generation in the state or central generating stations (methodology for IPPs will be notified separately). The methodology provides:

- Consolidation of coal company-wise linkages of state- or centre-owned power generating stations with respective states (or power utility) or central generating stations, as applicable
- CIL or SCCL has the flexibility to supply from alternate sources (of similar landed cost and quality), if supply from an identified source is not possible
- Provision of transfer of coal between (a) one state and another state (b) any state and central generating companies based on mutual agreement and applicable CERC/SERC regulations. Such an arrangement will not be considered as trade or barter for taxation.
- Coordination among MoP, MoC, Ministry of Railways, CEA and POSOCO for addressing issues in implementation of the scheme

The above features provide for the rationalisation of linkages and will help in ensuring optimum utilisation of coal for the benefit of the country. If successful, flexibility may also be provided for IPPs.

Key steps envisaged for reduction of cost of power:

- Increasing supply of coal
- Rationalisation of coal linkages
- Liberal coal swaps from inefficient to efficient plants
- Rationalisation based on GCV (gross calorific value) for coal prices
- Removing quality constraint by supply of washed and crushed coal
- States will be allocated coal linkages at notified price, based on which states will conduct tariff based bidding

Auction of coal linkages

On 15 February 2016, MoC issued policy guidelines for auction of linkages of non-regulated sector. This will increase transparency and may also result in revenue maximisation for the government. The first tranche of auction by CIL for around 23.25 MT (metric) per annum (MTPA) quantum is already underway.

As per various news reports, the central government may grant the power of distributing coal linkages for the power sector to an agency/company of a respective state, which would then allocate the linkages to consumers. This will lead to an increased role of the state in administering the coal supply.

Factors increasing cost of power generation

- Increase in Clean Environment Cess to 400 INR per tonne (from earlier 200 INR/tonne) will lead to additional cost to power consumers.
- Contribution towards District Mineral Fund (DMF):
  - 30% of royalty for leases granted before 12 January 2015
  - 10% of royalty for leases granted after 12 January 2015

Decline in cost of imports

Global coal prices have declined in the last four years and last year, the global seaborne traded coal prices was at a decadal low. India's coal import bill reduced by 25% from 95,500 crore INR in FY 2015 to 72,100 crore INR in FY2016, primarily owing to a drop in global coal prices. The recent release of market reports (Singapore Exchange, International Monetary Fund, World Bank, etc.) suggests that commodity prices may remain flat for the next few years and then start to rise as global demand exceeds supply. Considering this, the import of coal may be an advantageous option for some of power companies in India at least in the short term.

In conclusion

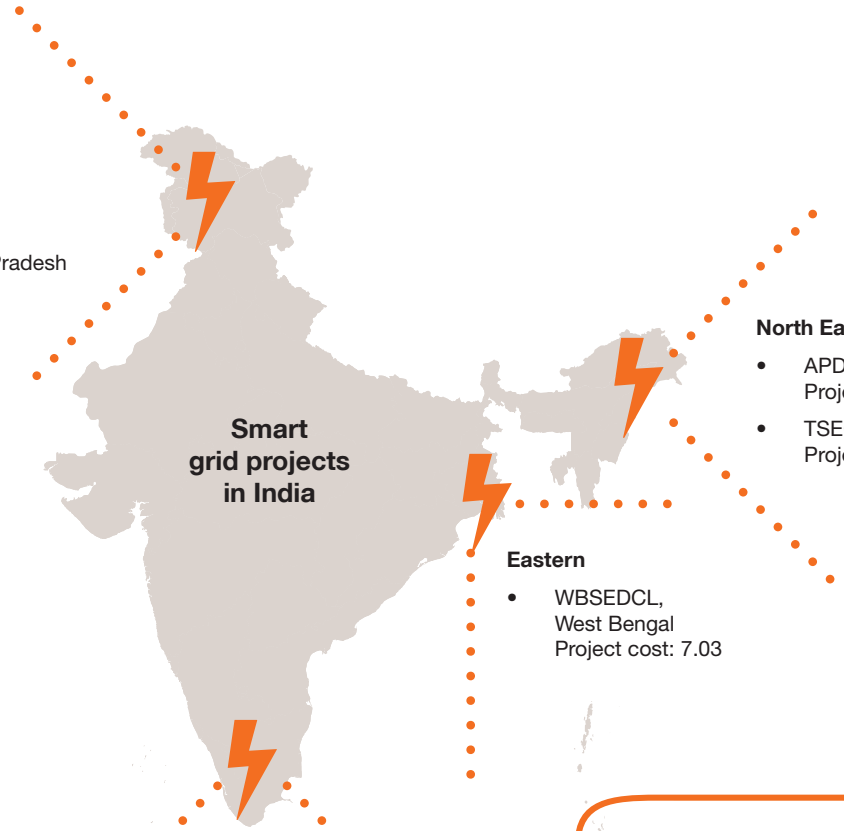
Owing to the number of changes in the sector, consumers now see more options such as captive blocks, commercial mining blocks, opportunities for efficient usage of linkages and cheap import coal to cater to their coal requirements. This calls for a prudent approach by companies to develop an integrated policy at company level to ensure coal security in the medium and long term and, at the same time, minimise the landed cost. The owners of captive coal blocks need to expedite the development and operations of projects to ensure they are on schedule. This would require setting up of effective project management units or systems and appointment of capable MDOs for optimum utilisation of resources.

