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Confederation of Indian Industry



DIGITAL IN POWER

INDIA PERSPECTIVE

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CONTENTS

3	EXECUTIVE SUMMARY
5	EVOLUTION OF THE INDIAN POWER SECTOR Evolution of Power Generation Evolution of Transmission and Distribution (T&D)
11	PRIORITIES FOR THE INDIAN POWER SECTOR Flexibility in Operations for Thermal Power Plants Increased Returns for Renewables Reduction in AT&C Losses Improvement in Network Reliability Customer Centric Business Models
14	DIGITAL: A NEW WAY OF WORKING
17	DIGITAL FOR BUSINESS TRANSFORMATION
21	DIGITAL IN POWER VALUE CHAIN
22	DIGITAL USE-CASES IN GENERATION
29	TRANSMISSION AND DISTRIBUTION
36	CONCLUSION
38	FOR FURTHER READING
39	NOTE TO THE READER

EXECUTIVE SUMMARY

THE INDIAN POWER SECTOR is evolving rapidly through changes in regulations, demand and technology. While the sector has seen strong growth and improved accessibility, challenges still remain across the value chain. Generating assets are increasingly faced with margin pressures owing to raw material volatility (for thermal assets) and increased competition (for renewables). T&D (Transmission and Distribution) in turn is plagued with legacy issues of constrained capacity and poor efficiency. In this environment, there is an increasing need for players in the power sector to rethink the way they do business.

Digital presents exactly this opportunity—by reshaping the way companies think about technology, data, new customer habits, new ways of working and new business models. Digital offers companies the toolkit to address emerging challenges and exploit opportunities.

There are multiple potential digital interventions across power generation, transmission and distribution. Many of these interventions are fairly well established and implemented in other geographies. Going ahead, we expect the Indian power sector to adapt similar solutions and also develop completely new ones to meet domestic challenges.

On the generation side, digital use cases in four areas are studied across both conventional and renewable generation. Flexibility in the value chain is important for coal based plants as the renewable mix increases and demand patterns shift. Generation planning, flexibility in coal sourcing and improving non-tariff income help in increasing this operational flexibility. Operational solutions such as digital tools to optimize conversion efficiency, unit heat rate and load allocation across units are also explored, coupled with digital solutions for maintenance, surveillance and inventory reconciliation. For renewables, digital tools to analyze generation patterns in wind and solar power plants are becoming increasingly popular as a means to extract additional value from existing assets.

On transmission and distribution, digital use cases for grid O&M (Operations and Maintenance), capacity planning and customer support are analyzed. In particular, Indian utilities lag not only global benchmarks but also other local service providers (such as telecom and banking) on traditional metrics used to gauge service levels and customer engagement. Revenue assurance, DER (Distributed Energy Resources), network asset management and storage are four areas where digital use cases are well established globally. These interventions become critical as DISCOMs (Distribution Companies) evolve into distribution services operators (DSOs).

Developing an environment for digital however comes with its own share of challenges. While a higher degree of digitization will make the entire value chain more responsive, effective and reliable, mere implementation of technology is not sufficient to realize value. Digital is more than a simple change to the IT of an organization but rather an entirely new way of working. To realize the benefits of digital, organizations must embed a “digital DNA” via development of the appropriate talent / capabilities, organization redesign and the development of a robust change management process.

As environmental factors change, the Indian power sector must embrace digital as the means to gear itself for the future.

EVOLUTION OF THE INDIAN POWER SECTOR

THE INDIAN POWER SECTOR is evolving at a rapid pace, driven largely by a conflation of demand, technology and regulatory changes, spanning across the value chain.

Strong economic growth and a push for 100 percent electrification has been the bedrock for increasing demand in the power sector. Policy interventions over the past 15 years

have however played a critical role in shaping how this demand is met: be it in power generation, networks or the market structures which have gradually migrated from a more protected and regulated environment to a more market oriented environment.

Exhibit 1 outlines a few such instances of how demand and regulatory changes have

EXHIBIT 1 | Demand and Regulatory Changes Impacting Power Value Chain

		Demand impact	Regulatory impact
Generation 	Fuel	Coal availability to remain a bottleneck	Privatization of coal mining
	Large-scale conventional	Capacity creation (1.7x) to meet demand growth (7% CAGR)	Competitive bidding Stricter SOX and NOX norms
	Large-scale renewable		Renewable energy push – 175GW by 2022
Networks 	TSO ¹	\$40 billion investment to boost transmission capacity	Competitive bidding to attract private investment
	DSO	100% household electrification	Content-carrier separation (Medium – long term)
Trading 	Commodity trading	Increase in % power traded in Short term markets	Rationalization of open access Product innovation at Exchanges
Customer 	Commodity retail	Power demand growth at 7% CAGR	DISCOM private franchisee (Short term)
	Decentralized solutions ²	Growth in decentralized solutions Energy Services Market	

Source: BCG analysis.

¹TSOs (transmission system operators) and DSOs (distribution system operators) service, own, and market their networks.

²Distributed renewables and combined heat and power (CHP) systems, e-mobility, smart home, and storage.

shaped the power sector: be it an impetus to development of larger and larger power projects (“Mega” and “Ultra Mega” power plants), the push for renewable energy, imposition of stricter emission norms, private investments in transmission networks, development of short term power markets or development of a framework for content-carrier separation (which is currently under progress).

A confluence of the above factors has brought the Indian Power sector closer to the benchmarks of its global peers. As the sector continues to evolve, in the near future, we expect that trends native to western markets will start to play out in the Indian market as well.

As a consequence of these emerging trends, a number of changes are expected across the value chain.

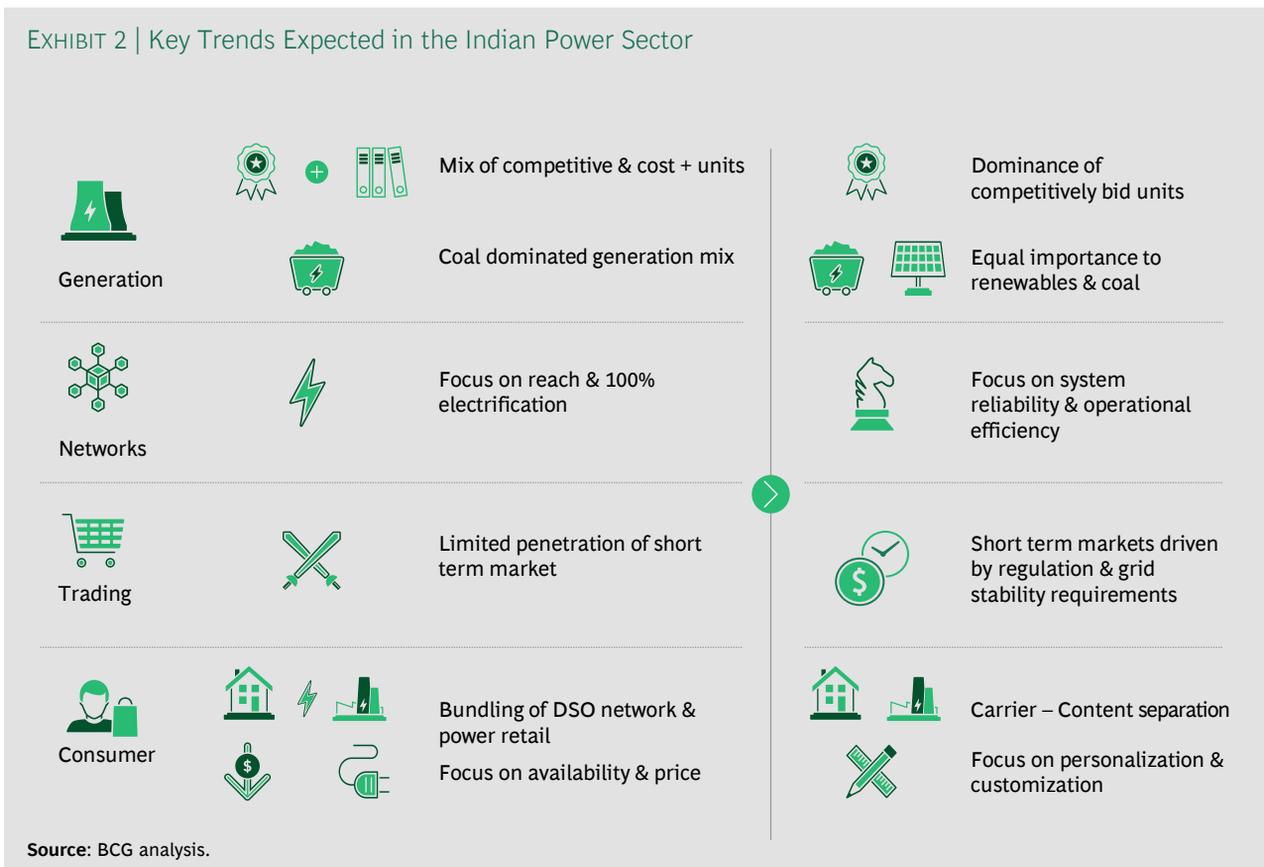
The sector is expected to increasingly shed its monopolistic, regulated, fixed return business model and move towards a competitive, market based model for both generation and supply. The basket of generation sources is

expected to diversify as the world moves towards newer and cleaner sources of power generation. With the eventual separation of content and carriage, consumers are expected to be treated to an explosion of choice. Their demands are thus expected to evolve from purely utilitarian (“cheap power”) to also encompass the quality of service delivered by their service providers: a-la telecom networks and financial service, which themselves are getting disrupted digitally. Exhibit 2 illustrates these key changes expected in the power value chain and builds a picture of what the future of the Indian power sector could look like.

Evolution of Power Generation

Power generation is undoubtedly the sector to have been most impacted by the changing regulatory landscape and has truly moved towards a more open and competitive business model. Going ahead, we expect this trend to continue with an increase in competitively bid assets coupled with an increase in renewables penetration continuing to drive change in power generation.

EXHIBIT 2 | Key Trends Expected in the Indian Power Sector



Source: BCG analysis.

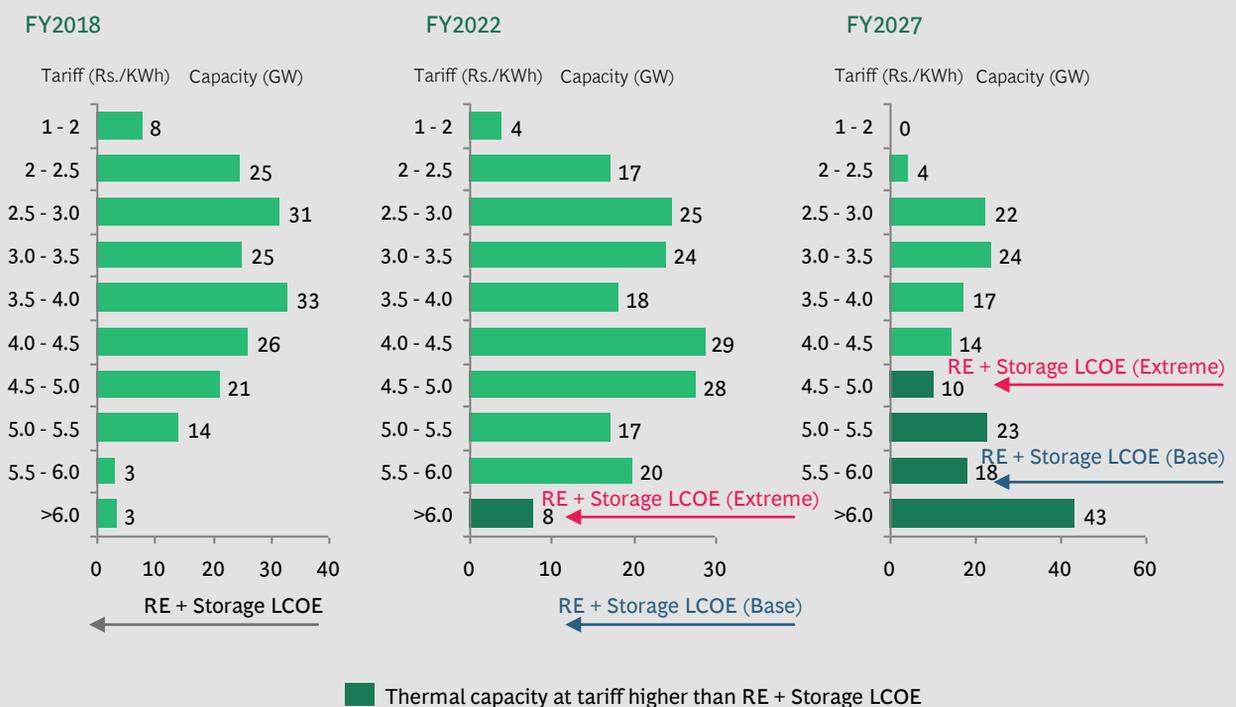
However, the sector is not without its own share of challenges. The aforementioned changes have created a situation where generators face significant downward pressure on utility margins.

