www.pwc.com/india

Emerging opportunities and challenges

India Energy Congress - 2012

WORLD ENERGY COUNCIL
CONSEIL MONDIAL DE L'ÉNERGIE
INDIAN MEMBER COMMITTEE

23 January 2012

pwc

Message from WEC-IMC

Indian Energy sector has consistently adopted relevant global trends to support sustainable growth in Indian economy. The increasing maturing of the sector is evidenced by adoption and indigenisation of new technologies across the energy sector in general and power sector in particular.

Of late, the sector has grappled with new challenges which have arisen out of rapid growth of the sector. Some of these challenges will be overcome relatively quickly; some will require all the resourcefulness and intellect to convert them into promising opportunities for future.

World Energy Council- Indian Member Committee provides an apt platform to debate the topical issues that we face as we collectively decide on the path for future. India Energy Congress has evolved with each edition and provides an excellent platform to discuss the energy sector in an integrated manner.

We would also take this opportunity to thank PwC, who is our knowledge partner and has brought out the background papers on the opportunities and challenges across energy sector.

WEC-IMC team,
New Delhi

Foreword

PwC takes great pride in supporting the India Energy Congress 2012 as a knowledge partner, and in presenting the background papers for sessions across different elements of the value chain.

The aim of these papers, anchored by one of the subject specialists, is to provide a baseline of the current situation, issues and challenges facing the sector. These would be used for discussions among the stakeholders including policy makers, regulators, lenders, infrastructure investors and operators, etc., to help evolve solutions and approaches for the sector's growth and development.

The India Energy Congress has grown from strength to strength, and provides a unique platform for an objective and dispassionate debate between diverse stakeholders on current issues. I hope you will find the Congress enriching and thought-provoking and invite you to participate in the discourse.

Kameswara Rao,
Leader-Government Reforms and Infrastructure Developements
PwC India

Power sector

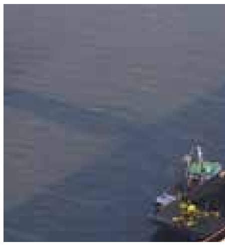
Electricity distribution

Oil and Gas

Renewable Energy

Energy Management

Coal

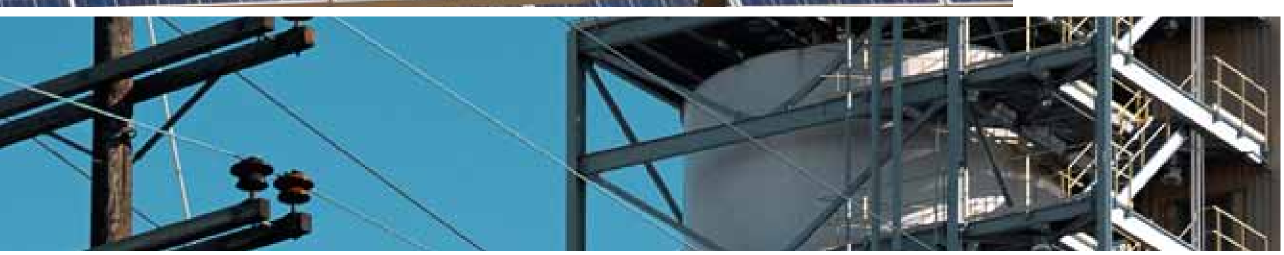


07

27

45

61



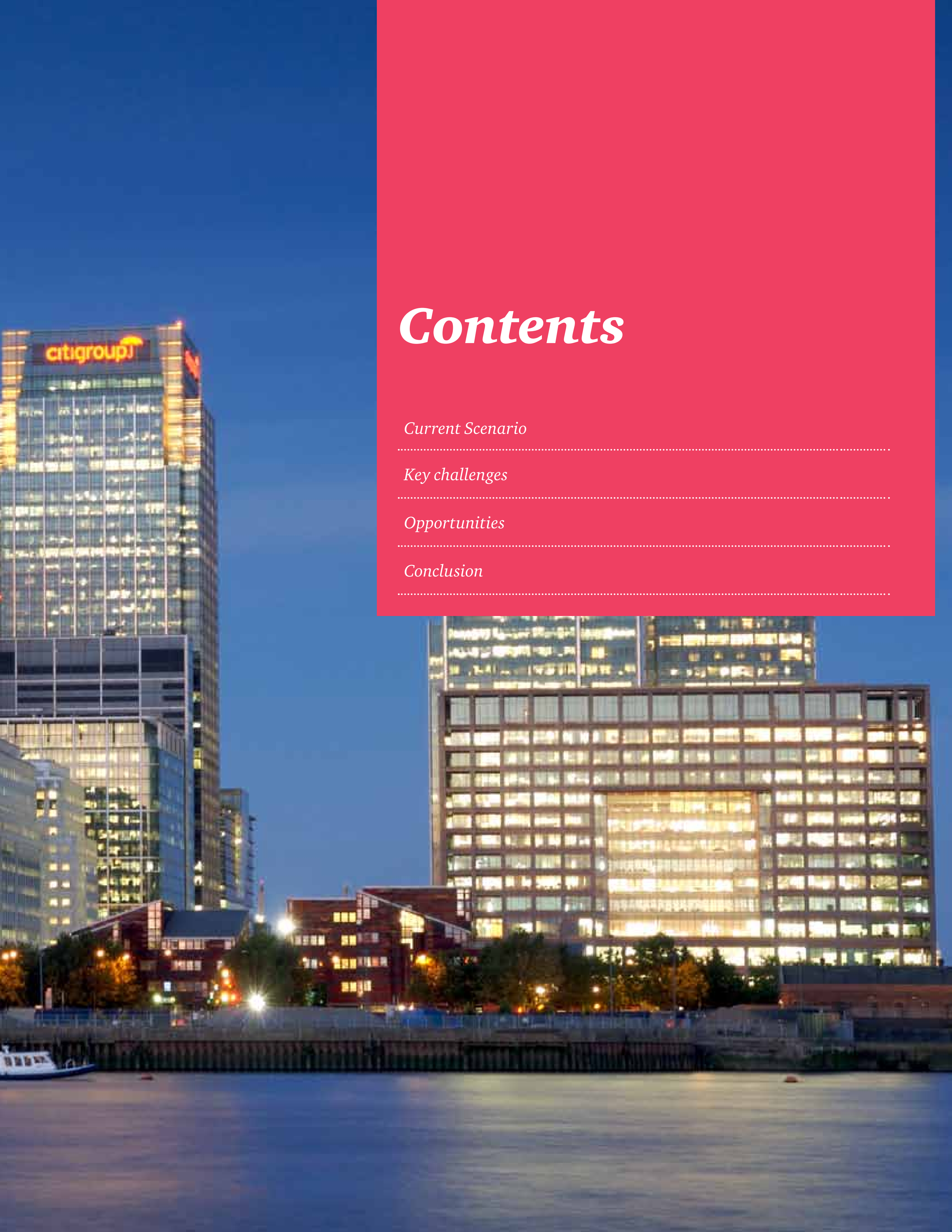
91

119

Emerging opportunities and challenges

Power sector


HSBC



Contents

Context

The context of this article is to identify key trends that is expected to drive the power generation and transmission in India and associated opportunities and challenges.

The Indian economy has experienced unprecedented economic growth over the last decade. Today, India is the ninth largest economy in the world, driven by a real GDP growth of 8.7% in the last 5 years (7.5% over the last 10 years). In 2010 itself, the real GDP growth of India was 5th highest in the world, next only to Qatar, Paraguay, Singapore and Taiwan.

Sustained growth in economy comes with growth from all sectors, among which growth in infrastructure sector is a key requirement for growth in sectors within manufacturing and services. With in infrastructure, growth in power sector is one of the most important requirements for sustained growth of a developing economy like India.

"Indian Economy has witnessed rapid growth in the past decade and to sustain a similar growth trajectory of 9%, power sector needs to grow at atleast 8.1 % per annum"

Planning Commission

Rank **|** 9th largest (nominal)/4th (PPP terms)

GDP **|** USD 1.884 trillion (nominal)/ USD 4.057 trillion (PPP)
GDP growth **|** 8.5% (FY11)

GDP per capita **|** USD 1,371 (nominal; 138th in world)/ USD 3,408 (PPP; 129th in the world)

Inflation (CPI) **|** 9.39% (November, 2011)

Population below poverty line **|** 37% (2010)

Income inequality **|** (GINI index): 36.8

Unemployment **|** 9.4%

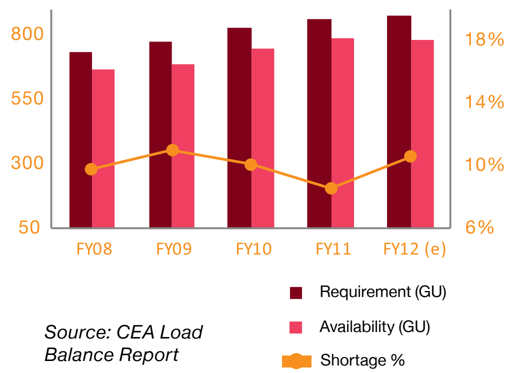
Ease of doing business **|** 132nd (rank in 2011)

Current scenario

Demand - Supply position

The energy availability in the country has increased by 5.6% in 2010-11, while the peak demand met has increased by 6% in the same period. Despite the increase in availability, India faced an energy deficit of 8.5% and a peak deficit of 9.8% in 2010-11. It is expected that the energy deficit and peak deficit will rise to 10% and 13% respectively in 2011-12[1].

Energy demand and supply



Source: CEA Load Balance Report

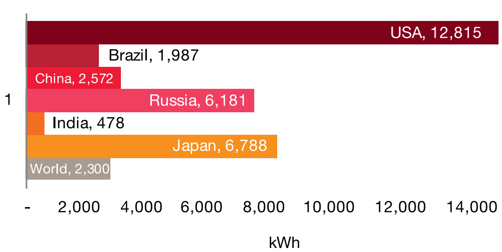
Low per-capita consumption

The average per capita consumption of electricity in India is a mere 478 kWh[2] (2010), compared to the world average of 2,300 kWh.

The other comparable countries, like the other BRIC nations, have significantly higher per capita consumption compared to India.

The average per-capita consumption has grown steadily at 1.3% CAGR annually over the last 10 years.

Per capita electricity consumption



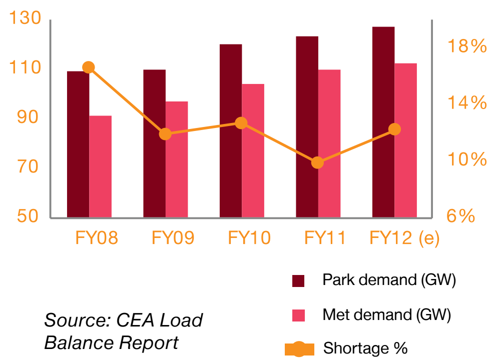
Source: CIA fact book

Government of India targets a per capita consumption of 1,000 kWh by 2011-12.

[1]CEA Load Balance Report, 2011-12

[2]According to CIA Fact book estimates; However based on UN methodology the per capita consumption of India is 779 kWh for 2010

Peak demand and peak met



Source: CEA Load Balance Report

Encouraging policy measures

The policy landscape in India has progressively evolved since Independence and has led to radical changes in the power sector, especially in terms of competition, private sector involvement and focus on green energy over the last decade, commencing with the passing of the Electricity Act 2003.

Till early 1990s', the power sector was shielded from any private sector involvement; however, the mounting pressure on Government resources to support capacity additions, repeated delays encountered by state utilities and the growing demand-supply gap urged the Government of India to open the power generation sector to private participation along with country's globalization policy.

The National Tariff Policy was notified in 2005, which mandated that, "All future procurement of power by the distribution utilities and all future investments in inter-state power transmission would be through competitive bidding route from January, 2011."

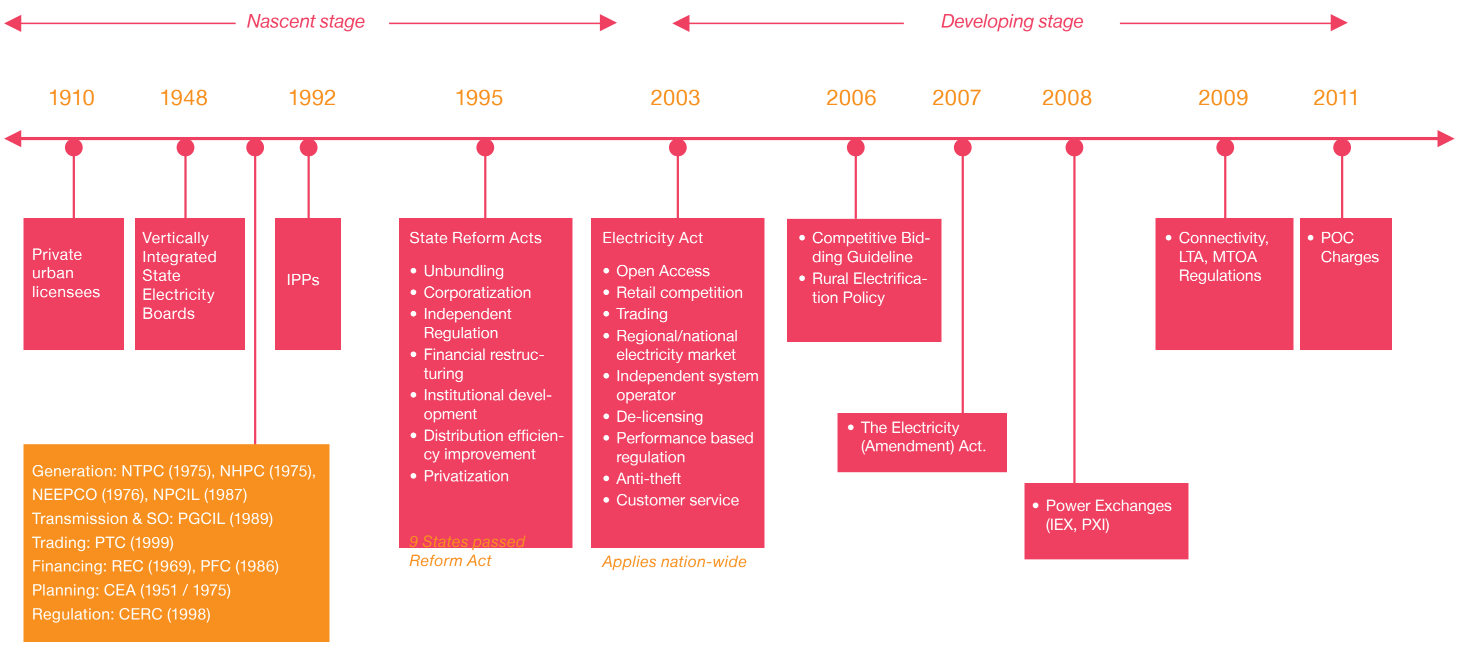
The amendment of Supply Act (1948) in 1991, followed by the enactment of Electricity Act(2003) and notification of Mega Power Policy(1995), National Tariff Policy (2005), National Electricity Policy and Integrated Energy Policy have all led to a much liberal power sector, which then saw active investments from private sector across the value chain.

However, most of the participation by private investors has happened in generation sector, driven by de-licensing of generation, fiscal incentives for large scale capacity additions and competitive procurement of power.

The Indian power sector has achieved a lot over the last decade in the areas of policy reforms, private sector participation in generation and transmission, new manufacturing technology and capabilities, but there is still much to achieve and a number of challenges to overcome before the opportunities can be leveraged.

In lines with the provisions of National Tariff Policy, the Ministry of Power, India notified the guidelines and standard bidding documents for competitive bidding.

Market Maturity



Key challenges

Several critical challenges exists in the country

Securing fuel

Shortage in coal supply

India has a coal production to reserve ratio of 0.94 compared to 2.83 for China, which indicates that India's current production, is far less compared to its potential. Hence, it is imminent that India boosts its coal production.

India's power requirement over the years has largely been dominated by coal based generation, with close to 55% of the 182 GW of installed capacity being coal based power plants, accounting for over 80% of the total units generated in the country.

However, more stringent rules and norms brought about recently by the MoEF over award of coal blocks have left many developers devoid of coal linkages. Even state Gencos are repeatedly under pressure due to lack of adequate and timely supply of fuel.

"Country will have a shortfall of coal of 238 MT/ annum by 2016-17, if current scenario continues…," - Working Committee Group on coal.

Working Committee Group on coal.

Securing fuel from imported coal market is becoming increasingly costly and uncertain

The recent change in international markets, most notably among which being the enactment of the new mining law in Indonesia, has significantly impacted the cost of imported coal for Indian companies, many of which were relying on supply of coal from this south-east Asian nation. Recently, both Krishnapatnam and Mundra UMPPs expressed their concern over rising cost of imported coal, which would make the projects unviable at the tariffs quoted by them. This has been aggravated by the fact that changes in international law and regulations are not currently covered under change in law in Indian Power Purchase contracts.

Erratic gas supply

The gas supply to power sector has been lower than the requirement over the last 10 years, although the deficit for gas has reduced from 45% in FY01 to 20% in FY11.

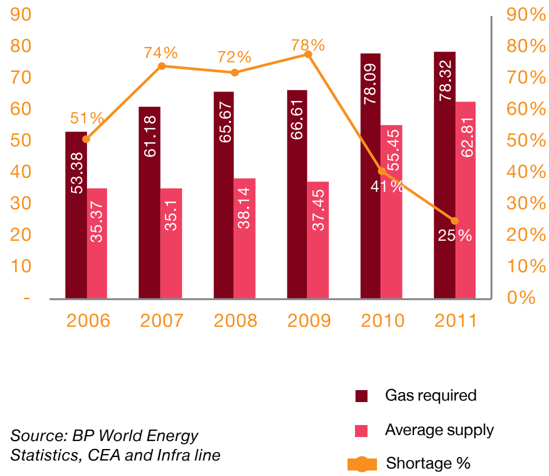
> *The National Tariff Policy was notified in 2005, which mandated that, "All future procurement of power by the distribution utilities and all future investments in inter-state power transmission would be through competitive bidding route from January, 2011."*

CEA reports that *"The total loss of generation in FY10 is 3.24 billion units due to shortage in gas supply."*

The need to revive confidence in nuclear based power generation

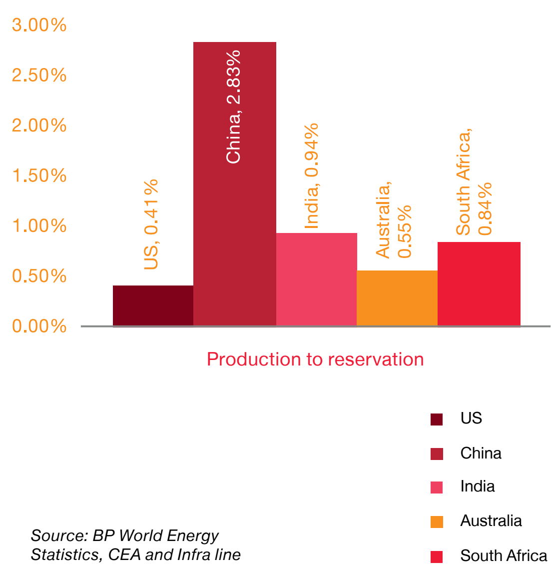
The recent calamity in Japan has also lowered the confidence on nuclear fuel as an alternative to conventional fuels and there seems to exist an apprehension regarding nuclear power, even as the country intends to supply 25% of the electricity through nuclear power by 2050. Nuclear power remains important for the country's energy security and an important means of protecting against fuel inflation, and must be pursued, but clearly addressing the safety aspects in design, planning, construction, and periodic monitoring.

Gas demand and supply (bcf)



Source: BP World Energy Statistics, CEA and Infra line

Coal production to reserve ratio



Source: BP World Energy Statistics, CEA and Infra line

Agenda

- *Allotment of 40 billion tonnes of coal reserves through competitive bidding/auction and improve short term availability through open market/e-auction*
- *Complete de-regulation of the sector to allow private investments and move to market based pricing and promote PPP with Coal India*
- *Single Window Clearance*
- *Develop a complete logistics for transportation of fuel*
- *Enhance gas production and imports from neighboring gas rich countries (like Bangladesh)*
- *Investment in technology for Thorium based power generation technologies.*

Securing land and clearances

Land is a basic necessity when it comes to pre-requisites for power generation projects. A lot of projects are either cancelled or delayed due to non-availability of land or difficulties in land acquisition. Another major hurdle post identification and selection of land is securing the required clearances. There are a number of clearances required from the MoEF, Ministry of Aviation, Department of Forests and other government bodies. Past experience indicates that there are major hurdles for land acquisition and securing clearances which include the following:

- Social reasons like opposition from nearby residents due to concerns over loss of land, water and pollution;
- Resettlement and rehabilitation issues;
- Regulatory delays;
- Environmental issues like afforestation;
- State specific issues like unavailability of supporting infrastructure;
- Financial reasons resulting from rising costs of land.

Agenda

- *Making land available for power projects without compromising with prosperity of farmers*
- *Fair setting of land prices for power ventures and release of land where the project development is not happening*
- *Fair R&R programme can help in acquiring land like evident in case of UMPPs Mundra and Sasan*
- *Time-bound award of clearances (setting up efficient process with high degree of transparency)*

Issues pertaining to competitive bidding

Competitive bidding in power generation and transmission is viewed as a major fundamental change – a move towards a competitive market, which would attract private sector participation and also help in discovering competitive prices in a largely regulated market. The typical duration for which companies quote their tariffs in competitive bidding scenario, is 25 years and 35 years for generation and transmission, respectively. The duration is fixed considering the life of assets and the period within which companies would be able to recover their costs at reasonable tariffs. The results in competitive bids in the recent past in India indicate that the tariffs discovered have been in most cases significantly lower than regulated tariffs.

There are risks associated with projects that, if the bidder does not cover/hedge, would expose the bidder to a potential downside over a 25/35 year period. The table below is a macro level risk matrix for generation and transmission:

Bidding route	Major uncertainties	Duration of risk
Case 1 (Power Generation)	• Cost of fuel local and imported • Cost of transportation of fuel • Cost of equipments – BTG and BOP • Financial closure	25 years 25 years 3-5 years impact till 25 years 10-15 years
Case 2 (Power Generation)	• Cost of equipments – BTG and BOP • Financial closure	3-5 years impact till 25 years 10-15 years
IPTC bidding (Transmission)	• Cost of equipments and input materials – Conductors (Aluminum) and tower (Steel) • Financial closure	10-15 years

Recently, a company undertaking two IPTC projects under competitive bidding has declared its inability to develop the project at quoted tariffs due escalation in raw material prices. Similar trends are also seen emerging in power generation, where a number of imported coal based power projects (including 2 UMPPs) have expressed their inability to deliver power at the quoted tariffs. This puts a serious dent on the Indian power sector and mechanisms needs to be put into place, to deal with such default scenarios and parties.

Agenda

- *Revision of bidding framework/evaluation criteria to ensure less default in case of projects awarded through competitive bidding*
- *Put in place a mechanism to check irrational exuberance in bidding*
- *Mechanism to prevent the defaulting bidders from participating in subsequent bids.*

Worsening financial health of the distribution sector

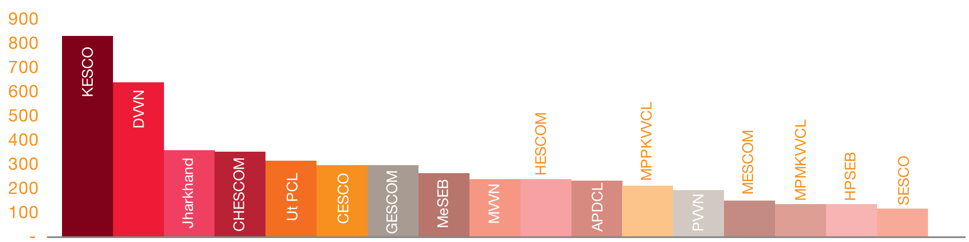
- *Average creditor days in 2009: 79 days.*
- *Average creditor days in 2010: 84 days.*
- *Highest creditor days reported by any state in 2010: 835 days.*

Apart from a handful of franchisees and privatized utilities, the distribution sector is still largely in the hands of the state owned utilities. According to PFC's report on performance of utilities-2010, the total AT&C loss in the country is 27.15% (2010), which is a mere 0.6% improvement from the levels of 27.74% in 2009. The low collections and cash deficit scenario of the distribution sector severely impacts the financial viability of generation and transmission sectors.

The total creditor period for distribution utilities in India was 79 days in 2009, which increased to 84 days in 2010.

The situation is far worse for larger distribution utilities in the country. In states like Karnataka, Madhya Pradesh and Uttar Pradesh, the average creditor days touched 300 days in 2010. This implies that generation companies, especially state owned ones which are much lower in the priority list of a Discom's creditors, would run into working capital problems owning to the high creditor days for distribution utilities.

Creditor days



Although power procurement through competitive bidding has been undertaken by a number of states with adequate payment security mechanisms in place (like LC and Escrow arrangements), this is not a viable solution in the long run.

Likely energy deficit scenario in 2012 in some states with high creditor days (CEA Load Balance Report):

- *Uttar Pradesh – 25.3%*
- *Karnataka – 4.8% (surplus)*
- *Jharkhand – 11%*
- *Madhya Pradesh – 19.4%*

Agenda

- *Making the distribution business viable so that downstream generation and transmission businesses are able to recover their revenues.*
- *Reduction in creditor days to manageable limits especially in large states like Uttar-Pradesh, Madhya Pradesh, Jharkhand and Karnataka among others.*
- *Liquidation of outstanding payables (above 1 year) through financial restructuring (FRP) measures.*

Project execution challenge

The major players in India Power Sector have shown strong operational capabilities but have fared poorly in project management and execution. A capacity addition of 41,110 MW was planned in the 10th five year plan period, against which only 21,180 MW was achieved, i.e., an achievement of merely 51.5% against the set target.

