Electric Power and
Natural Gas Practice

Powering India

The Road to 2017

McKinsey&Company

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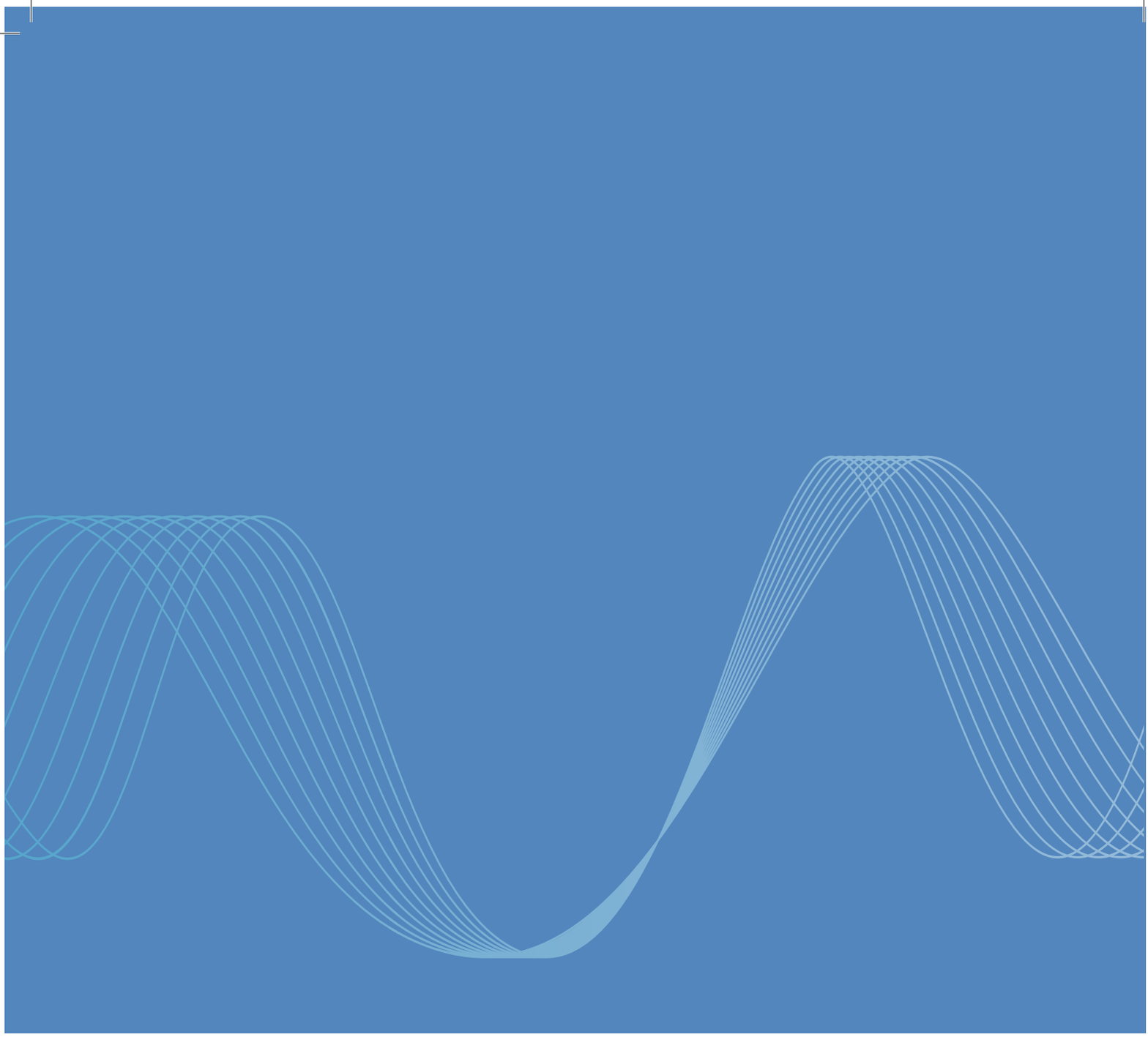
The Road to 2017



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Preface

India is amongst the world's largest electricity-consuming and generating economies. Its annual electricity consumption accounts for about 4 per cent of the world's total electricity consumption, and is set to grow at 8-10 per cent per year, propelled by the country's accelerating economic growth.

To address this growing demand and create a viable power sector, successive governments have undertaken progressive initiatives such as the Electricity Act 2003, National Tariff Policy 2006, the Ultra Mega Power Projects, the Integrated Energy Policy, the National Electricity Fund and many more. Yet, India's power sector remains plagued by a plethora of financial and physical risks and bottlenecks.

To understand the challenges that confront India's power sector, McKinsey & Company's Electric Power and Natural Gas Practice conducted a 6-month long research effort in collaboration with industry leaders and policymakers. The objective of the effort was to assess what additional measures are required at this time to ensure the sector is able to keep pace with the demands of the economy. This report, "Powering India: The Road to 2017" is a result of that effort. It provides a perspective on the demand outlook in 2017, the factors constraining the sector's development, and proposes a comprehensive 10-point roadmap to unlock the sector's potential. Finally, it discusses the opportunities, risks and winning approaches that will surface as the sector develops.

India will need a fivefold to tenfold increase in its rate of capacity addition if it is to meet demand. The magnitude of the challenge at hand makes it clear that piecemeal measures will not be enough. The country needs a radically new approach that enables financial viability, accelerates the pace of capacity addition, improves operational efficiencies and augments fuel supplies. Needless to say, the power sector's governance structure and monitoring mechanisms need to be strengthened to ensure successful execution of such a programme.

Several rewarding investment opportunities will unfold across the value chain as India's power sector develops. Our analyses suggest that a US$600 billion investment opportunity will arise over the next 10 years, if key bottlenecks are removed. Besides the traditional opportunities such as large-scale coal-fired plants, several non-traditional opportunities will emerge, such as peaking plants, renewables and demand-side management.

Finally, competing and winning in India will require players to tailor their business models to address existing bottlenecks, market inefficiencies and development risk. Players will need to develop and execute approaches that are quite distinct from conventional global models. In return, the payoff from entering early, when the sector is still underdeveloped, will be substantially higher than when it has matured. This has been proven by companies in other sectors, such as telecommunications and infrastructure development.

India's power sector is at a watershed in its development, and its progress is imperative to sustaining economic growth. The time is right for all stakeholders — policy makers, regulators, public and private providers, resource holders, equipment providers, financiers and consumers — to act in concert to power the country's future.

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Powering India:
The Road to 2017

Acknowledgements

"Powering India: The Road to 2017" is the result of a six-month long study conducted by McKinsey & Company's Electric Power and Natural Gas practice. We would like to thank all the people and organisations who supported us in the creation of this report.

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Executive Summary

Powering India:
The Road to 2017

Executive Summary

Rapid economic growth has increased the burden on India's infrastructure, one of the country's weak spots. An infrastructure deficit is widely considered to be one of the factors that could severely impede India's economic growth. In the past few years, policy makers have recognized this and have made concerted efforts to accelerate infrastructure development.

Much progress is evident in sectors like telecommunications, roads, airports and ports. But the power sector continues to lag behind despite the introduction of progressive measures. Shortages, tariffs and the dependence on imported fuels are on the rise, while the poor health of distribution continues to inhibit the inflow of investments. Unless this changes, India's economic growth will be at risk.

India's power demand is likely to cross 300 GW, in the next 10 years earlier than most estimates. Meeting this demand will require a fivefold to tenfold increase in the pace of capacity addition. The profile of planned capacities will also need to be suitably modified to fulfil peak demand, keep emissions under check, reduce dependence on imported fuels and provide affordable power. A step-up of this magnitude is unlikely to materialise with a traditional approach. A radically new approach is required.

A RADICALLY NEW APPROACH IS REQUIRED

In the past five years, strategic measures such as the Electricity Act 2003 and the Ultra Mega Power Projects (UMPPs) have been introduced, and a number of administrative steps, like tripartite agreements between the central government, central generators and the states and recapitalisation of State Electricity Boards (SEBs) have been taken to unleash the potential of the power sector. Though progressive and necessary, these measures have been insufficient.

By 2017 demand will be substantially higher than expected

Our analyses suggest that if India continues to grow at an average rate of 8 per cent for the next 10 years, the country's demand for power is likely to soar from around 120 GW at present to 315 to 335 GW by 2017, 100 GW higher than most current estimates. Four key factors will drive this demand: (i) India's manufacturing sector growing faster than in the past; (ii) residential consumption growing at 14 per cent over the next 10 years; (iii) the connection of 125,000 villages to the grid

through several programmes that aspire to provide power for all by 2012; and (iv) the realisation of demand supressed due to load shedding.

India's pace of capacity addition must increase fivefold to tenfold

To fulfil its power requirement of 315 to 335 GW by 2017, India will require a generation capacity of 415 to 440 GW, after adjusting for plant availability and a modest 5 per cent spinning reserve. This implies a tripling of installed capacity from the current level of about 140 GW, which, in turn, translates into an annual addition of 20 to 40 GW. This is fivefold to tenfold the 4 GW per year that was achieved in the last 10 years.

Furthermore, an evaluation of India's projected profile of capacity addition suggests that much needs to be done to alter the mix. In particular, India needs to shift its predominant focus from building base-load plants to a more balanced mix of base-load and peaking plants. This is imperative in order to ensure that the country can meet peak demand. Further, the current plans will significantly increase emissions, double India's energy imports, and increase input cost volatility.

The magnitude of the task at hand shows that piecemeal measures will not be enough. To achieve this quantum of increase in the pace of capacity addition, and to suitably modify the profile of fresh capacities, India needs to adopt a radically new approach. The 10-point programme presented in this report is our view of the comprehensive set of measures necessary to transform the sector.

A 10-POINT PROGRAMME

Our study and discussions with stakeholders—private and public-sector players, government officials across the centre and states, regulators, fuel suppliers, financers and other infrastructure providers—suggest that four issues plague the progress of the power sector: viability and market risks; a slow pace of capacity addition; inadequate fuel supplies; and operational inefficiencies. The 10-point programme described below aims to address these issues.

Address viability and market risks

To keep pace with soaring demand, India's power sector will need investments of about US$600 billion or Rs 24 lakh crores by 2017. Raising this amount of capital will require financially viable projects, which in turn, will entail addressing distribution and market risks. The first two elements of the 10-point programme focus on addressing these issues:

1 **Reduce AT&C losses to 15 per cent by 2017.** This can be achieved by systematically implementing a series of distribution reforms, including separating agricultural feeders that allow SEBs to distinguish agricultural from non-agricultural supply; partial or complete privatisation of distribution circles in tier 1 and tier 2 cities; lowering industrial tariffs by driving open access and setting up multi-year loss-reduction targets for SEBs and franchisees; using modern technologies, e.g., smart cards, to limit theft and target subsidies to agricultural consumers and consumers below the poverty line; and building consensus among stakeholders on loss-reduction measures.

2 **Create market mechanisms.** Two measures necessary to stimulate investments, especially in peaking plants, are creating a deep and well-functioning wholesale electricity market and introducing multi-year differential peaking tariffs. Investments in peaking plants are vital for India to meet its potential peak deficit of 70 GW by 2017.

Accelerate capacity addition

It takes five to six years to build a thermal power plant in India in contrast to two to three years taken in China, and less than four years in most other countries. Delays in acquiring sites and obtaining necessary approvals, as well as equipment shortages and EPC bottlenecks are constraining the pace of capacity addition. Continued global tightness in capital equipment is resulting in further delays. To accomplish a step change in the rate of capacity addition, it is imperative to:

3 **Prepare and bid over 140 project sites by 2012, with end-to-end approvals in place.** These project packages must include land with access to water, basic connectivity and site-related approvals.

4 **Create 30 GW per year capacity for equipment manufacturing and related supply chain.** To accomplish this, it is necessary to augment manufacturing capacity and standardise plant modules. This will also require reviving mothballed component capacity, unshackling PSUs by revamping internal approval norms and encouraging participation by local and international players.

5 **Train and develop 300,000 skilled and semi-skilled workers.** Resolving the severe shortages in manpower will require a host of new training and development service providers. The government can help by strengthening the Industrial Technical Institutes (ITIs), setting up certification standards for a range of roles, enabling public-sector companies to expand their training programmes and encouraging new entrants into training and development.

Secure fuel supplies

Though India has the world's fourth-largest reserves of coal, and has recently made gas discoveries that are notable even by global standards, inadequate fuel supplies are constraining the growth of its power sector. In the past few years, India's fuel imports have increased substantially and are likely to continue to do so if the current situation prevails, subjecting electricity prices to volatile international fuel prices and shortages. To deal with this problem, the government needs to:

6 **Accelerate captive mine development and create the requisite infrastructure capacity for 100 MMTPA of coal imports.** This entails levying higher penalties and enforcing deadlines similar to NELP for already allotted captive coal blocks, and streamlining the approval processes across multiple agencies in the central and state governments; and setting up an independent body to approve mine development plans. Meanwhile, it is imperative that efforts to deregulate the coal sector continue.

7 **Secure natural gas supplies for peaking plants.** This must be done by reviving LNG projects and making regional pipelines a strategic priority, building fertiliser plants in the Middle East, and examining the possibility of accessing ship-based supplies of compressed natural gas.

8 **Launch a renewable energy programme to generate 30 GW by 2020.** In particular, the focus of this programme should be on solar power by accessing international capital, and on biomass by devising viable business models to promote the use of this renewable source.

Improve efficiencies

Adding capacity alone will not suffice as a response to India's soaring demand for power. International and Indian experiences confirm that demand-side management (DSM) can reduce electricity consumption and operational measures can substantially improve the productivity of existing assets. To achieve these goals India must:

9 **Create an action plan for an over 10 per cent gain from DSM.** The plan should include the following initiatives: (i) mandating consumption standards and standby power standards for consumer durables; (ii) replacing incandescent lamps with CFL bulbs; (iii) establishing and enforcing energy-efficient standards for new constructions; and (iv) introducing real-time metering for heavy users.

10 **Extend the PiE programme to realise an additional 7 GW by improving the productivity of existing generation plants.** The programme has been limited to a few plants and has been successful where implemented. However, it has not

been crafted to attract private participation. To do so will require devising a profit-sharing model, which allows the profits earned from incremental generation to be shared between state-owned generation companies and private players.

The 10-point programme could transform India's power sector and accelerate economic prosperity. However, the current governance structure and mechanisms need to be strengthened to ensure its successful execution.

Strengthen governance to drive implementation

Accountability for the power sector is currently fragmented. Discussions with policy makers and the industry highlight the need for an empowered and accountable leadership group that can effectively steer the development of the sector. Based on past experiences, one of the following models, or a combination of them, may be optimal:

- **Strengthened Energy Coordination Committee (ECC)** to facilitate decision making on important matters pertinent to energy and to debottlenecks key issues.
- **Empowered Group of Ministers (EGoM)** could be an effective way to bring together multiple ministries at the central government and to invite relevant participation from states.
- **Cabinet Committee on Energy** that draws participation from the power, oil and gas, coal, foreign affairs, shipping and finance ministries.
- **National Power Commission** with the necessary resources and control over relevant agencies and PSUs could be an effective option.
- **Integrated Energy Ministry** whereby the responsibility for all energy-related issues are integrated within a single ministry.
- **Independent nodal ministry or agency** like the Planning Commission or Ministry of Finance that assumes responsibility for monitoring, reviewing and debottlenecking the sector.

Notwithstanding the governance model adopted, the leadership group will need to deal with a complex range of issues and manage multiple conflicting interests at the centre and state level. The charter of this group should be to ensure the successful execution of a comprehensive programme by focusing on the following three elements:

- **Improve the effectiveness of review and monitoring mechanisms.** To ensure efforts translate into visible results, a comprehensive five-step mechanism to review and monitor the progress of the sector is critical. First, conduct regular and cascading reviews on weekly, monthly, quarterly and annual basis across various levels. Second, establish a project monitoring centre or 'war room' at the central government within the power ministry that acts as the programme secretariat. Third, use inputs from independent third parties to assist the programme secretariat in its monitoring efforts by coordinating reviews, preparing timely analyses and conducting audits to ensure 'on-the-ground' performance is accurately reflected. Fourth, define a set of consistent parameters to track and measure the performance of each project. And finally, prepare a state-wise performance scorecard and widely disseminate it through mass media on a monthly basis.

- **Offer states the incentive to act.** The performance of the sector largely depends on progress made by state governments to improve the financial viability of state-owned distribution companies (discoms) and develop new projects. However, the central government can take several steps to incentivise and support states as they improve performance. The first step is to make the Accelerated Power Development and Reform Programme (APDRP) more effective. The proposed National Electricity Fund could also play this role. Soft loan disbursals need to be linked to achievement of distribution performance improvement milestones by the states. Loans provided by the programme should become grants when discoms reach a minimum loss-reduction threshold determined by a sliding scale and independent audits. Other measures, such as preferential allocation of central power pool[1] reserves, particularly from the 35 GW of new capacity being developed by central PSUs, and preferential allocation of coal linkages and captive coal blocks will also help. Finally, it is important to motivate host states to set up fast-track approval processes by defining a standard framework of benefits to the states. Possible ways to do this include increasing royalties on coal mining and supplying a part of the power generated for the resource-rich states at variable cost.

- **Unshackle public-sector units (PSUs).** Over the next five years, PSUs will account for the majority of power capacity created. To ensure they are suitably empowered to accelerate their capacity addition efforts, it is important to alter procurement processes and policies, offer greater flexibility to re-award or modify contracts in case of non-performance by vendors and contractors, and provide decision rights on matters related to joint ventures, mergers and acquisitions. These steps must be accompanied by means to strengthen the leadership of the Navratna

1 Accounting for 15 per cent of the unallocated power from central PSU power plants.

companies, including five-year tenures for CMDs and Directors, reviews to assess the effectiveness of the boards, processes to ensure the quality of independent directors, and measures to clarify board roles and contributions.

OPPORTUNITIES, RISKS AND WINNING APPROACHES

To meet India's growing power demand, investments of US$600 billion will be required across the value chain. Of this, around US$300 billion will be necessary for generation, about US$110 billion for transmission, and the balance US$190 billion for distribution. By 2017, the sector will present an annual profit (EBITDA) pool of US$135 billion to US$160 billion.

Substantial and rewarding opportunities across the value chain

Many traditional opportunities, such as the development of generation capacity, as well as non-traditional opportunities will emerge across the value chain. Some of the more exciting opportunities that will unfold across each segment are discussed below.

- **Generation.** Besides traditional opportunities in thermal power projects there will be many others such as:
  - Building merchant peaking plants located near load centres in northern or western India—while large base-load capacities are being built in eastern India, demand is growing faster in the northern and western regions.
  - Investing in over-sized captive plants by players in process industries, e.g., cement and chemicals could help raise the value of such projects by over 20 per cent.
  - Setting up group-captive plants to access relatively price insensitive and creditworthy customer segments.
  - Participating in trading activities by leveraging the various arbitrage opportunities that will emerge.
- **Fuel and related infrastructure.** Companies that can mine coal at lower costs will be sought after as most allocated captive blocks in India have not yet been developed. Significant imports of coal will also make it lucrative to participate in its trade and construction of import and handling infrastructure. Resource holders should consider integrating forward to realise higher prices for their resources. This is particularly relevant for gas, the price of which is capped at the moment, and could provide higher earnings if utilised to produce peak power, tariffs of which continue to spiral upward.

- **Transmission.** Transmission will offer a limited number of opportunities with stable returns, many of them in partnership with central or state transmission utilities.

- **Distribution.** As and when partial or complete privatisation gathers momentum, distribution will become a very large and potentially profitable opportunity. Large investments in agricultural feeder separation and metering could provide opportunities for equipment makers and project executors. There will also be demand for turnaround specialists—players with expertise in specific areas like network management, billings and collections, and for smart technology providers—players who can develop, commercialise and support technologies such as prepaid cards, real-time meters, tamper-proof meters and smart grids.

- **Equipment and EPC services.** With the creation of 300 GW of generation and related capacity, India will be among the largest markets in the world for equipment and component suppliers. Attractive opportunities include the supply of key components, such as heavy castings and forging, special steel pipes, balance of plant and engineering, procurement and construction services.

- **Solar power.** With one of the world's highest solar intensities and low cost manufacturing, India has the potential to become a global force in solar energy. An emergining regulatory regime and high peak prices make this opportunity real and attractive.

- **Demand-side management.** Growing focus on demand-side management with resultant shifts to compact fluorescent lamps (CFLs), enforced building and appliance codes, will create rewarding opportunities for professional services firms with expertise in the design and construction of green buildings and in the development and implementation of energy management solutions and products.

Inherent risks will need to be managed

Significant development risks, uncertainty of key regulations and potential market failures are inherent risks in the power sector—it is critical to recognise and proactively manage these risks. The evolving cost curve, volatility in fuel markets, uncertainty of nuclear capacity creation, and potential transmission bottlenecks will create dispatch risks. Continuing losses in distribution could lead to payment security risks. Bottlenecks across the value chain including delays in obtaining sites and approvals, coupled with committed fixed tariffs will create project execution risks. Similarly, there will be fuel supply risks resulting from restricted access to fuel supplies, underexplored sedimentary basins and soaring demand. Managing these risks will require a clear understanding of the impact of each risk on the project and

mitigation plans to ensure that projects remain viable under most outcomes. Finally, players will need to develop business models that overcome some key risks.

Winning approaches

Winning in this sector will require tailoring business models to Indian needs and conditions. Among many, three business models are likely to win and create sustainable value.

- **Integrators.** Market inefficiencies and bottlenecks suggest that integration by players into critical bottlenecked parts of value chain will be beneficial. For example, large-generation players can win by integrating into fuel and EPC, which will allow them to bid aggressively, win competitive projects and establish a low-cost position. Similarly, regulated fuel markets will mean that owners of coal and gas resources can create additional value by integrating forward into power generation.

- **Specialists.** Specialists will come in two forms. First, players who have deep operational expertise and capabilities in a specific segment—such players will succeed because there is a need for significant performance improvement in a particular segment. Most opportunities will come with performance-linked returns and will have to be won by participating in a competitive bidding process. To win, players will need to have the ability to accurately value the performance improvement potential on hand, and have the confidence to execute. Such specialists will include world-class O&M players in distribution, generation or mining and project specialists.