In the case of conventional generating stations (coal and gas), the “rise” of renewables coupled with systemic overcapacity has resulted in a continuous drop in plant load factor (PLF), across units in India. Over the past 5 years, the average PLF of coal based units in India has fallen to 59 percent (2017-18). The situation has been further exacerbated by the uncertainty over coal supply—domestic coal supply and rail freight capacity continue to lag while international coal prices remain stubbornly high. These two factors together have significantly dented the financial health of coal based plants with more than 35GW of coal based capacity currently under financial stress. While the shortage of coal supplies and the stressed finances of select assets is expected to ease out in the near future, PLFs for these power coal based plants are expected to only marginally improve to settle in the range of 60-65 percent.

An increasing focus on renewable generation is further expected to compound this problem. Renewables have demonstrated a continued drop in costs over the past 5 years. The drop has seen a steep increase over the past 2 years with more than 35 percent drop in tariffs witnessed in 2017 and 2018. The cheapest discovered solar prices are already cheaper than the average thermal power cost. With the increased competitiveness of storage coupled with renewable generation is now also expected to resolve the “concentrated” nature of renewable generation (with generation peaking at select times of the day) making it a “base-load” alternative to conventional power plants. As evident in Exhibit 3, up to 90GW of thermal capacity is expected to become uncompetitive against Solar + Storage over the next 10 years.

Renewables generators, however, have their own set of challenges to address. While the fall in levelized tariffs has been largely driven by a sharp fall in capital costs, competitive bidding of assets in the recent past has exerted a downward pressure on developer returns-on-equity. Especially for solar and wind projects, this situation has been characterized

EXHIBIT 3 | Renewables + Storage competitiveness WRT Thermal Capacities



Source: BCG analysis. LCOE = Levelized Cost Of Energy.

as a race to the bottom. Developers have continued to bid aggressively for projects with project returns falling to single digits (as evidenced by Exhibit 4). Such aggressive bidding risks the entire eco-system with project viability under threat and cascading effects across the value chain: from developer returns to margin pressures on OEMs and SME vendors. Step changes and unknowns such as the recently imposed import duty of 25 percent on imported solar modules are further expected to impact developer margins, given the uncertainty surrounding the government's intent to recompense developer losses.

Notwithstanding these challenges faced by developers, however, India has embarked on an aggressive renewables mission with a target of 175 GW capacity by 2022. While renewables are expected to continue to grow at an exponential rate, enhancing returns through operational and financial interventions will remain critical to the long term financial health of the sector. Most importantly, as the long terms costs of renewables breach spot market rates, merchant renewable plants will not be far from reality. Already about 500

MW renewable generation is registered on exchange platforms.

Evolution of Transmission and Distribution (T&D)

Transmission & Distribution in India continue to be influenced by regulatory drivers vis-à-vis generation. While generation has seen significant private participation, transmission and distribution are still dominated by state actors with sector dynamics primarily driven by regulatory action.

Transmission has seen an increase in private participation under the Tariff Based Competitive Bidding (TBCB) model. Private players have achieved ~60 percent share in projects under TBCB. Going forward, maintaining pace with increasing demand and de-bottlenecking local congestion due to the concentrated geographic nature of renewable generation, will be the key priorities for the sector.

Distribution on the other hand is poised for disruption. Legacy issues of lower tariffs and high Aggregate Technical & Commercial

EXHIBIT 4 | IRRs for Recent Solar and Wind Bids

RECENTLY DISCOVERED BIDS LIKELY AT 8-10% IRR, EVEN AFTER FACTORING IN ~20% REDUCTION IN EQUIPMENT...



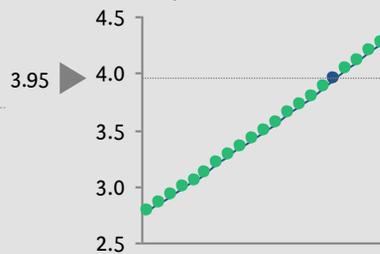
Base Case Tariff of ₹3.95 expected

Wind

Bid of ₹ 2.6 with aggressive assumptions

- Equity IRR of 16%
- Debt cost of 9.0%
- Equipment cost of 6.0 Cr/MW
- Equity IRR of 9-10% , Debt @ 8%
- ~15-20% reduction in equipment
- ~2-3% increase in PLF

Illustrative: Tariff vs IRR under base case assumptions



... WHICH POSES 3 RISKS TO THE ENTIRE ECO-SYSTEM

1

Project viability risks considering aggressive assumptions (risk of NPAs)

2

Pressure passed onto OEMs and then SME vendors

3

Shift to higher imports to support aggressive capex assumptions



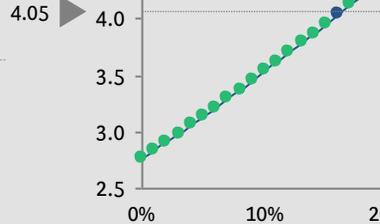
Base Case Tariff of ₹4.05 expected

Solar

Bid of ₹ 2.5 with aggressive assumptions

- Equity IRR of 16%
- Debt cost of 9.0%
- Equipment cost of 5.0 Cr / MW
- Equity IRR of 9-10%, Debt @ 8%
- ~20% red'n in Equipment, O&M
- ~2% increase in PLF factored in

Illustrative: Tariff vs IRR under base case assumptions



Source: BCG analysis.

Note: Y axis – Tariff in Rs. / KWh and X axis—Expected IRR%; Graph plots tariffs against different IRR expectations; Financial engineering not accounted for in the analysis.

(AT&C) losses continue to plague the sector. The poor financial health of State distribution companies (DISCOMS) has been one of the biggest sources of stress for the Indian Power Sector. Over the past few years, there has been a sustained push to improve the financial health of DISCOMS through the Ujwal DISCOM Assurance Yojana (UDAY). Reduction in AT&C losses has been a key priority of the UDAY Scheme. While there has been a heartening improvement in AT&C losses across the country, there remains significant headroom for improvement (Exhibit 5).

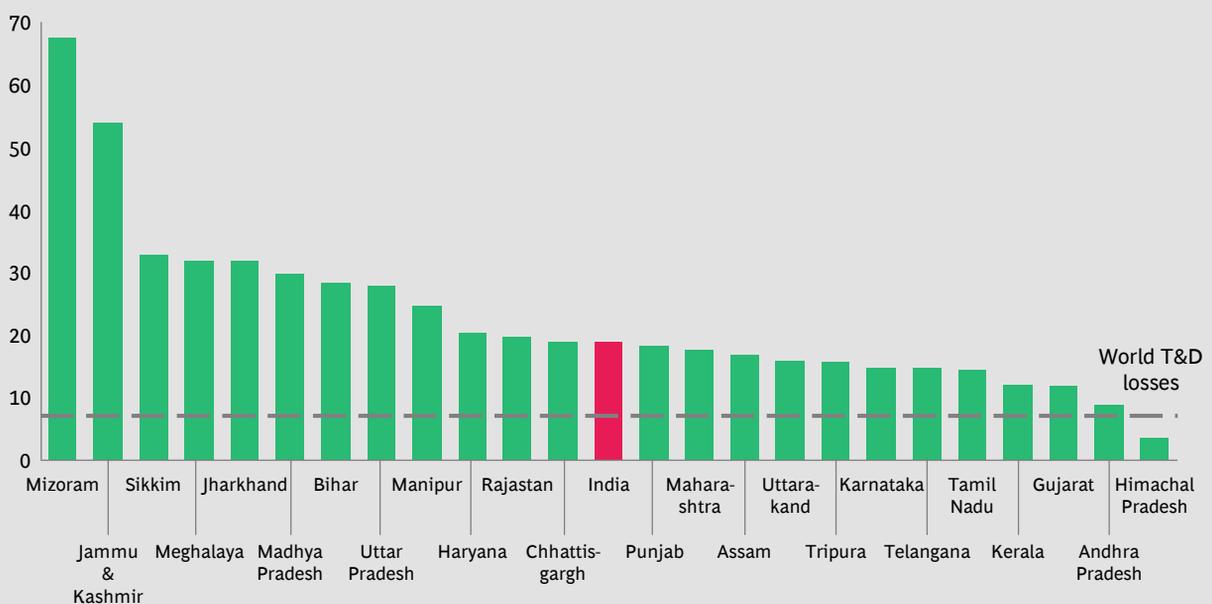
Distribution is the only part of the value chain of the power sector that is in direct contact with the consumer. Hence, it is vulnerable to changing consumer preferences. With a maturing economy, the focus is expected to shift from “availability” of power to “quality” of power.

India has recently achieved 100 percent electrification and is on course to achieve its ambitious goal of 100 percent household electrification soon. However, network reliability in India remains far behind global benchmarks as evi-

dent in Exhibit 6. The regulatory bodies governing distribution remain cognizant of the scope of work that remains to be done with the Central Electricity Authority (CEA), having issued a circular to initiate regular reporting of reliability metrics (SAIFI, SAIDI, CAIDI, MAIFI) across all distribution licensees. We expect network reliability to continue to be a key focus for the Indian distribution sector, going forward.

With Indian consumers becoming more commercially savvy and energy conscious, the pattern of power consumption in India is also expected to witness a momentous shift. The rise of electric vehicles, an increase in distributed generation and the adoption of “behind-the-meter” storage will require new business models of serving the consumer to emerge. Rooftop solar is poised to take off in India with installations crossing 1 GW. As battery costs continue to drop, behind-the-meter applications like peak shifting and renewables self-consumption are expected to gain traction. Demand prediction and peak demand management are progressively expected to get complicated, necessitating an apt response from DISCOMS.

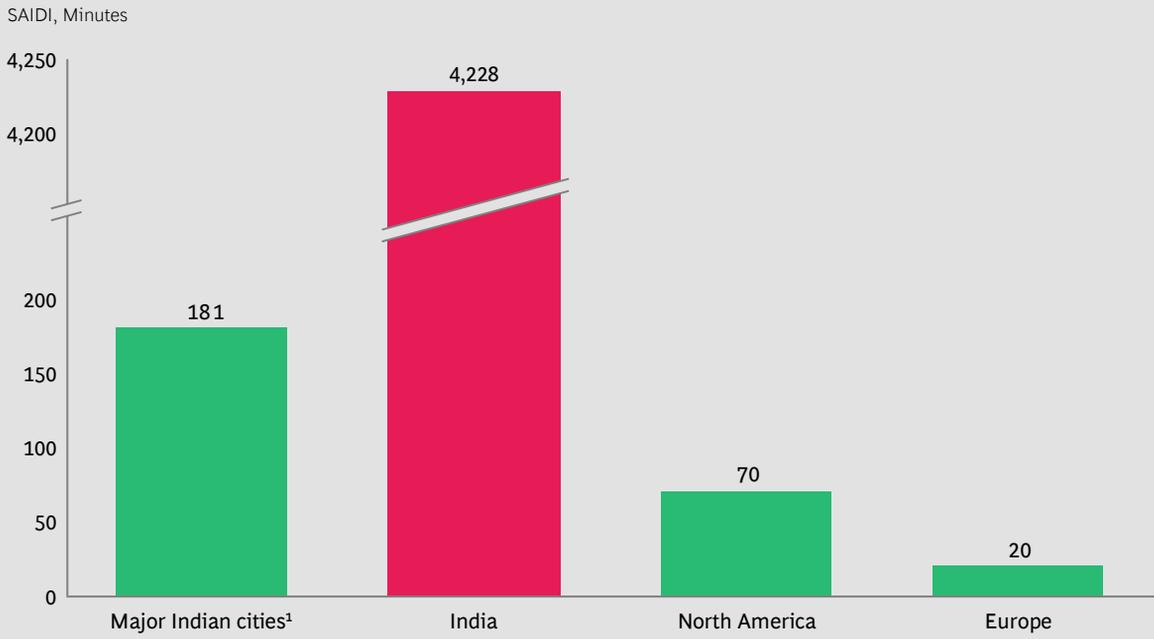
EXHIBIT 5 | State Wise AT&C Losses



Sources: World Bank; UDAY.