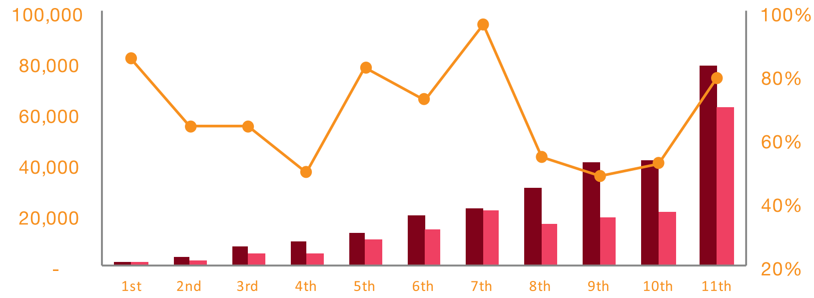
As on 31st March 2011, 41,297 MW of capacity has been added during the 11th Plan against the revised plan target of 62,374 MW (66%). It is widely expected that the actual realization would not exceed 50 GW[3], during the end of 11th 5 year plan.

In addition to bottlenecks in manufacturing (i.e. BTG and BoP manufacturers); environment clearances and land acquisition have been the major issues for delay in project execution. Investment of time, effort and money in developing project planning and project execution capabilities, streamlining of business processes and adoption of advanced technologies in the sector would enable the investors overcome such strategic hurdles to a large extent.

Agenda

- *On time and within cost execution of projects.*
- *Streamlined business processes, effective controls and transparency.*
- *Efficient inflow of right technologies and skills.*
- *Combination of in house and outsource activities.*
- *Use of right project management tools followed by timely monitoring and corrective actions.*

Investments in power sector



Source: CEA and Planning Commission

Change in regulation in transmission sector

Mid of 2010, CERC issued new regulation on Point of Connection (PoC) method for sharing of transmission charges of inter-state transmission services in India. Point-of-connection (POC) scheme of transmission pricing charges the participants a single rate per MW depending on their point-of-connection.

According to the commercial arrangement proposed under the PoC regime, the CTU would now be responsible for collection and settle of transmission charges on behalf of all transmission service providers. This would imply that there would no more be a TSA directly between transmission service providers and the beneficiaries (DICs). The collections would be disbursed by the CTU among the transmission service providers on pro-rata basis.

The change in regime is expected to increase the perceived business risk for transmission sector. Investors would no longer treat transmission as a safe business, if the issues pertaining to the change in regulation are not addressed.

Agenda

- *Putting in place right mechanism to reduce perceived market risk for investors.*
- *Reduce the impact of change in regulation on viability of the sector.*
- *Commercial agreements between TSP and CTU for timely payment and collection.*

[3] *As per Planning Commission- Approach Paper for 12th 5 year plan*

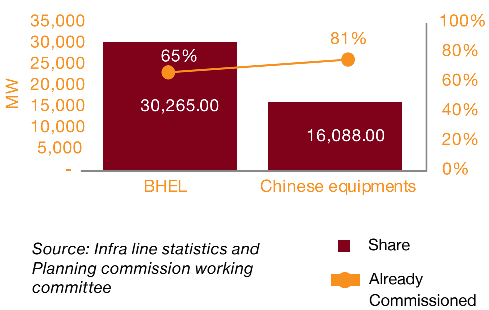
Competition from International OEM

The strong demand growth in the country has led to increased competition for domestic BTG industry from OEMs based in China (like Shanghai Electric, Donfang Electric Group and Harbin Power Equipments), as several private players are opting to import BTG sets from China due to faster delivery of equipments and lower cost of sourcing. The prices quoted by Chinese manufacturers are below INR 2 crores/MW compared to price range of INR 2.8-3.2 crores/MW of domestic OEMs (Infra line Research).

Importing equipment also provide developers opportunity to tap into Export Credit Market for equipment financing at extremely competitive rates.

The Mega Power Policy has provided waiver of customs duty on import of supercrtical equipments. In July 2011, to further eradicate difficulties faced by developers on furnishing "Certificate from Ministry of Power", Government of India enabled duty-free imports which is likely to continue till 2012.

BTG Market (Thermal Power Plants)



Source: Infra line statistics and Planning commission working committee

Agenda

- *Growth of domestic equipment market vis-à-vis the low cost and timely delivery of imported equipments.*
- *Readiness of India equipment players to compete with Chinese suppliers.*
- *Inflow of latest technology from developed countries like France and Germany.*

Opportunities

Opportunities

Indian power sector has made considerable progress in the last decade and has evolved from a nascent market to a developing market led by policy reforms and increased private sector participation. Challenges do exist in the sector, which India has to overcome, to evolve from a developing market to a matured market. Meanwhile, the gap between what can be achieved and what is currently present, uncovers a number of possibilities and opportunities for growth.

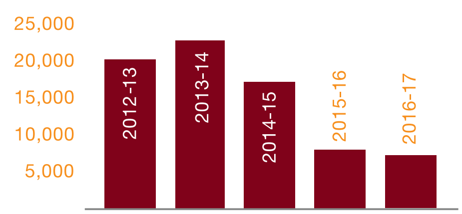
Strong growth in generation capacity led by per capita consumption, urbanization

There is strong growth opportunity in power generation led by exponential growth in economy, increasing propensity for electricity consumption and urbanization. India has made considerable progress in building up capability and uncovering opportunities for capacity additions.

Indian companies have shown a huge interest in power generation and the recent change in power procurement landscape towards competitive bidding is expected to drive investments and efficiency in the sector.

Compared to the 10th five year plan, the capacity additions have increased considerably in 11th five year plan as India Inc is slowly developing execution capabilities.

Capacity additions (MW) (excluding renewables)



In the 12th five year plan, India has planned to add close to 75 GW of power generation capacities. The huge capacity addition plan also offers opportunity for developing evacuation capacities and supply related OEMs like conductor manufacturing, insulator manufacturing, tower fabrication and EPC.

Highlights for evacuation of renewable energy:

- *INR 900 crores of investment for evacuation of wind energy in Gujarat.*
- *INR 1500 crores of investment for evacuation of wind and solar power in Rajasthan.*
- *INR 407 crores of investments for evacuation of power from SHPs in Himachal Pradesh.*
- *INR 3800 crores of investments for evacuation of wind power in TamilNadu.*

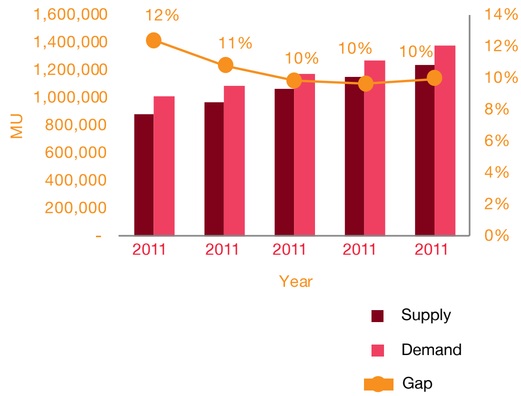
Agenda

- *Timely implementation of evacuation schemes dovetailing with investments in generation.*
- *Competitive bidding for large scale evacuation projects planned at central level.*
- *Easily available Right of Way clearances for long distance evacuation schemes.*

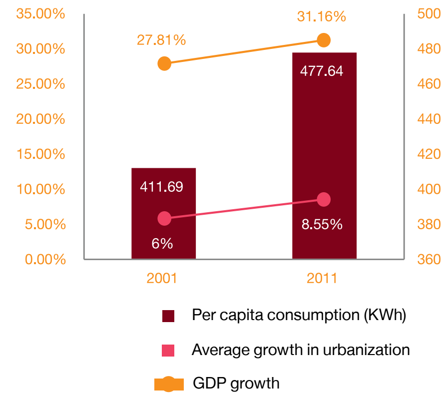
Agenda

- *Timely implementation of generation capacities.*
- *Increased participation from private sector.*
- *Increased competition by complete competitive bidding power procurement.*
- *Sustained economic development and increase in per-capita consumption.*

Demand supply scenario



Growth scenario for India



Source: CEA, Planning commission & PwC analysis

Alternate sources of energy

While Indian companies are largely focused on tradition sources of energy, global investments in renewable energy has jumped 32% reaching record USD 211 billion in 2010, which is over 5 fold increase since 2004. Even developing countries like China have ramped up their investments in alternate sources of energy.

Steadily, India too is looking at building a strong renewable energy portfolio in coming years. Government of India is offering a number of incentives to renewable energy developers to accelerate investments in renewable energy space.

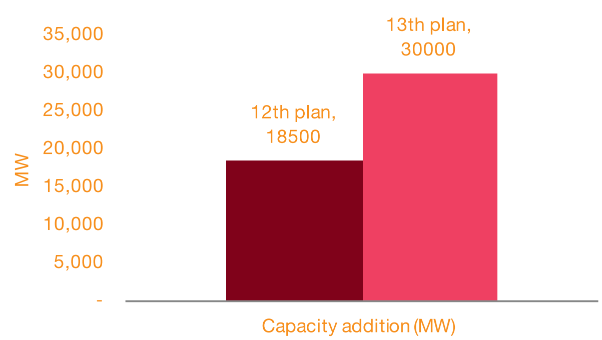
RPO requirements set by state regulators and REC mechanism is expected to create demand for renewable energy across solar and non-solar sources. In addition, several benefits like accelerated depreciation, preferential tariff and generation based incentives offer attractive incentives to developers investing in renewable energy, and aim to enhance supply through renewable energy.

The increased focus of Government of India towards renewable energy has created attractive opportunities for investments in this sector. The recent solar bids concluded is an indication the players are becoming increasingly competitive in the space while large scale capacity additions in wind continue across country (especially in Tamil Nadu and Rajasthan)

Renewable investments

Source: Bloomberg New Energy Finance

Capacity addition planned for renewables



The National Solar Mission plans a capacity addition of 22,000 MW by 2022. Government of India targets a growth in renewable energy consumption of over 6% CAGR and a capacity addition of 18500 MW during the 12th five year plan period.

Agenda

- *Increased R&D in India in cost effective renewable energy technologies*
- *Increased opportunities for private sector and success of schemes like RECs and RPO requirements*
- *Financing mechanisms and fiscal benefits to the renewable energy players.*
- *Increase investments towards global levels and special focus on large size renewable capacities like neighboring China.*

The Mission 2017 seeks to:

- *Identify the optimal steam parameters,*
- *Design the boiler-turbine system, and develop the requirements for the system components,*
- *Identify (and develop, if required) appropriate material for these requirements,*
- *Test the material, and components made of these material, at the required conditions,*
- *Integrate these components in the manufacture of the boiler-turbine system, and*
- *Construct commission and run 800-MW Adv-USC power plant.*

Investment in clean technology

Close to 55% of the installed capacity in India is coal based, as coal is the most abundant fuel available domestically. As the demand for electricity grows, the role of coal would remain undiminished.

Indian coal however has a high ash and mineral content while cleaner imported coal is very costly.

Hence, the focus is on development of clean coal technologies which is of paramount importance for a country like India.

Currently there are a number of existing technologies like coal beneficiation, coal combustion, coal conversion, coal gasification and carbon capture.

India has made some progress in implementing super critical, pulverized coal combustion, coal gasification technologies. Such technology choices would have a long term impact (life of the plant) and needs to be chosen carefully. More favourable policy initiatives would help overcome any economic hurdles towards which investors might face.

- *In India Circulating Fluidized Bed Combustion (CFBC) technology based boiler was first installed by BHEL in Pune. It is a promising technology and around 16 more power plants including UMPP's using this technology are under construction in India.*
- *Similarly in coal gasification, the first implementation happened in 10 MW captive power plant at TISCO Jamadova Colliery. Another two CFB gasifiers are installed at Gujarat Industries Power Co. Ltd.*

Agenda

- *Promote clean coal technologies in India by offering quicker clearances and other benefits for using costly technologies like carbon capture*
- *Increase R&D investments in clean coal technologies*
- *Increase penetration of new technologies in coal mining to make the process much cleaner*
- *Roadmap to achieve "Mission 2017"*

Opportunity in power evacuation

In the 12th five year plan, India has planned to add close to 75 GW of power generation capacities. The huge capacity addition plan also offers opportunity for developing evacuation capacities and supply related OEMs like conductor manufacturing, insulator manufacturing, tower fabrication and EPC.

Highlights for evacuation of renewable energy:

- *INR 900 crores of investment for evacuation of wind energy in Gujarat.*
- *INR 1500 crores of investment for evacuation of wind and solar power in Rajasthan.*
- *INR 407 crores of investments for evacuation of power from SHPs in Himachal Pradesh.*
- *INR 3800 crores of investments for evacuation of wind power in TamilNadu.*

Agenda

- *Timely implementation of evacuation schemes dovetailing with investments in generation.*
- *Competitive bidding for large scale evacuation projects planned at central level.*
- *Easily available Right of Way clearances for long distance evacuation schemes.*

Gap in manufacturing capacity

The capacity additions envisaged under 12th five year plan is 75 GW (excluding renewable energy) and almost double under the next five year plan (13th five year plan).

In addition, it is also expected that close to INR 33, 839 crores would be invested on R&M and LE works in the 12th five year plan.

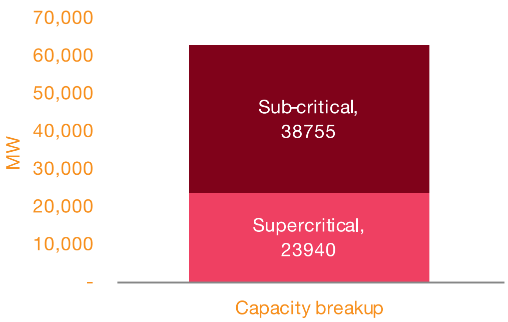
Works required	Number of units	Capacity (MW)	Estimated Cost (INR crores)
LE works	72	16532	28868
R&M works	23	4971	4971
Total	99	21503	33839

Source: Planning commission working committee on 12th plan

The demand for BTG equipments is expected to touch 35 GW by 2013[4]. The domestic equipment major BHEL is already loaded with bulk orders for next 2-3 years and there is a need to enhance private sector investment in OEM space.

The current scenario presents with immense opportunities for investors in manufacturing sector (OEMs) for building up capacities to cater to the growing requirements.

Total capacity planned (12th Plan)



Source: Planning commission working committee on 12th plan

The focus of investors would be on production capacity expansion, diversity of product offerings, developing new clean technologies and improving operational characteristics of their offerings.

Agenda

- *Promoting private sector investments in OEM space*
- *Facilitating new technology inflow in the sector*
- *Improving logistics and connectivity issues*
- *Availability of raw material domestically*
- *Single window clearance for movement of consignment across states.*

[4]Planning commission working committee on 12th five year plan on Power

Conclusion

The last decade has seen a sea change in India's electricity sector, from being 10th largest in the world to 5th largest now. The industry is moving away from negotiated & guaranteed arrangements of the past era, to more open market and performance based competition. The approach now is more pro-investment, although the legacy problems of cross-subsidies, losses, and rural access remain a challenge. The private sector has emerged as a key player in both conventional and renewable power, and increasingly in other parts of the business. There is still a long way to go.

The significant achievements of the power sector all sit atop a distribution business that depends on subsidies and carries growing uncovered financial losses. The losses are said to have ballooned to over Rs 1 lakhs crores and could get worse as we import higher proportion of coal and as global commodity prices rise. The resulting uncovered losses will impact the consumers and investors unless vigorous distribution reforms are pursued.

An encouraging development is the larger number of private bidders showing interest in distribution. The recent DF (Distribution Franchisee) tenders have attracted 20 to 30 bidders, and many bring experience from other industries such as power equipment, construction, and telecoms and IT. This helps seed in new technologies and strategies, such as the use of smart meters, targeting tools and CRM (Customer Relationship Management), shared services, standardisation, multi-skilling, and other techniques that can upgrade management of distribution businesses. The size of the distribution opportunity is very large; India could easily have over 50-60 specialist DF companies even at an enhanced size, that will attract more investment and innovation.

It is important to get back to basics, namely tariff reforms, private participation, and competition to make the sector attractive to capital flow. In last one decade, bank credit doubled in share from about 6% to 12% , and many private and state-owned power companies accessed capital markets. But it is hard to see the investors and lender return in strength without an improvement in overall credit standing of the power sector. Addressing sector viability is a must to avoid risk of non-performing assets cascading upstream. The Discoms must aggressively pursue performance improvement as the new generation capacity coming from large UMPPs to smaller solar power plants, can be botha boon (with improved supply and additional revenue) or a bane (worsening financial losses leading into a liquidity crunch) depending on how effectively the losses on every kWh sold are reduced.

The spotlight is as much on sector regulation as financial viability of licensees. The sector is impacted with several years of not revising tariffs, even to cover genuine and reasonable cost increases. To avoid lumpy hikes and inter-generational conflicts, there is a need to significantly improve the multi-year tariff methodology to incorporate costs in time, say on quarterly and annual basis.

Given our energy mix, and fast growing demand, we need to equally pay attention to the challenges of climate change. The energy efficiency initiatives introduced by the BEE (Bureau of Energy Efficiency) and others are necessary to reduce our energy intensity, but for them to bear fruit, we also need to redesign tariff structures to be cost reflective. The REC mechanism is a major step forward to bring renewable energy into market pricing, in a way that helps move away from administrative feed-in tariffs, but the REC market cannot form if the RPO (renewable procurement obligation) is not mandatory.

A closure can now be drawn on industry restructuring with unbundling nearly concluded. However, there remains considerable work in enhancing the capabilities and systems of these new companies and in preparing the STUs (State Transmission Unit) to act independently. The regulatory process for open access approvals also needs streamlining and made more transparent to promote competition. There is a good case for pursuing open access and competition for the long-term economic gain in investment, employment, better supply and lower tariffs.

Energy security is a significant challenge for future as coal based power plants fuel about 80% of power generation today and increasingly coal is imported. The regional electricity market integration initiated with Nepal, Bangladesh, and Sri Lanka and the strengthening of Bhutan relationship through the umbrella agreement are important for regional energy security. Hybrid technologies can also help such as use of concentrated solar power to pre-heat at power plants to save on coal and transport costs, which will only become costlier over time.

The interest in power sector has spurred a rush for resources viz. wind zones, coal blocks and hydro sites; and those owning these resources discovered tendering them a good way to raise funds, in form of upfront premium, in-kind royalty payments over the term, etc. The challenge is to ensure that these do not end up in a race to corner scarce resources but translate into producing assets.

The power sector plays a key role in industrialisation and urbanisation of India and faces challenges in absorbing high cost of inputs. It plays a socially responsible role in bridging rural-urban disparities by improving provision of affordable commercial energy access. These are important goals, and will help improve living standards of a billion people directly and indirectly, but will clearly need support and collaborative working of all the stakeholders.

Emerging opportunities and challenges

Electricity distribution

Contents

Context

Distribution and retail supply is the most important cog in the power sector value chain which interfaces with end customers and provides revenue for the entire value chain. Indian electricity distribution caters to nearly 200 million consumers with a connected load of about 400 GW that places the country among the largest electricity consumer bases in the world. The consumers are served by around 73 distribution utilities – 13 electricity departments, 17 private distribution companies, 40 corporatised distribution companies and 3 State Electricity Boards.

Sustenance of other elements in the sector like generation, transmission, equipment manufacturing is dependent on the commercial performance and financial viability of the distribution sector in India. Over the past 15-16 years, a number of states have worked to improve the commercial performance of their state utilities, unbundling state entities, creating independent regulatory systems, and putting in place measures to control losses and theft. However, progress has been difficult, and slower than envisaged.

Not long back, the Government of India had constituted a committee, headed by Mr. Deepak Parekh, erstwhile Chairman of IDFC, to study the electricity sector in India and suggest for improvements. The report, among other suggestions, remarked the following:

"India's power sector is a leaking bucket; the holes deliberately crafted and the leaks carefully collected as economic rents by various stakeholders that control the system. The logical thing to do would be to fix the bucket rather than to persistently emphasize shortages of power and forever make exaggerated estimates of future demands for power. Most initiatives in the power sector (IPPs and mega power projects) are nothing but ways of pouring more water into the bucket so that the consistency and quantity of leaks are assured..."

Twenty years after reforms were introduced in the Indian electricity sector, the above remark still holds good. The 'bucket' in the above remark is the Indian electricity distribution sector, which consumes no matter how much is generated, without adequately compensating the producers of electricity for the same.

Recently, Planning Commission had appointed a High Level Panel headed by Shri V.K. Shunglu, former Comptroller & Auditor General in July, 2010 to look into the financial problems of State Electricity Boards and to identify corrective steps. The terms of reference of this Committee included reviewing the accounts of State Electricity Boards and State Distribution Companies as on March, 2010 and to project their losses by 2017, reviewing the electricity tariff and also examining the role of the State Governments, Electricity Regulatory Commissions and Distribution Companies, assessing system improvement measures accomplished in distribution of power etc. and finally, to recommend a plan of action to achieve financial viability in distribution of power by 2017. The Shunglu Committee presented its Report to the Deputy Chairman, Planning Commission on 15 December, 2011.

It is time that we look at the underlying problems of this sector and constructively work towards removing the bottlenecks to make it more efficient and customer oriented.

This paper establishes the current scenario in the Indian distribution and retail supply sector and attempts to identify the major trends in India's electricity distribution sector. It also discusses the associated challenges and key interventions (and related emerging opportunities) going forward.

Existing Scenario

The Indian power distribution sector is witnessing a lot of activity of late with positives like increased consumer demand on the back of GDP growth, increased urbanisation, rural electrification and increased private sector participation. Apart from high financial losses and debt burden hampering the development of the electricity distribution sector, there are several challenges to the policy and regulatory initiatives being undertaken, as discussed below:

Structural reforms

The process of reforms and restructuring in Indian Power Sector begun in the early 1990's with a few State Governments enacting state level legislations[1] to reform and restructure integrated State Electricity Boards (SEBs) prior to enactment of the Electricity Act, 2003 ("the 2003 Act"). The first state to restructure its integrated SEB under a state level legislation was Odisha in 1995. Later, Haryana, Andhra Pradesh, Rajasthan, Uttar Pradesh, Karnataka, Delhi and Madhya Pradesh followed suit. Though power is a concurrent subject in the Constitution, the first major policy thrust from Central Government came only in 1998 when it enacted the Electricity Regulatory Commission Act, 1998 to pave way for formation of Central and State Electricity Regulatory Commissions and distancing of Government from tariff determination. The most significant and wide-ranging change in legislation was the promulgation of the 2003 Act, which superseded all the previous electricity related legislations and created a more open environment for investment and competition in the sector.

The 2003 Act also required statutory restructuring of integrated SEBs and separation of trading function from transmission and system operation. States like Odisha, Haryana, Rajasthan, Andhra Pradesh, Madhya Pradesh and Uttar Pradesh unbundled their electricity boards and created multiple distribution licensees. While states like West Bengal, Maharashtra and Chhattisgarh formed a single distribution utility model to restructure themselves, recently unbundled states like Tamil Nadu and Punjab have segregated the transmission business from the overall SEB operations to meet E Act 2003 requirements. Utilities are restructuring due to a mandatory prescription instead of a desire to reform and be commercially viable.

The objective to bring in operational efficiency and governance improvements across the state-owned power utilities is lost. While there is a huge focus on

State	Industry structure	Unbundling/ Discom formation
Odisha	G+T+4D	1995/1998
Haryana	G+T+2D	***1998/1999***
Rajasthan	G+T+3D	2000
Uttar Pradesh	G+T+6D	2000/2003
Uttarakhand	G+T+D	2001/2004
Andhra Pradesh	G+T+4D	1999/2000
Delhi	G+T+3D	2002
Madhya Pradesh	G+T+ 3D+TR	2002
Karnataka	G+T+5D	2001/2002
Assam	G+T+2D	2003
Gujarat	(H+Tr)+G+T+4D	2005
Maharashtra	G+T+D+H	2005
West Bengal	G+T+D	2007
Chhattisgarh	G+T+D+H+Tr	2008
Tamil Nadu	T+(G+D)	2010
Punjab	T+(G+D)	2010
Himachal Pradesh	T+(G+D)	2010

G-Generation company, T-Transmission Company, D-Distribution Company, H-Holding Company, TR-Trading Company, (G+D)-Generation & Distribution combined

1 Odisha, Haryana, Andhra Pradesh, Rajasthan, Uttar Pradesh, Karnataka, Delhi and Madhya Pradesh have restructured their SEBs under state level legislations.

distribution reforms in media and at highest levels of government, within utilities it has lost momentum. Lower than expected government support, lack of sustained improvement in efficiency and service delivery after the restructuring has waned the initial enthusiasm in many states impacting distribution sector.

Lack of credible information

Most distribution utilities struggle to maintain and utilise a comprehensive information system be it across their assets, commercial, customers or financial! Lack of accurate information hinders decision making especially in arresting theft, making investments and estimating losses.

IT based information system can be a key enabler in electricity distribution business to set baseline and measure performance. Restructured APDRP - II program is a step towards building such capabilities in urban areas.

Ministry of Power, Govt. of India (GoI), has launched the Restructured Accelerated Power Development and Reforms Programme (R-APDRP) for the XI Five year Plan period. The focus is on actual, demonstrable performance in terms of sustained loss reduction. The establishment of reliable and automated systems for sustained collection of accurate base line data, and the adoption of information technology in the areas of energy accounting will be necessary preconditions before sanctioning any regular distribution strengthening project. The project area coverage will be urban areas – towns and cities with a population of more than 30,000 for normal category states and above 10,000 for special category states. The objective of the programme is reduction of AT&C losses to 15% in project areas.

The program is divided into two parts – Part-A and Part-B:

- Part-A includes projects for establishment of baseline data and IT applications like Meter Data Acquisition, Meter Reading, Billing, Collections, GIS, MIS, Energy Audit, New Connection, Disconnection, Customer Care Services, Web self service, etc. to get verified baseline AT&C losses.
- Part-B will include distribution strengthening projects for reduction in baseline AT&C looses and increasing reliability of the network.

With a program outlay exceeding Rs.100 billion for implementation of Part A – includes investing in systems to accurately estimate the baseline parameters, it will definitely provide the much needed impetus to the distribution performance improvement programs and in improving the efficiency of the industry as a whole. Its specific focus on developing base-line data and addressing each element of performance improvement - process redesign, program management, implementation of IT solutions - is aimed at enhancing accountability and streamlining processes, without which capital investments in the distribution segment have not been able to sustain efficiency gains.