  Second, players who focus on relatively small and potentially valuable opportunities to build a strong position—examples include companies that develop loadcentre-based peaking plants, serve the captive power markets, or provide specialised services, such as demand-side management.

- **Regional entrepreneurs.** These play in multiple parts of the value chain but predominantly work in a few geographies. Such companies will create value by developing a deep understanding of conditions in the region and leveraging their strong relationships with stakeholders, and get access to privileged resources.

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The power sector will provide one of the biggest avenues to participate in the development of India's infrastructure. Undoubtedly, it is fraught with multiple challenges and risks. To overcome these, players will need to craft business models that will allow them to capture value in such an environment. The payoff of making

an early entry will be significantly higher compared to entering when the sector has been reformed—the development of India's telecommunications and infrastructure development industries serve as evidence of this.

Powering India is imperative to sustaining economic growth and will require a concerted effort by all stakeholders. If successful, the power sector will contribute to the well-being of more than one billion Indian citizens and in the process it will also create some of the world's largest energy companies.

Chapter One: Outlook 2017

Powering India:
The Road to 2017

Chapter One: Outlook 2017

India's status as an emerging economic superpower has placed it on the agenda of most countries and businesses. The country's rapid transition from an agrarian to a services-led economy has resulted in rising incomes and a significant increase in consumption. This has increased the burden on one of India's weak spots—its infrastructure. At present, the country is striving hard to fulfil its infrastructure deficit, unarguably one the greatest impediments to its growth.

In the past few years, policy makers have recognised the stakes involved and boosted efforts on many fronts. Although much remains to be done, India has made considerable headway in areas like roads and highways development, airport infrastructure, telecommunications and ports.

In the area of power, several progressive measures have been launched, such as the Electricity Act 2003. Despite these, India faces a substantial power deficit. By 2017, demand will be over 315 GW, significantly higher than expected. To meet this demand, India will need to substantially accelerate its pace of capacity addition, and suitably modify the profile of new capacities. This will require a fivefold to tenfold increase in the pace of capacity addition, which will translate to investments of over US$600 billion (Rs 24 lakh crores) over the next 10 years. To achieve this, India will need to adopt a radically different approach from the current one. The remainder of this chapter discusses these findings in greater detail.

PROGRESSIVE MEASURES UNDERWAY

In the past 5 years, the government has introduced several strategic measures to unleash the potential of the power sector. A number of policies have been enacted, notably the Electricity Act (EA) 2003, the National Electricity Policy, the Ultra Mega Power Projects (UMPPs), the Accelerated Power Development and Reform Programme (APDRP), the Integrated Energy Policy, and the National Tariff Policy 2006. Further, a number of administrative steps have been taken, including tripartite agreements between the central government, central generators and the states, recapitalisation of State Electricity Boards (SEBs), a thrust on captive coal mining, the establishment of electricity regulators, and selective unbundling of SEBs.

Implementation of the EA 2003 has created additional transparency and objectivity in the tariff determination process through the actions of central regulators and state governments. Further, the more progressive states have been able to significantly reduce aggregate technical & commercial (AT&C) losses by improving operations at state-owned distribution companies. The EA 2003 and the National Electricity Policy have also paved the way for competition in retail sales to large industrial consumers through open access, though tariffs remain high due to the surcharges levied by state-owned distribution companies (discoms). Similarly, the UMPPs have stimulated interest from private players, introduced a new accelerated approach to develop mega projects and led to competitive tariffs.

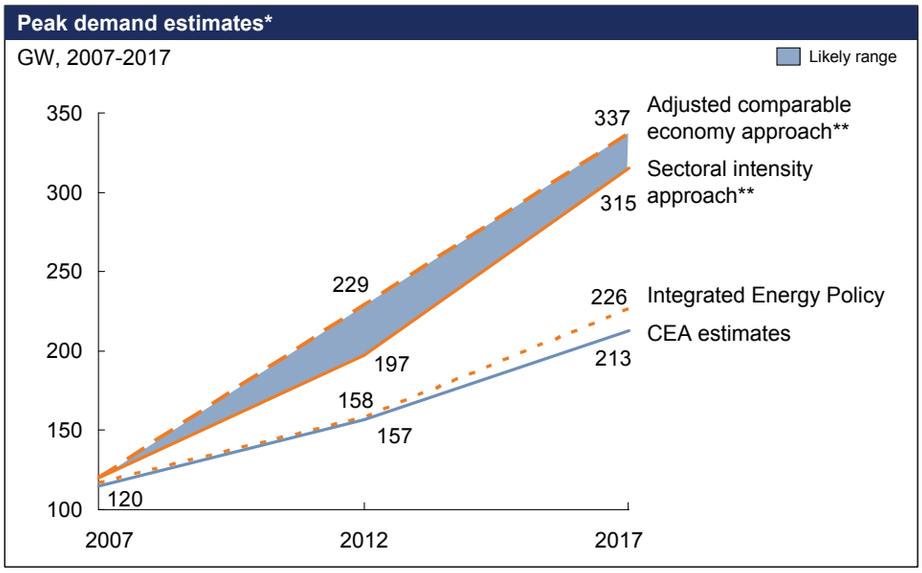
Though progressive, these measures are insufficient to meet India's needs. This is mainly because of soaring demand, discussed in the next section.

BY 2017 DEMAND WILL BE SUBSTANTIALLY HIGHER THAN EXPECTED

Our analyses suggest that if India continues to grow at an average rate of 8 per cent for the next 10 years, the country's demand for power is likely to rise from around 120 GW at present to 315 to 335 GW by 2017 (Exhibit 1.1). This is about 100 GW higher than most current estimates.

Exhibit 1.1

DEMAND WILL BE 315-335 GW BY 2017, ABOUT 100 GW HIGHER THAN CURRENT ESTIMATES



* Including captive demand
** See appendix for details on demand estimation approaches
Source: Central Electricity Authority (CEA); Global Insight (World Industry Monitor); Planning Commission; McKinsey analysis

Four key drivers will trigger this exponential increase in demand:

- **Growth in residential consumption.** Rising incomes have driven, and will continue to drive, demand across consumer classes in rural and urban India. Growing at 14 per cent over the next 10 years, India's residential power consumption will grow faster than its GDP growth at 8 per cent.

- **Electrification of rural India.** According to the 2001 census, 125,000 villages are yet to be connected to the power grid, and an additional 23 million households below the poverty line do not receive power. The government aspires to cover these areas and provide 'power for all by 2012' through the Rajiv Gandhi Gramin Vidyutikaran Yojana and Bharat Nirman programmes.

- **Realisation of latent and suppressed demand.** Scheduled blackouts suppress demand as residential and commercial consumers go without power for several hours every day. In addition, many industrial consumers are forced to use expensive diesel-based power. If added to the overall pool, these consumers will add significantly to the demand by 2017.

- **Manufacturing growing faster than before.** As the manufacturing sector in India accelerates, its relatively higher consumption of electricity will lead to a disproportionately higher demand. Already, manufacturing sector has growth from 5.9 per cent during 2000 to 2004 to 9.5 per cent in the last three years.

INDIA'S PACE OF CAPACITY ADDITION MUST INCREASE FIVEFOLD TO TENFOLD TO MEET GROWTH IN DEMAND

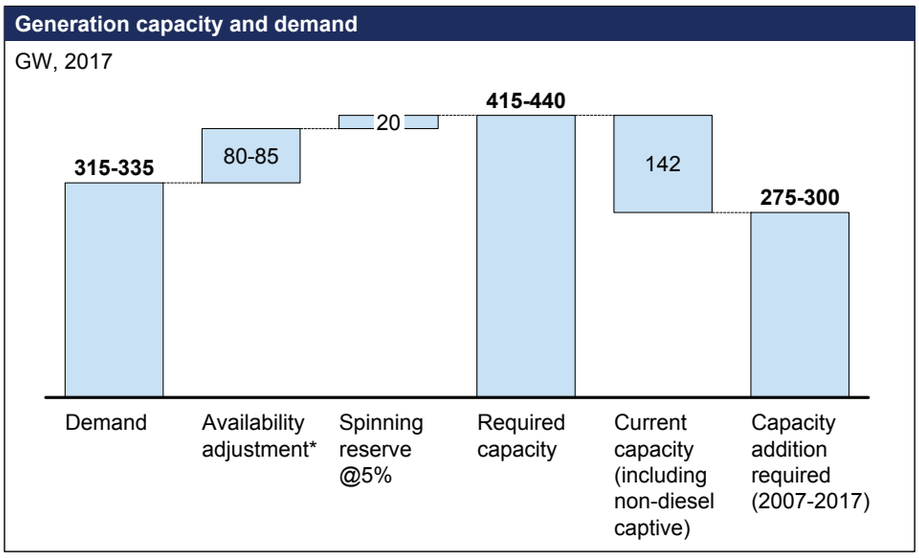
To fulfil its power requirement of about 315 to 335 GW by 2017, India will require generation capacity of 415 to 440 GW. The additional 100 GW capacity required over projected demand is due to plant availability adjustments and a modest 5 percent spinning reserves. In effect, this implies a tripling of installed capacity from the current level of 140 GW (Exhibit 1.2). Adding the required 300 GW of fresh capacity by 2017 translates into an annual addition of about 30 GW.

If India maintains the rate of capacity addition that it achieved in 2007-08, i.e., 9 GW per year, only 90 GW will be added in the next 10 years. In the IXth and Xth plan periods, however, India managed to add only 40 GW, or 4 GW per year. Our estimates suggest that in a best case scenario, 160-180 GW will be added in the next 10 years, or 16 to 18 GW per year (Exhibit 1.3). This is based on a bottom-up estimate of project implementation status for the XIth Plan, and an assumption that achievement during the XIIth Plan period will increase to 20 GW, equivalent to the visible equipment capacity available during that time.

Bridging this gap calls for a significant increase in the country's pace of capacity addition.

Exhibit 1.2

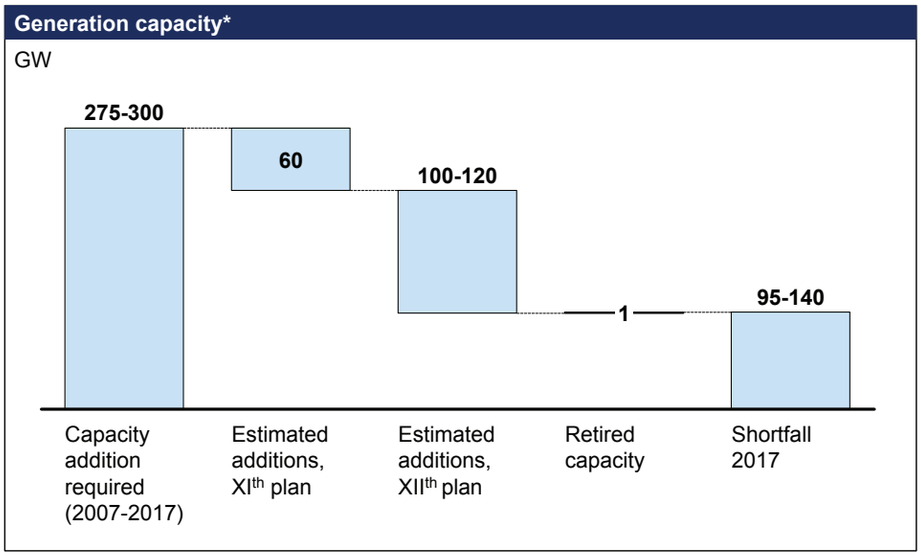
275-300 GW OF CAPACITY ADDITION REQUIRED IN NEXT 10 YEARS



* 90% availability for new plants; 70% availability for existing plants, similar to current levels
Source: CEA; Planning Commission; Literature search; Company websites; McKinsey analysis

Exhibit 1.3

IF BUSINESS AS USUAL CONTINUES, INDIA IS LIKELY TO FACE A CAPACITY SHORTFALL OF 95-140 GW BY 2017



* Assuming 50% target achievement in XIth plan; 45-50% in XIIth plan; 100% completion of XIth plan spill over in XIIth plan period
Source: CEA; Planning Commission; Literature search; Company websites; McKinsey analysis

THE PROFILE OF CAPACITY ADDITION MUST BE MODIFIED

While much has been said about augmenting India's generation capacity, not enough attention has been paid to the profile of capacity addition. Even as India significantly augments its generation capacity, it is imperative to evaluate the profile of new capacity across four dimensions:

- The mix of base-load plants and peaking plants
- The impact of fuel choices and sources on energy security
- Environmental impact, e.g., carbon emissions
- The economics of new capacity

India's current projected mix of capacity is likely to worsen the situation on all the above dimensions (Exhibit 1.4), suggesting the need to modify the mix. The implications of pursuing the current course are discussed below.

Exhibit 1.4

PLANNED GENERATION CAPACITY PROFILE WILL NEED TO BE MODIFIED

Dimensions	Description	Shortfall*
		Per cent
Mix of base-load and peaking plants	• 80% of present capacity addition plans focus on base load capacity	20
Impact of fuel choices and sources on energy security	• Primary energy imports likely to double by 2017	15
Environmental impact	• Carbon emissions likely to double from 1.2 billion tonnes to 2.4 billion tonnes	25
Economics	• Rampant power theft and cross-subsidies • Increasing volatility of fuel costs and electricity prices	10

* Compared to requirements or improvement potential from available resources

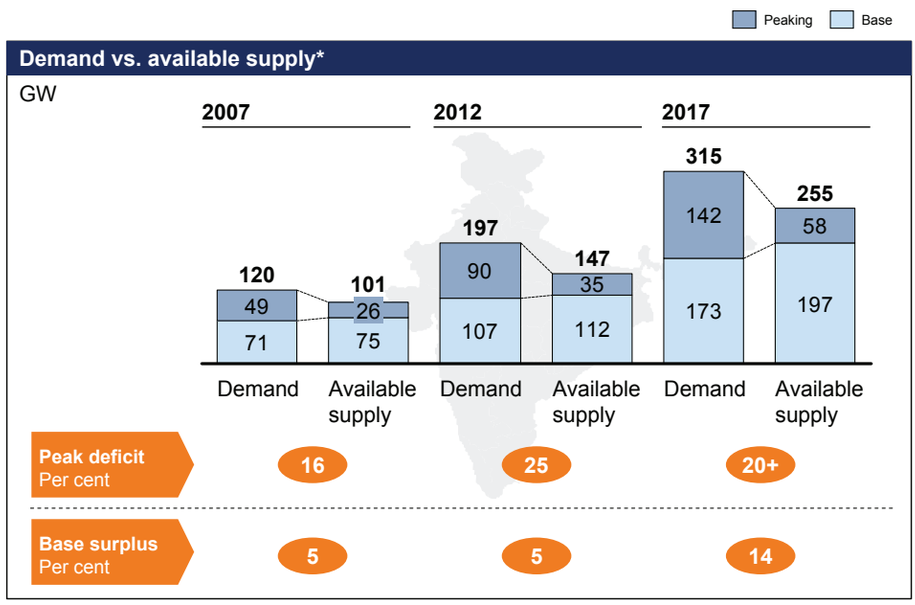
Source: McKinsey analysis

- **Mix of base-load and peaking plants.** Current plans focus primarily on creating base-load capacity and do not take into account the growing need for peaking power. This is primarily because it is more economical to build and run base-load plants than to develop and operate peaking plants. However, nearly 40 per cent of India's demand today is non-base load or cycling demand, i.e., it occurs for only a part of the day.

In the absence of peaking plants that can rapidly increase or decrease output, the country is witnessing a rising deficit during peak hours, and correspondingly high peak prices. If base-load plants are used to bridge this deficit, it would lead to reliability issues as these plants are not designed for heavy cycling. This shortage co-exists with a base-load surplus, with plants having to cut back output during off-peak hours. If base-load focused capacity addition continues, India is likely to have about 20 GW of surplus during base-load hours, but a peak deficit of around 70 GW by 2017 (Exhibit 1.5).

Exhibit 1.5

PEAK DEFICIT OF ABOUT 70 GW LIKELY BY 2017



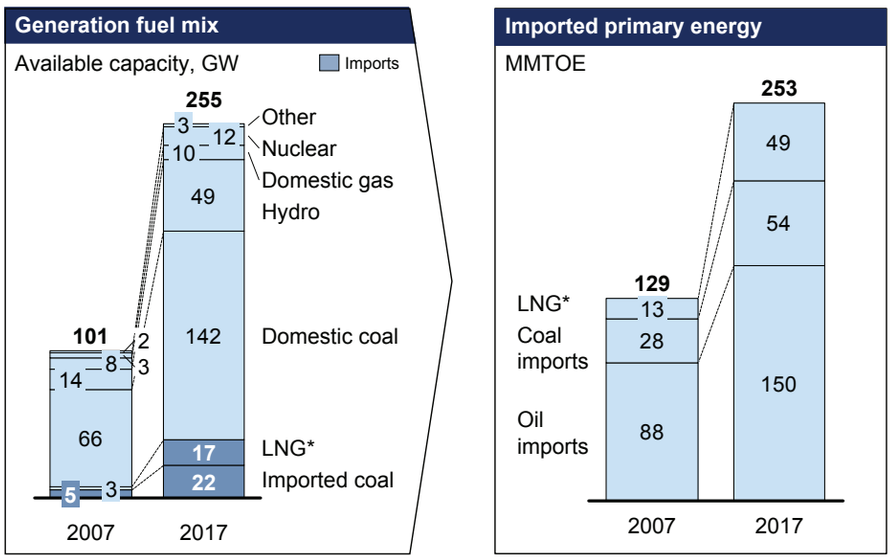
* Including captive
Source: Planning Commission; McKinsey analysis – Integrated Revenue Model (IRM)

Finally, as economic growth will accelerate, India's demand profile is likely to change. As witnessed in developed countries, India too can be expected to see a drop in the proportion of base-load demand from 60 per cent to 50 per cent of peak demand. If this happens, the situation of base surplus will worsen.

- **Energy security.** If the current scenario of restricted access to domestic coal prevails, over 30 per cent of India's fuel supplies are likely to be imported by 2017. This is despite the fact that India's coal reserves are the fourth largest in the world. India's rising dependence on imports for its overall energy requirements is driven by the shortage of domestic fuel supplies (Exhibit 1.6).

Exhibit 1.6

INDIA'S ENERGY IMPORTS LIKELY TO DOUBLE BY 2017

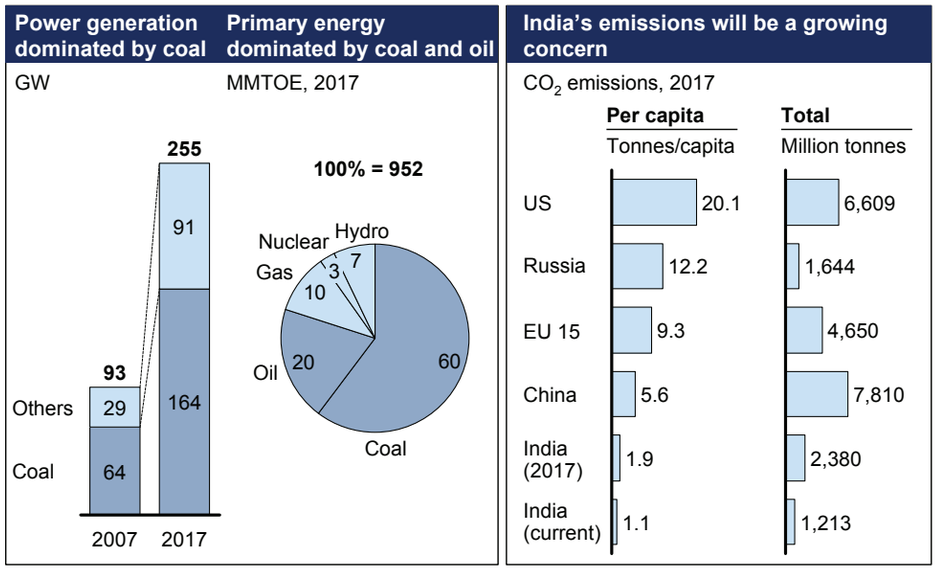


* Assuming that LNG import capacity required to bridge the gap between demand and currently visible supply will be set up between 2007 and 2017
Source: CEA; FACTS; Coal Ministry; BP Statistical Review; Ministry of Petroleum and Natural Gas; McKinsey estimates

■ **Environmental impact.** As India continues to add capacity, it will need to control its carbon emissions. By 2017, 80 per cent of India's power supply will be generated by fossil fuels (Exhibit 1.7), which is likely to double the country's CO_2 emissions from 1.2 billion tonnes today to about 2.4 billion tonnes.

Exhibit 1.7

INDIA'S CARBON EMISSIONS LIKELY TO DOUBLE BY 2017



Source: Global Insight (World Market Monitor); CEA; FACTS; International Energy Agency (IEA); McKinsey estimates

- **Economics:** Given its coal-dominated generation profile, India's power generation costs are relatively low compared to those in developed countries. However, current mining regulations and resettlement and rehabilitation issues associated with the development of domestic coal and hydro plants have led to increased fuel imports. Imported fuels are not only more expensive than domestic reserves but they also increase India's dependence on energy imports, which will result in greater volatility of fuel costs and electricity prices.

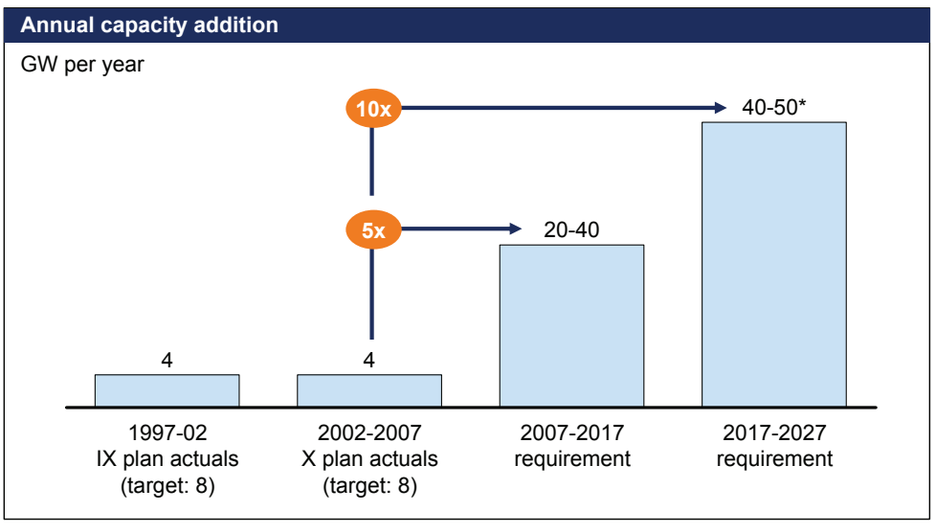
  Finally, challenges in distribution make power tariffs a concern. Rampant power theft and cross-subsidies have left industrial users bearing the burden of high power costs. Reforming distribution and rebalancing tariffs will be critical to ensuring that Indian manufacturing remains globally competitive.