Notes: Does not include data of Sikkim, Arunachal Pradesh, Mizoram, Nagaland, Andaman and Nicobar Islands, Lakshadweep.

EXHIBIT 6 | Reliability of Power Supply—SAIDI figures



Source: URJA Portal; CERC.

¹Average SAIDI – CESC, TPDDL, BYPL, BRPL, Rel Energy, Torrent, BEST, TPC-D.

PRIORITIES FOR THE INDIAN POWER SECTOR

IT IS EVIDENT THAT the landscape of the Indian Power Sector is rapidly evolving. The sector is gearing up for the future while still grappling with legacy issues. Consequently, we see key priorities emerge for the sector (exhibit 7).

Flexibility in Operations for Thermal Power Plants

Traditionally, thermal power plants have

largely operated as monoliths with O&Ms focused on ensuring peak availability and stable but continuous operations. With increasing cost pressures and low as well as varying demand, coal based power plants have to adapt to a reality where “flexibility” rather than “robustness” becomes the key driver for value creation. This mantra of “flexibility” would need to encompass all aspects of generation, from fuel supply to demand management to maintenance. The four key aspects

EXHIBIT 7 | Priorities for Indian Power Sector



Flexibility in operation of thermal power plants



Reduction in AT&C losses



Increase in returns of renewables



Improvement in network reliability



Customer centric business models

Source: BCG analysis.

of flexibility in generation are enumerated below:

- **Operations flexibility:** The impetus on renewables with a directive to operate them as “must-run” units has led to increased variability in power plant daily generation profiles. Increased flexibility in operations would be required to ensure stable and optimal performance under varying loads.
- **Short term flexibility:** Variability in contracted demand from long-term power procurers has also created opportunities for power plants to capitalize on opportunities in liquid short-term markets to offload surplus capacity. Dynamic demand tracking has thus become critical for generators to maximize value creation from power assets.
- **Fuel flexibility:** Constraints on fuel supply (both domestic and international) have necessitated increased flexibility in the bandwidth of eligible fuel grades that can be used at a thermal station—the ability of a generator to diversify its fuel basket with minimal capital expenditure has now become a key lever for value release.
- **Manpower flexibility:** Improving safety, productivity and managing the challenge of availability of manpower (especially in remote locations) will continue to be priority areas for talent management teams at generating stations going ahead.

Increased Returns for Renewables

Continued single-digit returns for renewable developers remain a major issue, both for individual developers and for the country’s ambitious target to achieve 175 GW generation by 2022. While strong project planning, execution and financial innovation will remain key to improving margins for assets under development, strong O&M practices become increasingly critical (especially for Wind based Power) to extract greater value from existing assets. Increasing the utilization factor for renewables will be central to improving renewable returns. As has been seen in developed markets, there

will be alternate commercial models beyond long terms PPAs—which can improve returns but increase operational complexity.

Reduction in AT&C Losses

AT&C losses remain the bane of Indian distribution. A concerted effort to reduce losses is imperative for improving the financial health of DISCOMs and giving them the financial heft necessary for future disruptions. As the experiments with DISCOM franchisees and private DISCOMs show, reducing AT&C losses to the 10 percent range remains an achievable target for Indian DISCOMs.

Improvement in Network Reliability

As the Indian power sector gears up to serve a more mature economy, improving system reliability remains another key priority. More critically, uniform improvement in system performance is now a priority to ensure that the vast majority of the population of the country in Tier II+ cities enjoy the same service levels as the urban elite.

The best performing DISCOMs in metros have an average System Average Interruption Duration Index (SAIDI) of ~180 mins which in themselves have significant room for growth against global benchmarks of 20-50 minutes. Worryingly, the national average remains significantly above these benchmarks. Poor reliability of the Indian grid has led to the emergence of a parallel back-up market dominated primarily by diesel generation sets. This is not only a cost in-efficient method of power production but also has negative effects on the environment. 100 percent reliability should be the next goal post 100 percent electrification.

Customer Centric Business Models

As the electricity value chain starts getting de-centralized and de-regulated, consumer preferences are expected to play a key role in shaping the sector. Electric vehicles and battery storage are expected to significantly alter demand patterns. Energy conscious customers are expected to demand better and cus-

tomized demand management solutions, tailor made to meet their specific energy needs. Further, distributed energy generation is expected to increase customer bargaining power as savvy customers evaluate simply “dis-

connecting”: a challenge that power utilities are increasingly facing in the more developed western markets. There is thus an urgent need to develop customer centric business models.

DIGITAL: A NEW WAY OF WORKING

AS THE PRIORITIES FOR the power sector evolve over time, it needs to adopt new and innovative methodologies to tackle emerging challenges. Old ways of working have proven to be only marginally effective in addressing these challenges. These new challenges require a “new way of working”: both for incumbents and new players alike.

One strong confluence is the emergence of digital technologies and the opportunities they present for participants in the electricity value chain.

Digital is transforming our lives in myriad ways—the way we communicate, shop or access services. Entire industries, let alone individual businesses have to keep pace with digital innovations to stay relevant and gain competitive advantages in the marketplace. Understanding of digital and its dynamics is crucial to this growth.

Exhibit 8 shows the various trends and their dynamics in the digital paradigm.

But What is ‘Digital’?

Digital is not just about data or new technology. It is more than a plain vanilla update to the IT and software of an organization. It is an entirely new way of working: of thinking about process and structures within an organization and about reimagining new possibilities.

Data, technology, new customer habits, new ways of working and new business models are the five key elements of the digital landscape. Each of the elements provide tools in the toolkit to deal with business challenges in the digital era.

Here we lay out a simple framework for digital, and explain why these capabilities would be critical for businesses of the future.

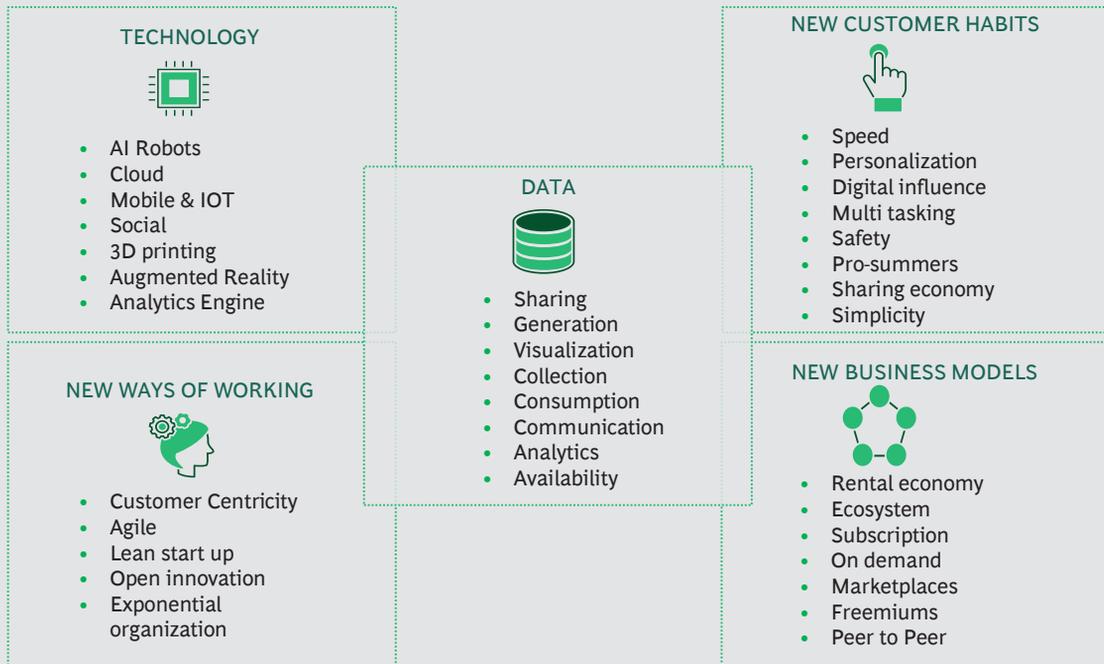
Data

Data lies at the heart of the digital revolution. Along with advancements in data generation and processing, increasing digitization has led to an explosion in the amount of data that is currently available. For example, data on business processes and customers is easily available and comes with more details. Not just the availability, our ability to store, process and analyze data has also gone up: a shift from “Data” to “Big Data”.

On the analysis front, Excel based analysis is giving way to platforms like Alteryx. Complex modelling and data visualization is more accessible to businesses via software like Tableau.

The ability of an organization to gather and process data has increased exponentially, be it data gathered by sensors in a manufacturing facility for process planning and efficien-

EXHIBIT 8 | Trends Defining Digital



Source: BCG analysis.

cy or the accurate modelling of end customers' demands and preferences.

Technology

Another trend in the digital landscape is the advancement of technology. From artificial intelligence (AI) and robots to social media and mobility, technological advances are changing the way we live and do business. Artificial intelligence has already found application across industries—manufacturing, healthcare, automotive etc. Robotics have entered the mainstream: from industrial robots in steel production to medical robots for surgery.

IoT (Internet of Things) devices have started to become common in homes and industries. The use of IoT devices in manufacturing and production in heavy industries, is changing plant maintenance and day-to-day operations. 3D printing technology is poised to disrupt the way businesses think of prototyping and field maintenance. AR and VR are revolutionizing the customers trial and purchase experience.

The onus is now on businesses to develop innovative business models that leverage these new and increasingly accessible technologies.

New Customer Habits

Simultaneously, customer expectations and aspirations are being transformed through the digital revolution. The massive growth in on-line customers and digital payments is indicative of the way customer habits are changing. Increasing capabilities on the data and technology front have led to personalization of services and increased speed of delivery. Businesses have access to massive amounts of data on customers and their preferences, making it possible to tailor goods and services to suit individual customers. Customers increasingly are demanding online presence for their preferred services and brands. In the case of manufacturing industries and utilities, businesses are recognizing the value generated from real time data on consumption, online payment, complaint tracking etc.

The Sharing economies—from cabs to furniture—are another customer preference

change enabled by the digital revolution. Safety and simplicity of service delivery and customer experience are now a basic expectation in the digital era.

New Ways of Working

To respond to the outward changes, industries are changing their ways of working. Organizations are increasingly becoming more and more customer-centric. Manufacturing and service industries are making the end customer the focal point of their decision making processes. Ability to respond to a dynamic digital environment necessitates new ways of doing business that are lean and agile. Irrespective of the size of the organization, the ability to “think like a start-up” is highly valued.

For large organizations, the ability of individual departments to innovate without losing sight of the bigger picture or getting stuck in

their respective silos has been made possible via digital enablers like collaboration software and organization structure innovations. Scalability is a key metric as we move towards an economy of abundance.

New Business Models

As discussed, the digital paradigm opens up opportunities for businesses across markets. Entrenched incumbents are attempting to mirror their “startup” counterparts by developing new business models to exploit “Digital”. Rent and share economies, subscription based services, on demand services, and market places are but a small subset of the ecosystem of new business models enabled due to “Digital”.

The digital toolkit may vary with industry or business, but the elements of the landscape that provide tools to address business challenges remain homogenous.

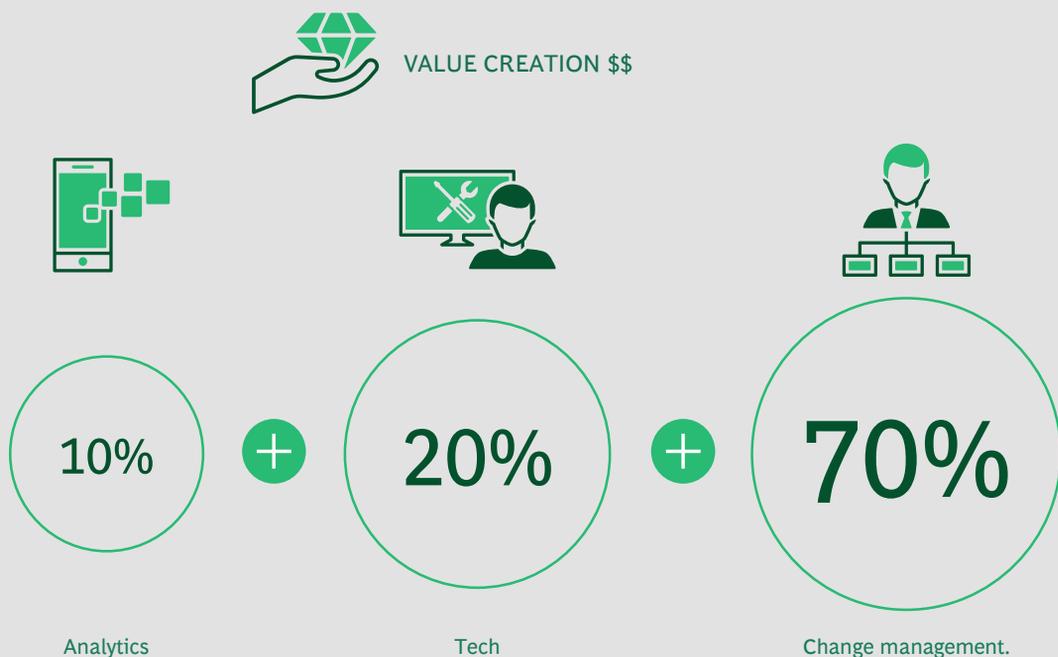
DIGITAL FOR BUSINESS TRANSFORMATION

IT IS NECESSARY TO understand that digital is much more than a set of new technologies. It is a whole new way of working and utilities must approach digital with an objective of complete business transformation. Digital is not a patchwork of data analytics / new technologies applied towards solving business problems. To achieve

maximum value creation from technology, organizations must embed a robust change management process to embed digital in the organization DNA (Exhibit 9).