The focus now shifts to developing the correct institutional and support framework for State Governments to implement these measures. Further clarity may be required on the scope of the program - whether it is limited to project sites or can be implemented across the organization – since discrete implementation in project sites might not result in organization wide envisaged benefits.

Metering & energy audit

Most of the sector reforms program designed and implemented by the State Governments and the utilities have given importance to develop a robust energy accounting system to identify the energy and revenue loss in the system. Despite the focus given to proper energy accounting and mandatory requirement of the Act to have all consumers metered, the metering especially for rural domestic and agriculture consumers is still to be completed. This in turn puts a question mark on the veracity of the distribution loss figures reported by the utilities based on estimated consumption taken for unmetered consumers.

The metering regulations issued by the Central Electricity Authority (CEA) identify three type of metering requirements in the power sector. These include the interface, consumer and energy accounting & audit metering. All above metering categories apply to power distribution where, in addition to consumer metering, interface metering is required with the state transmission utility and other interstate distribution utilities. The energy accounting & audit metering is needed on the feeders and the constituent distribution transformers (DTs) for accurate estimations of distribution losses.

The Electricity Act specifically mandates all licensees to ensure that electricity is supplied only through installation of correct electricity meters. Despite giving fixed timelines for completing cent percent metering installations, there are a significant proportion of unmetered connections, connections with electromechanical meters and connections with defective metering in the country's distribution system. Moreover, while most of the distribution utilities have achieved interface metering, they are struggling to achieve cent percent energy accounting & audit metering covering all feeders and constituent DTs.

The recent Forum of Regulators' (FoR) Working Group report on metering issues has recommended a series of metering interventions including:

- Evolving a robust and cost effective technology for Automated Meter Reading (AMR), specifically for rural areas;
- State Regulators to lay down a time frame for replacing electromechanical meters with advanced technology meters focussing on high loss areas;
- Remote reading enabled DT metering and consumer indexing to be undertaken to enable energy accounting;

The ongoing RAPDRP includes energy accounting & audit metering, including

AMR installations on HT consumers, under Part-A of the program with an aim to build robust baseline parameters in the project areas. The coverage of the program is for the urban areas and even after successful completion of the program, significant levels of network metering would be left unattended. Moreover, the presence of unmetered connections in the system also affects the energy consumption and loss estimations. While majority of distribution utilities have started emphasising on building a robust metering infrastructure, their existing financial losses are hindering the plans for arranging the requisite capital investments to achieve the same.

The presence of a robust metering infrastructure needs to be supported by an apt energy accounting system in the distribution utilities. The existing energy accounting is primarily focused on the business unit level energy accounting that makes it difficult to identify specific loss making networks within the business unit. Absence of a DT level energy accounting system, in most of the distribution utilities, is further limiting the results from field vigilance activities undertaken to arrest commercial losses.

Segregation of agriculture and rural consumption

India has a base of more than 15 million agriculture consumers, constituting nearly 10% of the total consumer base. However, this consumer base has significant contribution to the country's connected load, The CEA's general statistics for FY 2008 has estimated agriculture connected load in the country at more than 66,000 MW, contributing nearly 19% to the country's connected load. Most of the feeders connecting agriculture consumers also have rural domestic and commercial consumers in the system.

Absence of appropriate metering systems, and with agriculture connections mostly unmetered, makes it difficult for distribution utilities and the state regulators to ascertain actual consumption by these categories. It influences the loss calculations and resultant subsidy estimations.

Moreover, in the existing supply deficit scenario, utilities resort to supply restrictions on the agricultural feeders. Such supply restrictions severely impact the supply and quality to the associated rural consumer base and hence the overall socioeconomic growth in the rural areas.

States have recently started segregating the agriculture and rural lighting loads – ***by feeder segregation schemes*** - to facilitate better estimations of agriculture consumption and provide quality supply to rural consumers. The segregation approaches vary in states and range from virtual to physical segregation. States like Rajasthan have even integrated such segregation initiatives with other system improvement schemes in the rural areas. While states like Gujarat have shown successful results from such load segregation initiatives, other states like Haryana and Rajasthan are still in the process of maximising benefits after completion of the segregation activities.

Load segregation can be utilised to estimate agricultural consumption accurately and restate the rural consumption impacting the loss calculations. Clarity of agricultural consumption will have a direct impact on the subsidy estimations while estimating location of losses will drive performance improvements.

Financial distress

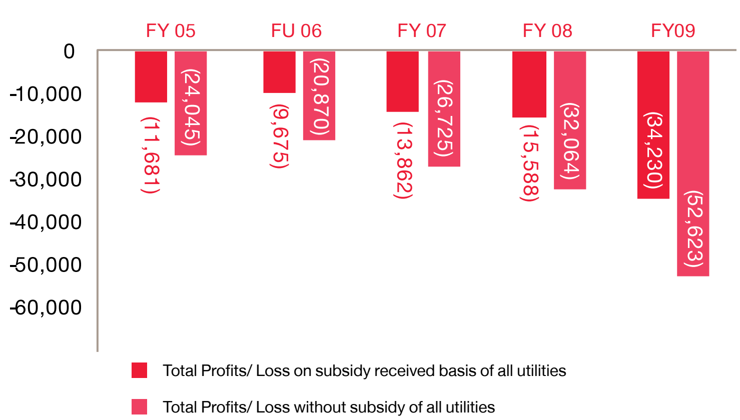
The average AT&C losses in the country are hovering around 35% and these losses are higher on both technical and commercial heads. While higher technical losses are due to old and dilapidated conductors, longer lines serving distant and remote loads, old and inefficient distribution transformers and incorrect configuration leading to load imbalances, higher commercial losses are due to stealing of power, poor billing, low collection efficiency and faulty metering.

In the absence of a proper energy accounting and auditing system in place for most of the utilities, the actual figures for the AT&C loss could be higher than what gets reported. Arresting the AT&C losses and reducing them year-on-year on a sustained pace will require disciplined approach by the utilities, mostly comprising behavioural changes to the functioning of the field personnel engaged in technical and commercial management of the distribution network and the customers respectively.

According to the Planning Commission's estimates, electricity distribution losses totalled a whopping Rs 70,000 Crores in 2010-11. It is projected that the losses will go up to Rs. 1,40,000 Crore by 2014-15, if the present loss levels are not significantly reduced.

There has been a continuous rise in the financial losses of the distribution utilities. As per the recent Shunglu Committee report on financial position of distribution utilities, the subsidy received as a percentage of revenue from the sale of power has gone up over the last five years. However, the net losses have also risen more than four times in the last five years. The cost recovery, excluding subsidy, has gone down to 75.7% in FY 2010 from 81.5% in FY 2008.

Aggregate financial lossess of utilities in Rs. Cr. (Source: PFC reports)



Focus on rural electrification

The Government of India (GoI) has initiated the national-level rural electrification programme, Rajiv Gandhi Grameen Vidyutikaran Yogna (RGGVY), to increase access to electricity in rural areas and for below poverty line (BPL) households of the country. While the scheme has been successful in providing electricity to 230,747 villages and electrification of 17,882,708 BPL households, the planned targets have not been achieved yet.

Rural electrification has a critical role to play in the overall economic growth of India.

According to The World Energy Outlook 2011, 268 million people of rural India and 21 million people of urban India do not have access to electricity (survey figures of 2009). This together constitutes 25% of the total Indian population.

The investment required for electrification in India is estimated to be around US$ 6.4 billion in off grid, mini rid and on grid segments. The access of electricity to the entire rural population in the country will require innovating and strengthening of processes within the utility operations. The existing processes were all oriented towards managing urban consumers, high value consumers and to a limited extent agricultural consumer.

Going forward, as more rural consumers are brought into the network, ability to service them at affordable costs will become the key. Reliable access to all will require the following:

- ***Off grid solutions:*** While investments have been lined up to provide electricity access to Indian rural areas, extending the grid connectivity to every remote location is an uphill task. Concepts like distributed generation, mini grids, etc., will play a critical role in this.
- ***Stress on internal processes:*** Providing electricity in every corner of rural India will come with challenges. These include managing more consumers, increased power requirement, better load management to limit the power requirements, better operational efficiencies, efficient revenue management process, etc.

Implementation of open access

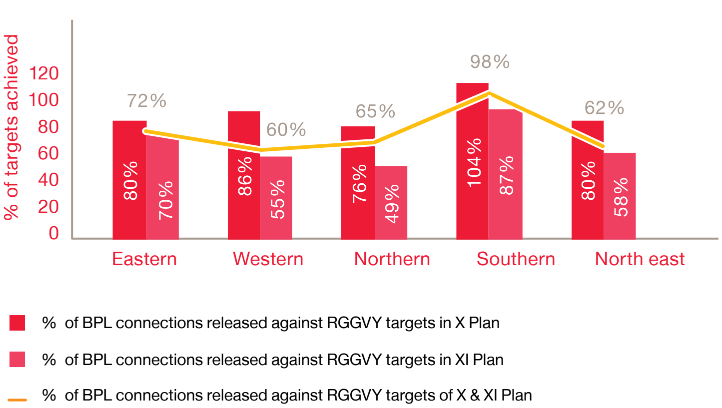
Among the most important problems faced today is the pervasive shortage of energy supplies to consumers. These shortages contribute strongly to reducing India's economic growth, as well as reducing levels of consumer amenity. The magnitude of lost economic growth, while difficult to measure precisely, is almost certainly many multiples of the direct costs of providing needed supplies.

At the same time, another related problem – that of a non-cost reflective tariff system – has the additional effects of eroding the international competitiveness of some Indian industries, and of driving some industrial (and other) consumers to make sub-optimal energy supply choices. These problems together – the lack of needed energy supplies as well as the economically poor tariff system and the responses of consumers to that system – essentially present a "lose-lose" situation for India's economy and its industrial consumers.

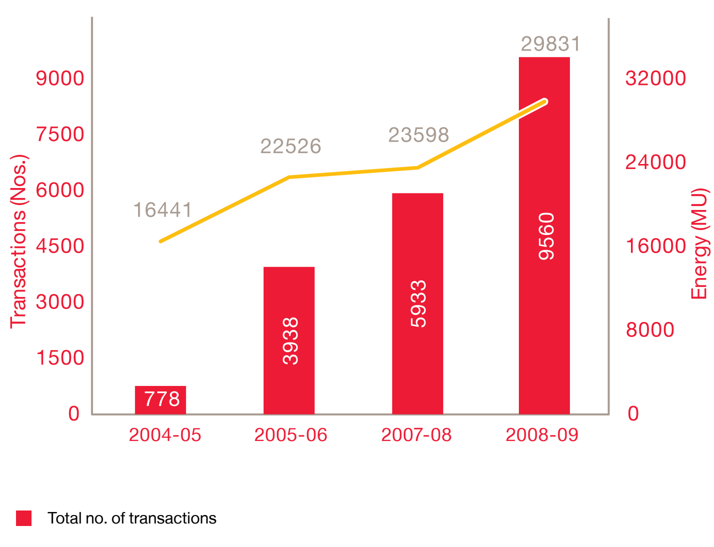
One of the policy responses intended to help address some of these issues is the introduction of Open Access as initially envisioned in the Electricity Act. The advent of the open access regime has ensured that end consumers, especially those with higher demands (above a threshold), have the right to choose the electricity supplier other than the geographical distribution licensee.

In recent years, there has been a rise in the number of open access consumers and the proportion of energy utilised through open access. The recent initiative in Maharashtra, to extend open access to LT consumers, has further empowered consumers to choose among distribution licensees on the basis of supply tariffs and service delivery standards.

% of BPL connections released against the RGGVY targets in X and XI Plan (Source: RGVVY website) Status as on 31.12.2011



Trend of short term open access in India (Rajya Sabha Unstarred Question No. 1184, dated on 08.03.2010.)



Slow progress on private sector participation

Involvement of private players in state owned distribution utilities was initiated with privatization of distribution in the state of Odisha in 1999. The initiative has not proven to be successful in reducing losses and making the sector viable. Some of the reasons attributed are inadequate support from the Govt. of Odisha during the transition period. This rendered the business plans of privatized distribution companies (DISCOMs) unviable with inadequate tariff increases and non payments of subsidies by the state government to cover the unexpectedly high T&D losses.

Subsequently, privatisation of Delhi Vidyut Board happened and was considered a success. The adjoining diagram presents the developments over the years.

Outright privatisation has faced several challenges in India, and as seen in the past transactions, several legacy issues such as past liabilities, run down network condition, staff terminal liabilities have proven to be a stumbling block. The Government of India proposed the Distribution Franchisee model as a suitable intermediate arrangement that transfers the operations to the private operator whilst retaining the licensing, assets and staff within the state-owned utilities. The Electricity Act 2003 provides for a wide range of franchisees including local bodies.

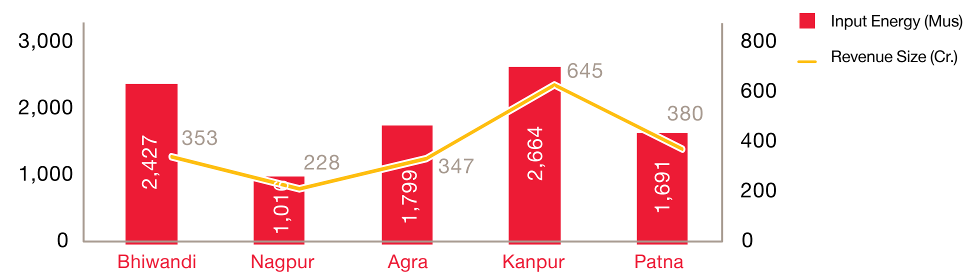
The distribution franchisee arrangement is a Public Private Partnership (PPP) contract that offers a clearly demarcated part of license area to an operator for a fixed period through a competitive auction wherein bidders are selected on best effective input price for purchase of power offered. The retail tariffs are externally imposed by the state regulator and apply uniformly across the license area. This means that the franchisee earns purely based on the improvements it achieves in terms of reduced losses and better supply.

The Distribution franchisee model came to prominence after the handing over of Bhiwandi to Torrent Power after a competitive bid.

Bhiwandi franchisee was able to show reduction in AT&C losses, reduced transformer failure rates, increased reliability indices and most importantly enhanced customer satisfaction.

Pre-reforms	**1999**	**2002**	**2007**	**2010**	**2011**
CESC, AECL, BSES, NPC, TPC (existing private players)	Odisha Privatisation - first state	Delhi Privatisation - Distribution utilities	Distribution Franchisee - Bhiwandi	Distribution Franchisee - Agra (operational) and Kapur (on hold currently)	Distribution Franchisee - Nagpur, Aurangabad, Jalgaon

Energy requirement and availability of India (Source: CEA reports)



Post the initiative in Bhiwandi, many such PPP models have been initiated. These include Aurangabad and Nagpur (late 2010), Jalgaon and Shil-Mumbra-Kalwa (under progress), and Agra and Kanpur (April 2010).

Distribution franchisees are currently seen as the way forward. Madhya Pradesh-based distribution utilities have recently identified nine districts for distribution franchisee. While the bid process is still underway, the pre-bid meeting has invited appreciable response from the private sector.

Managing talent

Average age of the employees in most of the state-owned utilities is around 50. Recruitments in majority of the utilities have either stopped or have been sporadic over the past 10-15 years, with some of them resorting to contractual employment to fulfil their manpower requirements. With the electricity distribution sector not being able to match the other attractive job segments such as IT, manufacturing or services sector, sometimes, recruitments are resulting in sub-optimal results, sometimes forcing the utilities to retain the older / retired personnel on roll. This further hits the efficient operation of the utility and the whole process run into a vicious cycle.

With engineers and other technical personnel being disinterested to join the utilities, because of the reasons cited above, utilities have to engage personnel on contract or outsource some of their core operations to agencies that claim to perform such jobs which the utility desires. However, in most of the cases, such personnel are found to be under-trained or unskilled to be able to deliver the requirements of the utilities.

Some of the vocational institutes being run in various states to produce technically qualified workmen, also lack adequate training infrastructure to train such personnel. Most of the utilities have either a defunct or under-performing training function. Most of the training programmes, whether run in-house or conducted externally are attended to by personnel who can be spared to attend such training programs.

One of the trends discussed subsequently in the paper is advent of specialized agencies taking up various elements in distribution segment through outsourcing, contracting or outright privatization. This is expected to provide a fill-up to lack of trained and specialized skill set within the utilities.

Major trends

This paper lists four key trends that will shape the country's electricity distribution in the next decade. These include the following:

- Increased customer expectations
- IT will be an enabler and differentiator
- Enhanced regulatory oversight
- Segregation across business elements

Increased customer choices and expectations

Consumers in India are becoming demanding with exposure to improved service standards across sectors such as communication, banking and healthcare etc. The key trends in customer expectations and service domain will be as follows:

- ***Multiple service delivery options:*** With parallel licensee, open access and private participation, the customer will have more options while choosing the power supplier. Competition will force utilities to look at innovative solutions for customer retention. Customised services delivered to the customer's doorstep, value-added services as part of the distribution business portfolio, etc., will start gaining importance gradually.
- ***Customer as a stakeholder:*** Going forward, customers will have a say in the manner utility operates. Feedback from customer complaints, interactions, institutions like Utilities Consumer Grievance Cell, Consumer Grievance Redressal Forum, Ombudsman, etc. will enable utilities to design services as per customer demands.
- ***Implementation of standards of supply:*** Implementation of standards of performance and making utilities pay for deficienct service standards will be a reality.

IT will be the enabler and differentiator

The investments made during R-APDRP will have a cascading effect on the IT infrastructure across the utilities as benefits will start flowing in. The current focus has been on the urban areas, subsequently the roll out will be organisation wide to cover all areas.

Smart grid interventions in distribution: The Power Ministry is finalising eight smart grid pilots worth 500 crore INR (US$ 9.69 million) in the country. Their focus will be on building a distribution business that is smart grid compatible and connects the proposed smart grid to the end consumer through smart metering and related technological interventions. Presently, the distribution-metering infrastructure is being used only as a one-way communication device for pulling consumption data to utility's database. Going forward, the meters will become a complete communication channel to undertake bidirectional communication with the end consumers.

Enhanced regulatory oversight

The existing trends in electricity costs and recovery in distribution sector are showing a rising gap between cost of supply and realisation per unit. With respect to allowing genuine utility costs and undertaking tariff revisions, state regulators in states like Haryana, Rajasthan, Tamil Nadu and Jharkhand undertook tariff revisions after a long period, several state regulators like Madhya Pradesh, Gujarat, Uttarakhand and Himachal Pradesh undertake revisions on regular basis.

The role of the state regulator has come into sharp focus with both the Shunglu Committee and Appellate Tribunal for Electricity taking strong views on the tariff determination process.

A relevant clause from the recent Shunglu Committee Report states:

"The approach adopted by most of the regulators during Tariff determination relating to updated accounts of utilities', truing of past costs particularly relating to power purchase and establishment, reduction in T&D losses may be theoretically correct, but it has often resulted in non recovery of valid expenses of the distribution utilities. Failure to revise and fix tariffs with due frequency has only aggravated the problem."

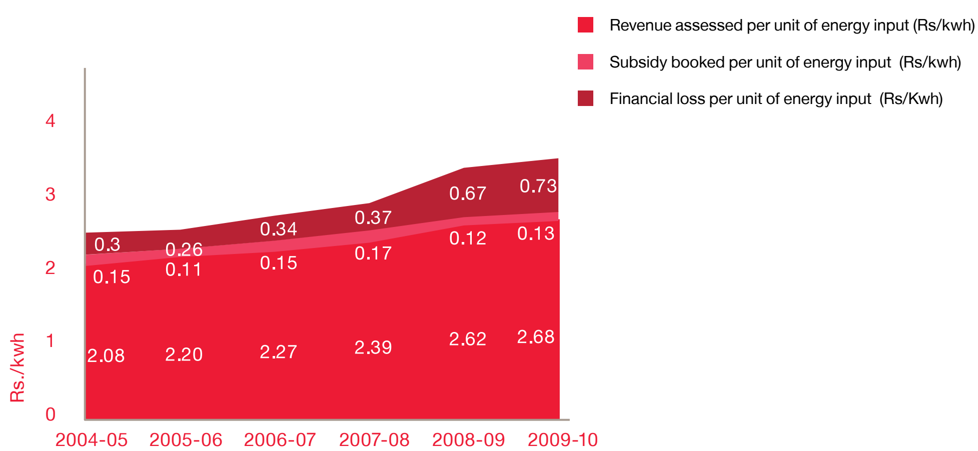
The recent suo-motu order, OP no 1 of 2011 dated 11 November 2011, APTEL has issued following directions to state commissions:

- Every state commission has to ensure annual performance review, true up and annual revenue requirement and tariff determination is conducted regularly.
- In the event of delay in filing (one month), the state commission must initiate suo moto proceedings for tariff determination.
- Regulatory assets must not be created,except where it is justifiable and recovery must be time bound and with in a period not exceeding three years.
- Truing up must be carried out regularly (every year along with the tariff determination).
- Fuel surcharge formula must be formulated by each commission and on a monthly basis (quarterly in worst case)

Going forward, while we might see regular tariff revisions, there will be stringent monitoring of standards of performance and penalties for service deficiencies.

As tariff is increased, propensity to avoid payments will increase. The collection mechanism of distribution utilities must be strengthened to ensure that the revised tariffs could be collected else it will only increase problems for utilities.

Per unit cost recovery (Source: PFC reports)



Segregation across business elements

If last decade saw unbundling and restructuring of the State Electricity Boards across the country in various segments like generation, transmission and distribution then next decade focus will be on segregating each element of the existing distribution business to drive efficiencies and getting in operators best suited to manage smaller segments of the business.

We would see an advent of specialised agencies entering these sub-segments and bringing in skill and expertise not available within the utilities. The scale and scope of such engagement may differ across utility but the principles would be to define a set of service level parameters and contract it to agencies best suited to handle them.

While fully fledged retail competition may still be far away, distinction and involvement of private sector in elements like metering services, managing revenue cycles, distribution franchisees, managing a set of customers, managing call centres, O&M outsourcing, will get more pronounced.

Going forward

The viability and efficiency of the distribution sub-sector would be critical to attract investment into generation, transmission and the electrical equipment sub-sector linked to it. The overall investments and efficiency of the power sector has significant impact on the overall socio-economic development of the country. Therefore, future strategies need to be based on an integrated approach supported by all stakeholders including government, regulator, utility and consumers at large.

Government support

Government support to distribution in the interim till sector is self-sustainable will be a significant need without which all other measures will fail. Government has to play the following roles

- Effective administrator and law enforcer - in terms of implementing effective legislation, by setting up special courts and police stations and creating an enabling environment to arrest power theft, support to utilities in registering genuine power theft cases and ensuring criminal conviction for such crimes.
- Provider of subsidies – Many state governments have clearly stated policies of providing subsidies to a particular category of consumers – agriculture consumers, BPL consumers, etc. Ensuring disbursement of timely (monthly) subsidy post ascertaining consumption levels across these consumer categories will go a long way in easing the financial crunch facing the sector.
- Owner - In the short term, government has to bail out the distribution utilities from the existing financial losses by providing operational autonomy, restructuring debts, and infusing equity.

Balanced regulatory interventions

A regulator plays the balancing role of ensuring sector viability along with managing customer interests. The recent Shungulu Committee report on the power sector has identified delays in tariff revision as one of the key concern areas in the functioning of the state regulators.

Some of the important recommendations of Shungulu Committee worth mentioning are the importance of maintaining independence of regulators and ensuring periodic evaluation of functioning of SERCs. Need for cost reflective tariffs and avoidance of creation of regulatory assets.

It's also the lack of enforcement of standards of performance and penalties for deficient service which needs a relook. Some of the measures which will make regulators aware of customer issues and the tariff revisions acceptable across customers would be measures on improving customer service delivery and competition:

- Mandatory customer feedback and satisfaction surveys on a regular basis on select customer base can help regulators understand issues relating to quality of supply, service delivery, tariffs, etc.
- Regular third party audits of the reported operational parameters and capital expenditure
- Enhance competition in the distribution sector by issuing parallel distribution licenses in select areas and implementing open access regulations.

Transforming utility operations

Integrated action plan

State utilities must have an achievable vision for themselves set by a fully functional and autonomous Board and the Board should be empowered to continuously monitor the performance of the utility and initiate independent actions, compliant to government and regulatory provisions, but devoid of any external interventions. Appointments to the Board as well as the senior management positions of the utility should be based on past performance and experience, and should be of fixed tenures linked to demonstrable performance.

Utilities should have an integrated performance management plan that measures, and monitors the progress of the key initiatives and interventions along with the corresponding investments. It is imperative that the plan is segregated across short-term, medium term and long-term targets that would then be broken into functional targets and action points rigorously monitored during the entire implementation period. To begin with, such action should start with ensuring appropriate utilization of funds available through R-APDRP and RGGVY. Such plans would also help the utilities cope with leadership changes at the various management levels when the new leader can simply take over the implementation, of the predefined action points, from the earlier leader.

In addition to the performance management process, utilities should also focus to improve their respective HR processes linked to recruitment, retention, training and development. Considering the challenges in recruiting commensurate talent from outside, the training & development programs should be appropriately developed and delivered, and monitored from time to time to keep the content contemporary to the developments in the electricity distribution sector.

Adoption of information technology application systems is no more an option for the utilities; it has rather become a necessity. The Government of India sponsored R-APDRP has all the necessary ingredients for an utility to adopt and succeed in becoming viable, only if the implementation is done diligently and the monitoring is stringent. Utilities should ensure that their integrated plans have the linkages to the progress of the R-APDRP and subsequent IT implementation programs are based on such functional objectives which contribute to the efficient operations of the utility.

Involve private players

As the distribution sector gets more segmented across network, metering and retail supply, the need for specialisation and appropriate risk allocation will increase. The existing resource and skill crunch in the utilities can be compensated by bringing in private players for managing a defined business unit/business process – by various forms.

Outsourcing, management contracts and franchisees may be different models of involving interested players. Recently there has been a surge of such initiatives in Maharashtra, Uttar Pradesh, Madhya Pradesh, Bihar and other states. A program to encourage private sector in developing and managing rural distribution infrastructure can also be thought of.