A RADICALLY NEW APPROACH IS REQUIRED

India will need a fivefold to tenfold increase in its rate of capacity installation, if it is to satisfy its demand of 315 to 335 GW by 2017 (Exhibit 1.8). In addition, as discussed above, the profile of this new capacity will need to be modified to meet the country's needs.

Exhibit 1.8

5-10X SCALE-UP REQUIRED IN RATE OF CAPACITY ADDITION



* Assuming required capacity of 415-440 GW by 2017, GDP growth of 8% and electricity elasticity of 1.5
Source: CEA; Planning Commission; McKinsey analysis

The sheer magnitude of the shift implies that a few measures alone will not be enough. Instead, India will need to adopt a radically new approach. While some of the basics, such as the EA 2003 and regulators are already in place, fundamentally new approaches are required to address market and viability risks, accelerate capacity addition, secure fuel supplies and improve the efficiency of the sector.

Chapter 2 of this report details the new approach that is required, in the form of a 10-point programme for the industry. As a result of this programme, several exciting investment opportunities will emerge across the sector's value chain. Chapter 3 describes these opportunities.

Chapter Two: A 10-Point Programme

Chapter Two: A 10-Point Programme

Chapter 1 described the magnitude of the scale-up required in India's power sector and established the need for a radically new approach to achieve it. At one stage, measures like unbundling and open access were considered to be optimal solutions. But multiple and complex challenges— equipment shortages, inadequate fuel supplies, delays in obtaining site approvals and a constrained regulatory environment—make it clear that no single measure can achieve the desired result. Instead, a comprehensive programme that debottlenecks the sector, creates the necessary regulatory environment and enables financial viability for creating assets is imperative.

Furthermore, the power sector has been the focus of many government reviews, audits and task forces, as India's administration has attempted to improve the sector's performance. While a few success stories are evident at both the central and state levels, it is clear that to scale up capacity fivefold to tenfold, the sector's governance and monitoring mechanisms must be strengthened.

The first section of this chapter describes a comprehensive 10-point programme for India to not only meet its soaring power demand, but also to fulfil its objectives of managing energy security and emissions. The second section focuses on the governance structure and mechanisms needed for successful implementation of the 10-point programme.

THE 10-POINT PROGRAMME

The 10-point programme represents a comprehensive set of initiatives required to unlock India's power sector. This view has been developed and syndicated through multiple discussions with key stakeholders—private players, public-sector units, government officials across the centre and states, regulators, fuel suppliers and other infrastructure providers.

The programme aims to address the following four issues:

- **Viability and market risks.** The sector is financially unviable due to high theft and losses in distribution and is unlikely to generate enough cash flows to stimulate investments.

- **Slow pace of capacity addition:** Coordination with multiple stakeholders across the centre and states most often leads to substantive delays in acquiring sites and obtaining approvals. Other major bottlenecks include shortages of engineering

procurement and construction (EPC) services, skilled manpower and equipment capacity.

- **Inadequate fuel supplies.** A regulated coal sector and limited indigenous gas supply are matters of concern.

- **Operational inefficiencies.** Poor operational efficiencies due to low plant load factors (PLFs) of generation plants, high rates of failures in transmission, rising losses in distribution networks and wasteful consumption patterns are unnecessary burdens.

The 10 points of the programme address these four major issues and are accordingly grouped under them.

Address viability and market risks

To keep pace with spiralling demand, India's power sector will need investments of about US$600 billion (Rs 24 lakh crores) by 2017. Raising this amount of capital will require financially viable projects, which, in turn, will entail addressing distribution viability and market risks.

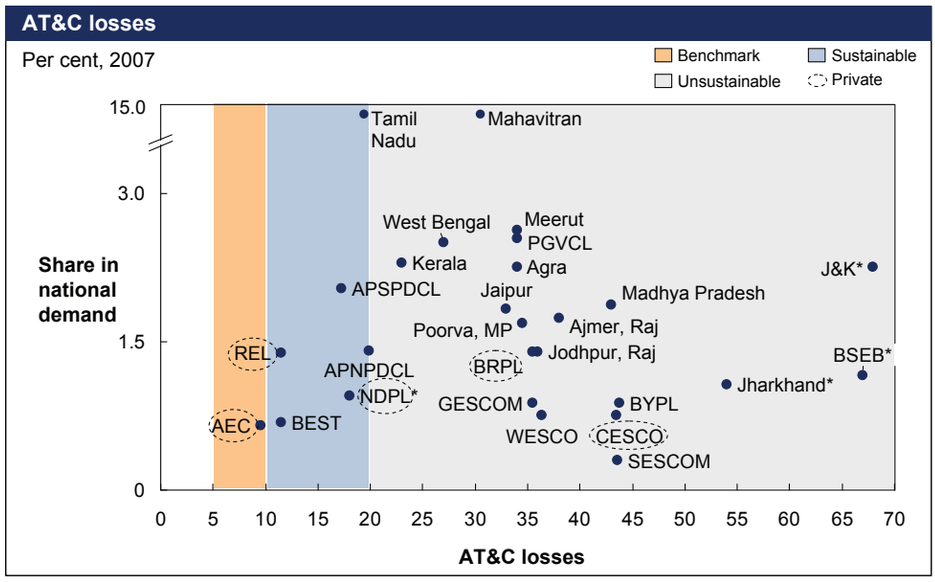
Moreover, the level of private participation in the sector will also need to increase, since India is expected to spend more than US$1 trillion[1] on infrastructure (Rs 40 lakh crores) in the next 10 years, and government funding is likely to be channelled towards other segments, such as irrigation, water and roads. For the XIth five-year plan period, investments by the private sector are as little as US$28 billion, against a total outlay of US$230 billion. This makes it essential to accelerate private participation in the sector, while strengthening the public-sector companies driving current growth. Finally, even PSU projects may need market funding which re-emphasises the need to address distribution viability.

Today, tripartite agreements and power purchase agreements (PPAs) with some viable distribution companies (discoms) are securing most of the investments being made in the generation of power. Despite recent moves by a few private players, especially around the UMPPs, several new entrants are discouraged by the viability risk in the sector, especially when relatively less risky investment alternatives are available. Aggregate technical and commercial (AT&C) losses continue to remain high. The recent drop in reported losses from 39 per cent in 2004-05 to 35 per cent in 2005-06 is a result of the improved performance of only a few discoms. Several large discoms continue to report losses of over 30 per cent, and some even as high as 50 per cent (Exhibit 2.1). And although these discoms receive financial support

1 Based on estimates in the XIth 5-year plan.

Exhibit 2.1

NEED TO REDUCE AT&C LOSSES AT MOST DISCOMS



* 2008E

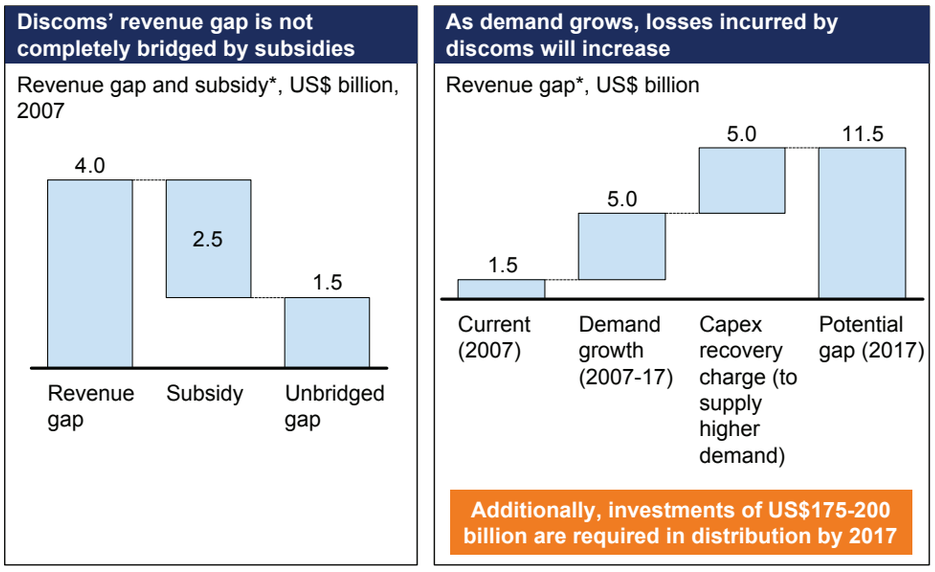
Source: State Electricity Regulatory Commission (SERC); CEA; McKinsey analysis

from their respective state governments, the quantum of funding—Rs 6,000 crores (US$1.5 billion) at present—could expand to over Rs 45,000 crores (US$11.5 billion) by 2017 (Exhibit 2.2), making these losses unsustainable.

Exhibit 2.2

DISCOMS REMAIN STRUCTURALLY UNVIABLE

ESTIMATES



* For top 8 states (Uttar Pradesh, Rajasthan, Gujarat, Punjab, Karnataka, Andhra Pradesh, Tamil Nadu and Maharashtra) that account for 70% of overall demand

Source: SERC websites; CEA; McKinsey analysis

The first two elements of the 10-point programme address the viability and market risks faced by the sector.

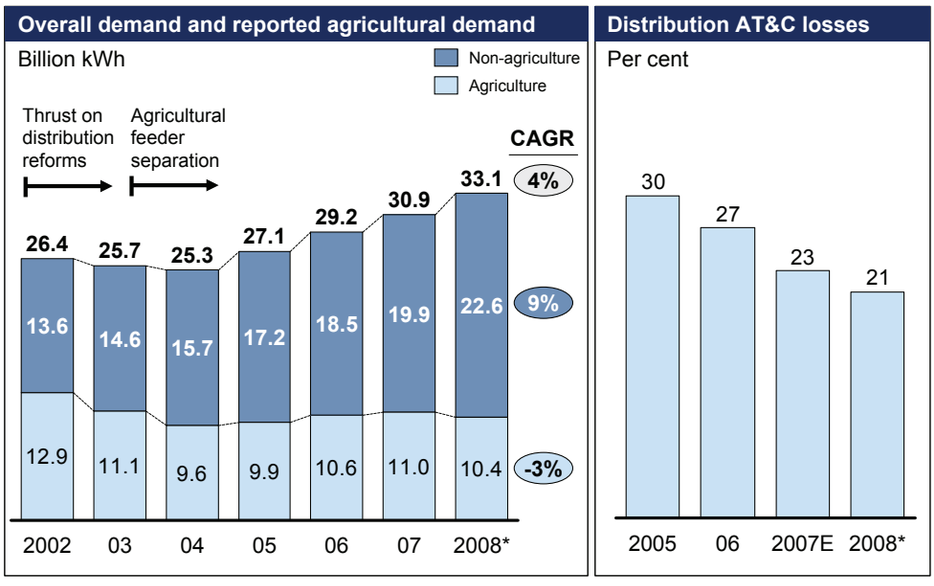
1. Reduce AT&C losses to 15 per cent by 2017

Performance transformations by state-owned discoms e.g., Gujarat and Andhra Pradesh, and the evidence of strong performance by private discoms, such as North Delhi (NDPL), Mumbai, Kolkata and Ahmedabad, suggest that reducing AT&C losses to this extent is quite feasible. Further, as confirmed by several experiences across the country; urban, industrial and rural customers are now showing a clear willingness to pay for uninterrupted power supply. The following four steps are essential for discoms to reduce AT&C losses to less than 15 per cent by 2017:

- **Ring-fencing agricultural supply** is a crucial starting point to identifying and measuring losses. For example, in Gujarat, a strong administrative focus on segregating agricultural feeders, among other initiatives, has resulted in a remarkable improvement in distribution performance. AT&C losses have dropped from 30 per cent in 2004-05 to about 20 per cent today. The effort has helped isolate and measure agricultural demand. This has put the spotlight on remaining losses, leaving little scope to pass off theft or inefficiency as lower-priced consumption by farmers. Agricultural demand for power in Gujarat now shows more realistic growth and overall losses are declining (Exhibit 2.3). A similar effort on separating

Exhibit 2.3

GUJARAT EXAMPLE: STRONG IMPACT OF AGRICULTURAL FEEDER SEPARATION



* Projected
Source: Interviews; Gujarat Electricity Regulatory Commission; McKinsey analysis

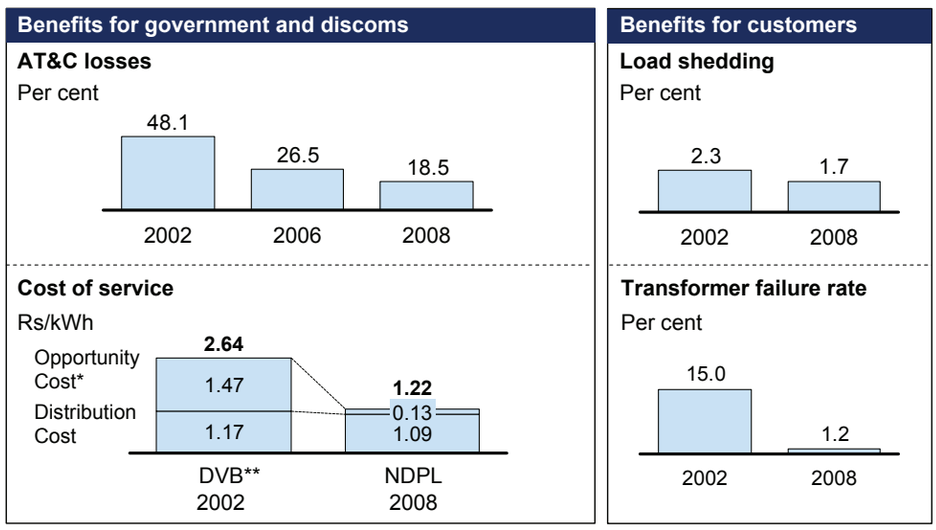
agricultural feeders will be relevant for most states with large rural populations. However, given the stakes involved, achieving this will take a combination of political will, strong administrative monitoring and efficient management of SEBs.

- **Partially or completely privatising distribution circles, especially in tier 1 and tier 2 cities.** Some states like Gujarat and Andhra Pradesh have transformed distribution by enhancing the operational efficiency of state-owned discoms. However, the likelihood of replicating—or perhaps even sustaining—such transformations of state-owned discoms is a tall order, given the level of alignment required between political, administrative and market objectives. On the other hand, privatisation is a realistic option that should be actively pursued. Privatisation could be partial (e.g., franchising collections), or complete (e.g., setting up joint-venture companies, as in Delhi).

  For example, after privatisation, North Delhi Power Ltd (NDPL) reduced losses from 48 per cent to 18 per cent in less than 6 years. Four focused efforts led to this outcome: (i) sustained investments in the network to reduce transformer failures; (ii) broad-based engagement with the community to minimise theft; (iii) strong management systems to facilitate accurate billing and collections; and (iv) greater commercial focus to balance economic and political objectives (Exhibit 2.4).

Exhibit 2.4

NDPL EXAMPLE: DISTRIBUTION PERFORMANCE IMPROVEMENT FOLLOWING PRIVATISATION



* Cost of high AT&C losses, estimated as the power purchase cost times actual AT&C loss less benchmark AT&C loss of 15 per cent
** Pre-privatisation in 2002
Source: Delhi Electricity Regulatory Commission; Ministry of Power; Literature search; Interviews; McKinsey analysis

Partial privatisation is also an alternative worth considering in cases where complete privatisation is difficult to implement. Partial privatisation is already

under way in some circles in Maharashtra. The critical success factor for such arrangements is the ability to give private players an incentive to make sufficient investments in upgrading and sustaining the network. This could get affected in a service-type arrangement. Measures to stimulate investments could include:

— A sufficiently long franchise period, e.g., 30 years

— Setting up aggressive targets to reduce AT&C losses with the option to allow the private incumbent to retain additional earnings when it outperforms, and vice versa

— Agreeing upfront on the minimum investments required to upgrade infrastructure. This should be regularly and systematically monitored during the franchise period.

Privatisation efforts should focus on tier 1 and tier 2 cities for the next 3 to 5 years, as they account for a large part of the demand and probably a larger part of the true losses in most states. Furthermore, linking partial privatisation of distribution circles to generation investments could also be pursued, as it would help lower the risks of building generation capacity. In effect, this would mean providing preference to players who have made substantive investments in generation by participating in a competitive bidding process e.g., UMPPs. Within these cities, distribution can be divided to the lowest level to build accountability and community ownership, for example, down to the colony or sector level, where residents' associations take responsibility for collections and become large enough consumption points to directly contract power from generators. Innovative measures like these will help strengthen distribution performance, the weakest link in the sector's performance.

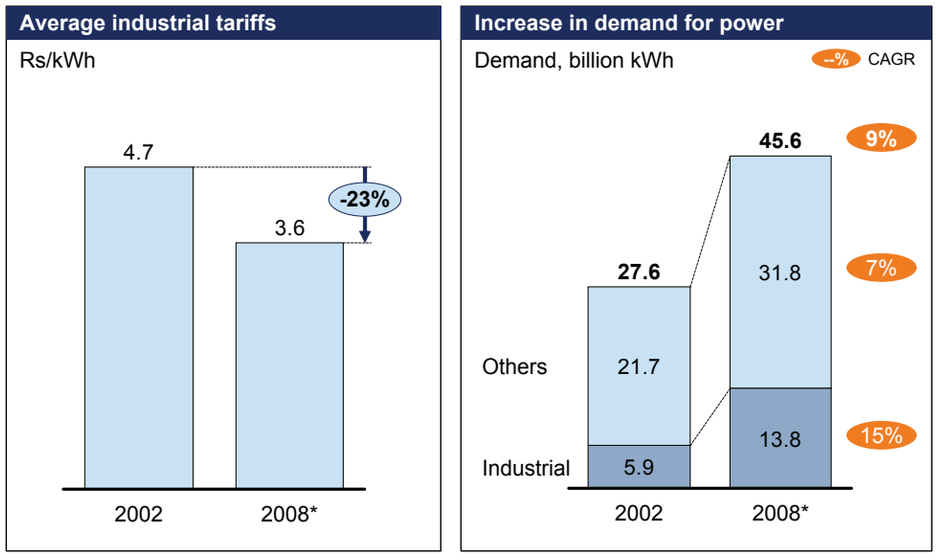
■ **Driving open access, lower industrial tariffs and multi-year targets to reduce AT&C losses.** For years, industrial and commercial customers have borne the brunt of theft, inefficiencies and skewed tariffs. Along with the measures described above, lowering industrial tariffs is critical to reducing the incentive for theft.

Moreover, as witnessed in Andhra Pradesh (Exhibit 2.5), lower industrial tariffs help spur demand. Regardless of whether the demand growth is genuine or simply substitution for theft, it improves economics for the SEB, and also contributes to the long-term health of the sector. To further encourage industrial customers, open access needs to be aggressively pursued and a possible incentive offered through the Accelerated Power Development and Reform Programme (APDRP). This is likely to succeed only once the agricultural feeders have been separated, that is, when SEBs can clearly identify non-agricultural demand from agricultural demand and losses.

Further, multi-year targets to reduce AT&C losses must be built into tariffs to ensure action from SEBs and franchisees alike. Implementing this as a priority for discoms that cannot be partially privatised will make apparent the revenue gap that needs to be funded by the state government. Lastly, allocations from the central power pool to such discoms should be linked to performance improvements.

Exhibit 2.5

ANDHRA PRADESH EXAMPLE: LOW INDUSTRIAL TARIFFS HAVE SPURRED INDUSTRIAL POWER DEMAND



* Projections

Source: Andhra Pradesh State Electricity Regulatory Commission; McKinsey analysis

- **Using modern technologies to limit theft and target subsidies.** The use of newer technologies has served many international discoms well. For example, the use of prepaid cards in Argentina has lowered theft and improved collections. Smart cards, prepaid cards and meters offer a good way to target subsidies to agricultural consumers and families below the poverty line, while ensuring payment security for suppliers and discoms. Early pilots with government consumers in Delhi have also shown good results.

- **Building consensus on stringent loss-reduction measures.** Broadcasting the rules of the game to all stakeholders can go a long way towards increasing public awareness and co-operation. Measures to this effect include:

  — Publishing well-defined, consistent rules linking the extent of load shedding to the extent of losses in specific areas

  — Regularly announcing the relative performance of discoms on AT&C losses, load shedding and unplanned blackouts, and network reliability

— Making public the list of defaulters

— Increasing community pressure by enlisting people's representatives, residents' associations and industrial associations in campaigns to reduce losses.

2. Create market mechanisms

Current plans to add capacity primarily focus on building base-load capacity, which will worsen peak-hour shortages. Today, however, even a peak shortage of 15 to 20 GW and high unscheduled interchange (UI) charges have failed to stimulate peaking investments. One of the main reasons for this is the lack of viable market mechanisms, vital to enhance investor confidence. Two measures necessary to lower the risk of investing in generation and raising investor confidence are:

- **Creating a deep and well-functioning wholesale market.** Though power trading has begun, it is yet to achieve depth. To reduce dispatch and collection risks that concern most generation investors, it is essential for India to have a deep and well-functioning wholesale electricity market. This also provides a creditworthy counterparty and reduces payment risks. To deepen the market, the government should consider:

  — Trading a part of the central pool reserves in this market

  — Encouraging new projects to reserve a certain portion of their volumes for the wholesale market

  — Mandating existing plants to channel a part of their capacity to the exchange once their PPAs expire.

  In parallel, the Central Electricity Regulatory Commission (CERC) will need to put safeguards in place to prevent market failures and prohibit gaming. This can be done by:

  — Ensuring participation by large numbers of buyers and sellers

  — Ensuring sufficient spare transmission capacity along major routes

  — Maintaining strong regulatory oversight along with price caps.