We believe that there are three key questions that utilities must address before they embark on a Digital Transformation journey.

EXHIBIT 9 | Value Creation Through Digital



Source: BCG experience.

WHY: Why should utilities engage in digital operations?

Digital transformation requires a complete turnaround in the way utilities work. It is, therefore, imperative for utilities to clearly articulate the value that is expected to emerge from such a transformation. Digital can effect improvement across multiple dimensions—operations, maintenance, safety, workforce productivity and asset construction (Exhibit 10). It is necessary to identify the use-cases that exist in the utility space and across other industries applicable to the utility business. A clear articulation of expected value from each use-case and the investment required, is necessary to create a business case for Digital Transformation.

WHAT: What equipment and capabilities are required for digital ops?

Digital transformation entails work across multiple technologies and facets of the utility business. It is, therefore, important to translate the digital use-case roadmap into a technology roadmap for the utility. Three key pieces of the technology stack need to be enabled to realize the value of business cases—Data Generation, Information Management

and Intelligence (Exhibit 11). Multiple options exist across these 3 facets:

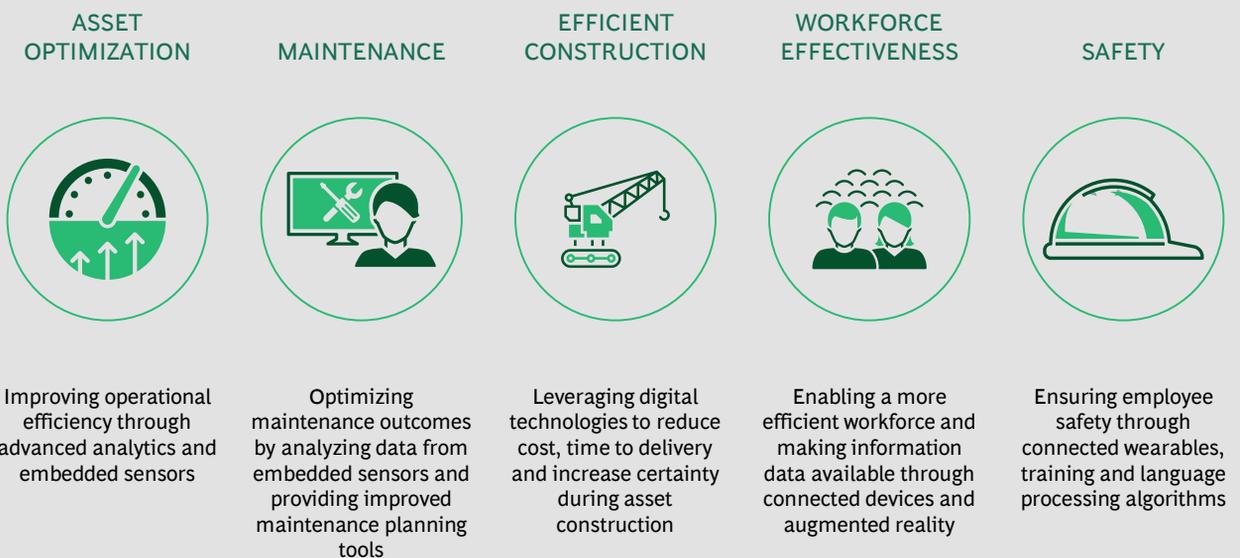
- Data generation can be effected through retrofitting or through building new machinery
- Data and Information management platforms can be bought or built—“off the shelf”
- Intelligence requires data analytics capabilities which can also be obtained either through pre-built off-the-shelf platforms or through custom build apps for the utility

The above choices require a careful analysis of priorities and capabilities. A poorly managed technology stack can not only diminish the value expected from digital use cases, but in many cases, can lead to value erosion in the organization.

HOW: How can assets / people be prepared to enable digital operations?

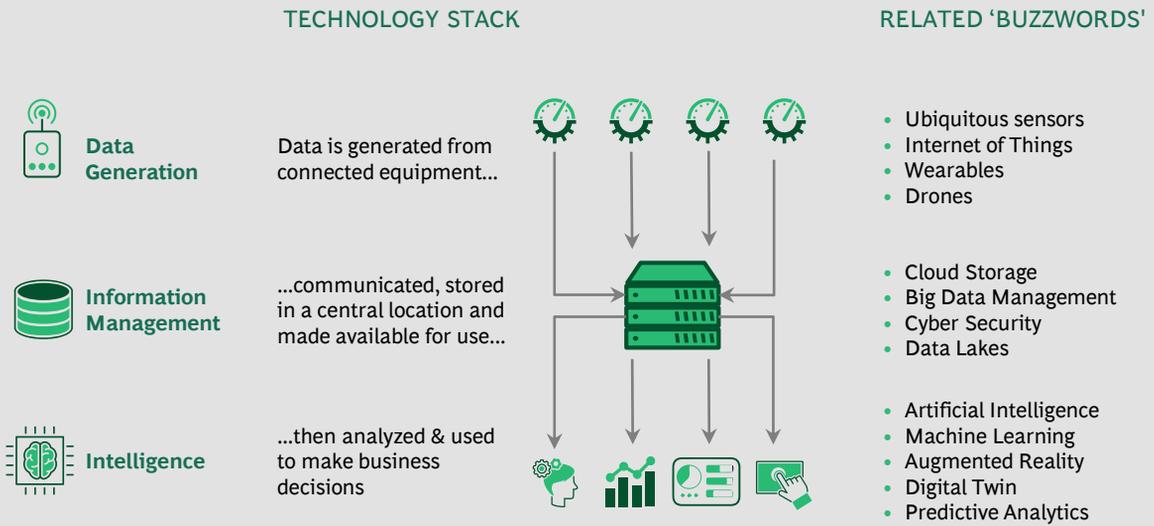
- People remain the core success factor for Digital Transformation programs. Adoption of digital technologies by the utility

EXHIBIT 10 | 5 Categories of Use Cases That Drive Value



Source: BCG analysis.

EXHIBIT 11 | Key Pieces of the Technology Stack to Realize the Value of Business Cases



Source: BCG analysis.

workforce remains a challenge. It is necessary to identify the right motivators and setup the correct incentives to regularly shape behavior (Exhibit 12). Digital involves a fundamental shift in the way an organization operates and requires a new set of capabilities in the organiza-

tion. While training and incentivization are necessary to increase adoption of digital across the workforce, utilities must also look to induct a new talent pool into the organization. Traditionally, utilities have been slow to change and react, given the long gestation periods and asset

EXHIBIT 12 | Key Takeaways to Help Drive Digital Operations Implementation

TAKEAWAY	DESCRIPTION
<p>1 </p> <p>Set up enablers</p>	<p>Send a clear message on importance of technology adoption Design training to fit the needs of your employees Equip personnel to use the technology to its fullest</p>
<p>2 </p> <p>Invest in motivators</p>	<p>Motivate adoption early, even if error rates are high to begin with Provide continual support & positive reinforcement for learning to improve Ensure motivators are aligned with desired adoption & use of the technology</p>
<p>3 </p> <p>Set up enablers</p>	<p>Each individual will make a choice to adopt or not based on personal impact:</p> <ul style="list-style-type: none"> • How does this personally affect the individual user of the technology? • Why would they choose to use or not use it in the desired way?
<p>4 </p> <p>Continually shape behaviors</p>	<p>Continue to shape behaviors from initial adoption to later phases of execution Full & consistent usage will take time to build—starts with basic adoption & forming habits, then builds to high quality & full usage</p>

Source: BCG analysis.

intensive nature of their businesses. As a result, attracting talent to create digital centers of excellence will remain a key challenge. There are models of how utilities are managing this transition—ranging from BOT transfer models to building in-house centers with HR practic-

es and environment that is different from the incumbent organization. A structured change management program to integrate the new capabilities in the organization will be essential to reap the full benefits of Digital Transformation.

DIGITAL IN POWER VALUE CHAIN

AS DISCUSSED, ANY DIGITAL Transformation exercise must begin with a clear articulation of the applicable digital use cases

and the expected value. Exhibit 13 provides a summary of Digital use cases across the Power Value chain.

EXHIBIT 13 | Digital Toolkit for the Power Value Chain

Power-generation value chain						Transmission & Distribution value chain			
Fuel procurement	Logistics & Warehousing	Operations	Daily maintenance	Large overhauls	Power sale	Power purchase mix	Network maintenance	Network operations	Power retail sale
Data analytics and integrated fuel supply chain	IoT , Drones and Robots			Digital outage planning	Data analytics and digital trading platform	Pricing optimization	Asset health monitoring	Meter analytics and MIS	DER management
	3D printing/spare parts	Operations simulation	Contractor integration and spares optimization			Dynamic pricing	Predictive maintenance		C2C trading
	Coal loss management	Digital workforce enablement		Long horizon simulation		Rate scenario modeling	Digital workforce enablement		Customer experience & new services
	Digital Stockyard	Remote monitoring and predictive maintenance					Outage and restoration	Operations simulation	Billing analytics
Real time data and KPIs									
Health, safety and environmental protection improvements					Business systems: HR, IT, Supply chain, Project management				
Geo-location tracking	Atmospheric sensors	Wearable safety and condition monitors		Proximity alarms	Automation	Inventory management	Workforce planning	IT lifecycle management	Collaboration, KPI management

Source: BCG experience.

DIGITAL USE-CASES IN GENERATION

GLOBALLY, THE USE CASES for generation are fairly well established and widely implemented (as shown in exhibit 13). The same is not the case in India due to two reasons (1) the value of these use cases to the asset owner varies based on asset type—cost plus vs. competitively bid asset and (2) limited labor arbitrage make use cases related to pure manpower efficiency, less relevant.

Use Cases for Digital in Generation

Given that 57 percent of India's generation capacity is still coal based—it is here that use of digital tools can drive maximum value. The most successful digital use cases in coal based generation assets in India can be categorized into three broad categories viz. (1) creating flexibility across the value chain, (2) optimizing conversion efficiency and (3) predictive maintenance to minimize asset downtime and maintenance costs. These use cases, however, need to be cognizant of the differences in priorities for a cost plus asset viz-a-viz. a competitively bid asset. As illustrated in exhibits 14A and 14B, the drivers of value in a competitively bid asset vary greatly from the drivers of value in a cost+ asset.