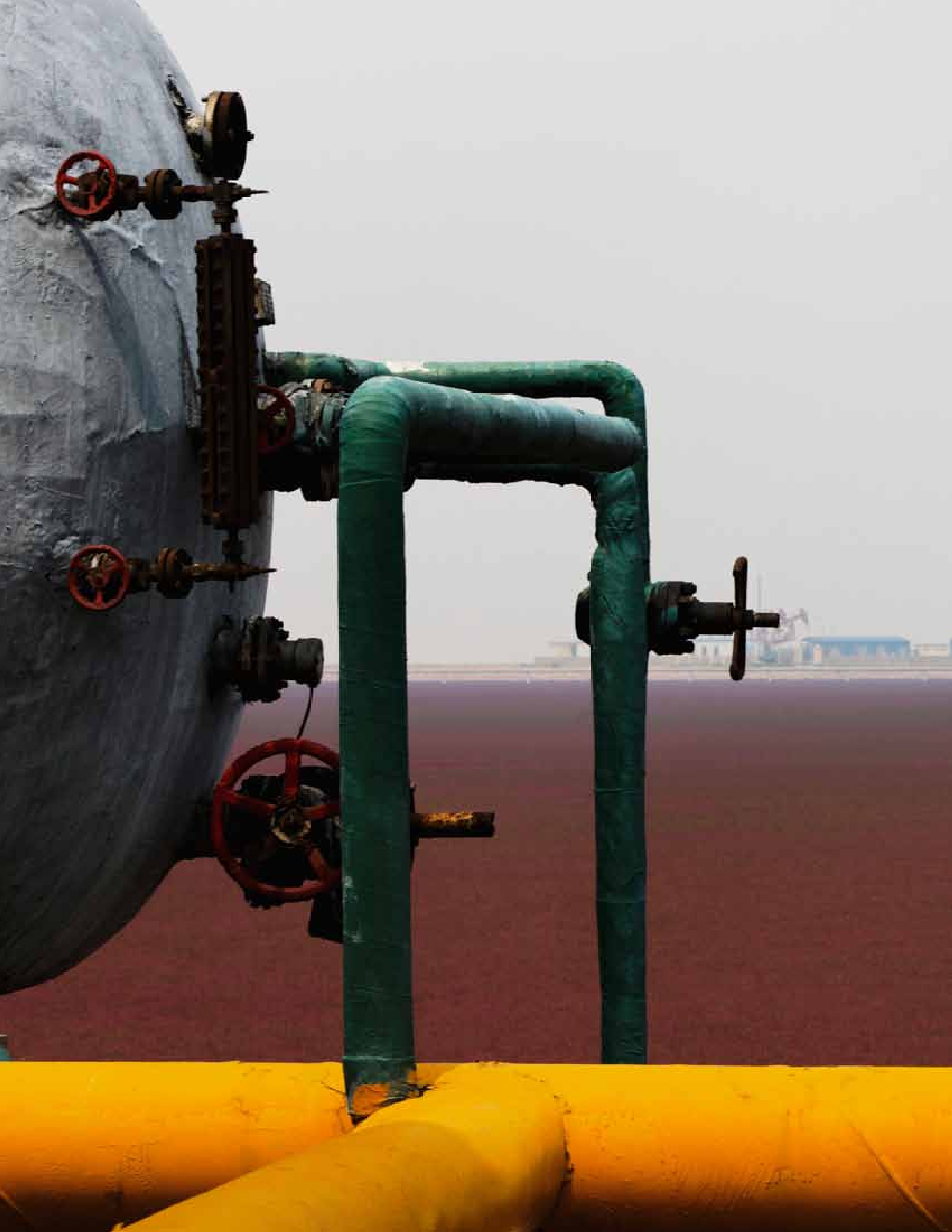
Customer awareness

Theft is not only prevalent in electricity distribution but most utility service providers in India face similar problems in water, sanitation and local government services. Attempting change of mindsets among citizens and society at large on theft is the most challenging aspect. Utilities should design communication / awareness strategies on the impact of theft on consumer tariffs and quality. Some regulators have started designing retail tariffs which offer rebate to a consumer group connected to a transformer for reducing losses in their transformer. Similarly, utilities have started awareness campaigns in schools. This creates societal pressure and encourages whistleblowers.

Emerging opportunities and challenges

Oil and Gas

Contents

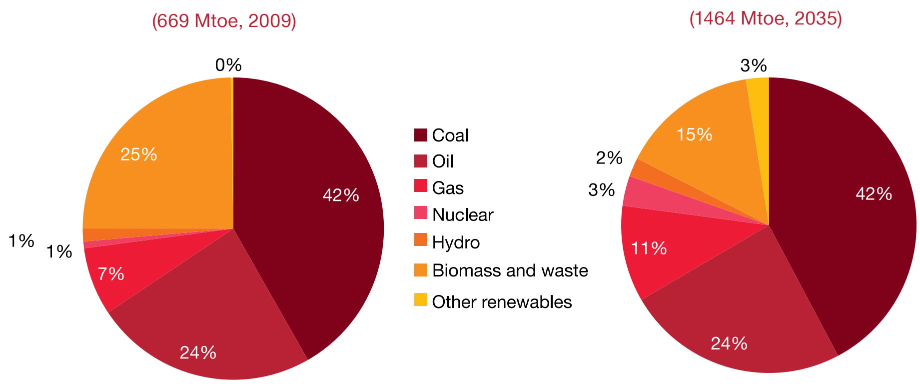


Context

Fossil fuels play a major role in meeting the energy demand of the nation and are expected to continue doing so in the foreseeable future. Oil & gas resources form a major part of our primary energy mix and touch our lives in more ways than one. The developing Indian economy has been constantly challenged for sourcing primary energy. India is dependent on imported crude oil to the extent that recently the US Energy Information Administration (EIA) has observed that India was the world's fifth largest net importer of oil in 2010, importing more than 2.2 million bbl/d, or about 70 percent of consumption. All stakeholders, therefore, continue to remain engaged in quest for energy.

This provides immense opportunity to investors to develop business opportunities in a country where demand exists. The opportunities are backed by a democratic governance system and a powerful judiciary. However, these opportunities are not without their share of unique challenges. This background paper aims to examine the interplay of these opportunities and challenges and at the same time identify some of the megatrends that will shape the future of the Indian oil & gas industry in the next couple of decades.

Figure 1: Evolution of Primary Energy Demand in Indiia



Source: World Energy Outlook 2011, International Energy Agency (IEA)

Sector Overview

Policy and Regulatory Environment

Country's upstream policies such as the New Exploration Licensing Policy (NELP) are focused at increasing investments in domestic exploration and production (E&P) activities. Nine rounds of acreage awards have been completed in ten years in which over 260 blocks were licensed out to companies. In the coming years, additional rounds of awards are expected to be rolled out for investors to bid. Total foreign direct investment is permitted without any necessity of NOC carry. The production share, cost recovery and work programme are biddable. The local NOCs – ONGC, OIL, GAIL, IOC, BPCL and HPCL – have actively participated, and so have the Indian private companies. They compete on equal footing with international investors. However, despite many promising discoveries in the NELP blocks, the policy has had limited success in reducing the dependence on foreign imports. The policies have also not been able to attract oil majors with experience and other technical expertise to invest in India. Experience of operating in deepwater and other difficult environments is critically required in India, if not the investments the international companies can bring in.

In the gas sector, the the government has continued to exercise its control on pricing. Administered Pricing Mechanism (APM) natural gas - produced from fields given to ONGC and OIL on nomination basis was increased in May 2010 – more than doubled in price in May 2010; from US$ 1.8 per MMBtu to $4.2 /MMBtu, although. Price for gas produced by companies investing through NELP is indexed to oil, and is in some cases marginally higher. The government has reaffirmed its intents to determine the marketing priorities for natural gas with a pricing formula stipulated by the government.

In the downstream sector, the government has introduced certain reforms including deregulation of petrol prices. However, with the marketing companies, under the control of central Government, still set the prices at levels which are more reflective of the consumer concerns and not markets, the sector represents an extremely risky environment to operate in for private fuel retailers which do not qualify for subsidy dissuading them from using or expanding their retail portfolio.

The regulatory and legal landscape in the sector involves many agencies and ministries. A snapshot of the same is given below:

Figure 2: Regulatory Landscape in the Oil & Gas sector in India

Policy-making & Planning

- Empowered group of ministers: Decision on industry issues that that have a strong impact on the country's economy and investment climate
- Planning Commission: Helps in formulated policies such as the Integrated Energy Policy
- Ministry of Petroleum and Natural Gas: Policy making and planning, overseeing E&P activities in India, pricing of regulated petroleum products, regulation of services and refining sector
- Ministry of Finance: Formulating tax and fiscal regime

Regulatory Bodies

- Director General of Hydrocarbons (DGH) under the Government of India is the upstream regulator and is entrusted with monitoring compliance to Production Sharing Contracts (PSCs) and other E&P regulations
- Petroleum & Natural Gas Regulatory Board (PNGRB) is mandated to regulate the refining, processing, storage, transportation, distribution, marketing and sale of petroleum, petroleum products and natural gas excluding production of crude oil and natural gas

Key Acts & Legislations

- The Petroleum Act, 1934 sets out rules for the import, transport, and storage of petroleum
- The Oilfields Act of 1948 has provisions for regulation of oilfield development
- 1976 Petroleum Rules has provisions for regulations governing pollution, safety and other operating standards
- New Exploration and Licensing Policy (NELP): Allowed for competitive bidding by foreign oil & gas companies for exploration and production licenses without any bias towards the public sector companies
- Integrated Energy Policy (IEP) of 2006 outlines goals for dealing with the challenges faced by the Indian energy sector

Source: DGH; Global Insight; PNGRB

Trends in the Indian Oil and Gas Sector

Sector Organization

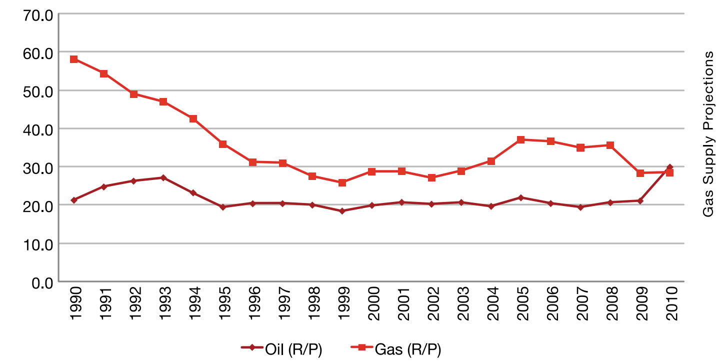
The oil & gas sector in India continues to be dominated by the central public sector undertakings. While the influence of private companies in the upstream sector is increasing, state owned ONGC continues to be in possession of the largest acreage for exploration and production. Reliance Industries Limited is the largest private sector player in the upstream sector in India and has gained increasingly important role especially in the gas sector.

The gas transportation, distribution and marketing sector is dominated by the state owned Gas Authority of India Limited (GAIL) which enjoys a virtual monopoly on the sector. However, the City Gas Distribution (CGD) sector may seen entry of private companies in the years to come.

The downstream marketing sector is also dominated by public sector refiners IOC, BPCL and HPCL, all of them incidentally are integrated oil companies with each of them in refinery segment. Reliance Industries Limited (RIL) is the largest refining company in India, though. Essar Oil Limited with its own refinery on the West coast is another major private sector company in the sector.

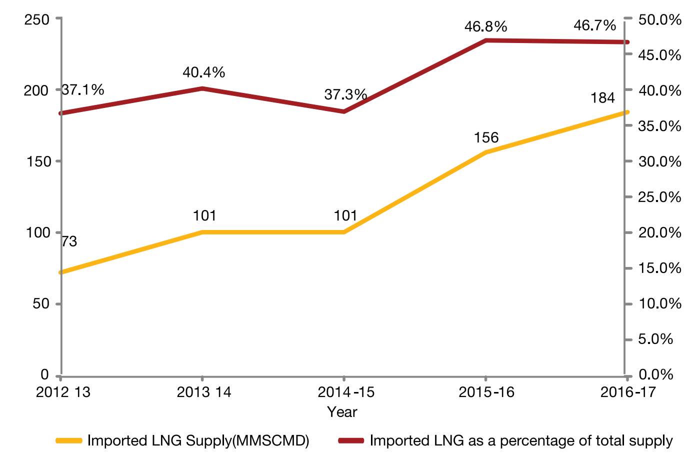
The E&P services and equipments sector in India sees participation from major international companies such as Schlumberger, Halliburton, Baker Hughes, Transocean, Weatherford etc. Some domestic companies having invested in assets have also started playing key role in offshore services.

India Oil & Gas R*/P ratio (1990-2010)



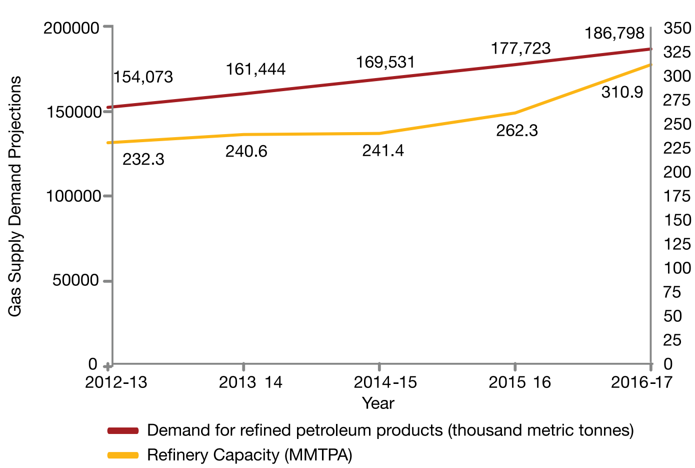
Source: BP Statistical Review of World Energy 2011; PwC analysis

India LNG Supply Projections (2012-2017)



Source: Demand Supply Projections for Gas during 12th Plan
Note: The above projections excludes source such as Shale Gas and Gas Hydrates

India refined products demand supply projections (2012-2017)



Source: Draft report by sub-group on refineries for 12th five year plan

Mega Trends that are shaping the Indian Oil & Gas sector

1. **Quest for security of supply:** According to the forecasts by the International Energy Agency under its new policies scenario, India's oil imports will increase by more than 4%per year over the Outlook period to reach 6.8 milli0n bpd. This implies that the country's dependence on imported crude oil will increase significantly from 73% in 2010 to a shocking 92% in 2035. This is expected to put a strain on the exchequer as according to IEA forecasts, India's oil and gas import bill will surpass that of Japan prior 2030 and that of the United States by the 2035 and will aggregate to a massive US$330 billion in 2035. Such alarming increase in reliance on imports is likely to force substantial focus being given to the issue of security of supply. This will have an impact on government policies as well as the future strategies of Indian oil & gas companies especially the public sector companies.

   The evolution of oil & gas R/P ratios in India over the period 1990-2010 is presented below. The growth in R/P ratio for Oil has been fairly flat for the last many years with a sudden increase its value in 2010. The R/P for gas has been declining over the last few years.

2. **Natural Gas along with LNG will gain prominence in the overall primary energy mix:** The Indian government is pushing for measures to increase the share of gas in its energy mix. According to IEA forecasts, the domestic gas market is projected to grow from 59 bcm in 2009 to 190 bcm in 2035, 11% of total primary energy demand. A major reason for this increase in adoption is because gas is a relatively greener fuel as compared to petroleum products.

   Re-gasified LNG will also form an increasingly important part the gas supply mix in the country in the coming decade. The sector has seen massive interest since the supply from KG-D6 began dwindling.

   The share of imported LNG in the natural gas supply mix is expected to increase from 37.1% in 2012-13 to 46.7% in 2016-17.

3. **India becoming a global refining hub on the back of major capacity expansions and massive investments:** The domestic demand of petroleum products is expected to grow at a Compounded Annual Growth Rate (CAGR) of 4.6% during the next 5 years. The projected expansion of refinery capacity from 310.9 MMTPA in 2016-17 from 232.3 MMTPA in 2012-13 is in line with India's aspiration of becoming a global refining hub. The sector is expected to see tremendous growth opportunities on back of strong domestic demand as well as significant export opportunities. The Indian refinery sector having established its ability to deliver in international markets is well poised to take advantage of this opportunity.

Opportunities in the sector

The Oil & Gas sector in India is replete with opportunities across its value chain and sub sectors. Many of these opportunities stem from the mega trends discussed above. A brief overview of these opportunities is presented below.

1. **Opportunities for foreign investments and technology partnerships in the upstream sector**: Securing supplies is expected to remain on top of India's energy agenda for the foreseeable future. While a lot of exploration activity has taken place in the on-land and shallow basins of the country, it is believed by many that deepwater and ultra deepwater Oil & Gas resources hold a key to substantially increasing domestic production. However, Indian companies especially the PSUs have limited technical and monetary bandwidth or experience to undertake exploration and development activities in such areas. This creates a plethora of opportunities for strategic investors having relevant technical expertise and financial muscle such as BP to invest in the country through partnerships with local public and private sector companies.
2. **Opportunities for transactions and partnerships in assets abroad:** The race for securing future energy supplies has led Chinese NOCs to aggressively scout for Oil & Gas assets abroad during the last few years. Many Indian companies have been aggressively scouting for opportunities to pick up equity oil abroad or pick up strategic stakes in unconventional acreages in order to acquire technology/expertise for similar developments back home.
3. **Opportunities in unconventional Oil & Gas (CBM, Shale Gas and UCG):**
    1. **CBM** is a proven energy source as it contributes approximately 10% of total natural gas production in USA. Given the substantial coal resources in India, experts claim significant CBM potential in the country. The CBM policy devised by Government of India (GoI) encourages investment and provides favourable investment climate like freedom to sell CBM in the domestic market, exemption from payment of customs duty on imports required for CBM operations and fiscal stability.

2. **Shale Gas:** According to the preliminary studies carried out by the US Energy Information Administration in April, 2011 India has technically recoverable Shale gas resources of nearly 63 trillion cubic feet (tcf). The draft shale gas licensing policy has been circulated to various industry members. The government expects the licensing round to be conducted during the first half of the 12th plan. *It is a well known fact that Shale Gas has transformed the landscape of the energy industry in the United States with the country becoming a net exporter of natural gas from a net importer of gas. According to the EIA, shale gas production in the USA in 2010 reached 4.87 Tcf (23 percent of total U.S. natural gas production), compared with 0.39 Tcf in 2000.*

3. **Underground Coal Gasification:** Underground Coal Gasification (UCG) represents another interesting area of opportunity in the Oil & Gas sector. Coal gasification has been notified as one of the end uses under the government's captive mining policy. Earlier this year, Coal India Limited invited bids from interested parties for the development of two blocks identified for UCG in central and western India. The UCG sector offers opportunities for both Indian and foreign companies to participate. The development of UCG projects requires technological capabilities that none of the domestic companies possess at present. This creates opportunities for companies in the following areas:
   - Collaboration/partnership with large Indian conglomerates for bidding jointly/ in consortium to seek allocation of coal and lignite blocks on offer by the ministry of coal
   - Independent bidding for coal and lignite allocation blocks put up on offer regularly by the Ministry of Coal for UCG

Along with investors and project developers, UCG project development also offers opportunities for technology companies, project management consultants and other service and equipment providers.

4. **Opportunities for E&P services and equipment companies:** The sector offers great future opportunities for both Indian and international companies driven by factors such as:
   a. vastly unexplored and underexplored sedimentary basins
   b. Pending work commitments on NELP blocks
   c. Enhanced recovery programs
   d. Unconventional hydrocarbon exploration activities gaining momentum in India

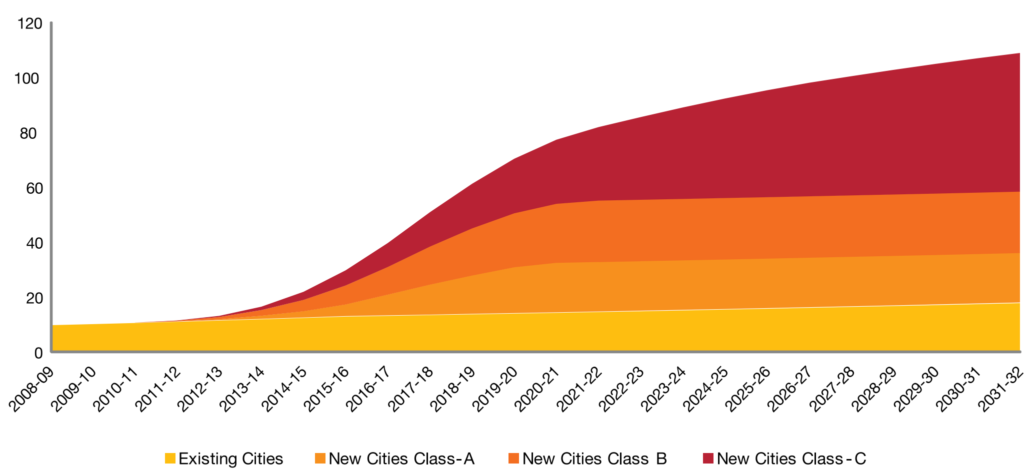
5. **Substantial latent demand in the natural gas sector:** Many of the end customers of the natural gas sector offer significant latent demand on account of factors such as lack of infrastructure or last mile connectivity. The opportunities available thought unlocking of this latent demand through infrastructure expansion are immense especially as gas is cheaper than crude oil and other feedstock for many industry sectors.

6. **Opportunities in the CGD sector:** City Gas Distribution (CGD) has been one of the most talked about subsector in Oil & Gas sector in India. : The CGD sector offers opportunities for both incumbents and new companies to participate. Owing to the capital intensive nature of the sector, PNGRB allows the following incentives to authorized entities:

- Exclusivity- Infrastructure exclusivity is available to the authorized entity for a period of 25 years. Exclusivity for the activity of marketing of natural gas is allowed to the authorized entity for a period of 5 years. For incumbents, the marketing exclusivity extends for a period of 3 years,
- The new and existing players view CGD as a combination of marketing and infrastructure development. While the activity of development of infrastructure for the CGD network is regulated, the activity of marketing is unregulated. Thus the bidders bid for lower tariffs to obtain authorization.

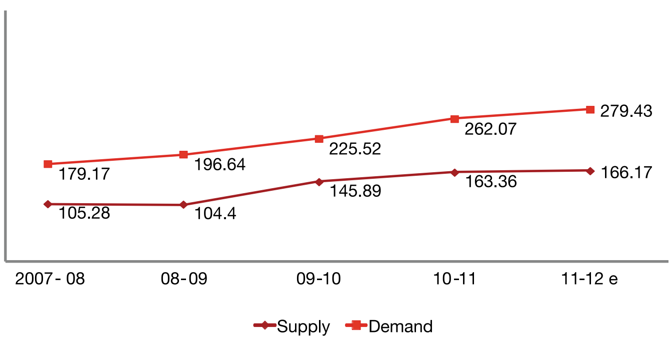
Along with investors and project developers, CGD project development also offers opportunities for technology companies, project management consultants and other service and equipment providers.

Projected demand for CGD



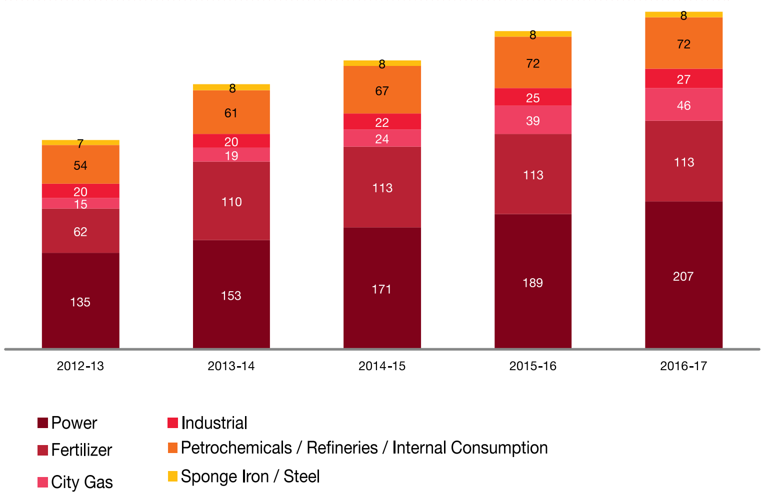
Source: PwC Analysis

Natural Gas Demand Supply differential (in mmscmd) (2007-12)



Source: MOPNG; PwC Analysis

Sector-wise Natural gas demand projection



Source: PwC Analysis

7. **Opportunities in the LNG sector:** LNG has great market potential due to huge demand supply gap (figure 1 below) which according to industry sources, is expected to widen in future in absence of LNG.

   The present gas demand supply scenario makes up for a good business case for setting up LNG terminals. The future too holds promising as the following chart below depicts the sector-wise natural gas demand which is overall expected to grow by 12.7% as per industry sources.

   Regulatory aspect: As of now, setting up an LNG terminal only requires notifying the government and there is no competitive bidding for setting up an LNG terminal.

8. **Refining Sector:** India has its sights well set on becoming one of the major global refining hubs. In order to realize this aspiration, India will focus on expanding its capabilities and position itself to become an increasingly important player in the international export markets for refined petroleum products. The country is expected to be one of the major investors in development of refinery infrastructure in the world during the next couple of decades. The cumulative investment in refining infrastructure in the country during 2011-2035 as per projection by the IEA under the new policies scenario is expected to be about US$ 140 billion.

9. **Opportunities in tankage:** Import of crude oil will grow at a CAGR of 4.25% as per IEA projections for the next 20 years. Average per barrel cost of crude imports has seen a CAGR rise of 6.42%.. Thus pushing a strong thrust on the infrastructure of storage tanks within the country.