- **Introducing differential peaking tariffs.** Given the rise in peak-hour shortages and India's large hydro potential, storing energy will be beneficial. Currently, India's hydro capacities are largely designed to operate as base-load plants. Our estimates suggest that converting most of India's reservoir hydro plants into peaking plants could add as much as 15-20 GW of peak capacity. Further, this capacity can be added faster than developing greenfield hydro plants, and with fewer relocation and rehabilitation issues. Additional investments are required to do this, such as

additional hydro-turbine capacity and creating pumped storage facilities, which in turn will require differential multi-year peak tariffs as a policy measure. Even new hydro plants should be designed as peaking plants with a pumped storaged unit, wherever possible. Tariffs for this type of power are likely to be in the range of Rs 4–6 per kWh, considerably lower than the current cost of diesel-generated peak power, which is more than Rs 10 per kWh.

Accelerate capacity addition

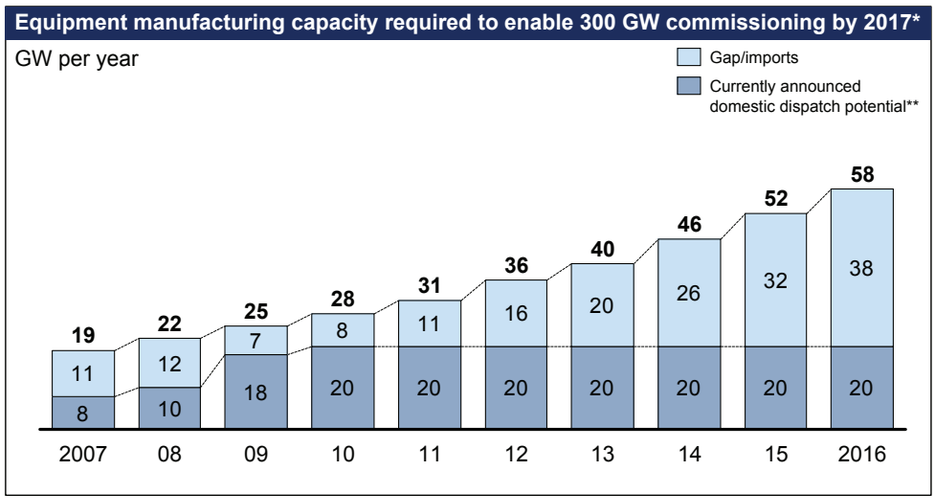
There is an urgent need to step up the pace of capacity addition by fivefold to tenfold in the next 10 years. Achieving this requires debottlenecking the sector, as well as anticipating and planning for future needs. Delays in acquiring sites and obtaining approvals, equipment shortages and the inability to achieve financial closure are the primary reasons that account for the shortfalls witnessed in previous plan periods. This holds, despite a few, recent instances of accelerated development of coal-fired projects e.g., UMPPs. Our findings suggest that:

- The availability of sites unencumbered by rehabilitation issues, water availability and environmental constraints is a major bottleneck today. Even after sites are made available, development activities are severely constrained by considerations of security, connectivity and local approvals.

- To reach a level of 440 GW of installed capacity by 2017, nearly 300 GW of equipment should be dispatched to sites by 2015. However, even if all current plans to expand the capacity of original equipment manufacturers (OEMs) like Bharat Heavy Electricals (BHEL) and Larsen & Toubro (L&T) stay on course, local assembly plants will only be able to deliver 160 GW (Exhibit 2.6). Even if adequate assembly capacity is created, capacity for critical components will continue to be scarce. Today, the local capacity for large forgings is about 3,500 tonnes per year, while demand will rise to 20,000 tonnes by 2012. Given that efforts to step up forging capacity are rather limited, the situation will progressively worsen.

Exhibit 2.6

NEED TO BRIDGE LARGE EQUIPMENT CAPACITY GAP



* Based on Boiler Turbine Generator (BTG) dispatch, 18 months prior to date of commercial operations

** Current announcements include 1) BHEL's capacity expansion from 8,000 MW/year currently to 15,000 MW/year by March 2009, 2) L&T-Mitsubishi Heavy Industries JV's plans to start super-critical boiler and large utility turbine production by 2009 and 3) Thermax's plans to start production of large utility boilers by June 2010

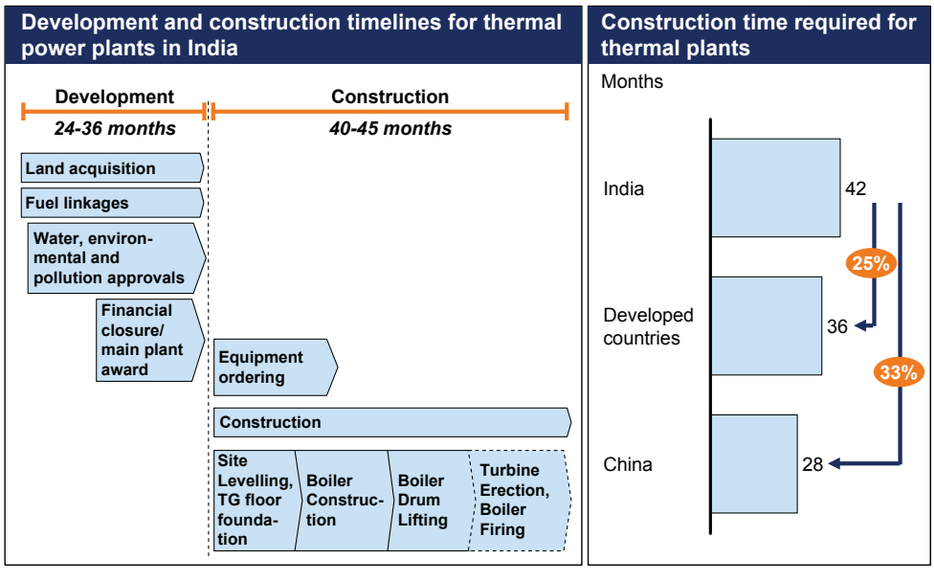
Source: Literature search; McKinsey analysis

■ The slow pace of executing projects will further compound shortfalls. It takes 24 to 36 months to prepare a coal-based thermal power project in India, followed by another 42 months to construct and commission it (Exhibit 2.7). In comparison, other countries take much less time—China completes the construction and commissioning of comparable plants in 28 months, 33 per cent lower than the

Exhibit 2.7

ACCELERATE PACE OF PROJECT DEVELOPMENT AND CONSTRUCTION

ILLUSTRATIVE



Source: Industry Interviews; McKinsey analysis

time taken in India. Finally, severe shortages of skilled manpower will further aggravate the situation.

To augment and accelerate capacity addition, action is needed on the following three initiatives.

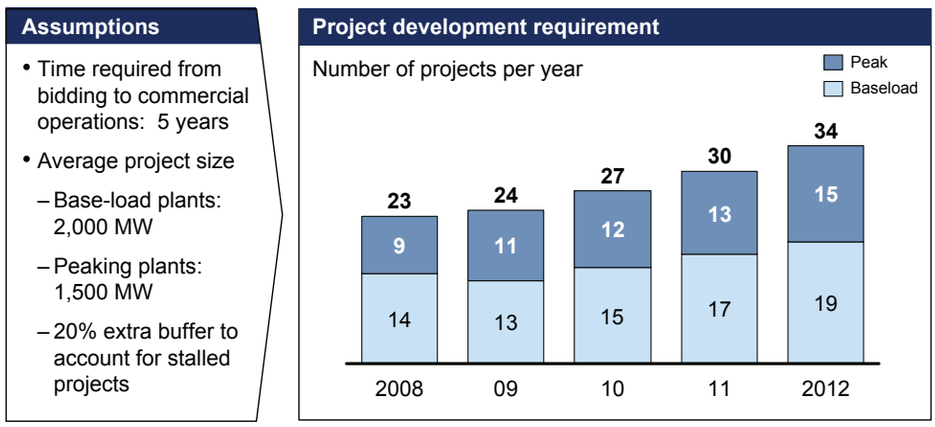
3. Prepare and bid 140 mega project sites by 2012 with end-to-end approvals in place

Preparing packages for approximately 140 projects by 2012 is critical to ensuring that development activities are on track to meet 2017 generation capacity requirements. These packages must include land with access to water, basic connectivity and site-related approvals. Exhibit 2.8 shows the number of these sites required each year.

Adopting existing models can be an effective way to streamline and to expedite the approvals processes that currently delays efforts to add capacity. For example, 'shadowing', the single-window mechanism that simplifies the approvals process in the Ministry of Environment & Forests and the Ministry of Mining among others, and proposed in the new draft National Minerals Policy, could be an option. Another could be that crafted for the UMPPs, whereby most approvals are in place prior to the start of the bidding process. Establishing a cross-ministry standing committee might also be a plausible route.

Exhibit 2.8

NEED TO PREPARE 140 MEGA PROJECT SITES FOR BIDDING BY 2012



Source: McKinsey analysis

While preparing site packages, it is important to consider two factors:

- **The profile of the project.** Given the nature of peak versus base demand in India, projects accounting for 90 to 110 GW of supply will need to be peaking plants. This already assumes that a part of the peaking requirements will be met by cycling of base-load plants. Peaking plants will need to be either hydro plants to the extent possible, as well as load centre-based gas plants.

- **Fast-track approvals.** This effort will need to first focus on generation sites. However, a similar fast-tracking approach to providing right of way and workable sites will also be required for corresponding transmission lines and substations.

4. Create 30 GW of annual capacity for power equipment and the related supply chain

At present, this is one of the most visible bottlenecks in the sector. Due to long lead times in the supply of equipment, several players have locked in overseas equipment capacities and are setting up engineering, procurement and construction divisions. While additional capacity to assemble equipment is important, supply chains are also essential to provide critical components and balance of plant equipment. These include several capital-intensive components like heavy castings and forgings, pressure piping and fabrication. Attracting entrepreneurs well in advance will be critical if these components are to be available in time.

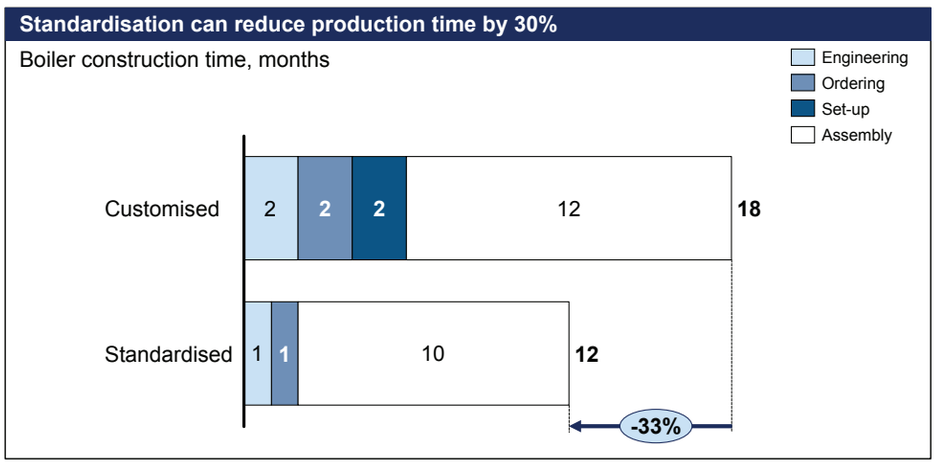
A few measures that could help reduce bottlenecks in equipment supply include:

- **Standardising plant modules.** Standardisation can reduce time to design, fabricate and erect plants by 30 per cent. Capital-intensive projects, such as refineries, are leveraging the repeat design approach to condense project time and cost. This approach was extremely helpful in China as standardised set sizes and plant layouts significantly reduced costs and timelines. In the case of India, it would be prudent to standardise at least SEB and central public sector unit (PSU) orders for one to two subcritical sizes, for example, 250 MW or 500 MW, and one to two super-critical sizes, for example, 660 MW or 800 MW. Over time, OEMs will be able to offer time and price incentives for standard designs, relative to customised modules (Exhibit 2.9).

Exhibit 2.9

NEED TO STANDARDISE PLANT MODULES TO REDUCE PRODUCTION TIME

ILLUSTRATIVE



Source: McKinsey analysis

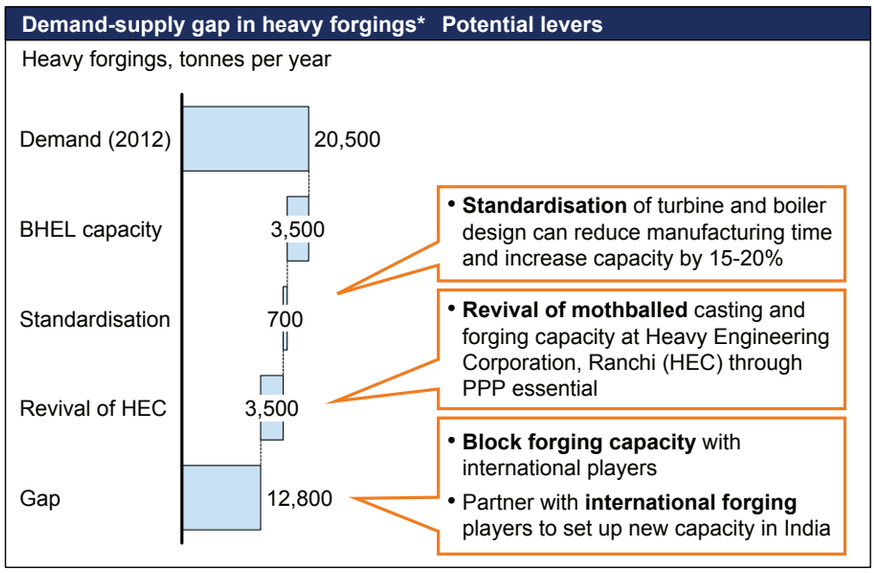
- **Stepping up component manufacturing capacity.** Component shortages of heavy forgings, casting and pressure piping could impede efforts to step up generation capacity. To override this issue, three measures can be undertaken:

  — **Reviving mothballed component capacity.** Capacity for key components, e.g., forgings, can be almost doubled by reviving sick units like the Heavy Engineering Corporation (Exhibit 2.10). The recent takeover of Bharat Heavy Plate Vessels (BHPV) by BHEL, for instance, should help revive heavy fabrication capacity. An attractive revival package from the government to cover historical liabilities and legacy labour issues for such priority units will enable faster revival of this vital capacity.

  — **Unshackling PSUs.** Enhancing internal approval norms at key PSUs, such as the National Thermal Power Corporation (NTPC), BHEL and others will enable them to move much faster to create the necessary capacities. Critical areas that could benefit from additional empowerment include: (i) booking capacity, including with overseas vendors to reduce time lags; (ii) variable price-indexed rate contracts to manage volatile input costs; (iii) acquisitions or joint ventures especially overseas to build new capacities or access new technologies; and (iv) investments in operational improvement programmes to enhance output from existing assets.

Exhibit 2.10

NEED TO ENHANCE COMPONENT MANUFACTURING CAPACITY



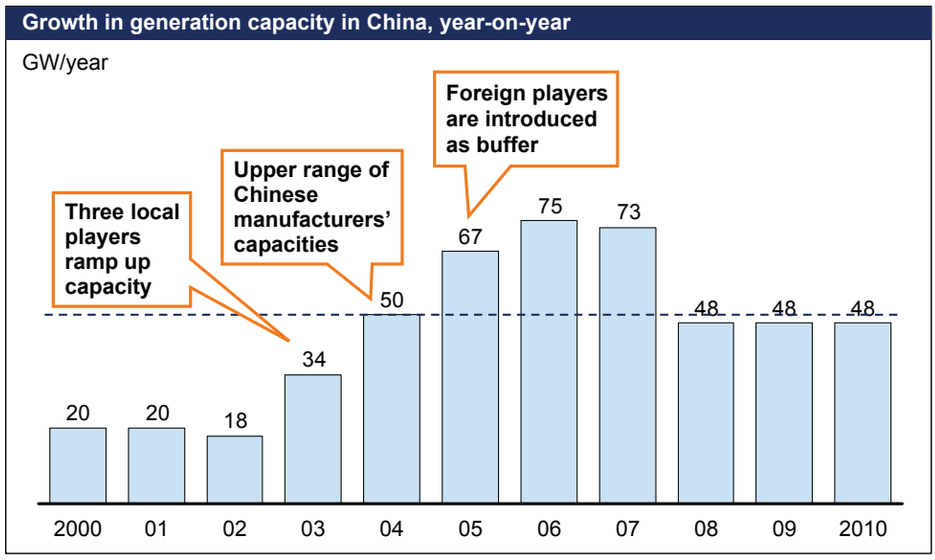
* Larger than 10 tonnes per piece
Source: Interviews; McKinsey analysis

— **Encouraging investments from local and international players.** Placing large orders with conditions for indigenous capacity creation and technology transfer is a tried and tested approach that will be helpful in this situation. China has used this lever to good effect. For instance, multinational companies could only enter China through joint ventures with local players, e.g., Shanghai Electric with Siemens, Dongfang with Mitsubishi and Harbin with GE. As a result, Chinese manufacturers benefited from technology transfers. This increased domestic equipment capacity from 18 GW to 50 GW between 2002 and 2004. Even today, multinationals are required to either co-bid with local partners for major projects or agree to transfer technology. In particular, wind and nuclear plants require 70 to 75 per cent localisation.

In addition to technology transfers, Chinese PSUs leveraged their relationships with multinationals to access additional supply when demand outpaced domestic manufacturing capacity. Between 2004 and 2007, China installed 65 to 75 GW per year, which included swing imports of 15 to 25 GW per year (Exhibit 2.11).

Exhibit 2.11

CHINA LEVERAGED MNCs AS SWING CAPACITY



Source: Morgan Stanley; Literature research; Interviews

5. Train and develop 300,000 skilled and semi-skilled workers

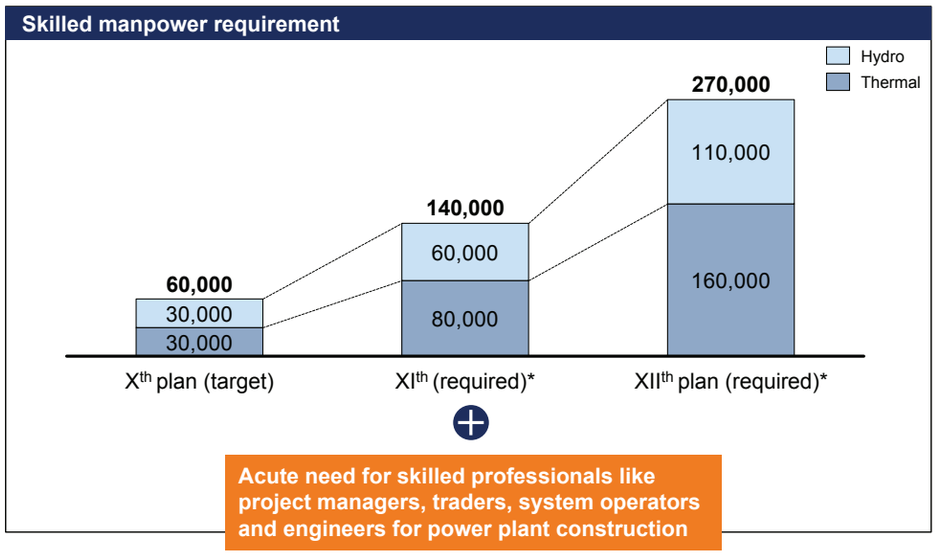
Significant shortages in the availability of skilled and semi-skilled manpower are beginning to constrain the growth of India's power sector. More so, as in the next 10 years India needs to build capacity equivalent to twice that built in the 60 years since independence. To support such large-scale build-outs, about 150,000 skilled workers are required in the next 5 years and around 270,000 between 2012 and 2017 (Exhibit 2.12). In addition, thousands of highly skilled managers will be required in areas such as project management, network operations, equipment maintenance, automation, monitoring and review.

This shortage represents an attractive business opportunity for training and development companies. The Indian government can accelerate this initiative by acting on the following four fronts:

- Setting up the necessary certification standards for a range of skilled and semi-skilled roles to ensure quality and provide benchmarks
- Hastening the revival and expansion of the Industrial Training Institutes (ITIs) with a special focus on the project, construction and operations disciplines
- Encouraging public-sector companies to expand their training programmes and set the standards and training procedures for major projects
- Publicising the opportunity and encouraging private entrepreneurs to establish training and development service companies.

Exhibit 2.12

NEED TO DEVELOP HUMAN CAPITAL TO SUPPORT GROWTH OF SECTOR



* To meet entire electricity demand in 2017
Source: Planning Commission; McKinsey analysis

Secure fuel supplies

Over and above the tight global markets, lack of easy access to fuels like coal and natural gas is a serious impediment in India due to various local factors. This not only hampers capacity addition efforts, but also inhibits the full use of existing capacity. Despite large coal reserves, domestic coal production continues to lag behind demand and consequently imports continue to grow. The situation concerning gas is worse—at present, most existing gas plants do not get the required supply, and, as a result, operate at either low PLFs or use relatively expensive fuels like naphtha. This explains why only a few gas-fired plants have achieved financial closure in the recent past. Ensuring easy and quick access to coal and gas supplies is critical.

Nuclear power is becoming an area of focus across the world because it is environment friendly and economical. It should remain a national priority as it has the potential to fulfill a significant share of demand beyond 2017. Achieving this will require access to uranium supplies and accelerating fast breeder reactor programme.

The following three initiatives would help improve the situation.

6. Deregulate the coal sector, with a short-term focus on captive mine development and import capacity

India has nearly 300 billion tonnes of coal reserves in place, of which 120 billion tonnes are extractable. If India is able to exploit its coal reserves, it can fulfil its coal requirement beyond 2040, despite a continuous acceleration in power demand. In addition, finding and developing prognosticated reserves could make available another 100 billion tonnes of extractable reserves. Opening up the coal sector to competition is critical for India to realise the full economic value of this natural resource. The New Exploration and Licensing Policy (NELP) in the oil and gas sector has been successful in identifying new reserves and bringing them to market. Further, NELP has succeeded in changing the fundamental view on India's hydrocarbon potential—in effect, it has recreated the excitement of the discovery of a new resource that the Oil and Natural Gas Corporation (ONGC) first created in the 1950s. A similar effort to lift the overall performance standards in the sector and to ensure faster discovery and exploitation of resources is imperative. Given that merchant mining is unlikely to materialise in the near to medium term, developing captive mines and building infrastructure to facilitate imports must be immediate priorities.