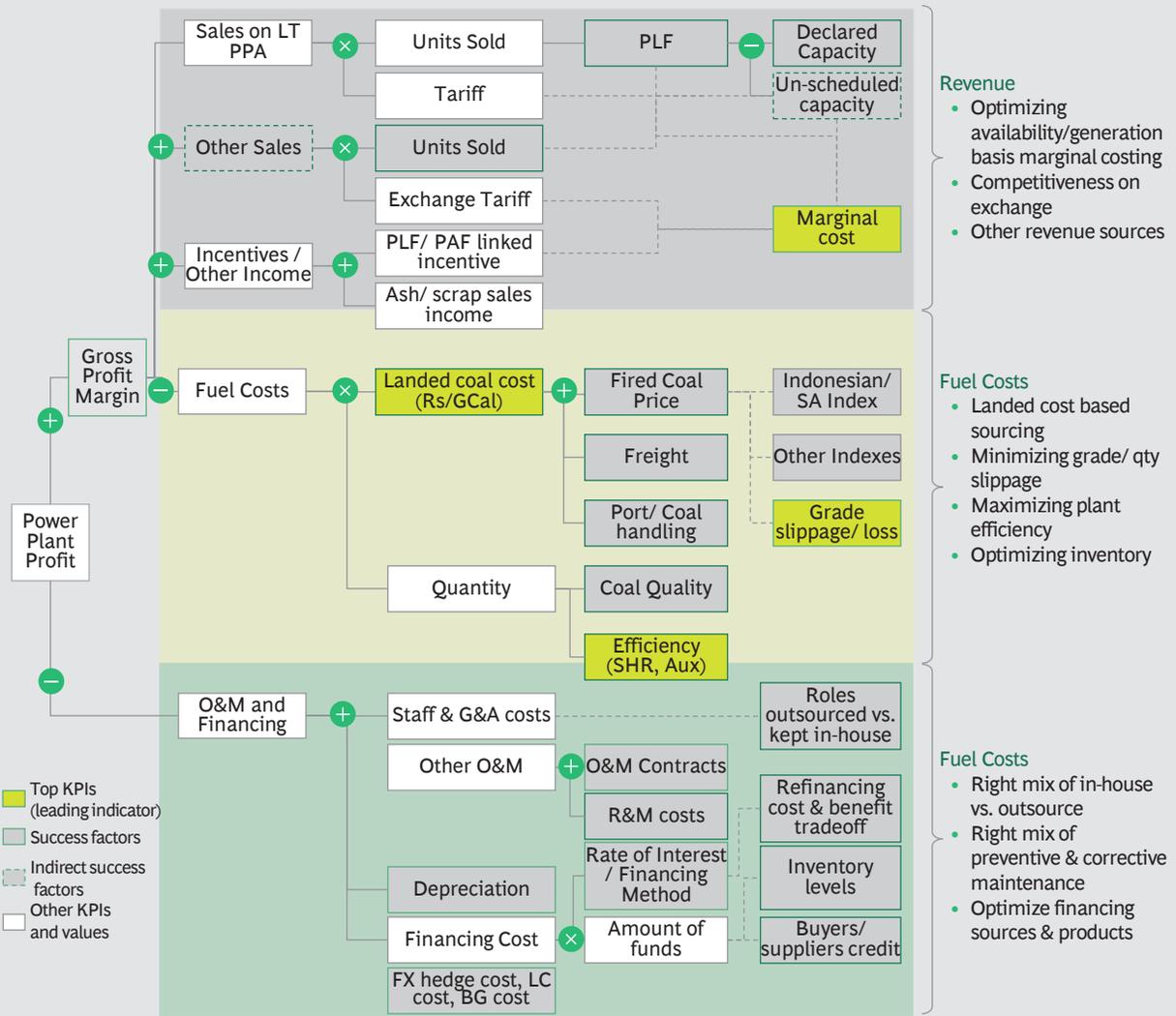
USE CASE 1: VALUE CHAIN FLEXIBILITY

Based on the objective function, the relative priority of the following four digital use cases may vary. However, a combination of these four

levers (in varying proportions depending on the priorities of the utility) present significant potential for value creation for a power plant.

1. **Generation planning:** For a competitively bid asset, the spread between revenue and cost / unit varies based on the coal price and overall surrender % (the gap between the availability as declared by a power plant and the actual demand of the procurer for power). Value creation is maximized through the optimum utilization of available plant capacity: be it for long term power generation or for maximizing returns on surplus capacity from liquid short term markets. As a result, significant value can be unlocked simply by timing the planned maintenance correctly. This requires accurate forecasting of the drivers of cost (coal prices, freight rates), demand (expected surrender % and market demand for short-term power) and technological factors (the Station Heat Rate (SHR) impact of delayed maintenance). Digital interventions can help improve both, the accuracy of these forecasts and also in running the overall optimization programs. Exhibit 15 depicts an analytics based generation planning tool to optimize generation schedules for profit maximization.
2. **Flexibility in coal sourcing (imported coal):** There are two key decisions with regards to

EXHIBIT 14 A | Key Value Drivers for Competitively Bid Tariff Asset



Source: BCG analysis.

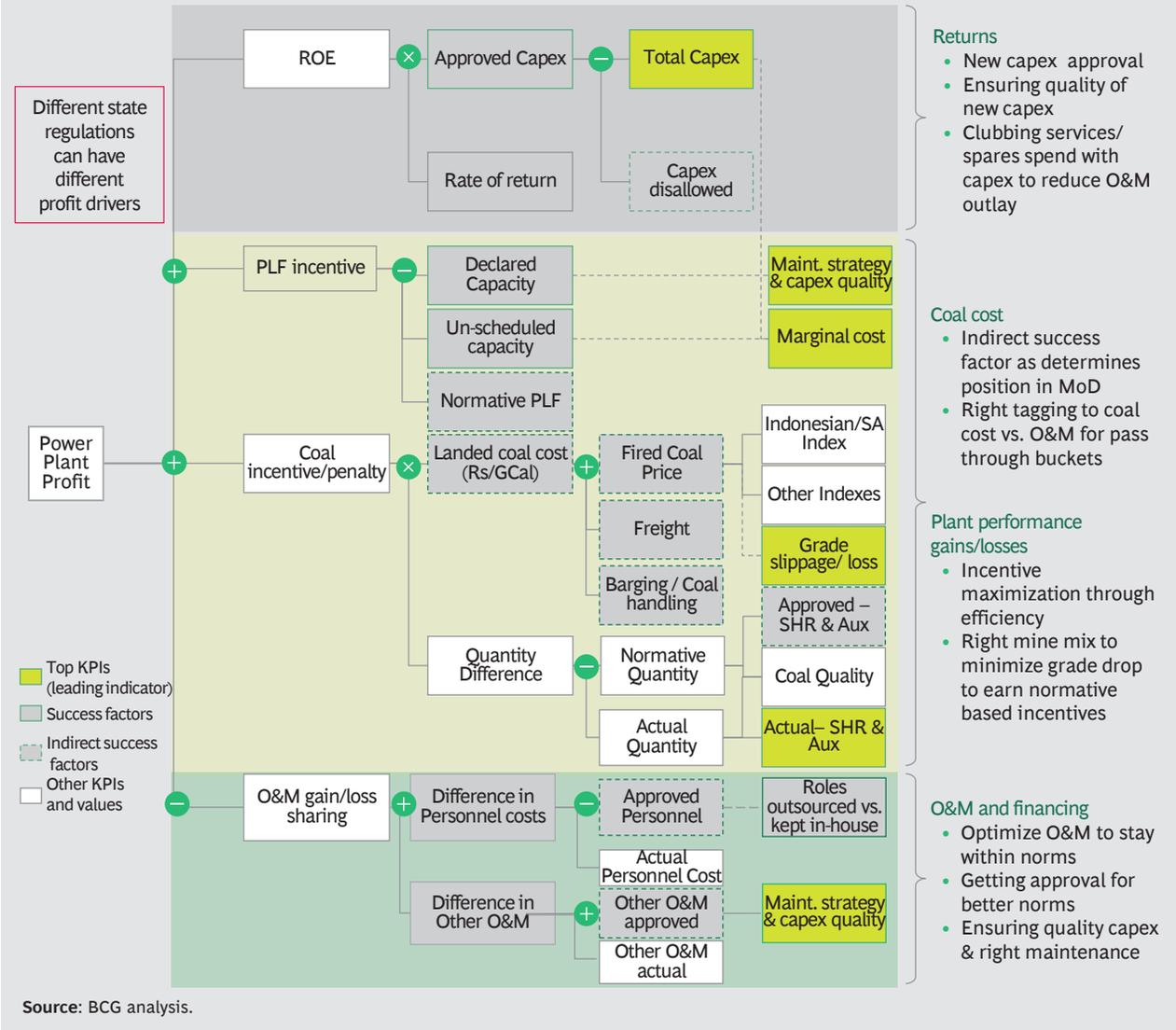
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coal buying—the timing of purchase and the source. This optimization can easily yield to 1-2 percent reduction in coal spend. Timing of coal procurement can be optimized by accurately forecasting coal (and freight) price variation viz-a-viz holding costs of fuel and Gross Calorific Value (GCV) degradation. Big data analytics can help improve such forecasts while a simulator can help ensure that such decisions are taken within the bounds of practical constraints like berth handling capacity, coal yard capacity, stacker / reclaimer / Coal Handling Plant (CHP) capacity and blend mix constraints. Utilities have also used similar tools to take decisions on executing financial trades to lock

in coal prices thereby overcoming constraints placed by capacity bottlenecks.

Similarly, expanding the basket of potential coal sources can unlock significant value. This requires both, digital and operational interventions. Operationally, assets need to develop the capability to blend coal (either in the yard, or on a conveyor belt or through choice bunkering) to work within the constraints imposed by the make of the boiler (especially on Sulphur, emissions and coal feed rates). This is illustrated quite well in the Korean model where blending facilities allow the assets to capitalize on momentary price divergence between coals of different origins, on “off-spec” coals and

EXHIBIT 14 B | Key Value Drivers for Cost+ Tariff Asset



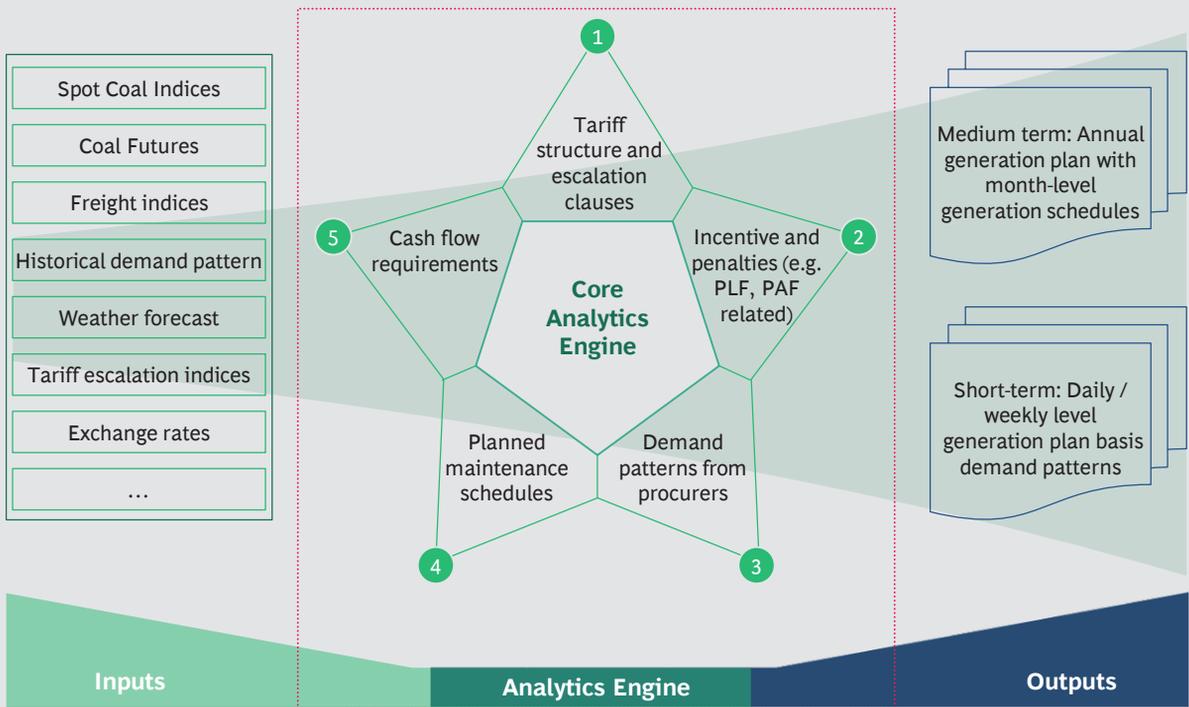
(opportunistic purchase of) stranded cargoes. This is in stark contrast to Japanese assets which are calibrated for a very narrow range of coal specs (which in turn disproportionately drive up the prices for the band of coal origins which meet these demanding specs). Digital interventions can help drive blending of coal on the conveyor in a cost effective manner by calibrating the reclaimers through a feedback loop, allowing blend ratio control in real time (with minimal capital expenditure).

Once blending has been operationalized, an optimizer can help determine the ideal sourcing mix by taking into account the different coal indices, freight rates from

different sources, coal specs and operating limits (GCV, Ash%, Sulphur%) of the asset. Exhibit 16 shows how a digital optimizer can be used to dynamically compute optimal coal mix.