10. **Opportunities for pipeline transportations:** Compared to advanced economies like USA, where more than 60% of petroleum product movements happen by pipeline, in India, currently, only 35% of product movement happen over pipelines. Cross-country pipeline networks, preferred as a cost-effective, energy-efficient, safe and environment friendly mode for transportation of crude oil and petroleum products, have been playing a vital role in meeting India's energy demand. They are now a key constituent of the country's infrastructure, transporting crude oil from import terminals as well as domestic sources to inland refineries, and finished products from refineries to major consumption centres. If the industry, regulator, Government and policy makers find suitable solution for regulatory approvals, right of way etc. India has a substantial "head room" for growth in both crude and petroleum product pipelines

Major issues faced by the Oil & Gas sector in India

Major issues faced by the Oil & Gas sector in India

The Oil & Gas sector in India has come a long way since our independence. There has been significant progress in every sub-sector of the Oil & Gas industry. The sector is teeming with opportunities but at the same time its dealing with some fundamental issues which can hinder its progress and thwart the achievement of its growth objective. While some of these issues are specific to a sub-sector, other such as infrastructure development are applicable to the entire sector. Some of these major issues have been discussed below:

1. **Limited participation by foreign companies in the Indian upstream sector - Prospectivity or Policy:** The nine rounds of NELP have seen enthusiastic participation by the state owned companies, the participation by private players especially the foreign majors has been limited. These companies bring a lot of investment muscle required for development of capital intensive and high risk upstream projects. More importantly however, these companies bring technological expertise and diverse project experience. Some sections of the industry attribute the lack of participation of these companies to the prospectivity of the Indian basins. However the DGH is extremely confident about the prospectivity of Indian hydrocarbon basins and do not deem it as a roadblock. Other sections of the industry believe that inconsistency and ambiguity in the policy and fiscal framework is one of the major factors due to which foreign companies either stay away or withdraw participation. Interference in terms of a signed contractual terms is also counted as a factor that discourages foreign participation
2. **Upstream skills, technology and equipment shortage:** Upstream talent shortage and ageing workforce is an issue being faced the global as well as Indian upstream industry. The industry is especially pressed with shortfall of labor with specialized skills such as reservoir engineering or with experience of developing unconventional gas assets.

Also, while we are counting the unconventional sources of energy such as Shale gas as major areas of opportunities we must also not forget the associated challenges such as high water and land requirements and also the limited availability drilling equipment. An enabling policy and fiscal environment that makes investment in this area an attractive proposition even after taking into account the associated risk and challenges is required to take advantage of the opportunity associated with unconventional.

3. Enablers for acquisition of oil & gas assets abroad: Indian Oil & Gas companies, especially the public sector companies have been competing with aggressive Chinese counterparts and IOCs for acquisitions of assets abroad. However, in many cases these companies have to lose out to the competition due to the slow speed of clearances and decision making process in place for making large investment decisions.

4. Also, the Indian companies are sometimes also constrained by lack of opportunity tracking resources and networks that can spot opportunities early and pass on to the companies. However, the Indian government has taken many diplomatic relationship building initiatives with countries in regions such as Africa. More initiatives are required for strengthening this network so that Indian companies are not at a disadvantage to the international competition.

5. Ambiguity on policies relating to pricing and marketing of domestic gas as well as the gas end-user segment policies creating hurdles to gas market development:

6. Gas sector in India holds tremendous potential as detailed in the section on opportunities. However, its growth is constrained on account of ambiguity in investor's mind about pricing and marketing policies of the Government with respect to the domestically produced gas. To add to the woes of investors the recent unexpected dip in domestic gas supplies has added new dimension of ambiguity – that of supply uncertainty. Growth in infrastructure has not kept pace with demand-supply dynamics largely owing to the way the new regulatory regime has unfolded over the years. LNG market development has also not realized its potential largely owing to the government's policies around the two major anchor customer segments viz. power and fertiliser.

Conclusion

The burgeoning demand of hydrocarbons in India necessitates aggressive exploration of reserves. Licensing policies, however, coming in the way of hydrocarbon finds is not uncommon in the world. Today, more and more companies are able to conduct their exploration and production in more and more countries. As a result, companies are competing fiercely for the best acreage. There exists an open market for exploration rights, which is good news and bad for host countries. The good news is that they can drive a harder bargain with the oil companies over access to acreage. The bad news is that, all things considered, too hard a bargain will drive the companies away, to other countries. Each solution depends on each country's individual circumstances. Geology, fiscal systems, regulatory capability, politics; all enter into it. Practices proven best in some regimes may not suffice in this realm.

India having recognized the need of much higher exploration investments must therefore enable that through a scientifically designed regulatory regime.

The downstream sector has demonstrated its capabilities in developing marketing, distribution as well as retailing infrastructure more than adequately. In return, the refining and marketing sector, as also other stakeholders like the exchequer, upstream companies and environment protection agencies have not got a fair deal. The pricing of domestic and transport fuels prices continue to remain controlled awaiting political will to provide for passing on burden to consumers and fuel conservation. The least that the sector needs is to make economic value of fuels start reflecting in its price. Anomalies of pricing in sector have led to adulteration, over consumption and financial weakening of integrated Refining & Marketing companies. The exclusion of petroleum sector products from GST is expected to accentuate the anomalies.

The demand is here and in the next two and half decade, the consumption would be three to four times. Unlike in the industrialised world, this future of Indian petroleum sector bodes well for best of the companies; they would like to lay finest of the infrastructure. Let's hope they are waiting in the wings for competitive, safe and efficient business environment to develop.

Emerging opportunities and challenges

Renewable energy

Contents

Context

India has one of the largest electricity systems in the world with a generation capacity of 185GW. However, the sector continues to require large investments to meet growing demand and provide universal access to the population of the country. Renewable Energy is expected to play a major role in creating a sustainable portfolio of energy. To tap the renewable power opportunity, Government has provided the sector with various policy and regulatory incentives, which has enabled considerable private sector participation in the last decade. The sector is expected to go through a paradigm shift from a regulated environment to a market oriented one. The change in sectoral dynamics is expected to present various opportunities and challenge.

Role of Renewable Energy in India

Role of Renewable energy in India

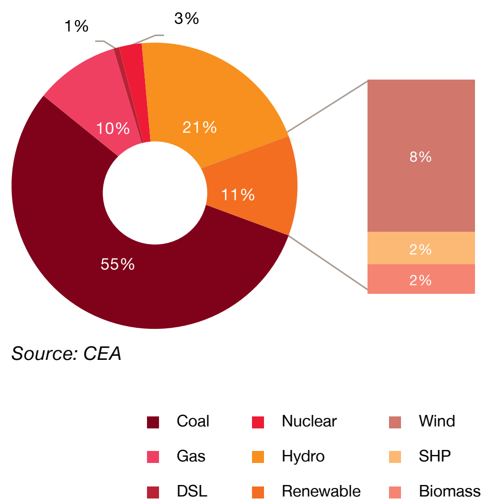
India's rapid and enduring economic growth is intrinsically linked to the increasing consumption of energy and natural resources. Renewable energy is increasingly viewed as a means to meet the growing power needs of the economy whilst reducing the dependence on limited natural resources.

Current renewable contribution stands at 21.1 GW out of the total installed capacity in the country at 185GW as of Jan 2012. This represents 11% of the total installed capacity.

Although India is a prominent player in Hydro and Wind Power space, a large part of the potential remains unrealized.

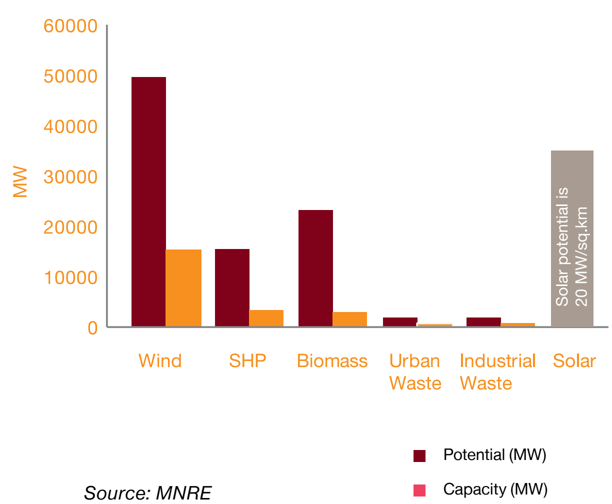
Since 2005, the energy and climate change agenda has taken centre stage in domestic and international policy arena. It has tripled its renewable energy generation capacity in the last five years.

Installed capacity in India (fuel mix)



Source: CEA

Potential vs Installed capacity of RE Sources



Source: MNRE

Rationale for developing renewable energy sources

India's significant untapped renewable energy sources will pave the way for a secure, affordable and environmentally sustainable energy future for the country. Development of these renewable energy sources will play an increasingly important role in

- Alleviating power shortages in the country – India's rapid and enduring economic growth is intrinsically linked to the increasing consumption of energy and natural resources
- Enhancing energy security through diversification of fuel sources and thereby reducing dependence on fossil fuels
- Sustainable and environmentally efficient growth.

Power Scenario in India

India faces formidable challenges in meeting its energy needs and in providing adequate energy of desired quality in various forms in a sustainable manner and at competitive prices. Persistent electricity shortages have been identified as a key bottleneck for sustaining India's growth rate. India's per capita power consumption is one of the lowest in the world at 733 kWh at 2010-11.

As per the Integrated Energy Policy (IEP) 2006, in the next 25 years, India's electricity demand is expected to grow at an average annual rate of 7.4%. This translates to an installed capacity of 800 GW by 2031-32, compared to the current installed capacity of ~ 185 GW. India's generation capacity will have to increase almost fivefold to keep pace with demand growth.

The Integrated Energy Policy, 2006 estimates that India will need to increase primary energy supply by three to four times and electricity generation by five to six times (of the 2003-04 levels) to meet the per capita consumption needs of its citizens and maintain 8% growth GDP growth rate.

The shortage conditions prevailing in the country in terms of both energy and peaking availability are given in the table below.

	Proved	Indicated
Requirement	694780	127724
Availability	639908	114233
Shortage	54872	13401
%	7.9	10.6

Source: CEA

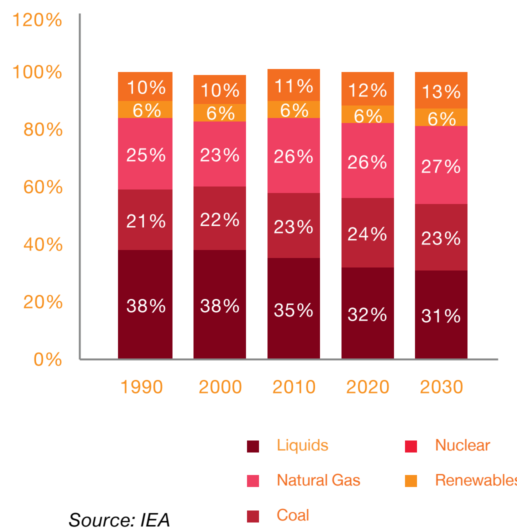
Enhancing Energy Security

India meets close to 65% of its electricity needs from fossil fuels such as coal, gas and diesel. At projected usage levels, questions are also raised about the period India's extractable coal reserves could last. Further, with an increase in demand for coal from the emerging economies in Asia, the global coal prices are expected to rise.

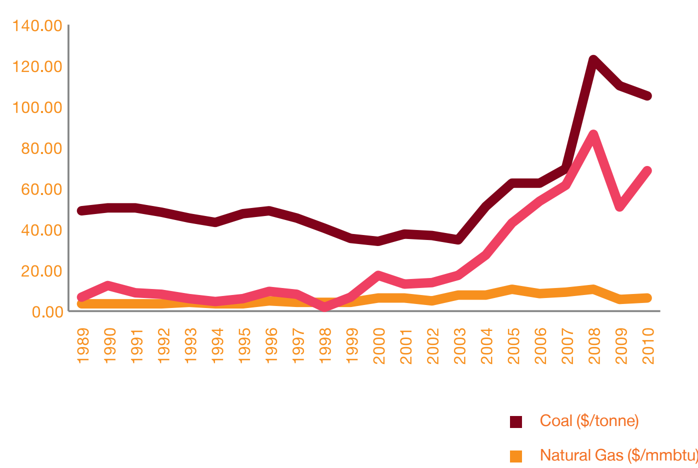
Natural gas currently contributes 10% of India's fuel mix. This is expected to double by 2025, according to India's Hydrocarbon Vision, 2025. Coal, gas and oil prices have seen considerable volatility in recent years, and the trend is likely to continue.

Renewable energy sources are essential contributors to the energy supply portfolio as they contribute to world energy supply security, reducing dependency on fossil fuel resources, and provide opportunities for mitigating greenhouse gases. Projected oil prices, as well as concern about the environmental impacts of fossil fuel use and strong government incentives for increasing the use of renewable energy in many countries around the world, improve the outlook for renewable energy sources worldwide.

Given expectations that world oil prices will remain relatively high through most of the next decade, liquid fuels and other petroleum are the world's slowest-growing source of energy. As per the Energy Information Administration, liquids consumption is expected to increase at an average annual rate of 0.9 percent from 2007 to 2035, whereas total energy demand increases by 1.4 percent per year. Renewables are the fastest growing source of world energy, with consumption increasing by 2.6 percent per year.



Source: IEA



Source: BP Statistics,Boomberg

Policy and Regulatory Framework for Renewable

Capacity additions in renewable energy industry are mainly driven by the requirement to achieve energy stability, security of energy supply and energy independence combined with the requirement to minimize carbon footprints. This has prompted governments to come up with schemes and policy frameworks supporting the promotion and development of renewable energy.

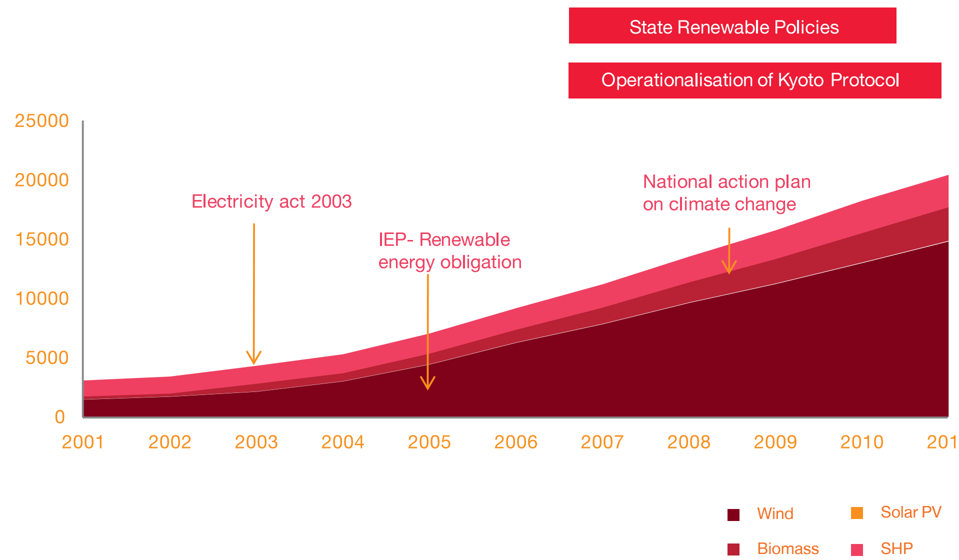
Investments in renewable energy sector are largely dependent on the regulatory and financial support offered by the respective governments. The governments in emerging economies, in order to achieve energy security and carbon emission reduction, are promoting the use of renewable energy sources for power generation.

Some of the key policy initiatives that led to a surge in the capacity addition especially in the renewable sector include:

- Introduction of accelerated depreciation
- Integrated Energy Policy prescribing obligation on consumers (distribution licensee etc) to procure renewable power
- National action plan on climate change, which prescribed long term renewable energy targets
- State specific renewable policies, which provided special incentives at the state level, such as banking of surplus electricity, merit order exemption, single window clearances etc

The Government of India came up with various incentive plans and policies to promote the development of renewable energy, while two of the largest solar markets, Spain and Germany, are cutting back on their incentives. These government policies will continue to drive the renewable energy market in India in the near future.

Moreover, newly introduced policies such as Generation Based Incentives (GBI), National Semi-conductor Policy, National Missions and Implementation of Renewable Energy Certificate Mechanism are expected to attract investments in all segments of the renewable energy value chain. The policy and regulatory framework is pro-investment; shifting away from negotiated and guaranteed to open and market competition.



The need for promoting renewable energy sources is also recognized and stipulated in the Electricity Act, 2003. The EA, 2003 and the National Tariff Policy, 2006, provide for both the Central Electricity Regulatory Commission (CERC) and the State Electricity Regulatory Commissions (SERC) to prescribe a certain percentage of total power purchased by the grid from renewable based sources.

Section 86 (1) (e) of the Electricity Act 2003 states that:

"the State Commission shall promote cogeneration and generation of electricity from renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any person, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licensee".

Related provisions of the National Electricity Policy are given below:

"5.12.2 The Electricity Act 2003 provides that co-generation and generation of electricity from non conventional sources would be promoted by the SERCs by providing suitable measures for connectivity with grid and sale of electricity to any person and also by specifying, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licensee. Such percentage for purchase of power from non-conventional sources should be made applicable for the tariffs to be determined by the SERCs at the earliest. Progressively the share of electricity from non-conventional sources would need to be increased as prescribed by State Electricity Regulatory Commissions".

Pursuant to the provisions of the Electricity Act, the Forum of Regulators (FOR) have stipulated that the SERCs shall fix minimum percentage of purchase of power from such sources taking into account the availability of renewable sources in the region and its impact on the retail tariff.

Further, the National Action Plan on Climate Change (NAPCC) has recommended increasing the share of renewable in total grid purchases to 10% by 2015 and 15% by 2020.

As on date, 24 SERCs have specified the Renewable Purchase Obligations (RPO) for their licensee distribution companies and have also notified regulations or orders pertaining to determination of tariff of RE sources of generation based on different technologies. Respective RPO specifications along with the prevailing tariff in certain selected states have been tabulated below:

State	RPO (per annum)	Solar RPO as a percentage of total RPO(per annum)	Tariff (Rs./ kWh)	FY 2012 Renewable Demand (MW)	FY 2015 Renewable Demand (MW)	FY 2020 Renewable Demand (MW)
			Wind	Solar	Biomass	SHP
Assam	1.4% during 2010-11(1.4% increase every year till 2014-15)	0.05% of total RPO for 2010-11(every year increase of 0.05% till 2014-15)		10 for Solar PV	4 for biomass and 3.20 for cogen	3.19
Andhra Pradesh	5%	0.25%	3.50		2.41-3.15 for biomass and 2.14-2.96 for cogen	1.88-2.60
Bihar	1.5% for FY2011, 2.5% for FY2012,4.0% for FY2013	0.25% of total RPO specified in 2010-11 and increased by 0.25% every year till 2014-15			3.33-3.44 for biomass	111
3.51-cogen		10	15	8	22	53
Chattisgarh	5% (for FY2011, 5.25% for FY2012,5.5% for FY2013)	0.25% for 2010-11 and 2011-12 and 0.5% for 2012-13		15.84-PV	820	1905
13.26-Thermal	3.24-3.64 for biomass developers		15	1581	4732	11059
Gujarat	5% for FY2011, 6% for FY2012, 7% for FY2013	0.25% of total RPO specified in 2010-11 and increased by 0.25% every year till 2014-15	3.56	5-15 for PV	62	152
4-11 for thermal	3 for cogen and 3.08 for biomass		15	75	412	1056
Haryana	1.5% for FY2011 and FY2012, 2% for FY2013 and FY2014, 2.5% for FY2015	0.25% of total RPO which has to be increased every year by 0.25% , i.e. 3% by FY2022	4.08	15.16- solar PV	4.29 for biomass	958
Himachal Pradesh	10.1% (annual increase of 1% until FY2013)	0.1% every year from 2010-11 to 2012-13				2.87

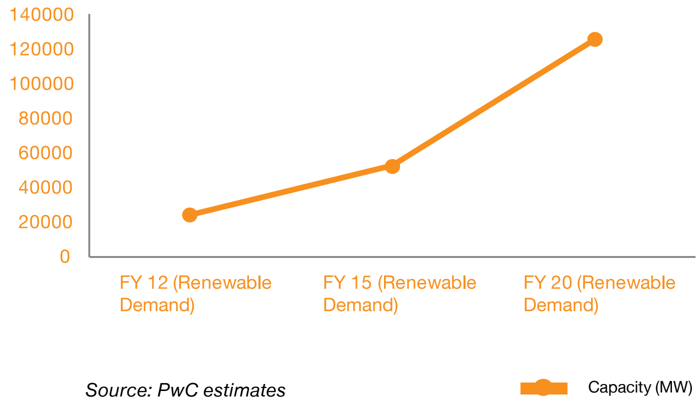
Jharkhand	1.75% for FY 2011, 2.5% for FY 2012, 3% for FY 2013	0.25% for FY 2011 with increase of 0.25% till FY 2013 (i.e. 1% of the total renewable consumption)				
Karnataka	10%	0.25% for all the distribution licensees in the state	3.70		3.66-4.13 for biomass 3.59-4.14 for co-gen	3.40
Kerala	3% (for FY2010, with annual increase of 0.3% until a maximum RPO of 10%)	0.25%		15.18 for PV	2.76 for cogen	2.44
Maharashtra	6% (annual increase of 1% until FY2014; 9% for FY2015 and FY2016)	0.25% (for FY2011–FY2013; 0.5% for FY2014–FY2016)	3.40	17.91-pv 15.31-thermal	3.04-3.43 for biomass 4.79 for cogen	3.65-4.26
Manipur	1% (for FY2011 and FY2012; 2% forFY2013)	0.25%				
Mizoram	5% (for FY2011; annual increase of 1% until FY2013)	0.25%				
Orissa	5% (for FY2012; annual increase of 0.5% until FY2016)	0.1% for 2011-12 with 0.05% increase in solar RPO till 2015-16	5.75	17.8 for Solar PV and 14.73 for solar thermal		4.40
Punjab	2.4% for 2011-12, 2.9 % for 2012-13, 3.5% for 2013-14 and 4% for 2014-15	0.03% for 2011-12, 0.07% for 2012-13 , 0.13% for 2012-13 and 0.17% for 2013-14	3.66			3.59
Tripura	1% (for FY2011, 1% for FY2012, 2% for FY2013)	0.1%				
Uttar Pradesh	4% (for FY2011, 5% for FY2012, 6% for FY2013)	0.25% (to increase to 1% by FY2013		15-Solar PV 12-Solar Thermal	4.21 for cogen	3.34-3.83
Uttarakhand	4% (for FY2011, 4.5% for FY2012, 5% for FY2013)	0.025% (for FY2012; 0.05% for FY2013)	2.9 to 4.75 on levellised basis	8-14.35-Solar PV 10.40-17.50- Solar Thermal	1.65-1.8 for biomass and2-2.60 for cogen	3-3.65 on levellised basis
West Bengal	2% (for FY2011, 3% for FY2012, 4% for FY2013)					
Rajasthan	8.5% and 9.5% for 2010-11 and 2011-12 respectively	RPO to be declared once the PPA of 100MW is signed	4.10-4.46	12.58-thermal and 15.32-PV	4.72-5.17 for biomass	
Tamil Nadu	9.05% for all obligated entities for 2011-12	0.05% for 2011-12 for all obligated entities	3.39		4.5 for biomass and 4.37 for cogen	3.35

Source: CERC and IREDA figures

Demand Estimation of Renewable in India

We try to estimate the demand for renewable energy in the country through the growth in installed capacity, as projected by the 17th Electric Power Survey of India (17th EPS) and the projected RPOs, as estimated by the FOR and NAPCC.

Demand from renewables (MW)



Source: PwC estimates

State	FY 2012 RPO Targets (%)	FY 2015 RPO Targets (%)	FY 2020 RPO Targets (%)	FY 2012 Renewable Demand (MW)	FY 2015 Renewable Demand (MW)	FY 2020 Renewable Demand (MW)
Gujarat	6	10	15	1723	4378	10423
Maharashtra	7	10	15	3450	7141	16156
Manipur	3	10	15	7	41	111
Mizoram	6	10	15	8	22	53
J&K	3	10	15	165	820	1905
UP	5	10	15	1581	4732	11059
Tripura	1	10	15	4	62	152
Jharkhand	3	10	15	75	412	1056
HP	11	10	15	322	422	958
Orissa	5	10	15	476	1491	3650
Assam	3	10	15	67	434	1227
Tamil Nadu	14	10	15	4398	4967	12263
Delhi	1	10	15	101	1584	3886
AP	5	10	15	1623	5009	12068
Karnataka	11	10	15	2057	2869	6872
West Bengal	10	10	15	1346	2018	4722
Rajasthan	10	10	15	1759	2794	6581
MP	10	10	15	1816	2918	7320
Punjab	4	10	15	744	2672	5997
Haryana	10	10	15	1385	2132	5125
All India	6.91	10	15	23670	52453	125390

Source: PwC estimates

New Trends in Renewable Energy

In India, a number of renewable energy technologies besides solar, wind and biomass have yet to be fully explored. Among these, the potential afforded by upcoming technologies, particularly in off-shore wind and geothermal energy appears promising in the immediate future. Here we give a snapshot of the new and emerging trends in off-shore wind and geothermal energy technologies on a global scale. Internationally, successful adoption of these technologies has largely been aided by policy directives laying out clear development roadmaps and incentivizing private sector participation. Building upon these experiences, we have tried to put together a case for adoption of these technologies in India as well. Further, the section brings to the fore a discussion on new market models likely to be adopted for maximizing revenue streams from renewable energy projects.

Offshore Wind

In this section, we introduce offshore wind energy. Since the technology is at a nascent stage of its development, we present some international experiences along with the Indian experience so far. While most experts tout offshore wind as the next big thing in the wind energy space due to its inherent advantages over conventional onshore wind, the commercialization of the technology is still some way off, especially so in India. However, a basic understanding of the developments in offshore wind will be important for developing a vision for its long term strategy.

Offshore wind power technology builds on onshore wind technology, with its future development requiring participation from other sectors such as offshore oil and gas engineering and technology, the logistical skills of offshore service providers, transmission system operators and infrastructure technology of the power industry.

To make offshore wind generation economically viable, a wind speed of more than 6.5 m/sec is needed. Efforts into commercialization of offshore wind have been underway for some years. Most of the initial efforts were in the waters of Northern Europe, where wind speeds in excess of 8 m/sec is available.