Though several captive blocks have been allocated, the pace of development has been slow. Cumbersome and complex approval and development processes and the tendency of some players to 'squat' on the allocated reserves account for this. If allocated mines were developed to their full potential, coal supply would increase by roughly 40 million tonnes, a quantity sufficient to partially replace 53[2] million tonnes of imports (Exhibit 2.13). To ensure that the captive mines are developed, a threefold approach should be pursued :

- Adopt the 'shadow' single-window mechanism proposed in the new draft National Minerals Policy to significantly accelerate the approvals process for environment, forest and other clearances, e.g., relocation and rehabilitation.

- Enforce strict time limits for the development of blocks, with reallocation and high penalties in case of non-development. This measure would be similar to the sunset clause in NELP.

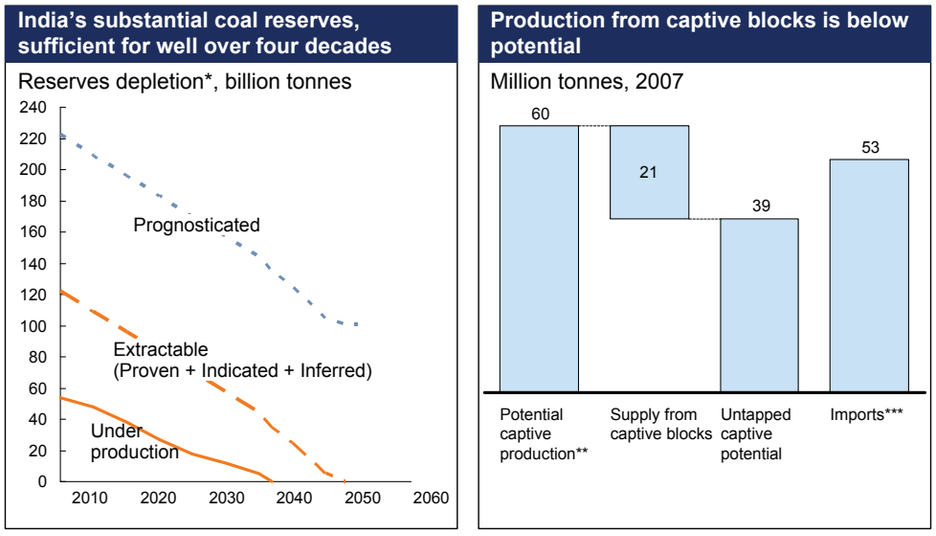
- Establish an independent statutory body along the lines of the Directorate General of Hydrocarbons (DGH) to approve mine development plans. This body should

2 Actual coal imports are around 35 million tonnes in 2007. However, after adjusting for higher calorific value of imported coal, it is equivalent to 53 million tonnes of Indian coal.

also be empowered to reallocate blocks in case they are not developed within the specified time limit. As proposed in the Union Budget 2007-08 the coal regulator can play this role.

Exhibit 2.13

NEED TO ACCELERATE CAPTIVE MINE DEVELOPMENT



* Assuming domestic coal and lignite production is increased to meet the entire domestic demand and demand projected to grow at annual demand growth of 7 per cent for the next 10 years and 5 per cent beyond that

** Based on blocks allocated before 2003

*** Adjusted for lower calorific value of Indian coal, using gross calorific value (GCV) of 6,000 kcal/kg for imported coal and 4,000 kcal/kg for Indian coal

Source: CEA; Ministry of Coal; Integrated Energy Policy; TL Sankar Committee Report; McKinsey analysis

In addition to captive mine development, infrastructure to facilitate coal imports also needs to be created. Based on the current outlook, India will need 40 million tonnes of additional port, rail and handling[3] infrastructure. Lastly, in order to insulate itself from the price volatility in the seaborne thermal coal market and address energy security concerns, India must systematically secure coal blocks and mines overseas through strategic acquisitions.

7. Secure natural gas supplies for peaking power plants

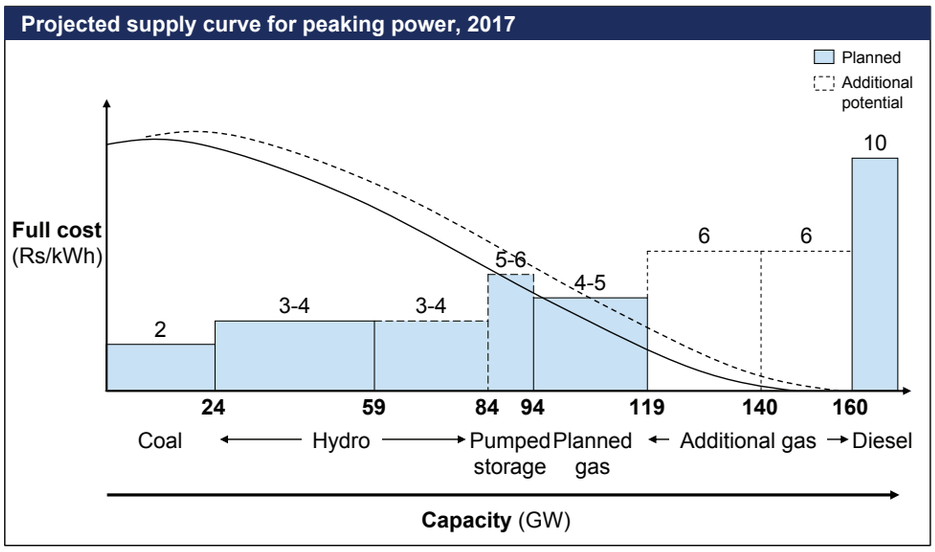
Even if all the hydro potential in India is captured, 120 mmscmd of natural gas will be required by 2017 to satisfy peaking needs (Exhibit 2.14). Even at the current liquid natural gas (LNG) contract price of $10 to $12 per mmbtu, gas-fired peaking power is an economical alternative to diesel-based power, which will be the only real alternative once the hydro potential is utilised. The current situation indicates that inadequate indigenous gas supply will be available in the short to medium term

3 Bulk handling facilities at ports to transfer fuels from one mode of transport to another.

(Exhibit 2.15). Therefore, securing adequate natural gas should be a national energy priority. For similar reasons, China is already moving actively on this front, securing regional pipeline routes for its oil and gas transit needs (Exhibit 2.16).

Exhibit 2.14

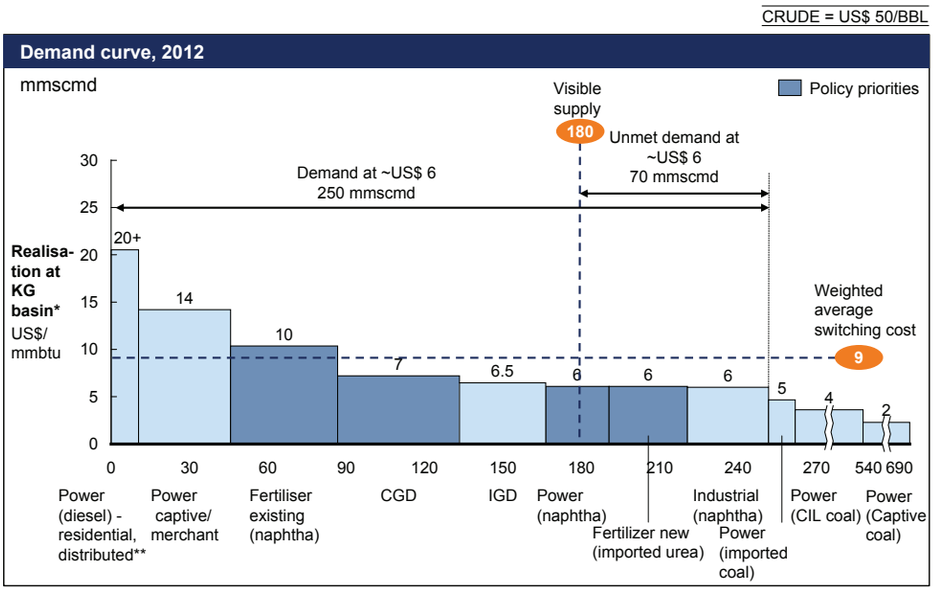
50-75 GW OF GAS-BASED CAPACITY REQUIRED FOR PEAKING DEMAND, IMPLYING NEED FOR 120 MMSCMD GAS



Source: McKinsey analysis

Exhibit 2.15

LOCAL GAS SUPPLY FOR POWER NOT VISIBLE



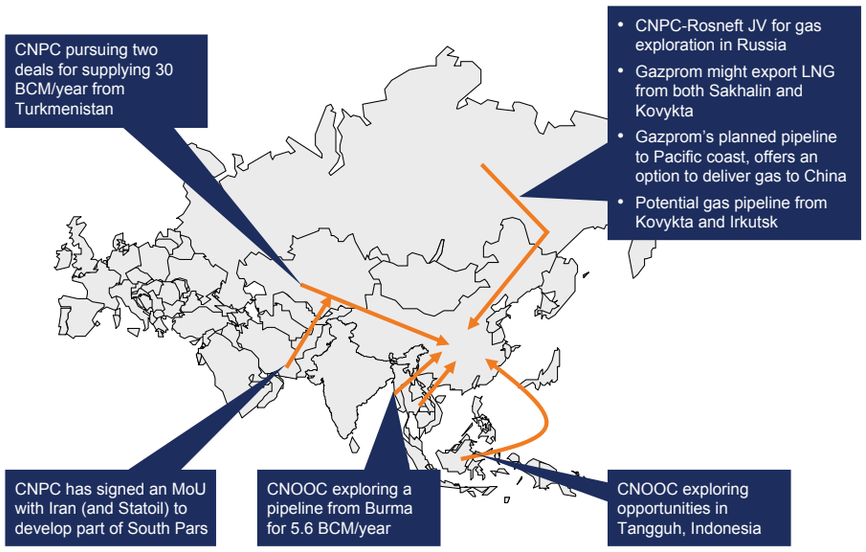
* Post 5% discount (as incentive) over actual switching costs

** Latent demand, difficult to address unless there is significant change in home appliance technology (e.g., reticulated systems)

Source: Planning Commission; Ministry of Petroleum & Natural Gas; Infraline; Director General of Hydrocarbons; McKinsey analysis

Exhibit 2.16

CHINA IS SECURING ITS OIL AND GAS NEEDS THROUGH A REGIONAL NETWORK OF PIPELINES



Source: Literature search; McKinsey analysis

India should pursue several approaches simultaneously to secure the necessary natural gas supplies:

- **Maintain a strong focus on domestic exploration.** Domestic discoveries will be the cheapest source of gas for India due to low transportation costs. During the last decade, India has made numerous gas discoveries, some of them substantial even by global standards. Yet significant potential exists for further discoveries, as only 20 per cent of India's sedimentary basins have been well explored. Ensuring the financial viability of future NELP rounds is essential if further capital is to flow towards exploration and production.

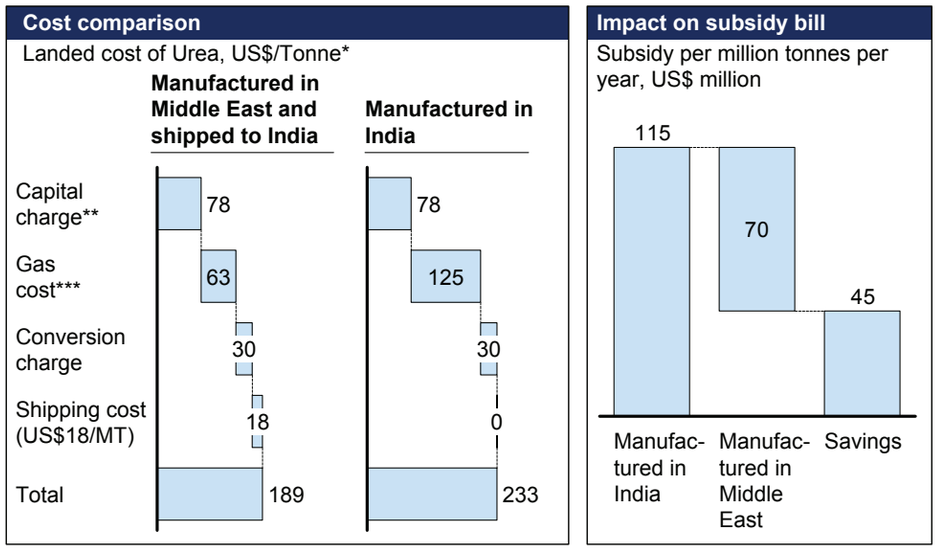
- **Make regional pipelines a strategic priority.** Given India's proximity to the Middle East, which has the world's largest gas reserves, regional pipelines are the most economically viable transportation solution to bring gas into the country. While keeping its geopolitical priorities in mind, India should pursue key regional pipelines such as the Iran–Pakistan–India (IPI) pipeline and the Myanmar–India pipeline. These together can provide 110 to 140 mmscmd of gas annually, significantly augmenting supply. Other pipelines such as those from Turkmenistan and the undersea pipeline to the Middle East should also be evaluated.

- **Secure LNG.** Even as it pursues regional pipelines, India must secure LNG supplies, especially for power plants in peninsular India. LNG-fired power continues to be an economically attractive alternative to diesel-based power despite the sharp rise in LNG prices in the last few years. This will require India to tie up LNG supplies through long-term contracts, together with developing the corresponding re-gasification infrastructure.

- **Build new fertiliser capacities in the Middle East.** At present, much of India's indigenous gas is used to produce fertilisers. While keeping food security concerns in mind, India should consider building new fertiliser capacity in the Middle East, where gas supplies are abundant and relatively inexpensive. This will free up incremental indigenous gas for power generation, reducing the need for LNG which is more expensive to transport than fertiliser (Exhibit 2.17).

Exhibit 2.17

ECONOMIC CASE FOR FERTILISER PRODUCTION IN THE MIDDLE EAST



* Exchange rate of US$ 1 = Rs 40

** Capital cost of US$ 50 million for 1 MTPA of urea and Weighted Average Cost of Capital of 14%

*** US$ 3 per mmbtu in Middle East and US$ 6 per mmbtu in India

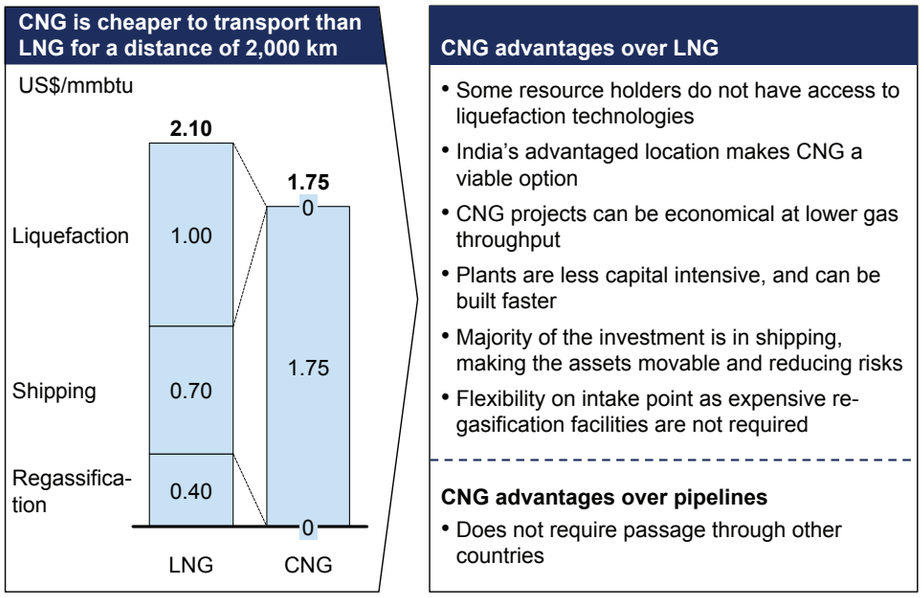
Source: Planning Commission Working Group Report; McKinsey analysis

- **Explore accessing gas through ship-based CNG supplies.** The technology to transport compressed natural gas (CNG) is becoming viable over short distances, i.e., within 2,000 kms, making it an option for India to import gas from the Middle East. CNG is cheaper and faster to bring to market than LNG since it does not require expensive liquefaction and re-gasification infrastructure (Exhibit 2.18). The cost differential could be even higher if the CNG route can help monetise

gas that does not have access to liquefaction. India could play a lead role in its development and deployment, as it is one of the key markets where this technology is applicable.

Exhibit 2.18

CNG: A POTENTIAL ALTERNATIVE TO LNG AND TRANSNATIONAL PIPELINES



Source: Study by Deshpande and Economides; McKinsey analysis

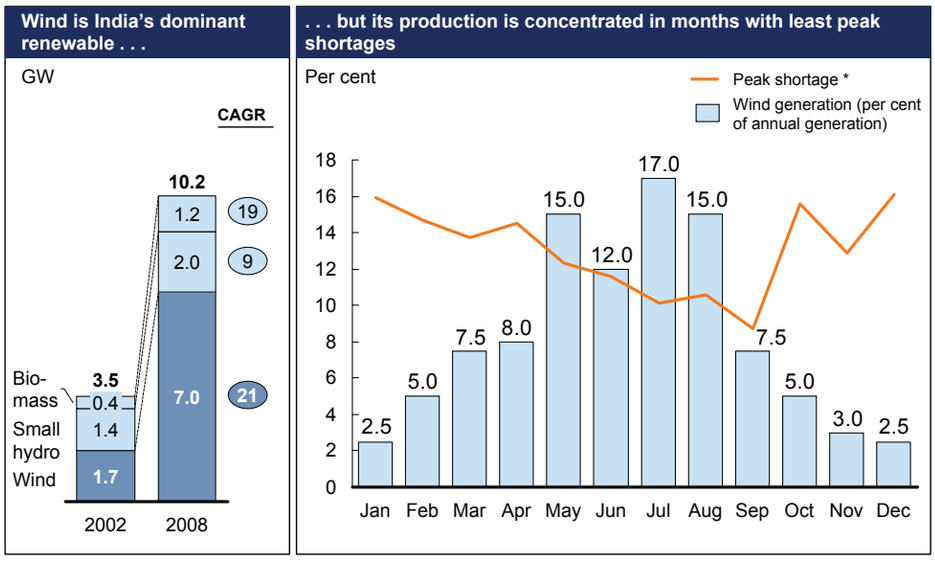
8. Launching a renewable energy programme to generate 30 GW by 2020 with a focus on solar

Renewable energy needs to be a priority, since it will help limit emissions while contributing to energy security. India has the natural conditions necessary to harness renewable energy—a strong solar and wind regime. Estimates suggest that India has the potential to generate over 100 GW of power from renewable sources, of which wind, solar and biomass energy form the bulk.

Wind power dominates our renewable capacity, and is projected to show strong growth driven primarily by fiscal incentives. However, a large part of wind energy generation occurs during monsoon months, when demand is low and hydro plants are operating at close to peak capacity. (Exhibit 2.19)

Exhibit 2.19

WIND WELL ESTABLISHED BUT GENERATION CONCENTRATED IN A FEW MONTHS

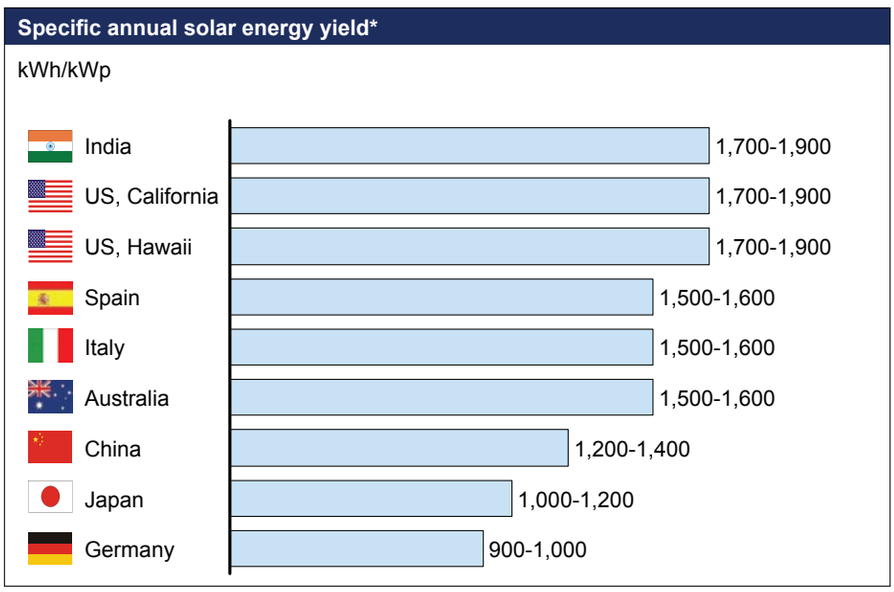


* For calendar year 2007
Source: Expert interviews; CEA

India's annual solar energy yield is among the highest in the world at 1700–1900 kWh/kWp (Exhibit 2.20). At present, however, India is set to be only a marginal player in solar power, accounting for only 1–2 GW of the total 90 GW of global solar capacity

Exhibit 2.20

INDIA'S SOLAR POTENTIAL IS AMONGST THE HIGHEST IN THE WORLD

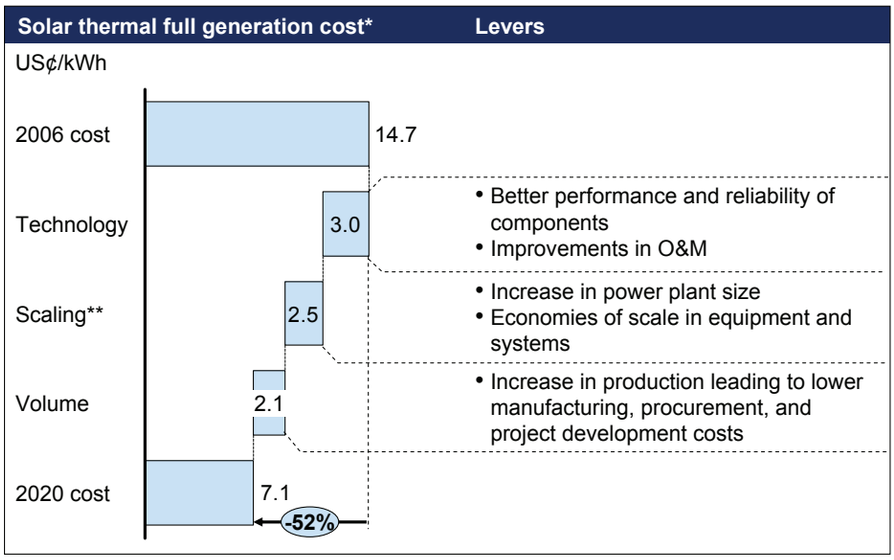


* Current PV technologies
Source: DLR; Fraunhofer Institute; DOE; NREL; Sargent & Lundy; McKinsey proprietary demand model; McKinsey analysis

likely to come on stream by 2015. Since the costs of solar power can drop to Rs 8–10 per kWh by 2012, it could be a viable source of peaking power. India should reduce cost of solar power through large-scale development and deployment of solar technology (Exhibit 2.21).