Technological enablement

Use of the latest technologies and IT implementation can have a major impact on the Indian power sector and will help the country to move a step closer to its round-the-clock power supply goal. The latest technologies such as advanced generation technologies, IT enablement, operational technologies and smart technologies will result in higher output of the sector.

Smart grid project overview

Participation of consumers to control power flows with the help of digital communication and control systems forms the core objective of smart grid projects. Rapid growth of renewable energy also requires a highly adaptive grid such as a smart grid, which can accommodate any irregular changes in supply. Till date, nine smart grid projects have been awarded in the country. An overview is presented below:



Northern

- UHBVN, Haryana
  Project cost: 93
- PSPCL, Punjab
  Project cost: 10.11
- HPSEB, Himachal Pradesh
  Project cost: 19.45

North East

- APDCL, Assam
  Project cost: 29.94
- TSECL, Tripura
  Project cost: 63.43

Eastern

- WBSEDCL,
  West Bengal
  Project cost: 7.03

Southern

- CESC, Mysore
  Project cost: 32.59
- TSSPDCL,
  Telangana
  Project cost: 41.82
- PED, Puducherry
  Project cost: 46.11

Key factors contributing to the success of smart grid projects across the world:

- Encouraging private sector participation
- Capacity planning and management
- DSM impacting analysis and identifying areas of improvement
- Equipment usage analysis and load planning

Figures are in crore INR

Source: ISGF

Other technologies

The Internet of things (IoT), along with smart grid projects, will have a major impact on the way the power supply chain operates. Business intelligence on the other hand will help the decision makers to take more informed decisions. But the extensive use of IT and digital networks will make the system prone to cyberattacks; hence, there is a need to promote cyber security of the power system.

Key trends

Cyber security

- With the increase in IT and OT enablement, networks are prone to attacks.
- A cyberattack on the power sector will have a cascading effect on other infrastructure such as transportation, communication.
- Security audit and risk planning strategies will help utilities to work in a secure environment.

Data analytics and business intelligence will help in

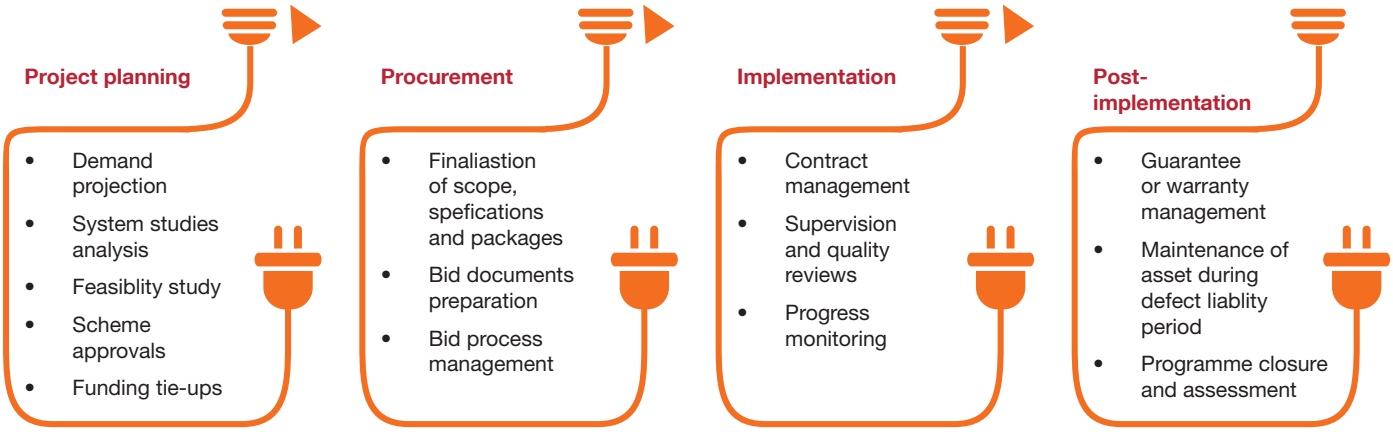
- Improved decision-making for commercial as well as operations
- Effective demand projections and planning
- Consumer meter data analytics helping utilities in identifying tempering
- Equipment or machine history analysis helping in predictive maintenance

Internet of things (IoT)

- Improve resilience of the grid
- Better chances of accommodating different energy sources
- Better asset management
- Actively manage and optimise the use of resources
- Field force communication

Effective programme management

Considering the complexities of various initiatives in power generation, transmission and distribution, the success of the 'Round-the-Clock Power for All' programme will largely depend on the way it is implemented in an integrated manner, including regular review of the progress and resolution of concerns by stakeholders. The programme implementation process in such a large sector programme can be broadly classified into four stages: project planning, procurement, implementation and post-implementation.