Difference between Offshore and Onshore Wind Technology

- Higher and more consistent wind speeds than on land, leading to higher efficiency
- Offshore turbines generate electricity 70-90% of the time
- Onshore wind farms are often subject to restrictions based on their negative visual impact or noise and obstructions from buildings, mountains, etc.
- Onshore wind farms are susceptible to land-use disputes and limited availability of land
- Offshore wind systems are costlier than their onshore counterparts, both in terms of capital and operating costs

Difference between Offshore and Onshore Wind Technology

- Higher and more consistent wind speeds than on land, leading to higher efficiency
- Offshore turbines generate electricity 70-90% of the time
- Onshore wind farms are often subject to restrictions based on their negative visual impact or noise and obstructions from buildings, mountains, etc.
- Onshore wind farms are susceptible to land-use disputes and limited availability of land
- Offshore wind systems are costlier than their onshore counterparts, both in terms of capital and operating costs.

	On-shore wind	Off-shore wind
Wind speed	4-6 m/sec	8 m/sec
Investment cost	Rs. 4-5 Cr/MW	Rs. 10-12 Cr/MW
O&M cost	Low	High
Size	May be built in small units	Large turbines and farms required
Land availability	Limited Availability, Clearances and Approvals, Social and Political Issues with respect to land acquisition	Site selection, allocation of oceanic zones, environment and legal clearances
Obstructions from building	Yes	No
Negative visual impact or noise	Yes	No

Source: PwC Estimates

International Experience

Europe was the first mover in the off-shore wind space and all the operational off-shore wind farms are in Europe.

Quick Facts

Total installed capacity in Europe at 2496 MW as of June 2010, compared to onshore wind capacity of 157 GW UK leads the expansion of offshore wind, with an installed capacity of ~ 1 GW. Other prominent countries in offshore wind are Denmark, Netherlands and Sweden 40 GW of offshore wind capacity is estimated to be operational in Europe by 2020, according to a report by the European Wind Energy Association (EWEA). At the Copenhagen climate summit in Dec 2009, 9 European nations vowed to create a super-grid for sharing offshore power

Potential

The United Kingdom (114 000 km^2) and Norway (88 000 km^2) comprise the largest share of available offshore area for wind energy generation. Europe's offshore wind potential is enormous with ability to power Europe seven times over. An EEA (European Environment Agency) study states that offshore wind power's economically competitive potential in 2020 is 2,600 TWh, equal to between 60% and 70% of projected electricity demand, rising to 3,400 TWh in 2030, equal to 80% of the projected EU electricity demand. The EEA estimates the technical potential of offshore wind in 2020 at 25,000 TWh, between six and seven times greater than projected electricity demand, rising to 30,000 TWh in 2030, seven times greater than projected electricity demand.

Capacity Installed

There are currently 1,136 wind turbines now installed and grid connected, totalling 2,946MW in 45wind farms in nine European countries. UK leads the expansion of offshore wind, with a current installed capacity of nearly 1 GW. The UK Government has awarded licenses for upto 44 GW of offshore wind. During 2010, 308 wind turbines installed and grid connected totalling 883MW, up 51% from the previous year's installations. (Source: EWEA). 140 GW of offshore wind projects are already in various stages of planning. Between 1,000 MW and 1,500MW expected to be installed during 2011. This shows the enormous interest among Europe's industrial entrepreneurs, developers and investors. (Source: EWEA)

Policy Support

In 2009, the EWEA increased its 2020 target for offshore wind to 40 GW and (out of a total 230 GW of wind capacity) and to 150 GW in 2030. The EWEA target comes under the backdrop of the 20-20-20 targets by 27 EU Member States with respect to climate and energy change.

- Reduction in greenhouse emissions by 20 percent by 2020 (compared with 1990).
- Renewable energies to make up 20 percent of gross domestic energy consumption
- Increase in energy efficiency by 20 percent.

Given the new climate change targets, the European Commission first highlighted the contribution that offshore wind can make towards achieving the objectives in 2008. In a memo dated 13 November 2008, the Commission calls for an expansion of installed offshore wind capacity (basis 1.1 GW by the end of 2007) by 30 to 40 times by 2020 (hence at least 30 GW), and then by another 100 percent by 2030 (at least 110 GW).

Under Construction

Currently there are 10 offshore wind farms under construction; totalling 3,000 MW and a further 19,000MW have been fully consented.

Grid Connectivity

There are 11 offshore grids currently operating and 21 offshore grids currently being considered by the grid operators in the Baltic and North Seas. EWEA has proposed a 20 Year Offshore Network Development Master Plan for the same.

Experience and Learning's for India

Suzlon has preliminary estimates of India's offshore wind potential at 25,000 MW – almost double of India's current onshore installed wind capacity. Offshore wind energy could be launched in India within few years if positive results are obtained from a New and Renewable Energy ministry-backed survey.

In November 2010, the secretary of MNRE had announced that a study was being undertaken with the help of CWET to ascertain the feasibility of setting up offshore wind farms in India, with 2 pilot projects in Tamil Nadu and Gujarat. MNRE's initial feasibility study is expected to take at least 2-3 years.

C-WET has also invited technical inputs from world's leading wind energy companies. The data from the companies would help C-WET to understand the soil conditions in the seabed and the different structural features required for offshore wind turbines. Recent news reports have also claimed that Indian govt. may enlist the help of ONGC in surveying offshore wind potential in India and setting up two wind farms at sea.

The key learnings on important facets to be inculcated form the experience of other countries with regards to development of Off-shore wind establishment is as follows:

- *Policy*
    - The government needs to establish a policy framework with clear quantitative targets for expected contribution of offshore wind power in order to develop investor confidence and sufficient scale
    - The government also needs to establish a credible planning and license rewarding mechanism, backed by good knowledge of impacts and assessment of risks, to ensure public acceptance of offshore wind facilities
    - Given the cross border nature of offshore wind, different aspects of the sea and its use will also have to be taken into account
    - Policies regarding shipping and navigation will also have to take offshore wind into account
    - The government also needs to ensure co-ordination with already existing policies for maritime industry and the oil and gas industry through strategic planning and resource management strategies.
- *Market*
    - Development of offshore wind facilities (as compared with onshore) entails greater challenges due to the scale of the projects, and the requirement of specialised equipment and expertise from sectors such as foundation manufacturers to vessel operators. All the key players need to plan and collaborate on meeting the challenge of offshore wind deployment.
    - Involvement of transmission system operators, health and safety bodies, and environment authorities will also be required
    - Regulatory efforts will have to be focused towards establishing credible cost benchmarks and targets for offshore wind energy costs
    - A large number of issues may arise with site selection, including legal rights. The government should have a regulatory mechanism in place for dealing with such disputes.
- *Grid Integration*
    - Augmentation of existing grid infrastructure will be necessary for absorption of power from offshore wind
    - Grid operators need to cooperate and assess the commercial and technical requirements from integration of offshore wind power under close regulatory supervision

Geothermal Technology

Geothermal energy is thermal energy generated and stored in the Earth. A well can be drilled down into the geothermal reservoir so that the heated water and steam can rise to the surface using a mechanized system, and be used to power geothermal power plants as well as for direct applications in smaller scale projects.

Overview of the Geothermal Energy in India

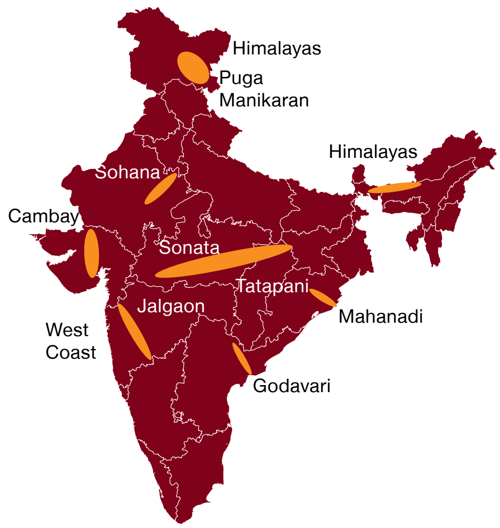
The potential geothermal provinces in India can produce ~ 10,600 MW of power. Though India has been one of the earliest countries to begin geothermal projects way back in the 1970s, geothermal energy has not emerged as a significant renewable energy option in the country, mainly due to its inability to compete with cheaper coal. However, the serious environmental concerns of coal based technologies now require usage of renewable energy sources on a large scale. Geothermal is one such option.

Geothermal provinces of India

In India, exploration and study of geothermal fields started in 1970s. After the oil crisis in 1970s, the Geological Survey of India conducted survey in collaboration with the UN to estimate geothermal potential in the country.

Subsequently, detailed, geological, geophysical and tectonic studies on several thermal provinces have been carried out. These investigations have identified several sites which are suitable for power generations well as for direct use. The total potential of these provinces for power generation is ~ 10,600 MW.

The GSI (Geological Survey of India) has identified 350 geothermal energy locations in the country. The country has several geothermal provinces characterized by high heat flow and thermal gradients. The seven major geothermal provinces in India are the Himalayas, Sohana, West coast, Cambay, Son-Narmada-Tapi (SONATA), Godavari, and Mahanadi as shown in the map.



There are no operational geothermal plants in the country. A pilot 3 MW project is slated to be set up in Puga Valley in Ladakh, which is likely to be the first such project in the country. Puga Valley is known for high temperature geothermal systems, with the geothermal activity concentrated in a three-sq km area of the 15-km long Valley. Thermax, a Pune-based capital goods manufacturer and Icelandic firm Reykjavík Geothermal will be working on this project. Reykjavik Geothermal will help in drilling and exploration activities for the project, which are part of Thermax"s plans to enter the „green energy sector.

Non- Conventional Energy Development Corporation of Andhra Pradesh (NEDCAP) announced the signing of

India's first Geothermal PPA between GeoSyndicate Power Pvt. Ltd and Northern Power Distribution Company of AP Ltd. (APNPDCL) in August, 2010. Andhra Pradesh is the first and only state in the country to have executed this PPA and GeoSyndicate, a spin off from the IIT Mumbai, would set this power plant with initial capacity of 25MW in Khammam District.

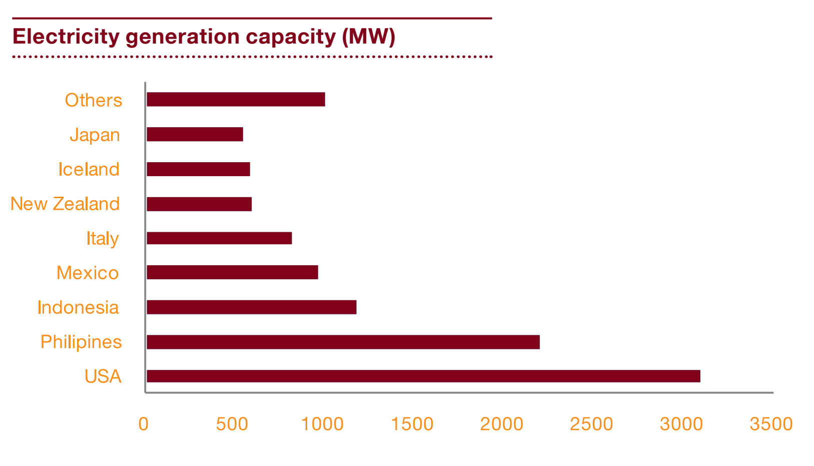
Policy Framework

Except for a few attempts, the Indian government has not done anything significant to exploit vast reserves of geothermal energy. The Government has not formulated or announced any policy for promoting geothermal energy to attract private sector.

The government may come up with a geothermal energy policy in the FY 2011-12. The Ministry of New and Renewable Energy is consulting with state officials to draft a national policy that will include how development blocks may be awarded.

International Experience

It is important to analyze the global scenario in terms of generation capacity, policy and



Source: Iceland Geothermal Market Survey regulatory framework and future outlook of the countries to develop geothermal. This would provide an understanding of the progress in countries in this regard and the factors responsible for such progress.

As is evident in the graph below, in 2009, United States led the world in geothermal electricity production with 3087 MW of installed capacity while Philippines, the second highest producer, with 2195 MW of installed capacity. Indonesia is the third largest producer with 1169 MW.

Indonesia has extensive geothermal resources and policies that favour the development of these resources, we present an analysis of the geothermal scenario in Indonesia considering that it is also a developing economy like India.

The second case to consider is Iceland which generates significantly high proportion (~ 25%) of its electricity using geothermal reserves and has made significant progress in terms of research and development of these reserves. The Government has played a key role in this regard by taking the responsibility of acting as a developer and operator of geothermal power plants. This includes undertaking the early stage risky activities like exploration and the role of the private sector has been mainly confined to providing technical support (like drilling, exploration, equipments and consulting services) in the construction of the plant.

Overview of the Geothermal Energy in Indonesia

Indonesian economy has showed a good recovery from the Asian economic crisis, and has been continuously expanding in recent years. Accordingly the domestic energy demand is also expanding. On the other hand, the oil supply has decreased due to depletion of its existing oilfields. As a result, Indonesia's status changed from an oil-export country to an oil-import country in 2002. Having been urged by such situation, the Indonesian Government decided to diversify energy sources and to promote domestic energy sources in order to lower oil dependency. The transition has spurred a new commitment to renewable energy and environmental sustainability.

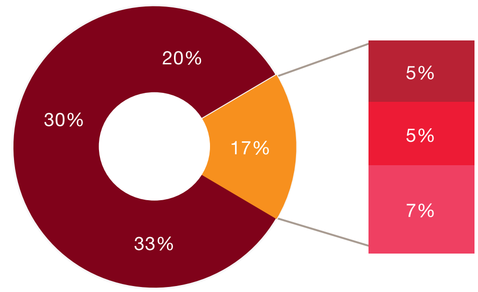
Today, renewable energy accounts for a small but growing portion of Indonesia's electricity portfolio. Most renewable energy comes from the hydropower and geothermal industries.

Policy Framework for development of geothermal sources

The Government worked out „National Energy Policy' (NEP) in 2002, and set a target of supplying 5% or more of the primary energy by renewable energy by 2020.

The Government enacted "Geothermal Law" for the first time in 2003 to promote the participation of private sector in geothermal power generation. Moreover, Ministry of Energy and Mineral Resources worked out "Road Map Development Planning of Geothermal Energy to materialize the national energy plan in 2004.

Geothermal: Indonesia's primary energy supply in 2025



Source: IEA Energy Review of Indonesia

The government has adopted specific medium and long-term renewable energy targets, with a separate focus on geo-thermal energy.

The policy framework supports renewable energy targets through financial incentives and noneconomic support structures. These include feed-in-tariffs where utilities pay a premium for electricity from renewable energy sources that are delivered to the electric grid.

The government has made significant efforts in reducing the bias in the energy market in favor of conventional fossil fuels. The subsidies are provided by the government to promote renewable energy. These efforts have led to the evolution of a stable and integrated policy framework to attract investments and private sector participation.

Renewable Energy Sources	Resources (MW)	Installed capacity (MW)-Year 2007
Hydro	75670	4200
Geothermal	27000	1052
Mini-Hydro	450	86
Biomass	49810	445
Solar	4.8 kWh/m2/day	12
Wind	9290	0.6
Negative visual impact or noise	Yes	No

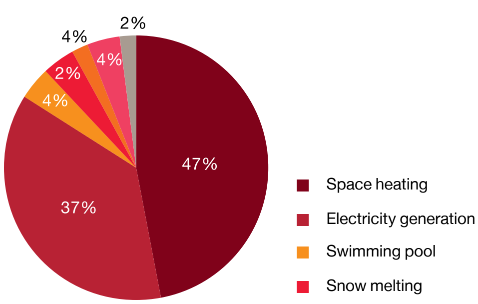
Source: IEA Energy Policy Review of Indonesia

Overview of the Geothermal Energy in Iceland

Iceland is considered to be the second largest island in Europe and a hot spot for volcanic and other geothermal activity. The country is located on the Mid-Atlantic Ridge, which makes it one of the most tectonically active places in the world. It is mountainous and volcanic with ample precipitation which provides an abundant supply of geothermal resources and hydropower, the two major sources of energy in the country. Iceland's unique geology allows it to produce renewable energy.

Almost ~ 82% of primary energy is derived from indigenous renewable sources (62% geothermal, 20% hydropower). The rest is imported fossil fuel used for fishing and transportation. The country's energy use per capita is among the highest in the world and the proportion of this provided by renewable energy sources exceed that of most other countries. Iceland's success in the utilization of locally available renewable energy sources, especially the geothermal energy and hydro power, has contributed substantially to its economy.

Sectoral share of utilisation of geothermal energy in 2008



Source: Iceland Geothermal Energy Market

Iceland utilizes ~ 37% of its geothermal energy for electricity generation. Geothermal generation capacity contributed to ~2% of the total electricity generation in2008.

High oil and gas prices and unstable supply provides an economic incentive for using renewable energy.

In recent years, the utilization of geothermal energy for space heating has increased as a result of changing settlement patterns, and the discovery of geothermal sources.

The country has geothermal experts which gives it a distinct advantage in specialized areas such as geo-survey, exploration and drilling, environmental assessment, reservoir modeling and management, power plant engineering, as well risk management and financing of such projects.

Icelandic financial institutions have specialized in financing renewable energy projects, particularly hydro and geothermal power.

Policy Framework

The transition from predominant fossil fuel use to renewable energy in the country was based on conscious political decisions with a view to economy and national energy security. The initial per capita investments were large, but more than recovered and have now become an important source of revenue. This was accomplished with active involvement of the central government and municipalities. The government has framed policy and legislation which aims to promote the use of clean and renewable geothermal and hydropower sources in an environmentally responsible manner.

In operative terms, government agencies conduct or sponsor basic research, issue permits, facilitate funding, risk mitigation, raise public awareness and provide information. The government has encouraged exploration for geothermal resources, as well as research into various ways in which geothermal energy can be utilized. The aim has been to acquire general knowledge about geothermal resources and make use of this resource profitable for the economy. New and effective exploration techniques have been developed to discover geothermal resources. The geothermal industry is now sufficiently developed for the government to play a smaller role than before.

The government has also set up the Energy Fund to further increase the use of geothermal resources. Over the past few decades, it has granted numerous loans to companies for geothermal exploration and drilling.

Learning's for India

Based on the analysis of the International experience in geothermal development, we believe that a sound policy framework is crucial to the development of geothermal reserves in India. The government needs to take the lead for promoting and developing geothermal energy in India. There are significant risks and investment involved in the research and exploration stage which makes it unattractive to the private sector participants. currently. There is also scope for developing the Public Private Partnership (PPP) model , with the role of each stakeholder clearly defined.

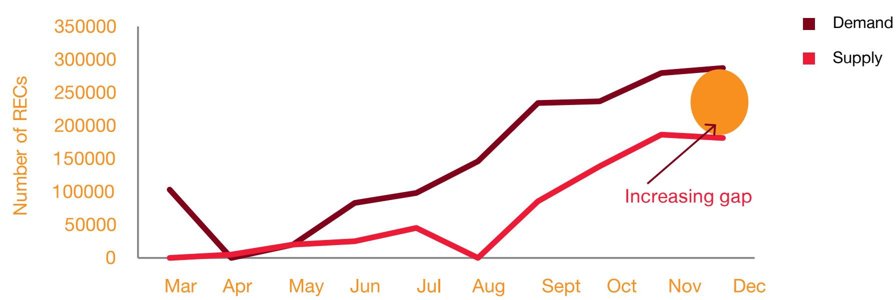
Lack of policy and regulatory framework is one of the main reasons for very low utilization of geothermal reserves in the country. The MNRE is expected to come up with the geothermal policy this year which will create a more robust and conducive environment for private sector participation. Similarly, there is a need for a regulatory framework to resolve issues related to ownership of land and geothermal reserves and licensing to undertake exploration. Currently, there are not many private sector companies in India which can provide technical support. Even for the pilot in Ladakh, a partnership has been entered into with an Icelandic company.

It is expected that once the government comes out with a policy framework as it has for other renewable sources of energy, private sector developers will explore this form of energy in the country in a big way.

REC Mechanism in India

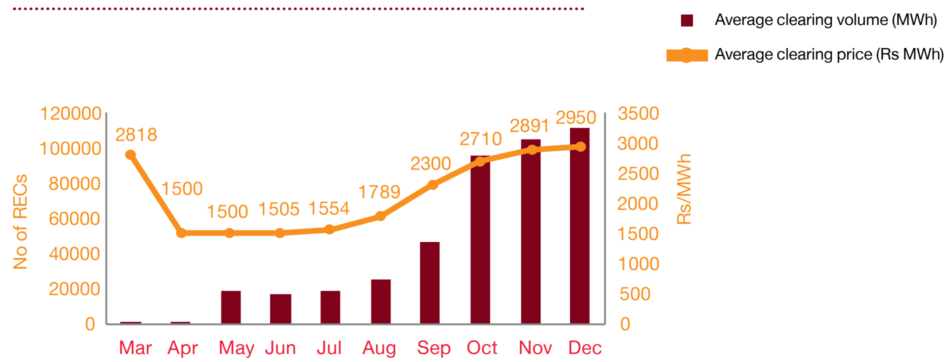
Renewable Energy Certificate (REC) Mechanism was a policy instrument prescribed by National Action Plan for Climate Change (NAPCC) that would enable large number of stakeholders to purchase renewable energy in a cost effective manner. The conventional revenue models of captive wheeling, third party wheeling and sale to Utility under Feed in Tariff (FIT) regime are models with significant potential even in the current renewable energy market. Latest in the class, the market model under Renewable Energy Certificate mechanism (REC) is emerging as a promising option, providing the investor with a nationwide market for their product. Renewable Energy Certificate (REC) mechanism in India, essentially seeks to address the mismatch between availability of RE sources and the requirement of the obligated entities to meet their renewable purchase obligation across States. So far, inter-State exchange of non-firm renewable energy was constrained due to the fact that such transactions are governed by inter-State open access Regulations and the regional energy accounting framework, which necessitates scheduling of power. Besides, the cost of open access wheeling under long term arrangement was prohibitive for such non-firm RE sources due to their inherent lower capacity utilisation factors. The REC mechanism addresses these constraining factors as the Certificate is issued for the energy generated at the point of injection into the Grid. Thus, it is envisaged that the REC mechanism shall facilitate emergence of large number of cross-border RE transactions based on non-firm RE sources, while at the same time, enhancing the volume of cross-border RE transactions based on firm RE sources as well. Nevertheless, the implementation of REC mechanism shall essentially overcome geographical constraints to harness available RE sources and also aim to reduce costs associated with RE transactions. It shall also provide increased flexibility for obligated entities to fulfill their renewable purchase specifications and shall also create competition among different RE technologies.

Demand Supply gap during REC trading



Source: REC Transaction at IEX and PXIL

Average clearing volume and prices of non solar RECs



Source: REC Transaction at IEX and PXIL

Demand and Supply of REC

Since the introduction of REC trading, the demand for non-solar RECs has far exceeded their supply. The large gap in demand and supply is an indicator that future power generation projects based on non-solar renewable energy technology can obtain REC accreditation. The demand and supply data for RECs is provided in the figure.

As is evident from the chart above, the demand for RECs has exceeded the supply of RECs in most of the months. There is a large supply gap in RECs which can be filled by renewable energy projects that are expected to be commissioned. Thus, project developers intending to commission non-solar renewable energy projects should evaluate the sale via REC route as an offtake arrangement for the power produced.

Trends in REC Prices

Based on the ten trading sessions that have been held so far, there is some indication towards a cyclic nature of demand for RECs. The trading sessions in the last financial year saw significantly higher demand compared to the supply at that time.

However, the demand remained at very low levels during the entire first quarter of this financial year. The demand picked up slightly from the second quarter. Analysts tracking these trades agree that the demand is likely to increase as the financial year draws to a close. A major factor that is likely to increase demand submission of Annual Revenue Requirement (ARR). The demand is likely to increase further as the distribution companies begin to submit their ARR reports detailing their expected power requirements for the next financial year. From the May 2011 session onwards it was observed that many developers started banking their RECs. While the demand was considerably higher than the supply in most of the sessions, the clearing price continued to remain much lower than the forbearance price.

According to analysts tracking the REC market, this was due to the non-willingness of the obligated entities to buy RECs at higher prices. Thus many developers chose to bank their RECs and wait for a suitable time and price to trade them. Since RECs are valid for a period of one year, it is advisable that the project developers monetize their RECs in the second half of the financial year. This is owing to the fact that the trend in REC trading till date has indicated a higher price for RECs in the second half of the financial year. A possible reason for this phenomenon is that this coincides with the Annual Revenue Requirement (ARR) filings by the state utilities. Since they need to fulfil their RPO obligations, there is an increased demand of RECs in the second half of the financial year.

Business Opportunities

Solar

Promulgation of the solar specific state policies and JNNSM guidelines has paved the way for development of the solar energy in the country. Although, the thrust of the initiatives for solar development is towards capacity addition but there are significant facilitations extended by the Central and State Government for shaping India as the solar manufacturing hub in world. Some of the enabling initiatives for promoting manufacturing and other downstream activities in India which can in turn be viable business opportunities for the investor has been discussed below.

Thrust towards usage of the domestic content

Indigenization and local manufacturing are seen as very important tools for bringing down the costs of solar power, which is presently costly, and in turn making strides towards achieving overall goal of the Mission of grid parity by 2022. In this context, MNRE has reviewed the present status and proposes measures to promote it. Specifically, the Mission has envisaged development of indigenous production facilities for critical raw materials, components and solar products to achieve the deployment goals. 4-5 GW equivalent solar manufacturing capacity is proposed by 2022, including 2 GW production capacity for poly silicon material.As per the excerpts from MNRE, it is revealed that setting up manufacturing capacity of 2500 MW of solar cells/ modules and 2500 MW equivalent capacity of components/sub-systems of solar thermal power plants will be required by the end of 12th plan period.

To date, there are about 90 solar PV manufacturing companies in India; with 60 engaged in system integration. The cumulative production of solar PV in India is about 800 MW in cells. In order to meet the requirements/targets envisaged under the NSM along-with the looming objective of using indigenized components, it becomes imperative to scale up the cell and module manufacturing capacity. Taking cue from the present demand-supply situation in the manufacturing space, setting up manufacturing bases assumes real significance and viable business proposition for the investors.