Exhibit 2.21

INDIA CAN DRIVE GLOBAL COST REDUCTION IN SOLAR



* Based on a current investment cost of US$4.5/We; 14% DNI to electric efficiency; 6,000 MW of cumulative capacity installed by 2020; 21% cost reduction due to technology innovation, 17% to scaling from 50 MW to 200 MW, 14% due to volume production; 25 years investment

** System scaled from 50 MW to 200 MW

Source: DLR; Fraunhofer Institute; DOE; NREL; Sargent & Lundy; McKinsey analysis

To achieve this objective, the government should:

- Provide tax incentives and feed-in tariffs[4] to drive adoption. The recently announced policy to provide Rs 12–15/kWh for solar power is a step in the right direction, but needs to be expanded beyond the current 50 MW limit, and augmented with other measures mentioned below
- Support pilot projects that deploy low-cost and innovative solar technologies
- Introduce a rooftop photovoltaic policy that offers incentives for deployment
- Offer incentives to players to invest in research and development of solar energy
- Access international funding with a thrust on solar power, since the programme will create globally applicable technologies and reduce emissions by avoiding coal-based capacity additions

4 Tariffs for supplying renewable energy to the grid.

Besides solar, biomass is another interesting renewable energy option. Some estimates suggest its potential is 50-70 GW, which could make it the renewable with the highest energy generation potential, since its utilisation will be higher than solar and wind. Biomass also offers other important benefits. First, unlike other renewables, it is a source of firm power, critical for the stability of the electrical system. Second, it is best suited to spur distributed generation. For example, if leveraged properly, biomass based power plants and biogas generators could make many villages self sufficient in their energy needs. However, biomass also faces significant challenges. A complex supply chain is required for leveraging the biomass opportunity from wastelands. Input price stability is critical as farmers tend to raise prices of agri-residue after plants are setup. Therefore, creating viable business models to address these challenges will be necessary.

Improve efficiencies

While the first eight points of the 10-point programme focus on capacity addition, the next two points focus on optimising the use of energy and existing capacity. International and Indian experiences confirm that demand-side measures can reduce electricity consumption, and operational measures can substantially improve the productivity of existing generation assets. Demand-side management is particularly applicable to India, since energy-efficiency measures are easier to install in the initial phases of building construction instead of retrofitting. Moreover, it is the cheapest and most environmentally friendly way of bridging an electricity gap. Operational measures are especially applicable given the poor performance of several power plants.

9. Create an action plan to gain over 10 per cent from demand-side management

India can learn from international experiences in reducing demand and shifting peak demand to off-peak hours. Several countries such as Brazil, the US (Exhibit 2.22) and China have successfully implemented demand-side management (DSM) programmes to curb demand by as much as 20 per cent (Exhibit 2.23). Our outside-in estimates suggest that the implementation of a DSM programme tailored to India's requirements could yield savings of 12 to 16 per cent (Exhibit 2.24).

Exhibit 2.22

COUNTRIES HAVE REDUCED DEMAND BY UPTO 20% THROUGH DEMAND SIDE MANAGEMENT (DSM) – 1/2

Country	Measures	Impact
		Per cent
Brazil	• 10-30% reduction targets set for all consumer categories • Higher prices for defaulting customers and bonuses for customers achieving targets • Commercial and industrial users allowed to buy or sell "electricity quotas"	20
California, US	• Offered financial incentives to consumers for demand reduction, called 20/20 i.e., 20% reduction of demand in summers entitled consumers to 20% reduction in tariff • Energy efficient appliances, building codes and utility efficiency programs accounted for most savings	20

Source: Literature search; McKinsey analysis

Exhibit 2.23

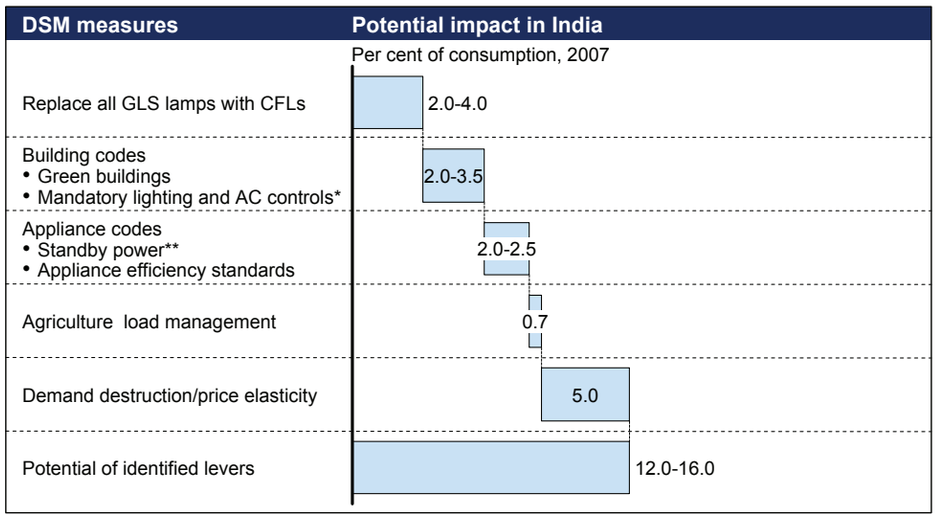
COUNTRIES HAVE REDUCED DEMAND BY UPTO 20% THROUGH DEMAND SIDE MANAGEMENT (DSM) – 2/2

Country	Measures	Impact
		Per cent
China	**Load management** • Instituted time-of-use pricing with large differences in peak and off-peak power prices (e.g., Jiangsu Province: peak price US$66.5/MWh; off-peak price US$36.2/MWh) • Interruptible tariffs to compensate consumers for voluntary peak demand reductions (e.g., Jiangsu province paid a compensation of US$12/kWh to customers) • Introduced off-peak storage techniques like ice-storage ACs and head-storage electric boilers to reduce demand **Use of energy efficient appliances** • Promoted CFL, adjustable speed motors, pumps and high efficiency transformers **Energy conservation** • Compulsory reduction in hours of operations; changing thermostat settings	2.5

Source: Literature search; McKinsey analysis

Exhibit 2.24

INDIA CAN REDUCE DEMAND BY 12-16% THROUGH DSM



* Europe case study figures adjusted for Indian sectoral demand and device penetration. For lighting and AC controls, saving assumed to be correlated to commercial demand as a per cent of total demand for both Europe and India

** Europe case study figures adjusted for Indian sectoral demand and device penetration. For standby power-saving estimates from EU25 adjusted downwards for appliance penetration in India versus EU25 (Indian PC and peripherals penetration is 15% of EU25). Further, assumed that appliances have a 5-year life

Source: Interviews; McKinsey analysis

Some of the key initiatives of this programme should be to:

- Replace incandescent lamps with compact fluorescent lamps (CFL) by embarking on one of two approaches—distribute CFLs free and recover the costs through certified emissions reductions (CERs), or 'lease' CFLs to consumers and recover the costs via monthly instalments charged in electricity bills.

- Mandate the adoption of energy consumption standards and standby power standards for consumer durables, such as air conditioners and geysers, and office equipment, such as computers, printers and photocopiers.

- Establish and enforce energy-efficient standards for new constructions across the commercial, office and residential segments.

- Adopt real-time metering for heavy users, such as industrial consumers, in conjunction with higher peak-hour tariffs to encourage shifting demand to off-peak hours.

10. Extend the PiE programme to realize additional 7 to 10 GW capacity

Despite having over 140 GW of nameplate generation capacity and peak demand of only 120 GW, India still suffers from a peak shortage of 15 to 20 GW. This is largely because of the poor availability of plants.

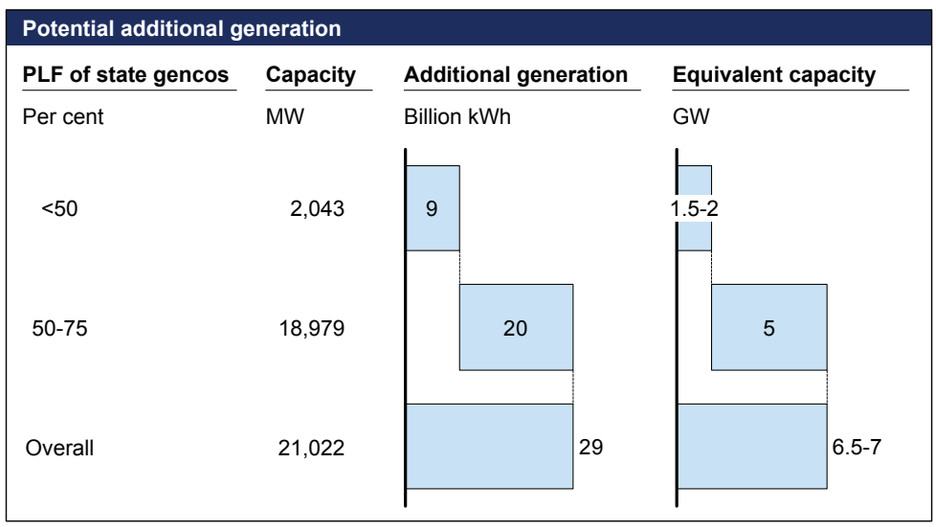
The potential to improve plant performance through focused operations improvement programmes is widely recognized within the industry. With this in mind, the government introduced the Partnership in Excellence (PiE) programme to revive thermal plants with low PLFs. This initiative has met with notable success wherever it has been tried, as illustrated by the SEB plants operated by NTPC. Despite this success, the rollout of PiE has been limited and has not attracted players other than NTPC, as it is not tailored to attract participation from private players.

Private companies typically have limited engineering and operations capacity that predominantly focuses on large-scale build-outs, leaving them with limited resources to participate in PiE unless its financial attractiveness is improved. To make the programme attractive to private players, the government should devise a profit-sharing model, which allows the profits earned from incremental generation[5] to be shared between state-owned generation companies and O&M contractor. Such an approach could potentially attract global players, who can bring international best practices to India. Participation in PiE should be facilitated through a transparent and competitive bidding process.

Redesigning the PiE programme could result in generating an additional 7 GW of power from existing plants (Exhibit 2.25).

Exhibit 2.25

POTENTIAL TO GENERATE 7 GW OF ADDITIONAL POWER THROUGH AN ENHANCED PIE PROGRAM



Source: Literature search; McKinsey analysis

5 Above the minimum threshold defined in the Partnership in Excellence programme.

STRENGTHEN GOVERNANCE TO DRIVE IMPLEMENTATION OF THE 10-POINT PROGRAMME

Power sector reform has been actively debated and much attempted since the early 1990s, when a spate of independent power projects (IPPs) were negotiated and launched, only to be shelved over the years.

Since then, the bankruptcy of distribution entities has made private-sector investments relatively scarce—a function of low entrepreneurial risk appetite rather than that of any structured policy framework. Now that several distribution entities have been recapitalised and tripartite agreements have boosted investments by central PSUs, the focus of reform should shift to equipment bottlenecks, the speed of execution and the sustainability of SEB payment surety.

Moreover, as mentioned earlier, the underperformance of the power sector has caught the attention of policy makers and administrators at all levels. As a result, the sector has been the focus of many government reviews, audits and task forces. At the central and state levels, power is even recognised as perhaps the single biggest infrastructural bottleneck to India's growth, besides being an increasing burden on state exchequers.

Yet despite these efforts, the power sector continues to lag behind the demands of the Indian economy. This indicates that improvements in governance are vital. Multiple discussions with policy makers and the industry make it clear that an accountable and empowered leadership group to steer the development of the sector is required. The three tasks for this group will be to offer states the incentive to act, to unshackle PSUs and to improve the effectiveness of review and monitoring mechanisms. The next section presents potential options for this group and elaborates on its three tasks.

Empowered and accountable leadership

Accountability for the power sector is fragmented. To ensure the successful implementation of any project, multiple agencies at the central and state level need to be aligned. This is often difficult to achieve, given differing priorities, agendas and demands on resources. The sector needs some form of an empowered body or forum responsible for the overall performance of the sector, charged with the responsibility for executing the 10-point programme.

Although the challenges of the power sector are unique, several governance models have been successful in accelerating implementation in different circumstances.

These models, or some combination thereof, may be required:

- **Revive and strengthen the Energy Coordination Committee (ECC).** The ECC was set up to facilitate decision making on important matters pertinent to energy and to debottleneck key issues. If adequately supported with a strong secretariat, such as from the power ministry, the ECC could be an immediate and effective option to help convene a leadership group that has collective accountability.

- **Empowered Group of Ministers (EGoM).** EGoMs have in the past been used to resolve contentious or sensitive cross-ministry issues. This construct may be another option to bring together multiple ministries at the central government, and potentially invite relevant states as well.

- **Cabinet Committee on Energy.** Energy-related issues cut across power, oil and gas, coal, foreign affairs, shipping and finance. Instituting a standing committee at the highest level could be a more permanent approach to giving energy-related issues the necessary importance.

- **National Power Commission (NPC).** Setting up an NPC with the necessary resources and control over relevant agencies and PSUs could be an effective way to ensure accountability, remove bottlenecks to decision making, and drive the implementation of a comprehensive programme, such as the 10-point programme. Examples include the Telecom Commission, NHAI and C-DOT, albeit models in less broad-ranging sectors.

- **Integrated Energy Ministry.** Some countries have chosen to integrate responsibility for all energy-related issues within a single ministry, recognising the criticality and inter-related nature of the issues involved.

- **Independent nodal ministry or agency.** This role could be played by an independent ministry or agency such as the Finance Ministry or the Planning Commission. As the nodal authority in-charge, this model could be effective to objectively assess the performance of all power-related ministries and to resolve the various inter-ministerial issues that clog the progress.

Notwithstanding the governance model adopted, the leadership group will need to deal with a complex range of issues involved, and manage multiple conflicting interests at the central and state level. Needless to say, the political and administrative leadership of the sector needs to be in the hands of individuals of the highest calibre with a result-oriented mindset.

Improve effectiveness of review and monitoring mechanisms

Given the number of projects and stakeholders, the complexity of each project, and the multiplicity of issues involved, a comprehensive mechanism for review and monitoring is critical. This mechanism would need to have the following characteristics:

- **Regular, cascading reviews.** Two to three reviews in a 5-year plan period are insufficient to prevent delays or take corrective action. A system of weekly, monthly, quarterly and annual reviews at different levels need to be introduced. The frequency and depth of each review would, of course, vary depending on the level at which it is conducted.

- **Establishment of a project monitoring centre or 'war room' at the central government within the power ministry.** This centre should have a strong staff, supporting the sector leadership group to ensure that accurate, timely and relevant data is made available for reviews, and that adequate preparation and subsequent follow-up to debottleneck key issues takes place. Corresponding centres should also be established at the state level.

- **The 'war room' should be supported by a strong and independent external body.** The involvement of a non-government body is important for the efficient functioning of the war-room. This body will help run a strong program-monitoring office by equipping it with accurate data, timely analyses, and support mechanisms e.g., modifications of procurement policies to enhance the performance of the state-owned companies.

- **A consistent, predefined set of performance parameters** applicable to all projects is also vital. This will help focus the reviews and track the true performance of each project and the concerned organisations.

- **A holistic, state-wise performance scorecard** that measures the progress of power-sector reform needs to be designed and monitored by the independent external body. It must conduct regular audits to ensure on-the-ground results are accurately reflected. This scorecard must be published every month and should include input (e.g., status of separating agricultural feeders) and output (e.g., extent of load shedding) measures. The scores for each state should be widely disseminated every month through the mass media.

Incentivise the states to act

The performance of the sector also depends on progress made by state governments. Efforts by state governments are pivotal to improve the financial viability of state-

owned discoms and develop new projects. Several matters like environmental approvals, land acquisition, rehabilitation and resettlement are also under their purview. However, the central government can play an important role in offering states the incentive to act. Four levers to enhance the performance of the states are:

- **Modify the Accelerated Power Development and Reforms Programme (APDRP).** Although a success when it was first launched, the pace of the APDRP programme has flagged.

  Three structural changes could improve the effectiveness of this programme

  — The qualifications criteria must be revamped to include separating agricultural feeders, corporatising SEBs, metering non-agricultural supply, and implementing open access.

  — The current system of grants and loans should be replaced with equivalent loans that should become grants only when AT&C losses are reduced to pre-defined AT&C loss-reduction targets.

  — The pre-defined loss-reduction targets should be structured into multiple slabs for discoms based on their loss positions. So, discoms with higher AT&C losses will have higher loss-reduction targets, while discoms with comparatively lower AT&C losses will have lesser targets.

  The recently proposed National Electricity Fund could provide an alternative if appropriately implemented. Disbursals from the National Electricity Fund should be linked to the performance of states as reflected in the monitoring scorecard. This will incentivise the states to improve performance in distribution, the weakest link in the power value chain

- **Preferential allocation of central power pool[6] reserves, particularly from new central PSU power plants.** Of the 35 GW of new capacity being developed by central PSUs, 50 per cent of power should be allocated to states based on their performance which will be reflected in the state-wise performance scorecard. If possible, similar performance criteria should be used to allocate 8 GW of the existing central pool reserves.

- **Preferential allocation of coal linkages and captive coal blocks.** State-owned generation companies in progressive states should get the first right of access to available coal blocks and CIL linkages. This was done for the UMPPs, which were competitively bid.

6 Accounting for 15 per cent of the unallocated power from central PSU power plants.

- **Offer host states the incentive to set up a fast-track approval process.** Given the concentration of India's coal reserves, most pithead plants are likely to be located in five to six states. Although these plants will cater to nationwide demand, the host states alone will bear the social and environmental costs. As a result, host states seldom see value in setting up a fast-track approval process. Possible ways to offer host states the incentive to do this include increasing royalties on coal mining, and supplying a part of the power generated to the host state at variable cost.

Unshackle PSUs

Over the next 5 years, PSUs will account for a majority of the power capacity created. However, current procedures and process capabilities limit their ability to ramp up project execution. Examples of areas where additional empowerment or attention is essential include:

- Procurement processes and policies to enable capacity booking at key vendors, variable price-indexed rate contracts, and commodity exposure hedging
- Tailored procurement processes to retain technical and proprietary expertise as required
- Greater flexibility to re-award or modify contracts in case of non-performance by vendors and contractors
- Decisions on joint ventures and M&A.

The Navratna package has led to a welcome introduction of independent directors and an increased focus on corporate governance. However, it is important to ensure:

- Companies enforce a minimum five-year tenure for CMDs and Directors
- Induction of consistently high-quality board members with exemplary track records
- Clarity on board roles and contributions
- Regular assessments of the effectiveness of Navratna boards.

* * *

Ensuring the success of the rapidly growing power sector is central to India's economic prosperity. As the viability of the sector improves and the bottlenecks plaguing the sector are resolved, numerous investment opportunities will emerge. Chapter 3 discusses the nature of these opportunities, and the risks associated with them.

Chapter Three: Opportunities, Risks and Winning Approaches

Powering India:
The Road to 2017

Chapter Three: Opportunities, Risks and Winning Approaches

India's power sector is at a watershed in its development. Over the next 10 years, the growth of the sector in India will be second only to that of China's.

Soaring demand, power shortages and reforms will create significant and rewarding opportunities across the value chain. These will include traditional opportunities, such as development of generation capacities, and non-traditional opportunities, such as demand-side management. Only the potential of distribution remains unclear, due to a high degree of regulatory dependence and uncertainty around the evolution of ownership structure. Our analyses reveal a US$600 billion investment opportunity is likely to emerge by 2017, if key reforms are implemented.

Competing and winning in India will require tailoring business models to address existing bottlenecks, market inefficiencies and development risks. In effect, winners in India will have business models distinct from conventional global models.

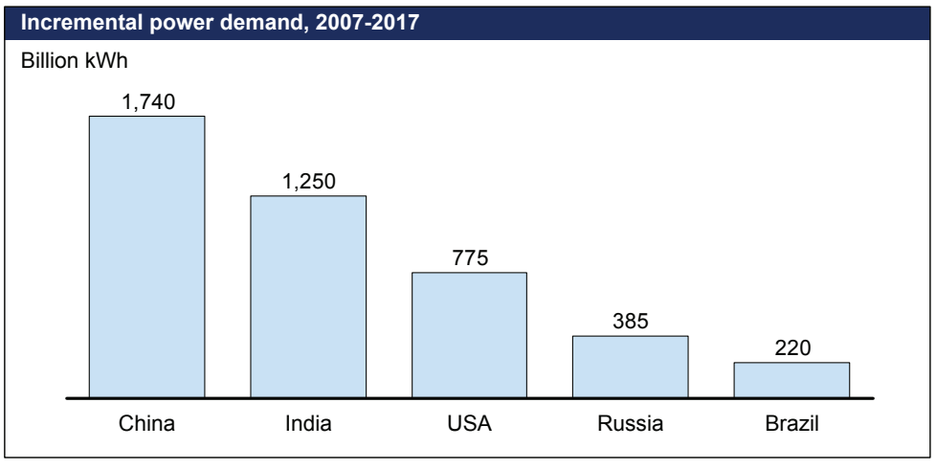
This chapter describes the opportunities emerging across the value chain and takes a closer look at approaches to creating value in generation, the largest opportunity in terms of investments and profit pools. It also discusses the key risks to be recognised and managed, and describes likely winning business models.