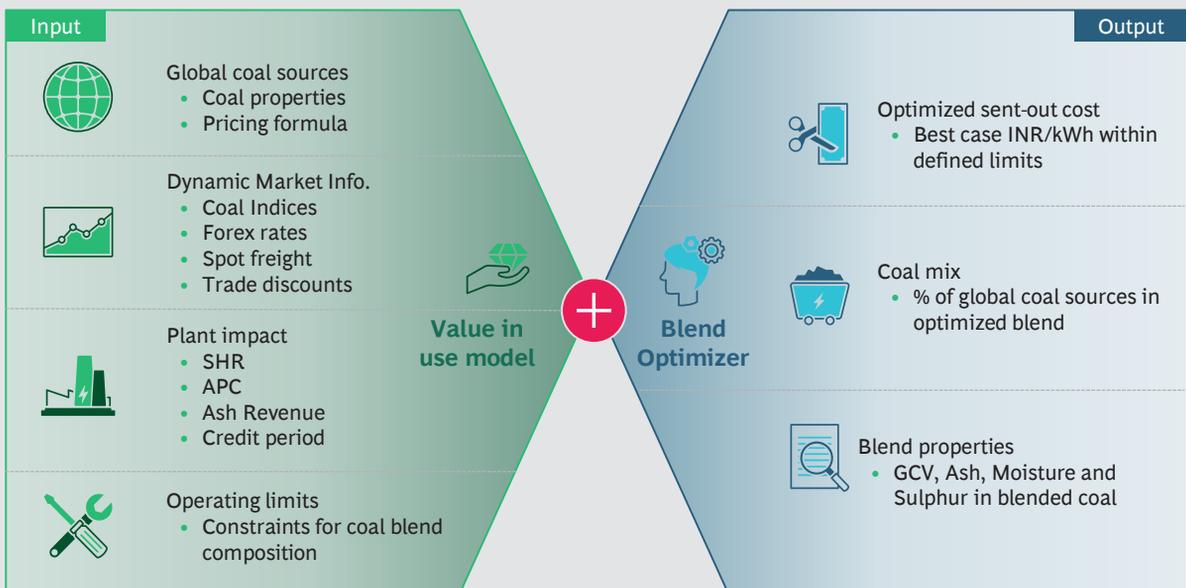
Flexibility in sourcing (domestic): Based on the Power Purchase Agreement (PPA) construct, the objective functions of sourcing for an asset may be to minimize either the grade slippage from mine to crusher (i.e. the variation between reported coal quality vs. actual coal quality as received at the plant) or to minimize the landed cost / energy (INR / Kcal) at the boiler. In either case, given the wide fluctuation in quality of coal from various

EXHIBIT 15 | Generation Planning Tool to Optimize Generation Schedules for Maximizing Profits



Source: BCG experience.

EXHIBIT 16 | Digital Optimizer Tool to Dynamically Compute Optimal Coal Mix



Source: BCG experience.

domestic mines, rake availability limitations and constant mine re-gradations, there is a need for generating stations to dynamically determine the optimum domestic sources for supply of coal which meet their objectives: be it minimizing leakages or reducing landed costs. A dynamic mine reprioritization tool can be (and in many generating stations across India, already is) deployed to drive the right selection of coals while incorporating intangibles such as historical quality variations and coal availability across sources.

3. Improving non-tariff income: Under injection / Over injection (UI / OI) income represents a significant source of non-tariff based income for a generating station. Leveraging this source however, requires two interventions—maximizing the number of blocks the plant responds accurately with the UI / OI needs of the grid and increasing the quantum of units injected as a part of this UI or OI. Given the time to ramp up / down units, this requires an ability to accurately forecast the grid frequency in advance, given extraneous demand factors.

Fluctuation in coal cost on account of varying blend ratios in different units further compounds this problem with unit operators often independently unaware of appropriate thresholds for UI or OI operation. Most assets lose out on potential income on account of static frequency threshold limits and delayed decision making (which in turn limit the quantum of units that can be injected to address UI or OI).

In our experience, this opportunity loss can be captured by deploying self-learning forecasting algorithms which have proven to achieve accuracy in excess of 75 percent+. We have seen examples of Indian assets trebling their UI / OI income by deploying such solutions.

USE CASE 2: CONVERSION EFFICIENCY OPTIMIZATION:

Use of digital tools to help optimize conversion efficiency can be taken up at two levels—(1) optimizing the heat rate of each unit and

(2) optimizing the overall station heat rate through optimal load allocation across available units (in the case of multi-unit plants).

1. Optimizing unit heat rate: This is a well-established use case adopted by most generating units in India. However, most assets limit use of digital tools (like PADO) to monitor performance, identify major deviations and prepare monthly MIS on loss reasons within boiler and turbine-generator islands: i.e a form of post-mortem analysis on historical deviations, rather than proactive and prospective analysis of future deviations. In our experience, very few assets have effectively deployed analytics to optimize the controllable parameters on a day to day basis. Analytics on metrics impacted by controllable parameters (e.g. Main Steam temperature impacted by Super Heater spray) can help identify positive spray biases in units, air ingress or steam / water leakage areas etc., which can easily be addressed through operator intervention or through minor maintenance activities. Regular monitoring of dashboards depicting such correlations has been the most effective SHR improvement driver in most programs that we have run globally.
2. Optimizing scheduled generation allocation across available units: Most asset operators have a fixed pecking order of unit loading based on a static view of unit efficiencies. For example, an operator may hold the view that Unit 1 is always more efficient than Unit 2 and consequently ramp up Unit 1 wherever possible.

However, what is often ignored in such decisions is the fact that unit efficiencies vary dynamically basis numerous factors such as the current load on the unit, the prevalent coal blend and the available time frame for station generation ramp-up. Furthermore, given the non-linear relation between unit SHR and PLF, there are occasions when increasing load on a unit perceived to be “less efficient” may be more beneficial than the marginal increase in efficiency on a perceived “efficient” unit. Intangible considerations such as the need to keep sufficient buffer capacity in

relevant units to achieve future ramp up requirements makes manual optimization of unit loads infeasible. Use of non-linear optimizers can help asset owners achieve a 2-5kCal / kWhr improvement in SHR across the station. Fleet owners globally have deployed end to end solutions like Plexos to perform such optimizations in addition to transmission modelling, capacity expansion planning, demand forecasting etc. However, such solutions prove to be cost prohibitive for Indian operators on account of small fleet size and limited use of other tool functionalities. As a result, many asset owners have reverted to in-house development of such optimizers or use of stand-alone, readily available solutions such as PowerOp.

USE CASE 3: MAINTENANCE

Predictive maintenance to minimize asset downtime and maintenance costs is another key area where digital can drive significant efficiencies. The potential benefits to predictive maintenance are only limited by the number of critical parameters within a power plant that are monitored on a real-time basis. Thus, the key requirement to get this started is the installation of a sufficient number of sensors across the cycle, setting up centralized monitoring and analysis centers and hiring analytics resources who can perform time series data analysis and modelling.

Once set up, this provides a three-fold benefit to the asset owner:

1. Reducing downtime by predicting errors and faults through the use of big-data and pattern recognition software
2. Ability to shift from an interval-based maintenance to a condition or even risk-based maintenance strategy
3. Driving manpower efficiency and overcoming talent availability issues in remote locations by centralizing monitoring (and even operations in some cases) of the entire fleet

These benefits can add up to 5-10 percent reduction in Operations & Maintenance (O&M) costs of an asset.

In addition to the established and (relatively) mature use cases described above, a number of new use cases are currently in pilot by companies globally and may soon become common place in most generation assets. Some of these are listed below:

1. Use of drones for surveillance and coal inventory reconciliation
2. Use of augmented reality to reduce critical breakdown maintenance lead time by leveraging remote expertise
3. 3D printing of spare parts
4. Use of robots in stores management

USE CASE 4: DIGITAL TOOLS IN WIND AND SOLAR POWER GENERATION

While coal / gas based generation assets have been slow in deploying digital tools, renewables assets have seen a much higher rate of adoption. This is largely driven by three factors:

1. Location selection based on the ability to accurately predict wind / solar conditions during life of the asset is a direct and critical driver for locking in value at the time of project set up.
2. Enhancing conversion efficiency and extending life of the asset is the most important driver for unlocking value, once the asset is in operation (since raw material cost is not a factor)
3. The distributed nature of the asset (especially for Solar and Wind) makes it critical to leverage digital to remotely drive O&M activities

Within wind, big data analytics can be leveraged to drive a spectrum of decisions which reduce cost, increase generation and drive higher revenue / unit. Some of these key interventions are:

- Optimal timing of down time based on demand-supply (and hence price) forecasts
- Condition monitoring to trigger maintenance activity or tweak operating conditions before failure occurs

- Control system to tweak Pitch, Azimuth and determine stops to enhance Wind Turbine Generation (WTG) aerodynamic performance as well as extend life
- Modelling to determine the ideal time to undertake key part replacement and / or retrofit to enhance efficiency and extend asset life
- Auto-trigger of part procurement tickets based on supply chain modeling to balance inventory holding cost and downtime

Executing this seamlessly requires deployment of the right sensors and an integration of multiple tools, supported by a pool of big data scientists (to make sense of the Tera-

Bytes of unstructured data). Choice of the O&M model is also critical in influencing the behavior of asset owners and O&M vendors, alike. Such deployments can easily result in a 20-40 percent reduction in service costs, 2-3 percent increase in APE and hence a 2-4 percent improvement in project IRRs.

Thus, as established above, there are numerous use cases across the various classes of generating assets which can rapidly create value for players across the value chain.

TRANSMISSION AND DISTRIBUTION

AS WITH GENERATION UTILITIES, Digital can add significant value for T&D utilities as well.

The Emerging Need for Digitization in T&D

As already discussed, the core challenge in the Indian context remains low tariffs, with the Average cost of Supply—Average revenue realized (ACS-ARR) gap being negative for a majority of the utilities. This is exacerbated by persistent technical and commercial losses in the grid, ranging from 8 percent for the best performing DISCOM to upwards of 30-40 percent in multiple DISCOMs. This is a very India specific (if not emerging market specific) use case that by itself can justify investments in digital geo-analytics, deployment of IoT etc.

In addition, the consumer is constantly evolving. There is a shift in expectations from just demanding availability of power to expecting and valuing reliability, trust and convenience. Furthermore, as and when the law for content and carriage separation comes into force, it will necessitate increased focus on customer centricity at DISCOMs, who have traditionally enjoyed monopolistic and regulated tariff regimes.

Multiple applications for digital and analytics can be identified within the domains of T&D and power retail, be it on the customer side, grid side or in back-end support func-

tions. 90+ such wide ranging use cases for digital and analytics have been enumerated in Exhibit 17.

Each of these use cases can be plotted on an opportunity vs. readiness index to assess value potential vs. near term feasibility of implementation (Exhibit 18). Example of some of the quick wins with high value potential include fraud detection, complaints analytics and field force optimization.

Some of these use cases have been elaborated in the following sections. Use cases exist both for efficiency improvement in current business models as well as implementation in anticipation of evolving business models.

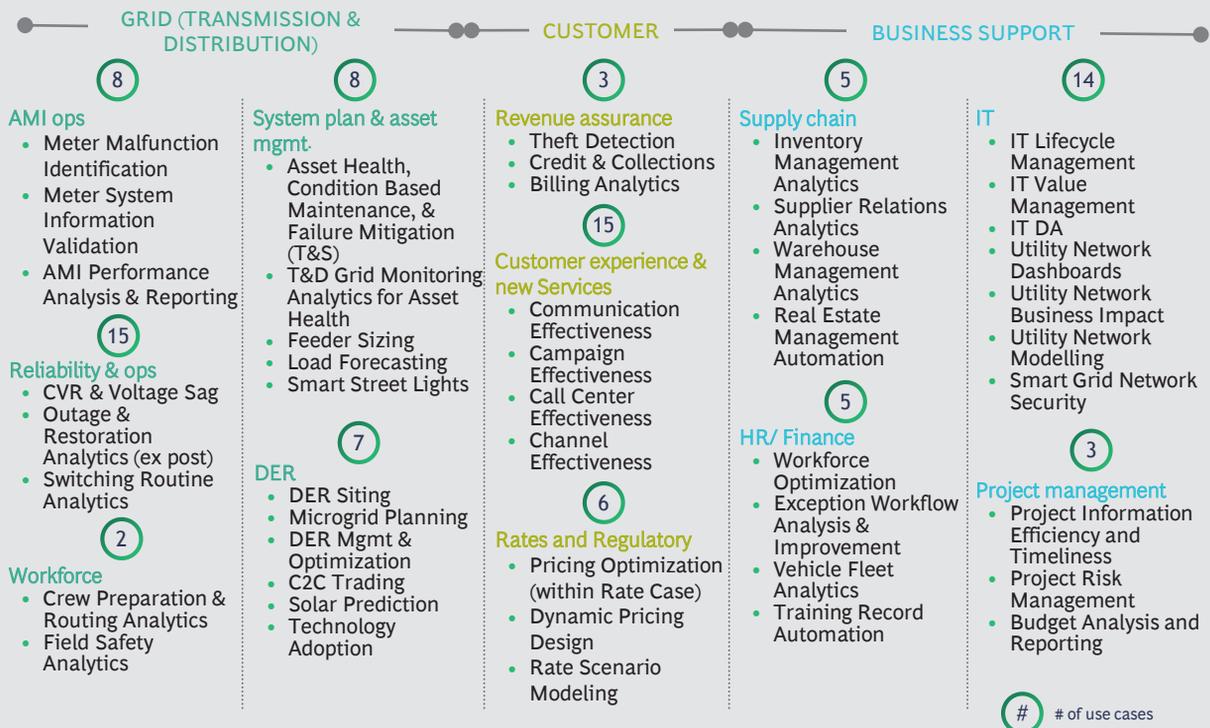
USE CASE 1: DIGITAL AND ANALYTICS FOR ASSET MANAGEMENT

Digital and analytics are increasingly playing a crucial role in network planning and asset management. Capex optimization (through new network planning as well as maintenance capex) can be significantly streamlined by leveraging digital tools.