Special Incentive Package Scheme-Phase 2(Proposed)

Special Incentive Package Scheme-1 (SIPS-1) was announced by the Union government in 2007 as part of the Semiconductor Policy to boost the semiconductor manufacturing sector. SIPS-1, which ended on March 31, 2010, attracted 12 proposals, worth Rs. 939 billion. It was observed that large number of solar PV manufacturers evinced interest in the development of manufacturing units under this policy. On the similar lines, Department of Information Technology (DIT), Government of India is planning to come up with a revised policy for supporting the semiconductor manufacturing sector. The latest policy aims to provide 25% concession on semiconductor manufacturing in India. From the learning of the SIPS-1, it becomes obvious that SIPS-2 promises to provide viable business avenues to the solar PV manufacturers who would be also eligible for availing the benefits proposed in the scheme. Once this proposed policy becomes notified, it will attract huge investments and thereby provide boost solar manufacturing in India.

Manufacturing facilities under Solar Park

Creation of solar park under the solar specific policies, namely by states of Gujarat and Rajasthan , provides avenues for setting and development of solar manufacturing facilities. The recently notified Solar Policy, 2011 of Rajasthan envisages of setting solar manufacturing facilities in the proposed solar parks. Under the notified policy, the state government pledges to extend all possible facilitation to the manufacturing facilities in the form of allocation of concessional land, providing special package of fiscal incentives etc. Similarly, the Gujarat solar park also makes special provisions for encouraging on-site manufacturing facilities to provide equipments to projects coming up within the park, as well as adequate repairs & maintainance as well as skilled manpower to service projects within the park.

With regards to business opportunities in the Engineering, Procurement and Construction (EPC) in the solar sector, it is viewed that with a large number of projects expected to come up in a short span of time, the demand for EPC services will skyrocket. Early mover advantage would be highly profitable.

Biomass

Biomass as a renewable energy sector has established itself as one of the oldest and well understood technologies in India. However, despite its long presence in the country, the technology has not managed to achieve the scale of installations in comparison to the huge potential that it enjoys, especially in agriculture rich states. Recognizing the potential for scaling up biomass energy can result in identifying viable business opportunities that can be tapped by the private sector in the near and medium term future. Some of these opportunities are described below:

Proposed biomass mission

The Government of India announced a proposed 'biomass mission' in late 2011 with a view to boost the biomass sector. The proposed mission is expected to be along the lines of the National Solar Mission and may offer specific and targeted support to various aspects of the biomass value chain in order to scale up installations. The proposed mission may target the installation of 16,000MW of biomass power by 2020. The provision within the mission to achieve this ambitious target is likely to provide ample opportunities to private developers and the growth of the sector as a whole.

Energy plantations and captive generation

One of the biggest problems plaguing the biomass sector is the non-availability of reliable and affordable feedstock. This is often on account of the fact that biomass projects are not able to secure guaranteed supplies of the feedstock, as it faces high demand from several alternate uses like breweries, bricketting etc. A potential solution to combat this problem is sourcing feedstock from captive generation. Large biomass power plants can establish their own energy-intensive feedstock cultivation to ensure adequate fuel is always available to operate the plant, and that minimal external feedstock needs to be purchased at any given time. Extending the concept further, smaller biomass plants can approach 'energy plantations' for securing their feedstock supplies. Energy plantations are dedicated 'fields' of feedstock cultivation with the exclusive purpose of providing fuel to interested biomass power plants. These plantations can either be run by a consortium of small biomass plant owners located in the same region, or by an independent third party. In light of the ever rising demand for biomass feedstock by all the various competing uses, energy plantations and captive generation can be promising business opportunities in the biomass sector.

Storage and transportation facilities

Often, biomass power plants and feedstock sources are not adjacent. This makes cost effective and timely transportation of feedstock from the point of origin to the power plant a critical link in the overall viability of the plant. In addition, a majority of feedstock is generated as a by-product during harvest season in the fields. This makes feedstock availability seasonal and dependent on the local harvesting cycle. It is not uncommon for biomass power plants to receive more than 60-70% of their annual

feedstock requirements during the harvesting season alone. In this scenario, proper storage facility for excess feedstock is a valuable asset for any biomass power plant.

These facilities, transportation and storage, are essentially logistical considerations which the power plant owner may or may not be qualified or even inclined to address adequately. As a result, this weak link in the value chain presents a viable business opportunity to third party entities to provide either stand-alone or integrated storage and transportation facilities to biomass power plants.

SHP

India is endowed with rich hydropower potential; it ranks fifth in the world in terms of usable potential. However, less than 25% has been developed or taken up for development. Thus hydropower is one of the potential sources for meeting the growing energy needs of the country. A judicial mix of hydropower in the energy portfolio can also contribute to energy security, reduction of greenhouse gas emissions, meeting the peak demand and also increased flexibility in grid operation.

Small Hydro Power (SHP) Programme is one of the thrust areas of power generation from renewable in the Ministry of New and Renewable Energy. It has been recognized that small hydropower projects can play a critical role in improving the overall energy scenario of the country and in particular for remote and inaccessible areas. The Ministry is encouraging development of small hydro projects both in the public as well as private sector. Although the technology has matured over the time, yet it offers significant business opportunities for the investors. The viable business opportunities in SHP segment have been discussed below:

Renovation and Modernization of the Old SHP Projects

The MNRE has been implementing a scheme of providing financial support for Renovation /Modernisation and capacity up-grading of old SHP Stations. The main aim of the scheme is to renovate the plants, to extend their life with improved performance and reliability. In order to ward off the risk for entry into this segment, under the scheme, it has been envisaged that 50%f the project cost undertaken during the renovation and modernization work shall be borne by the Central/State Implementing agency or the owner of the plant. The MNES has so far supported 12 projects for their renovation and modernization and the scheme has been rationalized and extended to cover projects up to 25 MW.

Since, SHP is an old and matured industry, so there are large numbers of SHP units which are in the need of carrying out the renovation and modernization work. Hence, there exists a significant potential for the investors to carry out the R&M work of the old SHP plant by availing the benefits as prescribed under the MNRE scheme

Waste to Energy

WtE is a relatively nascent renewable energy technology in India. Till date, only 73MW have been installed across the country. With the rise in population and urbanization, India is generating ever larger quantities of urban and industrial waste each year. Coupled with a constantly rising demand for energy, WtE represents a large untapped opportunity in India.

JNNURM

Taking note of the large untapped potential in WtE technologies, the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) has provided explicit support to WtE by "setting up projects creating 200 MWe for energy recovery from urban wastes (100 MW from MSW, 30 MW from biogas at STPs and 70 MW from other urban wastes such as vegetable market waste, kitchen waste and cow-dung generated waste in urban areas)." The specific policy and regulatory incentives and drivers to achieve these targets by the end of the 12th plan (2012-17) represent a huge opportunity for investments in this sector.

Waste collection and segregation

One of the biggest problems facing present day WtE plants is lack of availability of suitably segregated waste that can be processed to generate energy. This is in part due to the fact that the urban waste collection system is not geared towards waste segregation beyond a rudimentary classification. This challenge can be viewed as an ambitious opportunity for considering investments in a city-wide waste collection and segregation service with an end-to-end tie up with a WtE power plant.

Municipal command area

In continuation with the waste collection and segregation opportunity described above, the municipal command area concept, if implemented, can greatly facilitate the growth in WtE. The command area concept, akin to the concept for biomass, will assign exclusive rights over all waste that is generated within a municipal jurisdiction to one and only one dedicated WtE generation plant. This will ensure that the plant is assured of constant 'fuel' for generation, and can design large scale collection and segregation mechanisms to harness economies of scale and further improve efficiency.

Existing challenges in Renewable Energy

Solar PV-Key Challenges

Assessment of solar resource and site selection

Proper site selection is the key to the efficiency and output of a PV plant. Solar resource assessment plays a key role in this. Proper site selection can also play a key role in reducing site development costs.

Selection of Technology

The photovoltaic market is still dominated by silicon wafer-based solar cells, which accounting for more than 80% of the present market and is expected to continue the dominance for some years to come. Recent improvements in this traditional technology and its reliability, is expected to keep it in the forefront.

However, Thin Film Technology has an advantage, particularly in extreme temperature areas and where land is available easily. The sensitivity of efficiency of various cells with respect to change in temperature show that the annual energy yield for crystalline silicon solar array is expected to be lower than that of thin film modules in such conditions.

Storage and Amenability to Grid connectivity

PV technology is less amenable to very large scale and wide-spread grid connectivity due to bottlenecks in storage and hence the ability to have a flexible dispatch schedule. For example, if a large number of projects are concentrated in one particular area and are influenced by similar weather and sunlight conditions, then going off and on grid could potentially pose an issue for grid management.

Ability to improve efficiency

The performances of the modules depend significantly on the manufacturer of the cells and the modules. The ability of the developer to improve the cost and performance is therefore limited. As a result, procurement and contracts management plays a significant role in PV projects. The other alternative for a developer is to integrate backwards to module manufacturing, which is increasingly adopted by several players.

Solar Thermal-Key Challenges

Supply chain constraints

There is presently negligible indigenous manufacturing capability for CSP projects. Presently, significant components such as mirrors, receivers, turbines and other generation technology have to be sourced from few global manufacturers. This impact the project cost significantly. Therefore, it is imperative that as much indigenisation as possible is targeted for a cost-effective project completion.

Water

Depending on the technology used and the local geography, access to water could be a constraint on deployment of CSP. The degree of water constraint depends on a plant's use of water as a working fluid, heat transfer fluid, and/or cleaning fluid for the solar collectors. Adopting dry cooling would reduce water requirement but would require significant improvement in efficiency and of cost of dry cooling.

Land requirements and site selection

As solar thermal installations require large amount of land, dedication of land area for exclusive installation of solar fields have to compete with other necessities that require land. In addition, the nature of land also has a significant bearing on the project cost. Once exceeding a technology specific slope threshold, further 1% slope over 2km can mean $ 2-5M higher levelling cost. Additionally, since the land preparations are at an early stage of the project, they have a negative influence on the project cash flow.

Measurement and Importance of DNI

For a CSP Project, selection of a site having required DNI is the first and probably most critical task. A thorough investigation of irradiation databases can help in an initial assessment of sites. However, only on-ground measurements provide the accuracy to select the right one. And this accurate measurement is well worth its costs: finding a site with 10% higher irradiation decreases total electricity generating costs by approx. 8%. The availability and measurement of DNI is a crucial factor in achieving the optimal output at an optimum cost. Factors such as DNI distribution, is critical for optimal sitting and output. For a given Annual average DNI, a site with more or less even distribution of DNI over the year provides more energy yield (for the same configuration) than a site with more pronounced peak DNIs.

Installation Capability

Presently, there are no installed CSP projects in the country. Thus, project management and installation capability are questionable. Solar thermal power plants need detailed feasibility study and technology identification along with proper solar radiation resource assessment.

Biomass-Key Challenges

The following are the key issues faced by the biomass power generation sector across its value chain:

Issue in assessment of the feedstock/ Potential of biomass

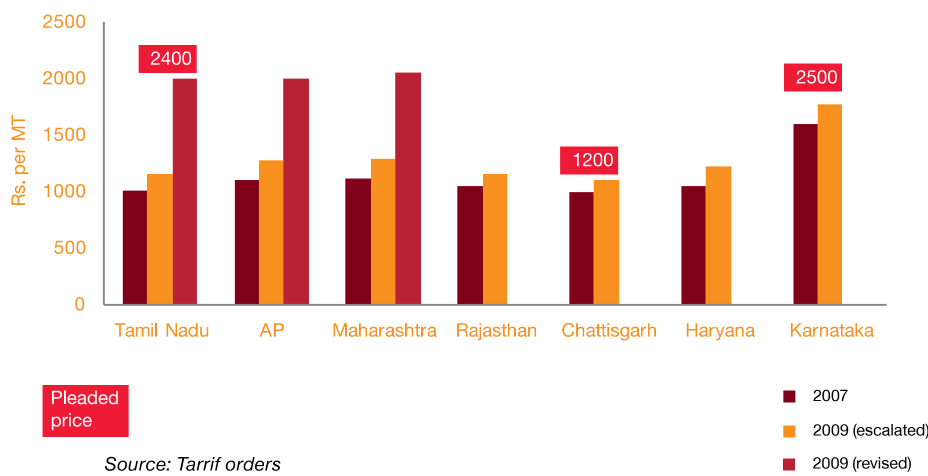
In the late 90s, Indian Institute of Science (IISc) commenced a study funded by MNRE for assessing biomass availability in India. Based on the data made available from different agencies and various scientific tools like remote sensing, GIS based interactive packages and other statistical tools, IISc prepared a country wide Biomass Atlas to assess taluka (Town) level production and type of biomass.

Although, the Biomass Atlas is a scientific tool to estimate the availability of biomass, alternate uses of biomass and the available surplus for potential of power generation in a given region is not specified. The assessment of biomass available for feedstock is extrapolated and hence the assessment of surplus biomass of 18000 MW may not be an accurate estimate of the viable potential.

Issues related to price stability

Unlike other RE technologies, bio-energy technologies like biomass and cogeneration require feedstock as fuel for the power plant which in turn entails an additional and significant cost to the project developer. Further, one of the most important issues faced by the project developers is volatility of fuel cost.

High and fluctuating cost of biomass is an issue impeding the growth of this sector. The cost of biomass was very nominal (Rs 300-400 per tonne) in most states in early 2000. However, over the last decade, the increasing demand of biomass for power generation as well as alternative uses in brick kilns and paper industry, and for cattle fodder and rural households has created a demand-supply gap in this sector, which in turn has inflated the price of biomass to very high levels of up to Rs. 2000 per tonne.



Source: Tarrif orders

While calculating the cost of power generation through biomass projects, most of the SERCs have considered the biomass cost in the range of Rs. 900-1000 with 5% escalation, but in reality, the cost of biomass has almost doubled in the last five years due to its increased use in the SME sector. This increase in cost has created a huge gap between the estimated fuel price considered as part of tariffs and the actual fuel price. The degree of price elasticity of alternative usage varies from state to state and across biomass types.

Another important aspect to be considered is the difference in prices of various biomass fuels. Since most of regulatory commission take average of the biomass price available in the market, there is potential of underestimating the biomass price as the normal average price of biomass might not be reflective of the biomass cost for a specific power plant.

Biomass business is subject to the volatile price movement of biomass in the markets and is dependent on factors affecting such price movement, including regional supply and demand, seasonality, rain, climate change, crop productivity, labor shortages and alternative uses for biomass fuel. Key drivers for increase in price include:

- Increase in alternative uses of biomass result in price escalation
- Unorganized and unregulated market leads to price inflation

Increasing alternative uses of biomass result in price escalation

- Many SME industries have emerged in the last 4-5 years, and consider biomass as an alternative fuel to coal.
- Due to the higher paying capacity of these industries, the biomass prices have reached as high as Rs 2500 per tonne.
- This is resulting in substantial losses to existing biomass based generators - and some have been temporarily closed down due to unavailability of feedstock and/or its high cost.

Unorganised and unregulated market leads to artificial price inflation

In most cases, the supply chain of feed-stock (collection, transportation and storage) is arranged by third party/ lorry owners who exploit their monopoly position to escalate transportation costs and cause artificial price inflation.

Challenges- Small Hydro Power

Despite support from the government by way of financial support and other policy incentives, SHP has not made significant progress due to various technical and procedural challenges. SHP projects are location specific, varying significantly in costs and feasibility depending upon topography, hydrology, geology and approachability related factors. Some of the major challenges have been discussed below:

Factors	Issues
Geology	Geological investigation is required at the outset including investigation of project site, preparation of a geological map based on surface observations supplemented by information from laboratory analyses of collected samples. • Such investigations are costly and rarely commercially justified for SHP projects. • In most cases, appraisal of site geologic conditions is based upon informed visual inspection of site features. Inadequate site investigation and project layout may lead to geological surprises which may result in cost escalations and time over runs. • Even when extensive investigations using state-of-the-art techniques are undertaken, an element of uncertainty remains.
Hydrology	The hydrological data of any river is the foremost requirement for planning and designing of any hydropower project. It has a direct bearing on the power generation of plants. • Stream/river-flow fluctuates (daily, seasonally and yearly) affects the generation capacity which may cause significant fluctuations in revenues. • Water from either rain or melting snow is not available immediately as stream-flow due to losses caused by evaporation from ground surface, seepage of surface water, etc.; can take weeks or months to appear as stream-flow. • Planning requires long term hydro-meteorological data collected by various Government agencies in the country which is often not available for adequate period. • Plants gets affected by excessive sediment which decrease the capacity of reservoir, erode or breach the hydraulic structures such as weir, intake, etc. and cause erosion of turbine components. The storage capacity of reservoirs decreases due to accumulation of sediment. The plants have to be shut down for approximately 30- days during monsoons due to high silt contents & debris in the flowing water.
Infrastructure	• SHP plants are generally located in remote hilly areas and construction of long transmission lines in such difficult terrains for evacuation of power to the load centres takes considerable time. • Other infrastructural facilities like construction of bridges, strengthening of existing roads, efficient and reliable telecommunication links, better road transport /air services etc. are required for their early implementation.
Clearances	• Typically, a developer is required to get a project allotment from the State Nodal Agency, obtain clearance from Ministry of Environment and Forest (MoEF) where forestland is involved, Irrigation/Water Resources Department, Land acquisition of govt. from District Collector, Approval of Power Evacuation Plan from the State Utility, permisssion from state govt. for construction, etc. • Approvals are required at various stages and there is a substantial time gap between receipt of an approval for the current stage and next stage. • Also, the number of clearances required is high and no single window clearance system available to the developers. • If a project fails to obtain any such approvals, within a timely manner or at all, costs associated with the feasibility studies and preliminary stages of development of the project may not be recovered.
Land Acquisition	• SHP project is not a very land-centric project with limited land requirement requirement. In a typical SHP project, land would account only for 1-2 per cent of the total cost. The problem, however, is not in land availability but on the process of acquisition. The laws governing land acquisition also vary from state to state and this could lead to considerable delays litigation, poor maintenance of land records, demand of higher price for land as compensation, etc. • SHP project may also involve Resettlement and Rehabilitation (R&R) issues where the government acquires land for the project and compensates the people who are displaced.

Challenges-Waste to Energy

Technical Risk

- Major technical aspects include soundness of the project in terms of proven track record, adaptability /success probability of the technology proposed. Also, impact of technology up-gradation on the project and access to such up-gradation should be considered in case of global technologies with a rapidly expanding market opportunity.
- For self-sustaining combustion, there should be a heat content of at least 2500 kcal/kg. Usually calorific value below 1500 kcal/kg is not recommended for combustion. Indian solid waste typically has low heat content (770 to 1000 kcal/kg, on dry basis), high moisture content (30 to 55 % by weight) and high inert contents (30 to 50 % by weight). These characteristics make it unsuitable for incineration / combustion.
- The foreign collaborators provide technical solutions based on very preliminary data of random samples which can seriously affect operations of the plant unit. The technical output stipulated in these foreign technologies is based on the actual operations but for waste of totally different nature and hence the factors considered for adapting these applications in this country may not be reliable. The scale of operations for the uncertainties in full scale operating plants abroad will not be comparable with the proposed installed capacities in India raising the scaling up factor.

Governance Risks

- Most of the project getting conceptualized are independent of a disposal facility and thus fail to provide a complete solution for an urban local body. Moreover, there are issues related to risk sharing in the past implemented cases. In many cases, the project awarded have been found to be either too favourable to the developer or provide adverse conditions. The project structure should enable equitable risk sharing by looking at critical factors such as: Municipal waste supply, Payment mechanism, Penalties and Termination.
- In many cases availability of land has been cited as one of the key concern. This is especially relevant for developed cities, which have high potential for solid waste. Another important issue have been ensuring timely award of clearance for implementation.

Conclusion

Renewable energy development in India has covered fair distance over the past decade. India has witnessed significant capacity addition in renewable energy based power. While the sector has its share of challenges, at the same time it offers immense opportunities for investors across the value chain. With a conducive policy environment and an enabling regulatory framework in place, the sector is poised to grow at a much higher rate in future. The Indian Policy and Regulatory framework, with an eye on promoting renewable energy development in the country, has opened up various revenue models for investors to choose from. This has made serious investors in the market to take note and evaluate them closely to extract maximum returns and strike the right balance between benefits and associated risks. Having said that, however, investors and policymakers must still keep in mind the megatrends that will shape the future of the industry while planning their next moves.

Emerging opportunities and challenges

Energy management

Contents

Introduction

Benefits of Energy Efficiency

Meeting global emission reduction targets

Meeting global energy saving commitments

Ensuring sustainable economic growth

This background paper aims to give an overview of status of policies, trends, opportunities, energy efficiency initiatives undertaken in key sectors.

Today, world is facing high energy prices, threat towards energy security & energy poverty as well as increasing concerns towards climate change. For year 2010-35 worlds' energy demand would increase by 1/3 as shown in Figure 1, because of the following two main factors:

- Increase in global population by 1.7 billion and
- High Annual GDP growth of 3.5% globally. (Source IEA)

Energy Efficiency could provide the quickest, cheapest and most direct way to turn these challenges into real opportunities. Rapid growth of any economy requires huge quantum of energy resources.

India is one of the world's fastest growing economies having third largest energy consumer accounting (about 5% of the world's total annual energy consumption). Projected GDP growth in India stands at 9% giving boost to further industrial development and improvement of the well-being of the nation. To meet increasing energy demand in the country installed capacities are expected to grow at 7% annually.

The installed power generation capacity in India has grown 94 times since independence and the total installed capacity of power generation in India has reached 1,82,345 MW (as on 30.09.2011).

- There is a peak demand shortage of around 10.5% and an energy deficit of 8.2% in the country and is consistently increasing. As shown in Figure 2. As per 17th Electrical Power Survey (EPS) of the Central Electricity Authority, the electricity demand likely to increase by 39.7% in 2011-12 as compared to 2006-07 and by 43.7% in 2016-17 as compared to 2011-12.

The historic trends in energy, electricity and CO_2 intensities of India indicate an overall decline over a period of time. The decrease

Figure 1: World's primary energy demand (Source IEA)

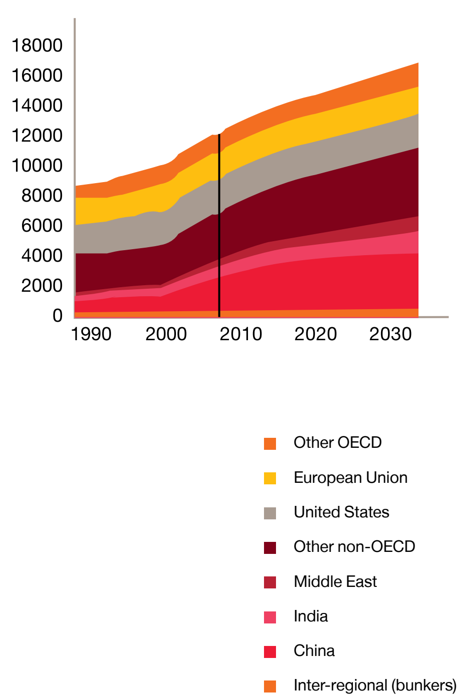
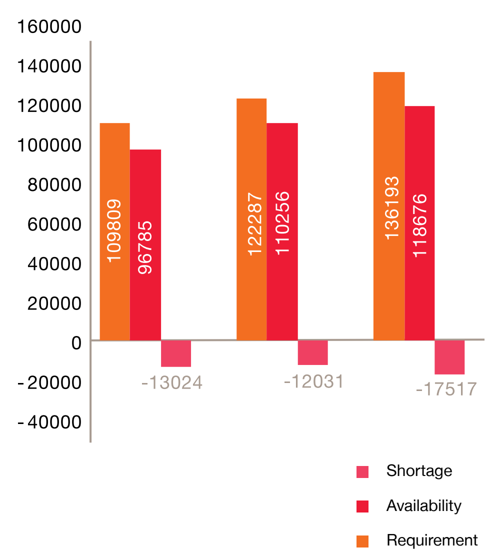


Figure 2: Peak Demand Supply Shortage in India (Source: CEA)



in India's energy intensity can be attributed to (a) the interventions by the Government of India for promoting energy efficiency (b) quest for global competitiveness; and (c) the increasing share of the lower energy-intensive services sector in the Indian economy.

Given the current scenario of energy constraints in India, sustainable development of the policy initiatives is an essential part of overall societal development.

Legal framework for Energy Efficiency

In India, energy efficiency related programs have been initiated by the Government of India (GoI) through various laws and regulations. These laws and regulations have been gradually introduced in the last 20 years. Following section discusses in brief different policy initiatives taken during this time period that have been instrumental towards encouraging businesses to adopt energy efficient methods in their regular operations.

Energy Conservation Act, 2001
In order to institutionalize energy conservation efforts in the country, the Government of India has enacted Energy Conservation (EC) Act in 2001, and established the Bureau of Energy Efficiency (BEE), under Ministry of Power, Government of India, on 1st March 2002 to promote the efficient use of energy and its conservation.

BEE is the nodal agency to promote energy efficiency initiatives in the country and has laid down a targeted national action plan in this regard.

Integrated Energy Policy (IEP), 2005
Integrated Energy Policy (IEP), as developed by the Planning Commission in 2006, is a crucial policy document, which is seen as guiding the medium to long term policy decisions of the government in the energy sector. The broad vision behind the energy policy is to reliably meet the demand for energy services of all sectors including the lifeline energy needs of vulnerable households, in all parts of the country, with safe and convenient energy at the least cost in a technically efficient, economically viable and environmentally sustainable manner. Assured supply of such energy and technologies at all times considering the shocks and disruption that can be reasonably expected is essential to providing energy security to all.

Currently, India consumes 0.19 kilogram of oil equivalent per dollar of GDP expressed in purchasing power parity terms. However, there are several countries in Europe at or below 0.12 with Brazil at 0.14 and Japan at 0.15.

Thus, clearly there is room to improve and energy intensity can be brought down significantly in India with current commercially available technologies.