SIGNIFICANT AND REWARDING OPPORTUNITIES ACROSS THE VALUE CHAIN

From now to 2017, demand growth in India will be second only to that in China (Exhibit 3.1). During this time, India's demand for power will surge from about 120 GW today to over 300 GW. To meet this incremental demand, investments of US$600 billion will be required across the value chain. Of this total outlay, around US$300 billion will be needed for generation, around US$110 billion for transmission and the balance US$190 billion for distribution (Exhibit 3.2). The sector will present an annual profit (EBITDA) pool of US$135 billion to US$160 billion by 2017 (Exhibit 3.3). Like in any other sector, players with the right strategy, business model and execution will capture a disproportionate share of this profit pool.

Exhibit 3.1

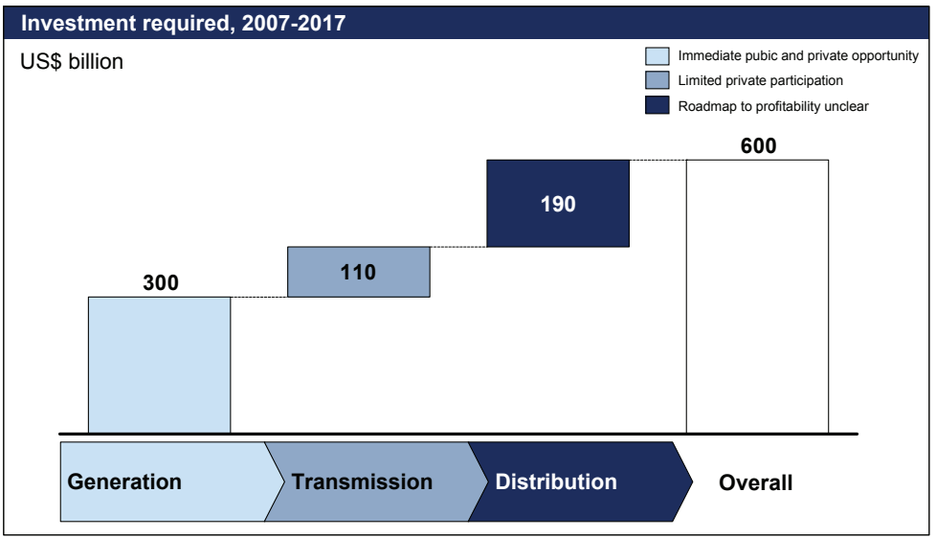
INDIA'S INCREMENTAL POWER DEMAND WILL BE SECOND ONLY TO CHINA



Source: Energy Information Administration (EIA); McKinsey analysis

Exhibit 3.2

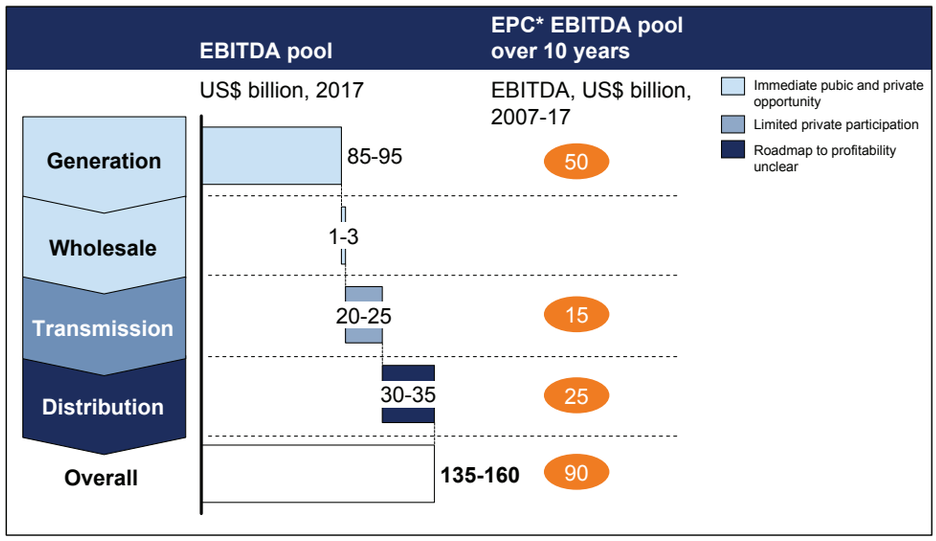
POWER SECTOR LIKELY TO REQUIRE US$ 600 BILLION INVESTMENT BY 2017



Source: McKinsey analysis

Exhibit 3.3

POWER SECTOR LIKELY TO OFFER PROFIT (EBITDA) POOLS OF US$ 135 - 160 BILLION BY 2017



* Engineering, Procurement & Construction

Source: McKinsey analysis

The following section highlights the nature of opportunities that will arise in generation, fuel, transmission, distribution, equipment, engineering, procurement and construction (EPC) and other services.

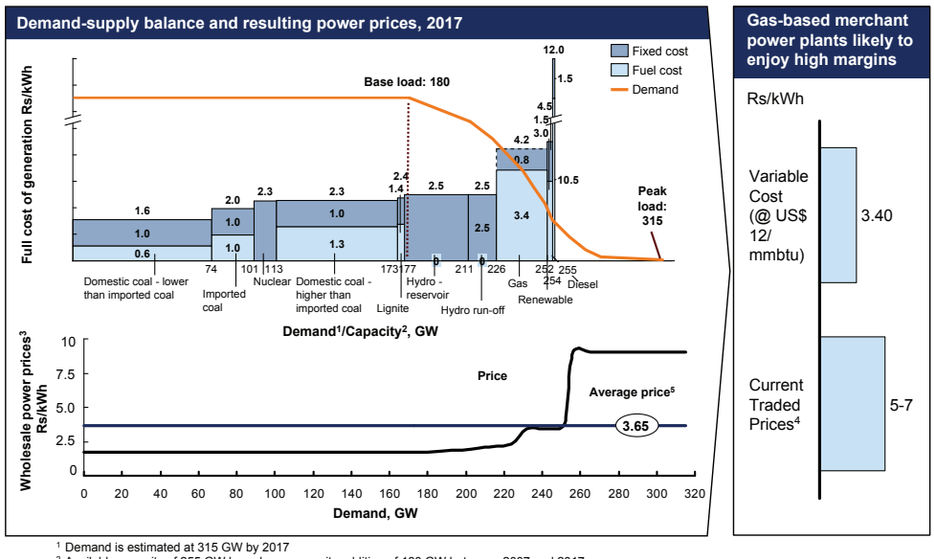
Generation

To create an additional capacity of 300 GW by 2017, investments of about US$300 billion will be needed across about 140 projects. Besides the traditional opportunities that will arise, such as setting up large-scale base-load thermal and hydro plants, several non-traditional opportunities will also be available. Examples of these include:

- **Merchant peaking plants.** Rising peak shortages and high peak prices will make merchant peaking power plants attractive, especially if located near load centres in northern or western India. This is because while considerably large capacities are being built in eastern India, demand is growing faster in the northern and western regions. In fact, many cities rely partially on expensive diesel-generated peak power. Even if differential tariffs are structurally not introduced, current peak prices of Rs 7–10/kWh will provide returns of over 50 per cent, making this an attractive play for companies (Exhibit 3.4).

Exhibit 3.4

HIGH PEAK PRICES MAKE MERCHANT PEAKING PLANTS ATTRACTIVE



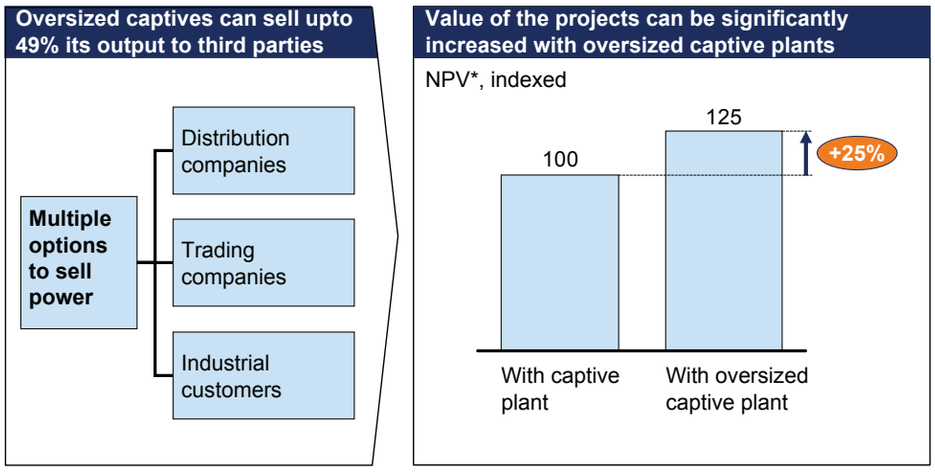
[1] Demand is estimated at 315 GW by 2017
[2] Available capacity of 255 GW based on a capacity addition of 180 GW between 2007 and 2017
[3] Wholesale power prices estimated based on cost curve economics and are set at cost of generation and transmission for the marginal supplier
[4] One-third of traded power in 2007 was traded at prices above Rs. 5/kWh
[5] Assuming free market pricing based on cost curve economics, ignoring existing or potential PPAs

Source: IRM Model; McKinsey analysis

- **Oversized captive power plants.** Heavy industrial consumers like metals producers, cement and chemicals manufacturers benefit from investing in captive plants. Recent regulatory changes have permitted building oversized captives that can sell 49 per cent of their output to other customers. Building oversized captive plants is a practical way to enhance the value of the project. Not only does it enable companies to enjoy lower capital and operating costs, but it also creates an attractive revenue stream. Further, it enables monetisation of scarce and otherwise regulated resources (Exhibit 3.5).

Exhibit 3.5

OVERSIZED CAPTIVE POWER PLANTS BENEFICIAL FOR HEAVY INDUSTRIAL PLAYERS



* Net Present Value
Source: Interviews; McKinsey analysis

- **Captive and group-captive plants.** Several small industries, commercial establishments and even residential complexes need a continuous power supply. These consumers may not have the capital or skills required to set up and manage captive power plants. They can be served by either a small captive unit of 10–50 MW or through group captives. Further, large commercial complexes will benefit from co-generation plants. Supplying to these segments presents an opportunity to target creditworthy consumers who are willing to pay for reliability.

- **Trading.** As power trading in India develops and grows, it will offer some interesting and attractive opportunities. Trading companies can participate in this space by capitalising on the price arbitrage opportunities that will result from a large number of small captive plants. Such plants owners are typically not in a position to maximise prices. They provide trading companies with the opportunity to buy excess capacity at relatively lower prices and trade them at competitive peak tariffs.

Fuel and related infrastructure

Restricted access to domestic supplies, underexplored sedimentary basins and growing electricity demand have resulted in increased imports of coal and natural gas. If this situation persists, coal and natural gas imports are likely to further increase. Resource-holders and related infrastructure providers can benefit from this constrained situation by:

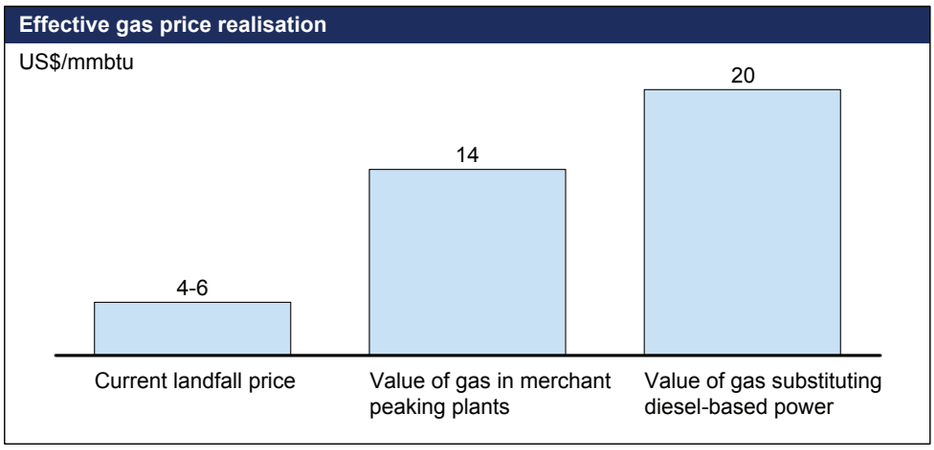
- **Integrating forward.** Owners of domestic natural gas can enhance the value of their holdings by setting up peaking power plants. Two factors make this a viable option. First, gas prices in India are moderated, and much lower than peak power

prices (Exhibit 3.6). Second, given gas shortages, resource holders will benefit from faster financial closure, as inadequate fuel supplies has delayed financial closure of most gas-fired projects.

Exhibit 3.6

FORWARD INTEGRATION INTO POWER GENERATION CAN ENHANCE VALUE OF HOLDINGS FOR GAS RESOURCE OWNERS

CRUDE = US$ 50/BBL



Source: McKinsey analysis

- **Coal trading.** If the current resource-constrained scenario prevails, imports of thermal coal could increase to 100 million tonnes by 2012 from the current 35 million tonnes. At those levels, India will account for a sizeable portion of the global seaborne thermal coal market. While some large consumers of imported coal will potentially acquire mines overseas, a large number of smaller players will depend on merchant purchases, making coal trading an attractive option.

- **Contract mining.** Though a large number of blocks have been allocated, only a few have been developed. Companies that can mine coal at a substantively low cost will be sought after, as this ability will be an important differentiator in winning competitively bid projects. Over time, as the development of underground coal mines gains momentum, companies with this expertise could charge a premium for their services.

- **Building import and handling infrastructure.** The large volume of imports will require enhancing the country's dry-bulk port capacity by 30 million to 40 million tonnes. Moreover, investing in deepwater ports that handle large ships will be a worthwhile opportunity in light of increasing commodity movements. In turn, this will create a need for handling infrastructure.

- **Developing coal washeries.** The high ash content in domestic coal makes it expensive to transport. But once washed the transportation cost of coal drops by 10 to 15 per cent. As a result, generation companies that will not build plants at pitheads due to lack of water supply, etc will instead seek to wash coal before transporting it, leading to a surge in demand for washeries.

- **Exploring and producing domestic gas.** India's gas resources remain fundamentally underexplored. Given the shortage of gas, prices will continue to rise towards levels set by liquefied natural gas (LNG) imports, despite near-term price curbs imposed by the government. Any pricing close to LNG levels will make domestic E&P extremely lucrative. Adjacent opportunities including coal-bed methane, gas pipelines and distribution, and selected oilfield services will also present attractive opportunities.

- **Solar power:** With one of the world's highest solar intensities and low cost manufacturing, India has the potential to become a global force in solar energy. An emerging regulatory regime and high peak prices make this opportunity real and attractive.

Transmission

To supply 300 GW of power by 2017, investments of about US$110 billion will be required in transmission. These in turn will offer a return on equity (ROE) of about 14 to 15 per cent. Most of these opportunities are likely to be reserved for public-sector units (PSUs) such as PowerGrid (the Central Transmission Utility) and State Transmission Utilities (STUs). However, private players can participate in this segment in one of three ways:

- Entering into a joint venture with PowerGrid (PGCIL) to build a transmission line from power plants to load centres across the country

- Setting up an Independent Power Transmission Company to build networks across the country. This will entail participating in a competitive bidding process

- Constructing and potentially operating dedicated transmission lines for generation companies from power plants to load centres and to large industrial consumers.

While a joint venture with PGCIL is likely to have an ROE of about 14 per cent, players would have an opportunity to earn more if they are able to build transmission lines at lower capital costs than those in the bid.

Distribution

As described in Chapter 2, partial or complete privatisation is likely to emerge as a realistic option because turning around state-owned distribution companies (discoms) is challenging given the level of alignment required between political, administrative and market objectives. As and when discoms are privatised, opportunities for turnaround specialists and smart-technology providers will arise.

- **Turnaround specialists and franchisees.** Players with expertise in network management, operations and maintenance, metering technologies, billings and collections management functions could play a strategic role in transforming erstwhile state-owned discoms. Given the current privatisation model, if these companies surpass pre-set targets, they could benefit from higher returns.

- **Smart-technology providers.** Leveraging smart technologies such as real-time meters, prepaid cards for subsidy disbursements, and smart grids will be essential for transforming discoms. Players, who can develop, commercialise and support technologies such as these could capture significant value.

Equipment and EPC

Building over 300 GW of generation capacity and related transmission, distribution and fuel-handling capacities will create substantial opportunities for equipment and EPC providers. This segment of the value chain will offer an annual profit pool of around US$10 billion. Attractive opportunities will emerge across a range of products and services. Specifically, these will be in four areas – components, renewable energy equipment, distribution equipment and EPC.

- **Components.** As new assembly capacities are set up, the scarcity of critical components, such as heavy castings and forgings, special steel alloys, pressure parts and balance of plant equipment, will become even more pronounced. Players who can help bridge this shortfall in capacity by offering short delivery periods and locking in customer contracts can grow rapidly. On the other hand, existing players can capture some value by improving asset productivity.

- **Renewable-energy equipment.** Renewable energy has witnessed rapid growth in India, in particular wind power. Over the next 10 years, India's focus on developing and deploying its solar energy yields is likely to increase substantively. Manufacturers of solar technologies will benefit from this shift in focus, much like their counterparts in the wind energy segment. India will offer a dual opportunity to solar players—as a market, and as a low-cost centre for technology development and manufacturing. Biomass, too, is an appropriate technology option for rural electrification. It can provide sustainable distributed generation, thereby reducing the need for investments in generation and transmission, and increasing community participation in collections.

- **Distribution equipment manufacturers.** Separation of agricultural feeders and extension of metering to all users will have to form an integral part of any distribution reform. Equipment and component makers with feeder and meter manufacturing facilities and project specialists who can support high quality and rapid execution of the subsequent services should consider making substantive plays once a systematic distribution reform process sets in.

- **EPC.** The massive increase in infrastructure projects across India is leading to a severe shortage of skilled manpower. Besides the obvious opportunity for EPC service providers given the number of projects under way, the 300,000-person shortage in power alone indicates an opportunity for training and development services. As the need for manpower includes substantial numbers of skilled trades people (e.g., high-pressure welders, maintenance crews) and managers (e.g., project managers, network engineers, turbine specialists), the economics of training services can be quite attractive.

Other opportunities

As discussed in Chapter 2, India's response to its soaring demand for power must extend beyond only adding capacity. Demand-side management (DSM) and improving the performance of existing generation and distribution assets will also be necessary. Opportunities to participate that are likely to emerge from DSM include manufacturing CFL bulbs, designing services for green buildings and introducing solutions and products for energy management.

VALUE-CREATION APPROACH FOR GENERATION

Generation offers the largest investment opportunities in the power sector. Today maximum participation and the biggest bets are being made in generation. Therefore, it is worthwhile describing the important value creation levers for generation. Value creation in generation, as in most other sectors, depends on strategic choices as well as critical capabilities. Some of the choices are discussed below:

- **Fuel and location choice.** Fuel and location have a significant impact on the long-term competitiveness of any generation asset. There are multiple fuel options available to power plants. Coal-fired plants can get a coal linkage from CIL, have a captive mine (either open cast or underground) or use imported coal. Each option leads to a fundamentally different cost structure and impacts the long-term competitiveness of the asset. Captive open cast mines are likely to be the most competitive in all regions of India. In case most of the allocated captive coal blocks are developed, then plants based on higher cost CIL coals or underground mines may become uncompetitive. On the other hand, plants fed from underground coal mines can become competitive when complimented with a dedicated high-voltage direct current (HVDC) transmission line. Similarly, imported coal plants in

western India will be competitive under all scenarios, whereas they may be a risk in southern India.

- **Customer and contract portfolio.** As the sector develops, selling to state electricity boards (SEBs) under long-term power purchase agreements (PPAs) is not the only option. Keeping a part of the capacity for merchant sales could increase margins significantly. As open access becomes a reality in progressive states, targeting large industrial or commercial users becomes a viable option. In many states industrial and commercial tariffs are quite high and such customers may be willing to pay premiums over what generation companies could realise from sales to discoms.

- **Bidding strategies.** Most new capacity is likely to be competitively bid, and the bidding strategy will be a very important driver of value creation. Bidding too aggressively to ensure success could leave no room for profits, while safe bidding may mean losing the opportunity altogether. Developing a robust bidding strategy will require a deep understanding of three elements: First, the bidding approach and capabilities of competitors, for example, the EPC, equipment contracts or partnerships they have entered into, their conduct in previous rounds of bidding, or in any other industry in which they are present, and the kind of shareholder or stock market pressures they face. Second, the need to understand the project, the options available, and unique challenges which may be faced. Finally, before bidding, it is necessary to understand the extent of in-house capabilities and the level of stretch targets that can be set.

UNDERSTANDING AND ADDRESSING INHERENT RISKS

Although the opportunities in the sector are significant, it is critical for players to recognise and proactively manage risks inherent to it, such as localised or time-of-day surpluses, bottlenecks to approvals, uncertainty around key regulations and potential market failures. The following section describes the salient risks in sight and the kinds of measures that will need to be taken to mitigate them.

Dispatch risk

As India makes substantial investments to expand generation capacity, the power sector's cost curve will undergo a significant shift. New plants—many double the size of existing ones—are likely to be built over the next 10 years, many of which are anticipated to be more efficient than existing ones, despite the exposure to greater fuel risks resulting from the increasing diversity and volatility of fuel sources.