Illustration: Let us take the case of a utility wanting to augment its network elements (distribution stations, transformers etc.).

- Augmentation targets can be identified basis selection criteria like excess load / number of faults etc.

EXHIBIT 17 | 90+ T&D utility use cases for digital and analytics with a wide range of applications

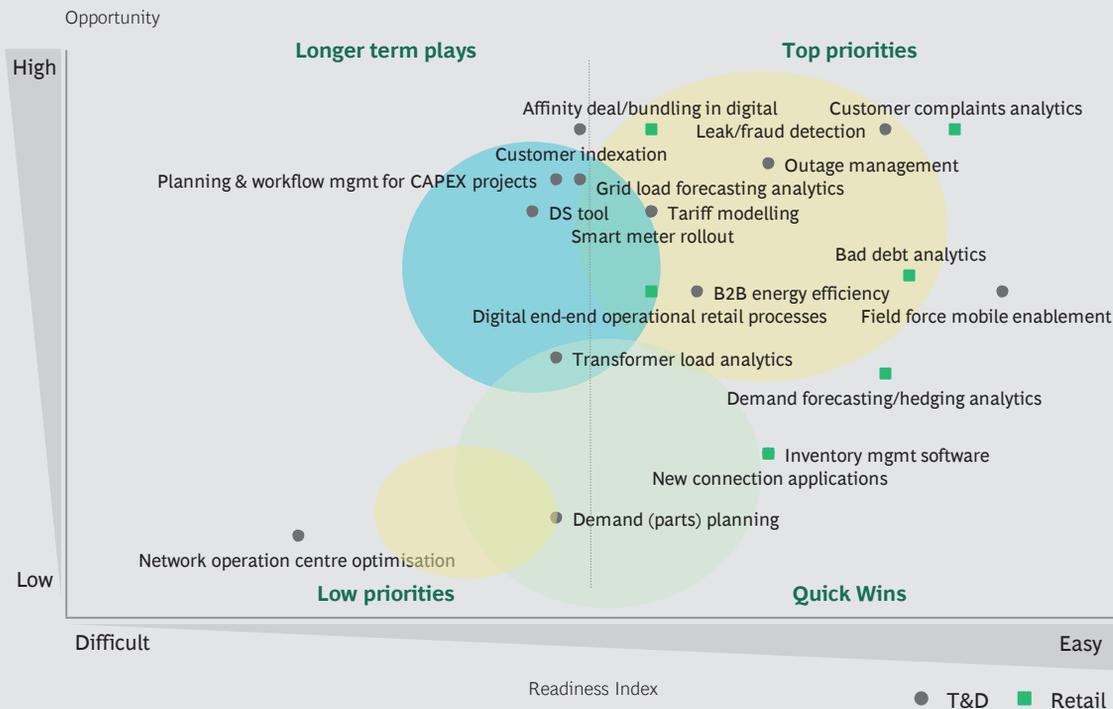


Source: BCG case experience.

Note: DER = Distributed Energy Resources, CVR = Conservation Voltage Reduction.

¹A single use case in this context is understood as a coherent set of Big Data analytics activities with benefits for the utility and/or the customer.

EXHIBIT 18 | Use Cases Plotted on Opportunity vs. Readiness Index



Source: BCG case experience.

Note: Each opportunity was evaluated on a 1,3,5 scale along digital value potential and ability to achieve. 2 and 4 scores were used to differentiate similar opportunities. Current scores only take into account EBIT impact, investment cost, technical complexity and time horizon

- Network elements can thereafter be ranked basis SAIDI, energy loss and interruption times to arrive at a priority order
- Prior to investment in capacity augmentation, a list of nearby under-loaded network elements can be developed with proximity to the identified overloaded elements. These can thereafter be evaluated for their potential to take up a part of the load of the overloaded network elements, basis parameters such as inter-element distance and their under-utilized capacity
- Following this evaluation, the utility can now take an informed and scientific decision on which network elements need to truly be augmented and which elements can be managed through low-cost, operational interventions without compromising on reliability

As far as maintenance is concerned, DISCOMs have moved from planned to condition based monitoring and maintenance. For greater cost efficiency and network reliability, predictive maintenance will require algorithms based on large amounts of data available through IOT, SCADA, OMS, Static Meters / AMI for prediction of faults and timely and targeted maintenance actions. This requires capability development for large scale data integration and real time data flow.

USE CASE 2: ANALYTICS TO MANAGE CHANGING DEMAND PROFILE / FLOW WITH IMPLEMENTATION OF DER (DISTRIBUTED ENERGY RESOURCES), EV AND STORAGE SYSTEMS

Continuous research on energy storage technology for low cost bulk storage and its future integration with the grid will change the demand profile and power flow. Bulk storage systems will start getting incorporated into the grid due to falling prices of storage systems. Expected cost reduction in different storage technologies is making storage connected grid a near term reality.

Storage systems would allow the decoupling of consumption from electricity generation and therefore have the potential to change

the daily demand profile seen by the network, in a significant way. This has far reaching consequences for many stakeholders, as changes in the net demand would impact electricity prices and change the requirements for peak generation.

Further, a strong shift away from traditional fuel to alternate sources for transportation has been noticed due to rising fuel prices and declining availability of fossil fuels. Most auto manufacturers are experimenting with electric vehicles (EVs) or hybrid automobiles. The EV / hybrid market is expected to grow at the rate of +30 percent CAGR in the coming years.

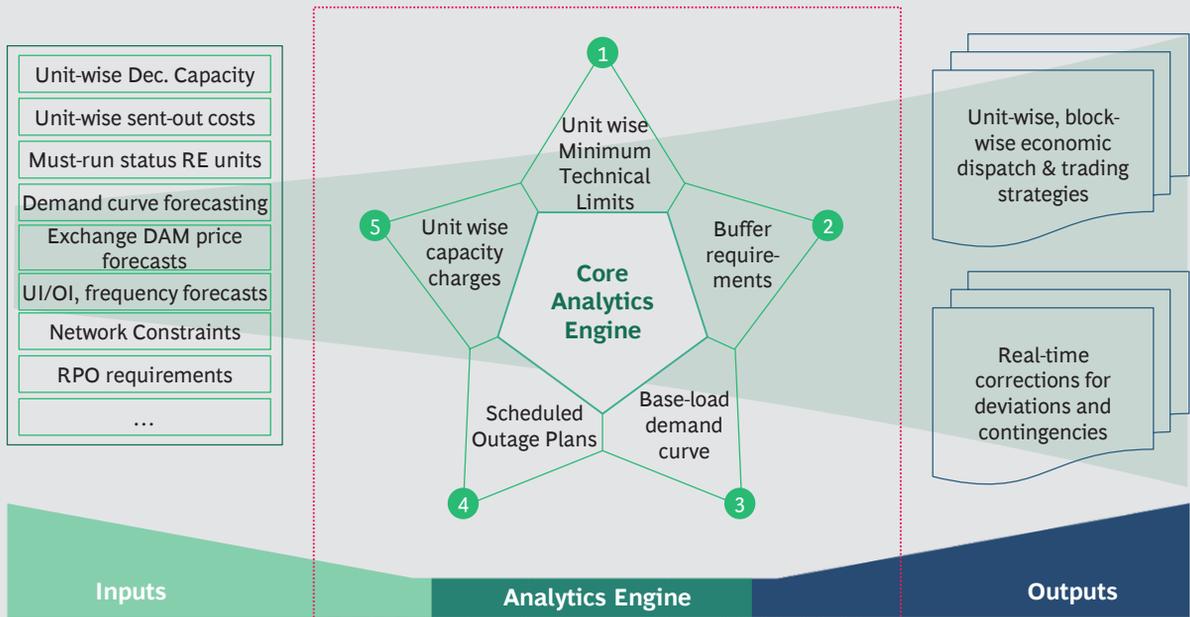
To enable an electric transport ecosystem, the country is expected to see a significant uptick in the need for charging infrastructure. The load on the grid and the subsequent need for improved reach and uptime for the distribution network are thus likely to see a significant increase.

The demand pool for distribution is expected to increase with the gradual introduction of EVs and development of Distributed Energy and Storage solutions. Demand estimation and network planning can be better assessed with digital interventions, mainly with data analytics. To be able to adapt to this change, DISCOMs need to be equipped with data analytics tools coupled with digital tools for support and maintenance.

USE CASE 3: ANALYTICS DRIVEN POWER PROCUREMENT

Low tariffs and a negative ACS-ARR gap are expected to remain a reality for the sector in the near future. In such a scenario, optimal power procurement to minimize the average cost of procurement becomes critical. Optimization of power procurement cost requires consideration of multiple factors—PPA tariffs (both capacity and energy), declared availability, must run RE units, short term market forecasts, demand forecasts, network constraints etc. As shown in Exhibit 19, a customized data analytics engine can take multiple factors into account to provide the optimum procurement plan in terms of generating stations, trading strategies, real time corrections and contingency planning. Such systems are already becoming popular across DISCOMs.

EXHIBIT 19 | Data Analytics for Optimizing Power Procurement Costs



Source: BCG analysis.

USE CASE 4: DIGITAL AND ANALYTICS FOR REVENUE ASSURANCE

Another critical application of digital and analytics is for fraud detection and revenue assurance. Powerful algorithms can be created to aid theft detection and manage credit and collections.

A big data model can be created along the lines of fraud detection models used by credit card and finance companies, to identify “customers at risk of fraud” through demographic profiling, past payment and consumption history. Advanced algorithms (like “random forest”) and self-learning models can be used to progressively enhance the effectiveness of fraud detection, basis real time data. This can help a utility focus specifically on targeted customers and protect revenues in a more efficient manner.

USE CASE 5: DRIVING CUSTOMER ENGAGEMENT / CENTRICITY THROUGH DIGITAL

Pre-liberalization, customer experience across service sectors had been poor. This however, changed post liberalization, with financial services and telecoms becoming the frontrunners in embracing digital to enhance their

customer experience. Customer experience in these sectors has been enhanced via multiple targeted interventions:

- More frequent interactions (Automated SMS, calls and emails)
- Faster response (Robotic Process Automation aided by AI solutions for automated responses and actions)
- Improving access by reducing dependency on physical presence (interact anywhere solutions)
- Improving quality by reducing human touch points (difficulty in predicting human behavior and unionized nature of this workforce increases risk of poor customer experience)

Electric utilities have however lagged other sectors on customer centricity and digital adoption. Going ahead however, this will be a key priority for electric utilities as customers are now starting to expect the same higher levels of service across all their service providers.

There are six key touchpoints of customer engagement / service for utilities—system reliability, new connections, billing and payments, complaint management and customer services (Exhibit 20). Utilities can deploy multiple digital interventions across these touch points to enhance customer service levels. (Exhibit 21).

Digital also presents a unique opportunity to re-model the front-end towards a lower „cost to serve“ structure.