Key areas of concerns in different phases of project implementation

Project planning

- Unrealistic demand forecasting
- Lack of information of existing assets
- Inadequate planning without systematic system studies
- Delays in proposal approvals
- Concerns related to fund tie-up due to poor financial condition of utilities
- Competencies upgradation of utility staff

Procurement

- Lack of standard specifications
- Utility centric tender conditions
- Non-standard bidding documents
- L1-based selection results in quality procurement and delivery
- Delay in bid process management
- Enforcement of funding agencies
- Competencies upgradation of utility staff

Implementation

- Lack of programme monitoring practices and tools
- Absence of field quality plan
- Lack of implementation supervision
- Issues pertaining to land acquisition and RoW remains
- Performance of vendors and suppliers
- Competencies upgradation of utility staff

Post-implementation

- Substantive deviation from initial plan
- Poor maintenance of assets in defect liability period
- Minimal support from vendors
- Absence of programme closure assessment vis-a-vis programme objective

Exact load estimation is critical to capacity development and project planning. System studies help in analysing ad-hoc project implementation trends, and thereby help to improve the accuracy of project planning. Lack of adequate information on existing assets leads to faulty requirement estimations and analysis of the existing system. DPR reports prepared for the projects should be comprehensive. The statutory clearance process involved in the project planning phase is usually time consuming, often leading to delays in project implementation.

The procurement stage involves bid process management. In bid process management, approvals are taken for inviting tenders, bidding documents are prepared and tenders are published. Upon receiving a number of bids, successful bidders are selected, purchase orders or work orders are issued to them and an agreement is signed. Lack of standard bid documents, standard specifications and a strict timeline for conducting the bid process are some of the key challenges associated with this stage.

The implementation stage deals with supervision, monitoring and review of the actual physical progress. A lack of programme monitoring practices and usage of tools is the key problem associated with this stage. For a long time, the Indian power sector has been facing a key problem in the form of land acquisition and RoW, thus delaying project implementation.

In the post-implementation stage, the focus is on asset maintenance, guarantee or warranty management. Usually, there is a notable difference between the initial plans and final outcomes. This substantive difference is one of the key challenges faced in this stage. A number of parallel programmes are running at the same time; thus, there are no programme closure assessments, which otherwise would have improved the outcomes of any similar future programme.

Expectation from key stakeholders

The key stakeholders that would be responsible for successful implementation of the scheme are the central or state government, respective electricity regulators, power utilities, OEM and service providers. The following table highlights key expectations from these stakeholders for the successful implementation of the programme.

Government	Electricity regulator	Power utilities	Equipment supplier and service providers
• Facilitate timely approval and clearances • Participate in regular programme monitoring process • Encourage private sector participation in T&D • Support in development of domestic vendors by providing incentives • Encorage policy for development of RE • Arrange funds for schemes and programmes	• Timely investment approvals • Periodic investment monitoring and including penalty and incentive provision • Allowing regular tariff revisions, liquidation of regulatory assets, etc.	• Improve project planning methodology • Adopt standard practices such as standard drawing, specification and introduce balanced contract provision • Improve programme/ project management practices • Improved vendor management • Institutional reforms, fix responsibilities and accountabilities, capacity building of staff	• Increase production capacity to meet the requirement • Increase research and development and technologic innovations • Enhance competency of staff and contractor

Way forward

Achieving the objective of the 'Round-the-clock power supply' programme will not be an easy task. But the improved fuel availability scenario, achieving the target capacity additions well within time or even earlier, increasing investments, and aggressive bids for renewable energy projects are some of the encouraging trends that indicate that India can achieve this humongous feet in the near future. Some other notable factors that are essential for the success of this programme are as follows:

- Coal, hydro and renewable energy sources development is necessary for both the energy security of the country as well as enabling it to supply uninterrupted quality supply to the entire population.
- Generation capacity is expected to increase by more than 15% from its present installed capacity to meet the demand level by FY 2019.
- Generation companies need to develop an integrated policy at the company level to ensure coal security in the medium and long term, and at the same time minimise the landed cost. The owners of captive coal blocks need to expedite the development and operations of projects to ensure that they are on schedule. This would require setting up of effective project management units/systems and appointment of capable MDOs for the optimum utilisation of resources.
- The inter-regional transmission network needs to be strengthened to tackle the persisting problems of corridor bottleneck and congestion issues.
- Adoption of efficient technologies and stringent qualification is one of the prerequisites to facilitate the participation of competent players.
- A realistic policy for the payment of reasonable compensation to ease out the problems of RoW may help in avoiding cost and time overruns of transmission projects.
- IT and new technologies implementation systems such as smart grid projects, IoT and BI will significantly improve the operational efficiency of the power system.
- Effective programme management of government schemes like DDUGJY, IPDS and UDAY will be key to the successful implementation of projects and achievement of the 'Power for All' programme objective.
- Institutional strengthening and capacity building of utilities shall be critical in order to reap the benefits of sector reform.
- Programme closure assessment will be helpful in devising a better plan for any future projects.

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