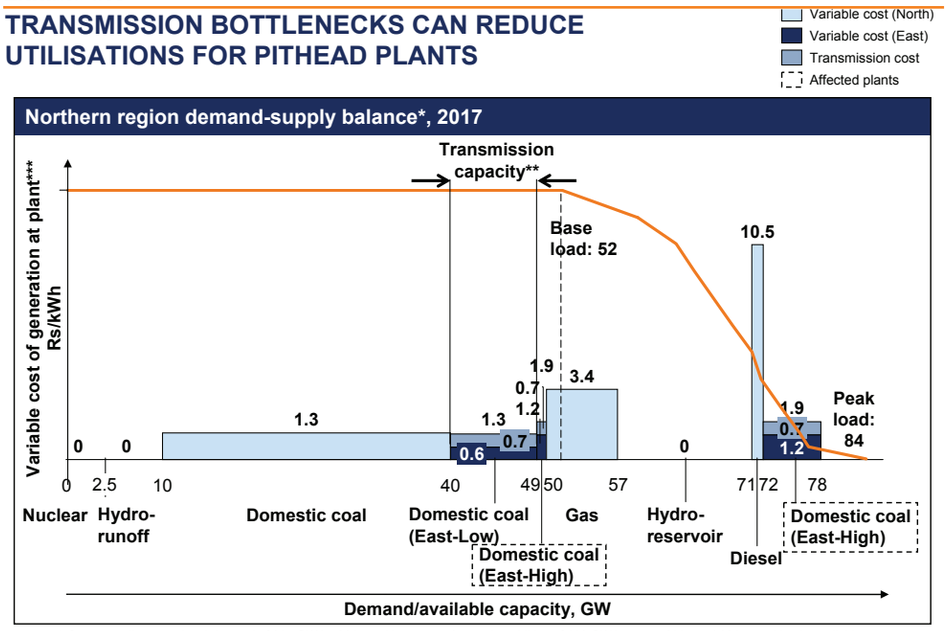
To avoid dispatch risk, new plants must be competitive against a range of demand and supply scenarios. The first step is to understand the quantum of this risk by simulating the dispatch performance of the plant under a range of competitive

scenarios. Such an assessment cannot be made through simplistic analysis like examining the relative costs. It needs to take into consideration the dynamics of regional and national power flows and the profile of the load curve.

For example, consider a plant in eastern India which resides in the middle of the cost curve and is considered a safe investment. Its costs are low compared to a plant in the northern region, but they are high relative to those of other plants in the east. Given a plausible scenario where the eastern region will have excess capacity while the northern region will be short, power will flow from east to north. If transmission capacity is inadequate, it is highly likely that the plant in the eastern region will not get fully dispatched even as more expensive northern plants get fully dispatched (Exhibit 3.7). Now extend this example to the monsoon months when demand is low

Exhibit 3.7

TRANSMISSION BOTTLENECKS CAN REDUCE UTILISATIONS FOR PITHEAD PLANTS



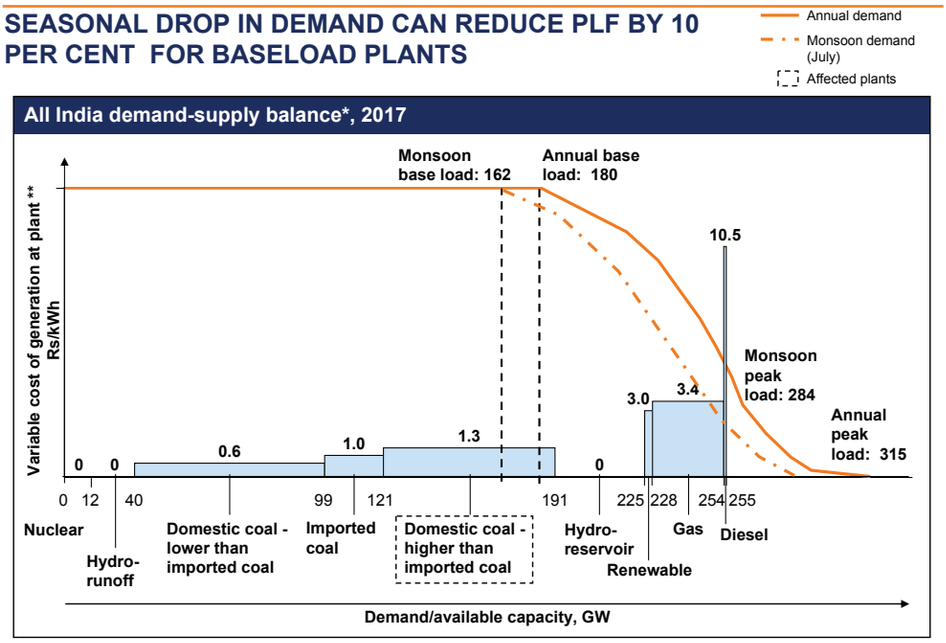
* Corresponding to national demand of 315 GW by 2017 and incremental capacity addition of 180 GW between 2007 and 2017 resulting in available capacity of 255 GW nationally
** If transmission capacity between Eastern and Northern grid remains at current levels of about 10 GW
*** Corresponding to gas price of US$ 12 per mmbtu and imported coal prices of US$ 60/MT for 6000 kcal/kg coal
Source: Ministry of Power; Regional Load Dispatch Centres (RLDCs); McKinsey IRM model

and newly built hydro capacity in the North East is running at full capacity. At this time, the plant in eastern India will get even lower dispatch, to the extent of a 10 percentage point drop (Exhibit 3.8).

In addition, certain events can dramatically alter the cost curve. For example, if the Indo–US nuclear deal goes through and significant nuclear capacity gets built, marginal thermal plants may not get fully dispatched. Exhibit 3.8 shows an example of how different plants might stack up on a dispatch curve, with higher variable-cost plants facing low dispatch despite an overall peak shortage.

Exhibit 3.8

SEASONAL DROP IN DEMAND CAN REDUCE PLF BY 10 PER CENT FOR BASELOAD PLANTS



* Corresponding to demand estimate of 315 GW in 2017 and incremental power generation capacity of 180 GW
** Corresponding to gas price of US$ 12 per mmbtu and imported coal prices of US$ 60/MT for 6000 kcal/kg coal
Source: Ministry of Power; Regional Load Dispatch Centres (RLDCs); McKinsey IRM model

This example and several other scenarios have been built using McKinsey's proprietary Indian generation dispatch model that allows generation plants of any configuration to be modelled against a range of scenarios to test their dispatch performance, risk and economic returns.

Payment security

Payment security risk is relatively unique to India. Most Indian state-owned discoms do not effectively convert power supplies into revenue due to a high degree of theft and technical losses which account for about 35 per cent of the overall power supply. This, coupled with imbalanced tariffs, has resulted in discoms that are not financially viable.

In the past 5 years, tripartite agreements and the Electricity Act (EA) 2003 have improved the payment track record of most discoms. By and large none of them have defaulted due to the financial support received from their respective state governments.

Generation companies will need to manage this risk by identifying and predominantly selling their supplies to viable discoms that have relatively healthy finances, stronger regulatory mechanisms, and are not overtly dependent on subsidies for survival. Some states may also offer opportunities to mitigate payment risks by forward integration into distribution.

Project execution risk

These are challenging times for capital projects across the globe. Tightness in equipment markets and limited availability of critical project management skills and capacities are leading to overruns in costs and time. This problem is compounded in India with significant approval and infrastructure bottlenecks as well as local resettlement issues. Furthermore, power projects will have to compete with a large number of projects in other sectors for scarce E&C resources and manpower.

Overruns in costs and time can impact project returns in any sector. However, pricing flexibility and steepening cost curves could provide some cushion to projects in other sectors. The unique challenge which power projects will face is that they will have a fixed, committed tariff. Often these projects would have been secured through aggressive bidding with limited cushion for any overruns. This risk can be addressed by either building in-house EPC capacities, which is the route most incumbents are taking, or by forging strategic partnerships with established EPC players and jointly bidding for projects. Furthermore, fully understanding and assessing the execution risks of specific projects, sites, mines and regions will be critical to ensure that the euphoria of winning major projects does not wear off during execution. Finally, successful companies will proactively engage with local communities and their leaders, and understand and respond to local socio-economic needs and concerns.

Fuel supply risk

Fuel availability and pricing is another source of risk. India is already experiencing a shortage of coal and gas, and in many instances, plants have come close to coal stockouts. Likewise, gas plants have witnessed acute fuel shortages and as a result have either been operating at lower utilisation or are using alternative expensive naphtha. Fuel shortages could worsen as the supply struggles to keep pace with growth.

Already, supplies from Coal India to companies in sectors like cement have been curtailed. As a result, these companies are either importing coal or buying domestic coal through e-auction. In both situations, the price of coal is at least 30 to 40 per cent higher than the price charged by Coal India. Similarly, gas supplies continue to remain constrained due to limited indigenous production and increased competition between gas-consuming industries. Policy moves towards sectoral volume allocations for gas are creating uncertainty around supplies. Finally, regulated prices can further distort demand and worsen shortages.

To overcome the risks associated with fuel shortages players will need to find ways to access supplies. This could include investing in fuel sources where possible, such as coal and E&P blocks, partnering with resource holders to share integration upside and access supplies, or accessing or creating import infrastructure.

Market failure risk

Peaking power is being traded at very high prices—some recent trades for power during summer months have been upwards of Rs 7 per kWh. However, since these markets are neither deep nor secure, there is a risk that plants built as peakers may either not realise true peaking prices, or that market intermediaries may capture the surplus.

These risks can be mitigated by choosing a mix of contracts that match the developers' risk appetite. For example, selling 50 per cent of the power each on long-term 20-year PPAs and spot contracts can hedge the risk on a part of this investment and access higher prices on the remainder. The other option could be to develop a trading operation or enter into a PPA with a trader with a provision to share upside.

Regulatory and political risks

Regulations for the power sector are still evolving. While the EA 2003 laid out a comprehensive framework, it is likely that the implementation of some of its elements would continue to be delayed or get distorted due to market inefficiencies. For example, open access is still not a reality in most states. In the few states in which it has been implemented, it is not realising its potential due to the high incidence of wheeling and cross-subsidy charges. But if shortages worsen, important rules governing the sector could also change. For example, power plants in special economic zones (SEZ), which have tax concessions, were intended to sell only to customers operating within the SEZ. Given the recent power shortages, there is now a proposal to allow them to sell to customers located outside the SEZ. Distribution companies can also face some risks—they may not be allowed to pass on the high cost of procured power to customers, or to enforce stringent measures to reduce power theft.

These risks can be managed by building strong regulatory capabilities, understanding and engaging with a broad range of stakeholders across the political and economic spectrum, and understanding and implementing tried and tested models for community engagement in the India context.

WINNING APPROACHES

Among others, the following three business models are likely to emerge as winning approaches.

Integrators

Market inefficiencies and prevailing bottlenecks will drive the need to integrate. Three types of integration plays will emerge:

- **Backward integration by generation companies into fuel and EPC.** The ability to bid and win projects, execute projects efficiently and sustain a low-cost position will be the cornerstones of any successful generation business in India. The structural advantage enjoyed by captive fuel and the non-availability of project development and execution providers will drive the need for large multi-plant generation companies to backward integrate into these areas. On the fuel side, captive coal will be the most competitive source of power across India. Moreover, many projects will come with a captive mine and the ability to effectively plan mine development—will be crucial to capturing this advantage. Even plants built on imported coal will need to own overseas mines to avoid exposure to volatile prices. Without the promise of strong EPC capabilities and delivery, it will be very difficult for a player to profitably execute a competitively bid project. However, given market conditions, building this capability in-house is an attractive option. The fact that players will be executing multiple projects makes this option even more attractive. The main incumbents are already adopting this business.

- **Forward integration by resource holders.** Fuels are still regulated in India, the merchant mining of coal is not allowed, and even gas prices are governed by moderate price controls. Therefore, forward integration into power will allow resource holders to fully capture rent on their holding. As shortages increase, companies allotted captive coal blocks will be under increasing pressure to develop their blocks or risk losing them. If executed well, plants developed on such fuel sources will be very competitive. Similarly, moderate price controls on domestic gas are likely to continue, making it more valuable to convert gas into peaking power than to sell it as gas.

- **Forward integration by equipment manufacturers.** This model will prevail in areas where co-investment in new technologies by suppliers is essential, such as new high-voltage direct current transformers, and where Operations & Management (O&M) of equipment is relatively simple and better done by equipment providers themselves, for example, wind generation and solar power.

Specialists

Players with deep expertise or privileged positions in specific areas will also emerge winners. Companies in this category will generate significant returns by leveraging their expertise in a specific segment of the value chain or by serving particular customer types. Specialists are likely to include:

- **World-class O&M operators.** These players would possess best-in-class capabilities in a specific segment of the value chain. For example, they could have a unique business model, which allows them to deliver superior contract mining services and earn relatively high returns. This is illustrated by one of the largest contract miners in the world. It creates value by offering services at low costs—a competitive advantage gained from high utilisation of its heavy mining equipment. The company runs a lean operation that allows it to effectively manage logistics. As a result, it minimises the turnaround time for large equipment such as dumpers.

- **Fuel specialists.** Suzlon is one such example—it has a proprietary database of wind flows, which provides it with a competitive advantage in site selection. Another example could be a company that is proficient in estimating fuel availability for biogas plants. Similarly, companies may specialise in medium-sized hydro projects, such as Jaypee, or mega-coal projects, such as NTPC.

- **Customer-segment specialists.** Specialists of this nature would have a deep know-how of the requirements of a particular customer type and the subsequent ability to service the customers. For example, KSK Energy Ventures provide services to captive and group captive customers. In particular, they identify clusters of industrial customers who cannot individually support captive power plants and serve them through a group captive plant.

Regional entrepreneurs

Regional entrepreneurs would play in multiple parts of the value chain but predominantly work in a few geographies. Such companies deliver superior value by building a strong understanding of the local conditions in the region and leveraging their strong relationships with stakeholders. Deep knowledge of the local conditions

and strong relationships empower them with access to privileged resources. Typical examples of regional entrepreneurs would be companies based in a particular state, with strong relationships with the local and state governments, who can secure access to attractive natural resources, de-risk generation investments by ensuring payment security, and where possible, access distribution collection rights.

* * *

The power sector opportunity in India is large and attractive. It also poses unique risks, but with thoughtful strategies and the willingness to create tailored business models, these can be managed. The payoff for embracing development risks and regulatory and market uncertainties is large. Players who enter early will create significantly more value than players who enter after reforms have stabilised and the sector has matured. The valuations of a few players in the Indian telecommunication and infrastructure development sectors serve as good evidence. Those who entered when the sector was in its infancy and regulations were clouded in uncertainty, have created far greater value than players who are entering now.

Powering India is vital to sustain the country's economic growth. To achieve this, all stakeholders—policy makers, regulators, public and private providers, resource holders, equipment providers, financiers and consumers—must act in concert. A well-coordinated effort in the next 4 to 5 years can turbo-charge India's power sector, and enhance the well-being of its billion citizens.

Appendix:
Approach to estimating demand

Powering India:
The Road to 2017

Appendix:
Approach to estimating demand

Most current estimates of power demand in India are based on projected GDP growth and historical electricity demand elasticity[1]. With a projected GDP growth of 8 per cent over the next 10 years and an elasticity of one, this approach suggests peak demand (including captive) growing from 120 GW in 2007 to 175 GW by 2012 and 260 GW by 2017.

As the economy grows and patterns of consumption and economic activity change, we believe a few significant new sources of demand will emerge. We have considered four additional sources of demand. These are (i) higher demand from manufacturing, where growth is accelerating and electricity intensity[2] is high; (ii) residential demand outpacing the economy, based on rising incomes; (iii) latent demand from un-electrified households; and (iv) demand that is currently suppressed due to load shedding.

We have adopted three approaches to determine peak demand by 2017. These include:

- Sectoral intensity approach
- Comparable economy approach
- Adjusted comparable economy approach

The remaining part of this section discusses these three approaches.

Sectoral intensity approach

This approach takes into account faster growth of the manufacturing sector, impact of rising income on growth of residential consumption and latent demand from currently un-electrified consumers.

- **Faster growth of manufacturing:** This approach estimates the demand for each sector using two macro-economic indicators – projected contribution to India's GDP in 2017 and electricity intensity. For example, by 2017 the manufacturing sector is likely to contribute about 27 per cent or US$450 billion to India's GDP (assuming GDP grows at 8 per cent per year). This combined with an electricity intensity of 1.91 for the manufacturing sector results in a demand estimate of

1 Ratio of electricity demand growth rate to GDP growth rate.

2 Electricity consumption in kWh per US$ of output (GDP).

870 billion units by 2017. Demand for other sectors is estimated along similar lines (Exhibit 4.1).

Exhibit 4.1

SECTORAL INTENSITY APPROACH – INDUSTRIAL, SERVICES AND AGRICULTURAL CONSUMPTION

Sectors	Contribution to GDP (Per cent)			GDP (US$ billion) [X] (Per cent)			Electricity intensity (kWh/$) [Y]	Electricity consumption (Billion kWh) [X*Y] (Per cent)		
	2007	2012	2017	2007	2012	2017		2007	2012	2017
All India*	100	100	100	77	1,130	1,665		565	803	1,157
Manu-facturing	27	27	27	208	305	450	1.91	397	583	860
Services	55	58	60	424	655	1,000	0.11	47	72	110
Agriculture	18	15	13	139	170	215	0.87	121	148	187

* Excluding residential consumption

Source: CEA; Planning Commission; Global Insight; McKinsey analysis

- **Rising prosperity:** Residential consumption tends to outpace economic growth as rising prosperity leads consumers to demand more luxuries such as air conditioners, heaters and other white goods. Residential consumption has had an electricity demand elasticity of 1.82 over the past 10 years. Assuming a GDP growth 8 per cent per year for the next 10 years, residential demand for electricity is likely to grow at 14 per cent annually resulting in residential demand of 678 billion units by 2017 (Exhibit 4.2).

Exhibit 4.2

SECTORAL INTENSITY APPROACH – RESIDENTIAL AND MISCELLANEOUS CONSUMPTION

Segments	GDP growth (%) [X]	Electricity elasticity[1] [Y]	Electricity demand growth (%) [X*Y]	Electricity consumption (Billion KWR)		
				2007	2012	2017
Residential	8	1.82	14.6	174	343	678
Latent residential	8	1.82	14.6	N/A	32	62
Miscellaneous	8	1	8	56	82	120
All India[2]	–	–	–	795	1,260	2,017

[1] Growth in electricity demand for 1% growth in GDP

[2] Including industrial, services and agricultural demand from Exhibit 4.1

Source: CEA; Planning Commission; Global Insight; McKinsey analysis

- **Demand from un-electrified households:** Currently, only 55 per cent of all households in the country are electrified. While the government's stated policy objective is to provide power for all by 2012, we have conservatively assumed that only households above the poverty line will be electrified by 2012[3]. Further, we have assumed that due to socio-economic constraints, the average consumption in these newly electrified households will be about half the average consumption[4] in already electrified households. This will yield an additional demand of 62 billion units by 2017 (Exhibit 4.2).

Finally, the energy demand estimated above is converted to peak demand using the current energy-to-peak ratio for the power sector in India. This results in a peak demand estimate of 195 GW by 2012 and 315 GW by 2017

Comparable economy approach

This approach estimates demand by using per capita electricity consumption for comparable economies at a similar stage of economic development. We have used China and Thailand as comparative benchmarks. By 2017, India's per capita GDP in PPP terms is expected to be similar to China's in 2010. If our per capita electricity

3 This would result in an additional 20 per cent households being electrified by 2012. The remaining 25 per cent of households are assumed to be unable to consume electricity, being below the poverty line. This is a conservative assumption.

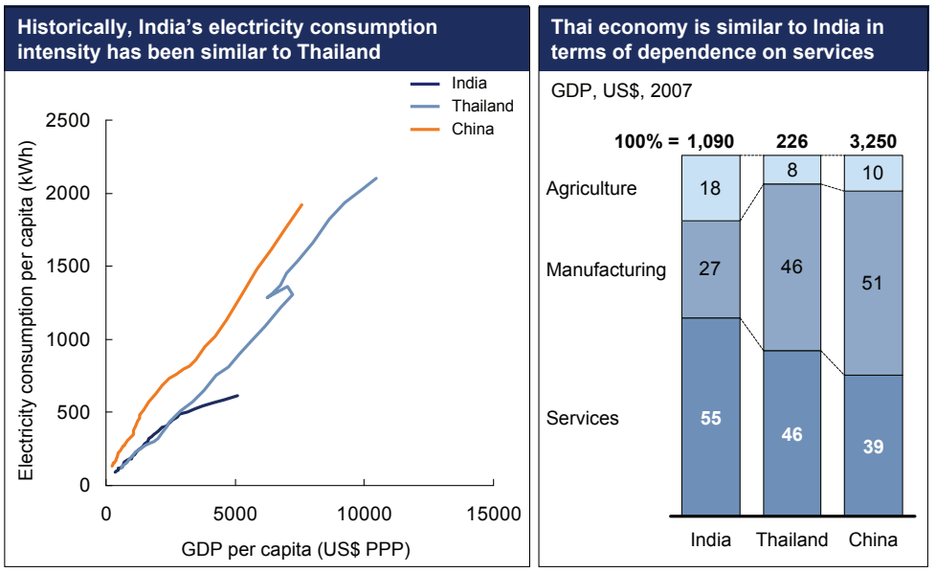
4 Average household consumption is taken as 1580 units per annum.

consumption reaches China's level, India's consumption in 2017 will be 2675 billion units. This would result in a peak demand of 310 GW by 2012 and over 420 GW by 2017.

Historically, Thailand's electricity consumption intensity was very similar to India (Exhibit 4.3). Looking ahead, India's per capita GDP in 2017 is likely to be at the same level as Thailand's in 2009. If India's per capita electricity consumption grows to Thailand's level, it would translate to a peak demand of 450 GW.

Exhibit 4.3

THAILAND'S ELECTRICITY CONSUMPTION AND ECONOMIC PROFILE IS CLOSER TO INDIA AS COMPARED TO CHINA



Source: Central Intelligence Agency (The World Factbook); Global Insight; McKinsey analysis

However, manufacturing accounts for much larger share of China's and Thailand's economies. As a result, this approach tends to overestimate demand, as manufacturing is more electricity-intensive compared to services. To address these crucial differences, we have adjusted the comparable country intensity approach.

Adjusted comparable economy approach

The demand estimates from the previous approach need to be adjusted for sectoral differences between different economies. We have adjusted electricity demand in the ratio of a sector's actual contributions to the country's GDP. For instance, the industrial demand for electricity is adjusted downwards in the ratio of manufacturing's contribution to the Indian economy versus the Chinese economy. On the other hand,

the commercial and agriculture demand for electricity is adjusted upwards in the ratio of services' and agriculture's contribution to the Indian economy versus the Chinese economy.

The demand from these three sectors (manufacturing, services and agriculture) combined with the residential sector demand from the sectoral intensity approach results in an overall demand of 2160 billion units by 2017. This corresponds to a peak demand of 335 GW by 2017.

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For the purpose of the analyses in this report, we have used the estimates from the first and the third approach, i.e., peak demand in 2017 estimated to be between 315 GW and 335 GW.

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