- Chatbots help reduce the need for extensive call center facilities by automation of 40-80 percent of calls / queries
- Improved resolution time with chatbots and Robotic Process Automation (RPA) tools—More queries per hour answered, increasing bandwidth availability and improving service time
- Improved FCR (first call resolution): AI helps to codify processes along with the right level of escalations to reduce repeat calls, thereby increasing bandwidth

USE CASE 6: EVOLVING CONSUMER MODELS AND EMERGING ROLE OF DISCOMS AS DISTRIBUTION SERVICES OPERATOR (DSO)

The rollout of Smart grids has resulted in a variety of structured and unstructured data being generated from multiple sources (Exhibit 22).

- Structured data
 - Smart meters
 - Grid monitoring devices
 - Load prediction models
 - Weather and climate data
 - Electric vehicle data
- Unstructured data
 - Social media data, customer call logs, home appliance consumption data, weblogs

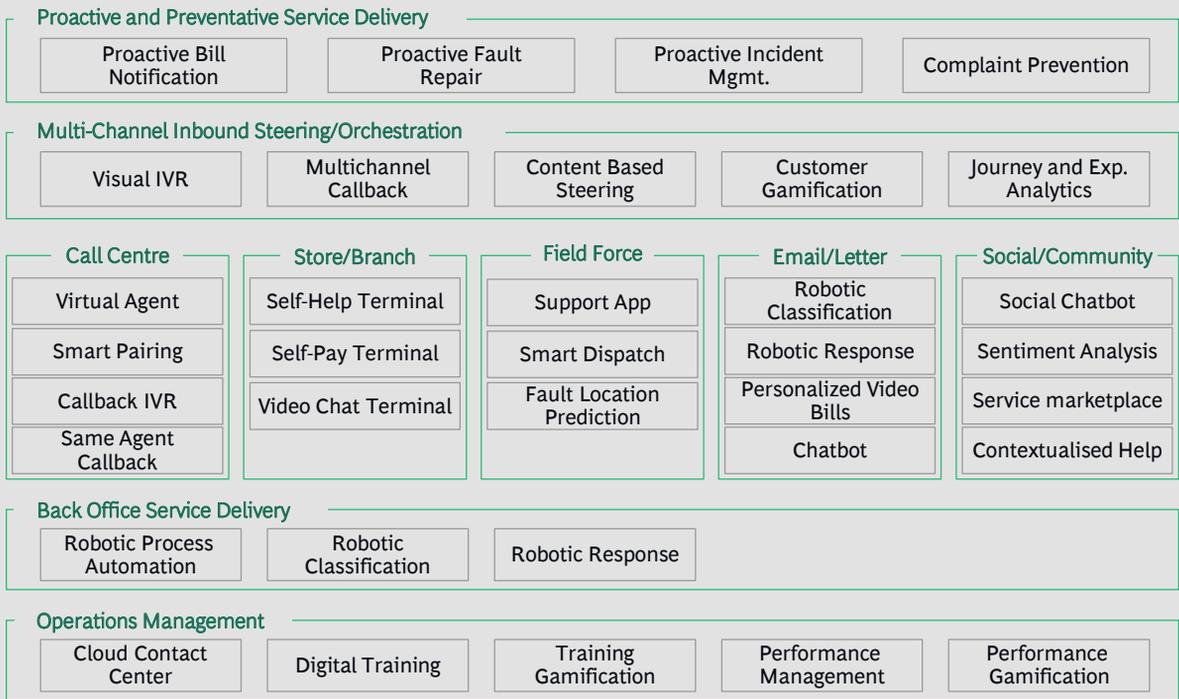
This has resulted in an expansion of data that DISCOMS need to collect and manage. Over

EXHIBIT 20 | Key Aspects of Customer Experience for Utilities

		WHAT CUSTOMERS WANT
Key Customer touchpoints	1 	Network reliability Minimum outages (SAIFI) Faster correction (SAIDI)
	2 	New connections Faster TAT for new connections/metering
	3 	Billing Accurate, understandable and timely billing
	4 	Payment Ease of payment w. several channels of non walk-in payments
	5 	Complaint mgmt. Faster TAT for complaints (for outages, billing, meter issues, etc.)
	6 	Customer services Efficient and helpful call centers, office staff, online portals

Source: BCG analysis.

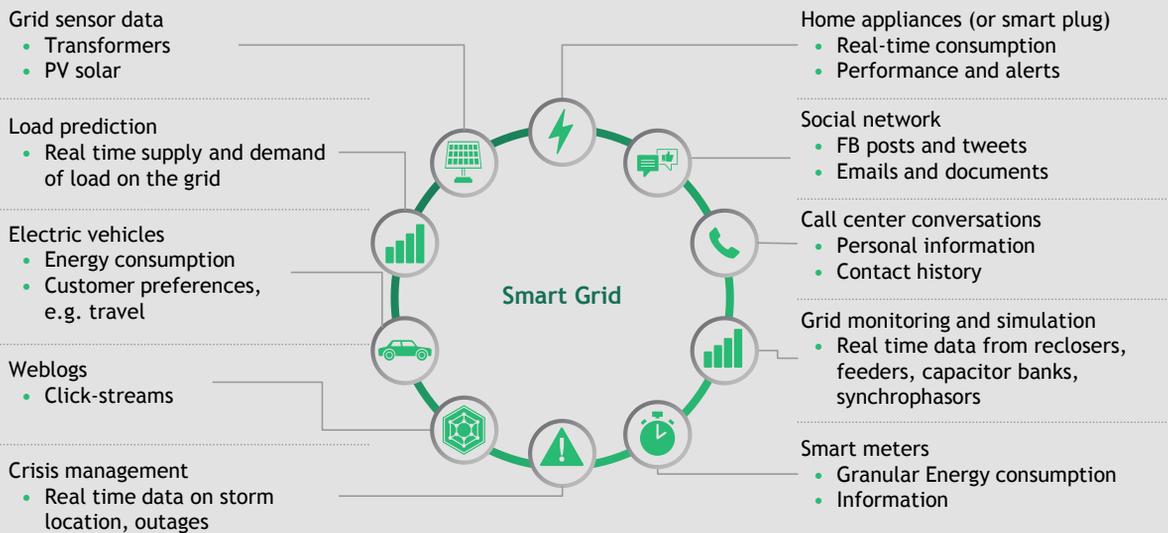
EXHIBIT 21| Digital Use Cases to Improve Customer Experience at Each Touchpoint



Source: BCG analysis.

EXHIBIT 22 | Structured and Unstructured Data Flow due to Smart grid Roll Out

SMART GRID SOLUTIONS OFFER NEW BEHIND-THE-METER BUSINESS OPPORTUNITIES FOR DISCOMS, E.G. HOME AUTOMATION, STORAGE, DATA MONETIZATION ETC.



Source: BCG analysis

4000 TB of data is expected to be collected with the onset of smart meters. In the Indian context, the development of smart cities and connected services is likely to further increase this data by leaps and bounds.

Cross industry applications of these large data sets are expected to be tremendous and the value of digital and analytics in this environment is ever increasing. To maximize value creation, there is an increasing need to evolve new business models on the consumer side which leverage this access to consumer data, consumption behavior and unparalleled access to homes and businesses, in a given

geographical area. These models could include home automation, storage, data monetization, peer-to-peer trading of renewable energy through block chain technology and others. Digital can enable DISCOMS to look to transition from a traditional electrical utility to a true distribution services operator.

Thus, as established Digital can not only play an important role in addressing the challenges faced by utilities in T&D but also equip them with the necessary tools to keep up with the ever changing ecosystem and market models.

CONCLUSION

DIGITAL OFFERS A COMPREHENSIVE tool-kit across the value chain to fundamentally transform the way of working and generate sustainable value for the economy. The use cases and value potential of digital interventions have been outlined in the report. However, articulating use-cases and value is just half of the journey in Digital Transformation. Utilities need to actively engage in developing a commensurate technology stack to drive and implement the above use-cases. Such stacks will need to be customized for each utility basis their digital aspirations, legacy architecture and organizational capabilities. Finally, people remain central to any transformation exercise. Utilities must invest in a strong change management program to identify the right talent, capability development and incentive program to instill a digital culture in the organization. Recruiting, developing and retaining this talent pool requires completely new approaches as compared to traditional Utility centered HR model.

It is necessary to understand that Digital is much more than a set of technologies / solutions that can be deployed as a stop-gap solution. Digital transformation requires a new way of working across the entire Power sector. As such, it is incumbent upon each stakeholder in the sector to play its part in this journey. Key roles to be played by individual stakeholders in Digital transformation journey is highlighted in Exhibit 23.

Generating utilities: A major barrier to the more widespread dissemination of digital tools within power generation utilities has been the fact that relevant custodians of these tools currently straddle three distinct functions within a utility's organization: regulatory, commercial and coal procurement. Hence, the primary enabler for digitization of power generation utilities is the breaking of the silos across these three functions and the adoption of a more holistic view of "end to end operations". Given the difference in value drivers and priorities across generators (PPA structure, coal availability etc.), it is necessary for generators to develop a customized list of potential use-cases specific to their requirement. Utilities should clearly articulate the roadmap for deploying these use-cases after a careful evaluation of business cases. It is advisable to build momentum with use cases that directly impact revenue and cost structures, followed by customer service and business model innovations.

Distribution utilities: Digital offers the most comprehensive tool-kit available to DISCOMs to adapt to the upcoming disruption in the sector. It is necessary for DISCOMs to chart out their aspiration on efficiency, customer service and emerging business models. Operational efficiency in terms of AT&C losses, procurement cost reduction and asset management are central to improving the financial performance of the DISCOMs in the near

EXHIBIT 23 | Key Roles of Stakeholders in Digital Transformation Journey



Generating utilities

- Create an overall digital roadmap in phases
- Focus on use-cases with immediate returns with existing data infrastructure



Distribution utilities

- Digital roadmap anchored on operational efficiency and customer service
- Digital center of excellence to carefully select and develop talent



Regulators

- Encourage benchmarking of customer service and operational metrics incorporating digital elements
- 'Soft competition' across utilities to create digital culture



OEMs & System integrators

- Collaborate with utilities to develop India specific solutions—especially tailored for Tier 2 and Tier 3 towns for distribution
- Generation use cases need to be tailored to Indian market and regulatory models

Source: BCG analysis.

future. However, emerging business models of Distribution Services Operator require a clear articulation of DISCOM aspirations and strategy in the emerging distribution sector. It is necessary to align future aspirations and the digital tool-kit to derive maximum benefit from the operations. As utilities embark on a digital journey – the right talent is expected to be a key concern. It is necessary to adopt cultures and working practices to inculcate digitally savvy talent. An effective approach across industries has been setting up of a digital centre of excellence to begin the journey across the organization.

Regulators: Regulatory bodies (CERC, SERC, CEA etc.) can play a big role in kick-starting the Digital Transformation process. They can look to encourage benchmarking of customer service and operational metrics on a more frequent basis incorporating digital elements. Given that currently discoms operate in monopolistic markets, “soft competition” across utilities can help unleash digital led customer service revolution.

OEMs, System Integrators: It is necessary to develop India specific solutions for Power Utilities. Indian Power sector remains unique in

certain aspects—Dominance of coal, AT&C losses, and Regulated tariff and power markets. In such a scenario, barely mimicking the solutions of western countries will not yield the desired benefit. It is necessary to customize the solutions as well as develop new ones to capture the value arising out of Digital opportunities. OEMs should collaborate closely with Indian utilities to create India specific use cases and solutions—specifically around line losses, heat rates and coal quality monitoring.

The Indian Power Sector stands at cross-roads. As the sector emerges from its monopolistic, regulated legacy, trends similar to the global power sector are starting to emerge. Going forward, the headwinds are only going to get stronger—a decentralized electricity value chain led by distributed renewables, battery storage, IoT and Cloud may be a reality in the near future.

A higher degree of digitization will make the sector more responsive, reliable and be an enabler in maintaining a service economy with improved efficiency. It is up to the utilities to rise up to the challenge. A bright future beckons.

FOR FURTHER READING

The Boston Consulting Group published other reports and articles on related topics that may be of interest to senior executives. Recent examples include:

New Paths to Productivity in The Digital Energy Retailer

A report by The Boston Consulting Group, April 2018

The Power Grid of the Future

An article by The Boston Consulting Group, July 2018

Finding the Sweet Spot in Distributed Energy

An article by The Boston Consulting Group, May 2017

Rewiring Utilities for the Power Market of the Future

A report by The Boston Consulting Group, October 2016

New Paths to Productivity in Power Generation

A report by The Boston Consulting Group, August 2017

Optimizing Grids to Meet New Demands on Power Systems

An article by The Boston Consulting Group, September 2016

BCG Center for Digital Transformation in Power & Utilities

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NOTE TO THE READER

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