National Mission for Enhanced Energy Efficiency (NMEEE), 2008
The prime minister of India on 30th June 2008 announced "National Action Plan for Climate change" recognizing the need to maintain a high growth rate for increasing living standards of the vast majority of people and reducing their vulnerability to the impact of climate change. The action plan highlights eight missions out of all "National Mission for Enhanced Energy Efficiency" targets key programs for energy efficiency in the country.

Implementing NMEEE would save about 23 million tons of oil equivalents (MTOE) of fuel by 2015 and about capacity addition of 19000 MW will be avoided.

The following four key initiatives are proposed under NMEEE:

- Perform Achieve and Trade (PAT) – A market based mechanism to enhance cost effectiveness of improvements in energy efficiency in large energy intensive industries and facilities, through certification of energy savings that could be traded.
- Market Transformation for Energy Efficiency (MTEE) – It accelerates the shift to energy efficient appliances in designated sectors through innovative measures to make the product more affordable. Super Efficient Equipment Program is part of MTEE.
- Energy Efficiency Financing Platform (EEFP) – It promotes the creation of mechanism that would help finance demand side management programs in all sectors by capturing future energy savings.
- Framework for Energy Efficient Economic Development (FEEED) – It develops fiscal instruments to promote energy efficiency.

Globally, market transformation has emerged as the preferred instrument for promoting energy efficiency and reduces energy consumption. It is due to the fact that energy efficiency pays for itself without much need for upfront capital subsidy, rebate etc. This background paper highlights salient features of following key initiatives, which has been accepted at a global level for market transformation through energy efficiency provided in Table 1 below.

Table 1: Key Initiatives for Market Transformation

Key Initiative	Objective
Market Transformation through Energy Efficiency in Appliances	To set minimum energy standards for products and transform the market towards super efficient products.
Cap & Trade Program for Market Transformation	It is market based mechanism by which Designated Consumers (DC's)/Energy Intensive Industries are motivated towards Energy Efficiency.
Energy Efficiency in Buildings	Implementation of EE measures in existing buildings through ESCO's mechanisms and sets minimum Energy standards for new buildings.
Agriculture DSM program	Energy consumption reduction in agriculture sector through replacement of inefficient pump sets through PPP mode with efficient pump sets.

Market Transformation through EE in Appliances

Standards & Labels are tools, which promote efficiency improvement of appliances and products. Standards set minimum benchmark of efficiency to be achieved for products, whereas labels provide consumers informed choices about the products.

Background

Traditionally final energy consumption of all the nations across the world is classified into three sectors –Buildings, Industry & Transportation. Building sector is one of the major chunk areas & consumes around one-third of total global energy consumption with major loads include appliance, equipments & lighting loads. Energy is consumed in the appliances in residential as well as office buildings. It is one of the major sources of CO2 emissions with residential sector contributing to around 10% of global CO2 emissions as shown in Figure 3.

Thus countries all over the world realized the importance & need of promoting energy efficiency in appliances. “Labeling programs” & “Minimum Energy Performance Standards” for domestic appliances has emerged as a useful instrument to improve energy efficiency and market transformation. The evolution of key programs & policies for market transformation across the globe is given in Figure 4.

Figure 3: Sector wise CO2 emission in 2010(Source: IEA)

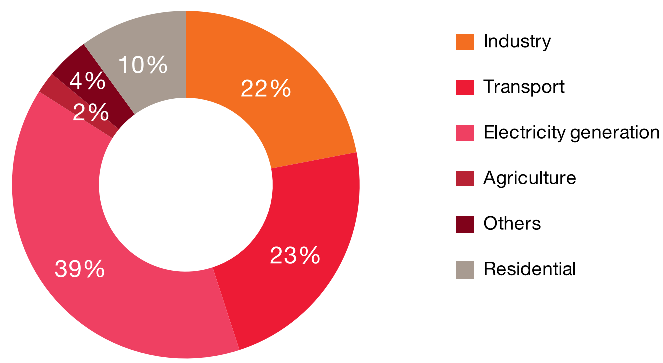
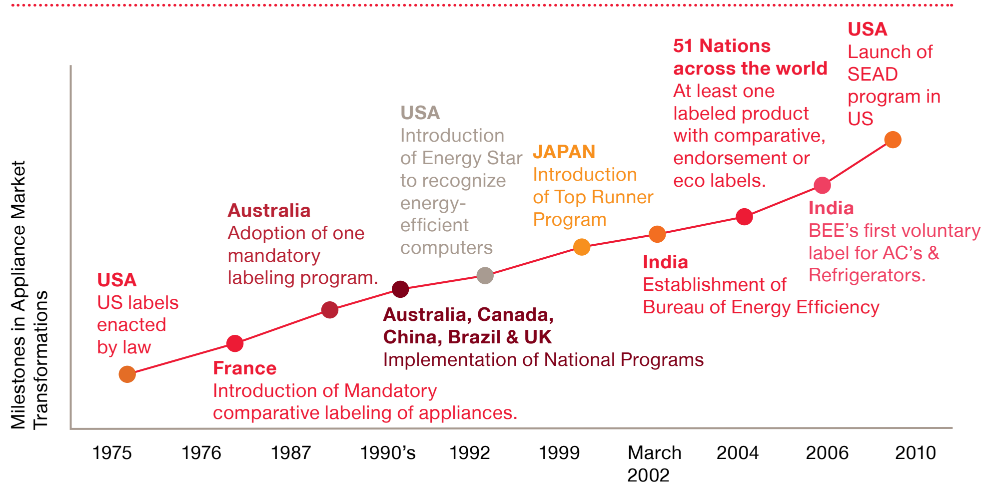


Figure 4 : Milestones in Appliance Market Transformation



Appliance EE Program in India

Importance of Energy efficiency is well understood by Government of India and Standard & Labeling program, as one of the flagship program of BEE, was launched in the year 2006. The program has contributed a lot in market transformation.

Policies & Programs

Energy Conservation Act, 2001 empowers BEE to develop policies for improving energy efficiency of appliances in the country. The program was launched in year 2006 with voluntary labels for Air conditioners and Refrigerators. Bureau of Energy Efficiency has following programs in place to improve energy efficiency of energy using appliances and market transformation.

- Appliance Standard & Labeling Program
- Super Efficient Equipment Design program

Appliance Standard & Labeling programs are the first step to target products to achieve minimum energy standards. Till date, BEE has covered 14 products in their standard & labeling program & 6 products are in preparatory stage for development of standards.

Super Efficient Equipment Program (SEEP) is a key program under NMEEE, which targets to create market for super efficient products. It may involve providing incentives to manufacturers for incremental cost of producing super efficient products/ technologies and addressing other market issues. As per BEE’s proposed plans, the target products to be covered under this scheme are fans and LED lighting products.

The Super-Efficient Equipment and Appliance Deployment (SEAD) initiative is another program for global market transformation effort, launched in Washington in July 2010. Its objective is to promote & raise efficiency ceiling by super efficient appliance through procurement, R & D, strengthening the foundation of efficiency programs etc. Six product categories focused in first phase of SEAD are Commercial Refrigeration, Computers, Distribution Transformers, Solid-state lighting, motors & televisions. This program is yet to evolve in India.

Opportunities in Appliance Standard & Labeling in India

Potential drivers: Population Growth and Economic Development

As per different market studies, the contribution of various appliances in residential energy use is depicted, which shows that lighting and fans contribute to

Figure 5: The energy consumption share of different domestic appliances, 2009 (Source: External Studies)

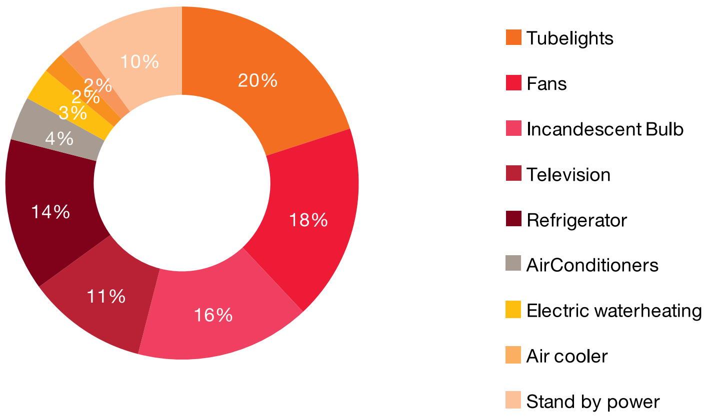
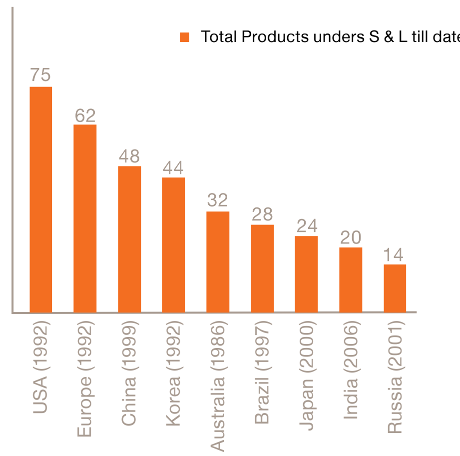


Figure 6: Global Standard & Labeling Scenario



Counties & Year of Establishment of Standard & Labeling Program

Figure 7: Potential in energy efficiency for Air conditioner (Source: Techno-Economic Analysis of Indian Draft Standard Levels for Room Air Conditioners LBNL-64204)

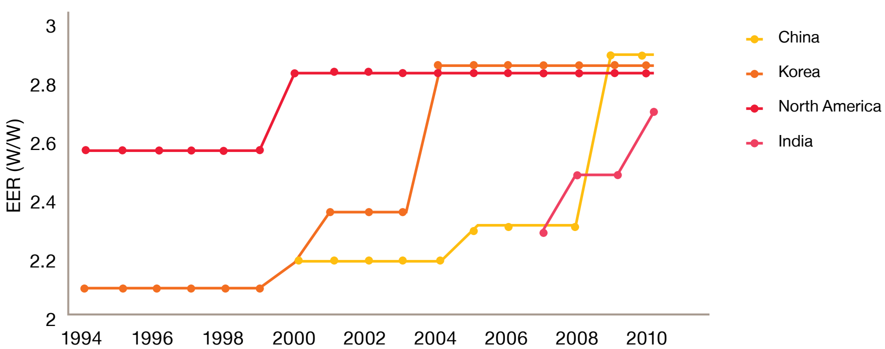


Figure 8: Global Policies to support use of energy efficient appliances

Utility driven White Ceritificates Scheme in France

It promotes end-user to use energy efficienct appliances.

Upfront capital subsidy or Rebate on bill is given to the end users using energy efficient products.

Government Driven EU Program

Tax Credit is given for EE equipment purchasing in residential sector

Eco-PTZ (Zero Interest rate loan for energy efficient investment in residential)

Reduced VAT 5.5% (instead of 19.6%) on EE appliances

Market Transformation Driven EU program

Promoting minimum energy performance standards (MEPS) of energy using appliances, EE labeling for appliances & equipment.

Car Labeling (Bonus Malus). Promotes lower CO2 emiting vehicles.

around 50% of the household energy consumption as shown in Figure 5.

Population growth & economic development in India will lead to rise in incomes and affordability of consumers to buy more energy gadgets/appliances in each household, which means more energy demands.

The demand for new technologies is bound to increase. There is an opportunity for all manufacturers to invest, as this is going to drive the market. The shelf life for existing products is decreasing, which means more market for new products.

Large Window of Products to be covered

Analysis of global programs suggest that developed countries like US, Europe and Korea have progressed and have covered number of product categories in their programs. There is a huge opportunity and program learning's to be adopted in India. Status of product covered in different countries is presented at Figure 6.

Global commitments for energy consumption reduction as the driver

The analysis suggests that global commitments of developed/developing countries for energy consumption reduction targets would push for enhanced investments in energy efficiency in appliances and new technological developments. This would be one of the key drivers for policy interventions in India.

Technology Up gradation being the driver

In present times, technology change is happening very fast and this becomes the challenge as well as key driver. Policies can't be made for keeping long time lines because of changing market scenarios. As such we have moved at a very fast pace, but there exist a gap between existing products in our market and best products sold globally. This is a huge opportunity to be tapped and create products of global standards. Figure 7 highlights difference in Minimum Energy Performance Standard (MEPS) of Energy Efficiency Ration (EER) of Air conditioner in India with other countries.

Utilities/Fiscal Incentives as the Driver

Utilities have played an important role in successful deployment of appliance energy efficiency programs all across the world. Our analysis suggests that countries have developed fiscal instruments as part of their policies to pace these initiatives. Key features about some of the global programs are presented at Figure 8, which gives direction about possible measures to be adopted in India.

Key Challenges for the Standard & Labeling Program in India

Involvement of manufacturers to drive the program

Manufacturer engagement/buy in is very critical for successful implementation of the program. True data performance data sharing remains the key.

Testing of Products

Harmonization of Indian test standards with International standards is must for acceptability of Indian Products in International markets.

Some of the old Indian standards need to be revised to cater to emerging technologies.

Capacity of test laboratories needs to be strengthened in India to undertake performance testing.

Capacity constraint at Regulatory level

There is need to build capacity at State level to ensure compliance. This needs to be developed if program is to be executed at national level.

Penalties for Non Compliance

The compliance can only be promoted achieved by setting right mechanisms and having sound regulations. This should clearly define process /penalties for non compliance.

High cost of energy efficient products

Producing efficient products and maintaining cost economics is a challenge. Role of incentives for manufacturers to invest in new technologies is a key here.

Key Discussion Points

- Future Policy and Programs - Roadmap
- Role of manufacturers/their associations to drive the program
- Targets for Utilities to push energy efficiency initiatives
- Role of Fiscal Incentives for promoting energy efficiency
- Encourage Investments for new efficient technologies and addressing cost economics
- Capacity building of Test Laboratories to support appliance testing in S & L program.

Cap and Trade Program for Market Transformation

Trading of Energy saved is a well accepted mechanism to promote Energy Efficiency across the world. Many countries reaped high savings benefit by this "Cap and trade mechanism".

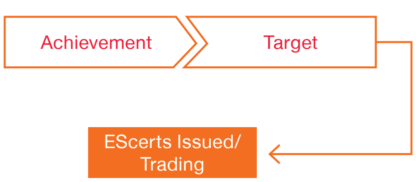
PAT program in India

Perform Achieve and Trade (PAT) is a similar mechanism developed in India. PAT is a market based mechanism for promoting energy efficiency in large energy intensive industries and facilities known as "Designated Consumers" (DC), through the means of energy saving certificates (ESCerts).

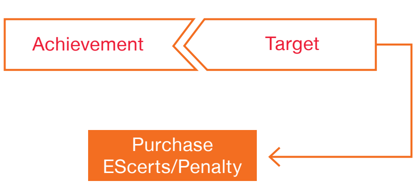
PAT scheme was launched in April, 2011 under National Mission on Enhanced Energy Efficiency (NMEEE) with an objective of saving 9.78 million metric tons of oil equivalents and which in turn will avoid 5623 MW generation over a period of three years in India. (The scheme is awaiting final notification for making it mandatory).

Under this scheme, DCs will be given the specific energy consumption (SEC) targets to be met over the period of three years. The scheme may have following three scenarios.

- The DCs achieve their set target.
- The DCs over achieve their set target. The overachievement may result in issue of Energy Saving certificates (EScerts) to the DCs.



- The DCs may under achieve their targets. These DCs can trade EScerts from DCs, who have over achieved their targets.



Introduction to DC's

In India, Energy conservation Act, 2001 (duly amended in 2010) has identified 15 sectors as large energy intensive sectors, which are named as Designated Consumers. These consumers account for 25% of the national gross domestic product (GDP) and about 45% of commercial energy use in India.

Presently, eight out of fifteen energy intensive sectors viz. Aluminum, Fertilizers, Iron and Steel, Cement, Pulp and Paper, Chlor Alkali, Power Generation Plants and Textile are chosen as the target sectors under PAT scheme in India. The designated consumer of above stated 8 sectors consumes about 54% of the total energy demand in India as mentioned in Table 2 The remaining DCs like sugar, port trust, transport sector, petrochemicals, chemicals and commercial building & establishment are planned to be covered in next phase

Table 2: Minimum annual energy consumption for the designated consumer and estimated number of DCs. (Source: PAT Consultation Document 2010-11)

Sectors	Minimum consumption to become a DC (Mtoe)
Aluminium	7500
Fertilizers	30000
Iron and Steel	30000
Cement	30000
Pulp and Paper	30000
Chlor Alkali	12000
Power Generation Plants (Thermal)	30000
Textile	3000

The Energy Conservation Act assigns certain roles to DCs which are mentioned below:

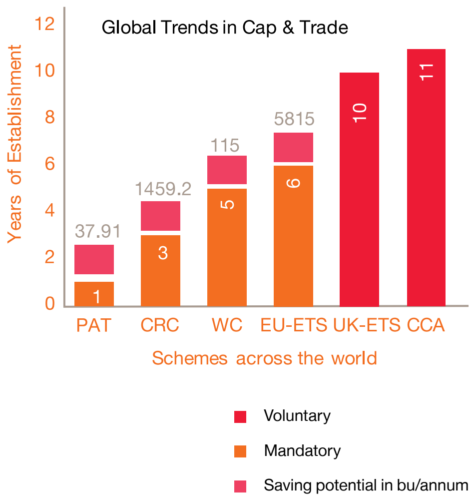
1. Furnish report of energy consumption to the Designated Authority of the State as well as to BEE (section 14 (k)).
2. Designated or appoint an Energy Manager who will be in-charge of submission of annual energy consumption returns of the Designated Agencies and BEE (section 14 (I)).
3. Comply with the energy conservation norms and standards prescribed under section 14 (g) of the Act.
4. Purchase Energy Saving Certificates (ESCerts) for compliance to section 14 (g) in the event of default. The Act has been amended with the addition of new sub-section 14A to enable this and section 14A (2) allows such trading. ESCerts are defined by adding a new sub-section 2(ma).
5. Monitoring and Verification of compliance by Designated Energy Auditors (DENA) which will be prescribed the Government/ BEE under section 14A/13 (p) of the Act.
6. Excess achievement of the target set would entail issuance of ESCerts under section 14A (1).
7. Penalty for non-compliance being Rs. 10 Lakhs and the value of non-compliance measured in terms of the market value of tones of oil equivalent by inserting a new section 26(1A).
8. BEE to be the overall regulator and dispute resolution agency and Energy Efficiency Service Ltd. (EESL) to be the process manager.

Opportunities in PAT

There are similar international schemes in place, which have played a key role in addressing issue of energy efficiency in energy consuming facilities. These schemes act like a pilot before designing key components of PAT scheme.

Earlier these schemes were launched in voluntary phase but since 5-6 years mandatory obligations are emerging.

Figure 9: Global Trends in Cap & Trade market



As per the figure India has a lot of milestones to achieve. The achievements of these schemes are as discussed in the Table 3.

India specific learning's/opportunities from various schemes

- In India, DCs are responsible for 25% of the gross domestic product (GDP) and about 45% of the commercial energy. Henceforth schemes like PAT can be very useful to promoting energy efficiency in these highly energy intensive sectors and thus contributes towards energy efficient India.
- Large bandwidth in energy consumption in same sector promises considerable savings, which means high investments.
- Baseline setting exercises and Monitoring & verification procedures addresses hidden barrier
- To drive economy and respond to global energy reduction requirements in advance
- To build capacity across the country to implement and invest in energy efficiency
- Greater opportunities for Indian products to be competitive at international market

Table 3: International Cap and Trade schemes

International Scheme	Target	Description
European Union Emission Trading Scheme (EU ETS)	Saving by 500 Mtoe/ Annum by 2020	The EU ETS is a mandatory emissions trading scheme covering over 10,000 energy intensive installations across the 25 member states of the European Union. Phase 1 of the scheme operated from 2005-07. Phase 2 started in 2008 and will last until 2012.
Climate Change Agreements (CCAs)	Voluntary	CCAs are voluntary mechanisms that encourage energy efficiency in energy intensive industries in United Kingdom. CCAs were introduced in 2001 and are set to expire in March 2013. However, the government intends for the scheme to continue until 2007.
Tradable White Certificates (TWCs)	France WC phase 1 target = 54TWh, Phase 2 target = 345 TWh from 2011-2014	Tradable White Certificates are part of mandatory schemes implemented in several EU countries. Under this mechanism, producers, suppliers or distributor of electricity, gas and oil are required to undertake energy efficiency measures for the final user. ***France overachieved its target by 11.2 TWh in phase 1 (2006-2009)***
CRC Energy Efficiency Scheme (CRC)	Reduce carbon emissions by 1.2 million tons of carbon per year by 2020.	The CRC is the UK's mandatory energy saving scheme aimed at improving energy efficiency and reducing carbon dioxide emissions, as set out in the Climate Change Act, 2008.
United Kingdom Emission Trading Scheme (UK ETS)	Voluntary	The UK ETS was a voluntary emission trading scheme created as a pilot prior to the mandatory EU ETS. The scheme ran from 2002-2006
Perform Achieve and Trade (PAT)	9.78 million metric tons of oil equivalents	Discussed above

- Opportunities for manufacturer to overachieve and earn profits by selling EScerts

Possible Challenges for PAT scheme in India

- Baseline Assessment of the Individual units
- Setting Unit based targets
- Trading of EScerts
- Building of Trading Platform
- Monitoring & Verification

Key Discussion Points

- Role of Policy makers in promoting PAT – Penalisation Vs Incentivization
- Role of Designated consumers /their associations to drive the PAT program in India
- Monitoring and Verification of Targets achieved by DC's
- Financing issues both Economic & Fiscal
- Investments for new efficient technologies and addressing cost economics
- Creating Pool of Process Energy Auditing agencies for different sectors
- Capacity of financial institutions in India to support PAT
- Addressing people issues – Knowledge, Awareness, Motivation etc

Energy Efficiency in Buildings

Global building sector

Traditionally final energy consumption of all the nations across the world is classified into three sectors i.e.:

- Buildings
- Industry
- Transportation

Building sector accounts for nearly one-third of final energy consumption worldwide. Building energy consumption worldwide could be around 3800 million tonnes of oil equivalent (toe) by 2030 (As per IEA). Building sector also contributes to major climatic changes & around 20% of GHG emissions amounts from this sector. The emissions could be as high as 4300 million tonnes of CO2 equivalent by 2030.

Opportunities in Indian Building Sector

Electricity consumption pattern in India can be divided into the following sectors: industrial, residential, agriculture, commercial and others.

"Building energy consumption accounts for over 30% of electrical energy consumption in the country, and is rising annually at 8%"

During the past decades, population growth, the increase in economic development and greater access to diversified energy source and migration from rural to urban areas has resulted in the building sector experiencing many changes in the energy consumption, in both quantitative and qualitative terms.

Some facts about growth in Building sector: The overall constructed area would increase by about 5 times from 21 billion square feet (2005) to approximately 104 billion square feet by 2030 as shown in Figure 12 (USAID ECO-III project). *"More than 70% of the building area is yet to be constructed".*

There is a huge potential in building sector as there is technology and knowledge that could be used to create better, high-performance buildings. However, to turn these opportunities into reality, multiple challenges must be addressed.

Figure 10: Building sector energy demand

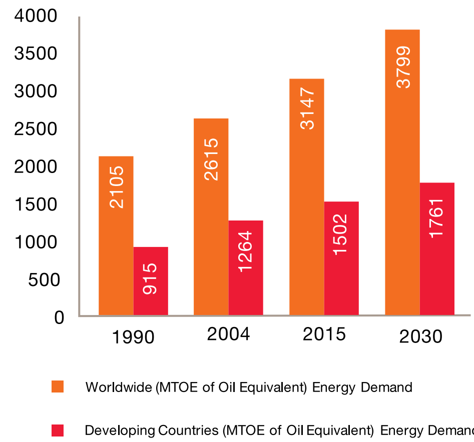


Figure 11: The energy consumption share of different sectors, 2010-11

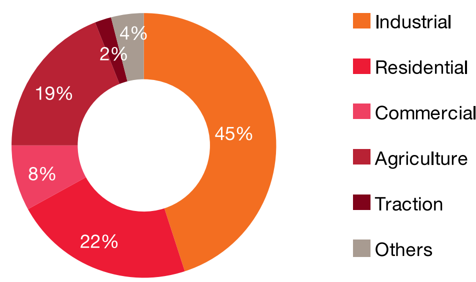
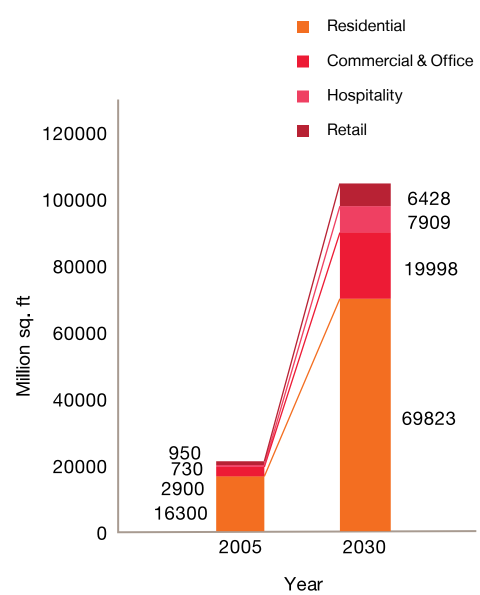


Figure 12: Floor space area in India by 2030 (Source: Growth of Indian Building Sector (CWF, 2010))



Energy Saving Potential in Buildings

Main Energy consumers in buildings are Lighting and Air conditioning. The energy saving potential in key sections is given below:

Table 4: Energy Saving Potential in Buildings

S.No.	Consuming section	Saving potential
1.	*Lighting*	Up to 30 %
2.	*Air Conditioning*	Up to 25%
3.	*DG Sets*	10-15%

Policy framework for Energy Efficiency in Buildings

BEE has the mandate to promote energy efficiency for existing as well as new buildings.

Existing Buildings

- Promoting EE retrofits in Central/State Government/PSU buildings through Performance Contracting.
- Providing financial platforms for ESCOs in the country for successful implementation of EE projects
- Star rating of buildings

New Buildings

- Developed the "Energy Conservation Building Code (ECBC)" for energy efficiency in buildings in India.
- Ministry of Environment and Forest in India has a Environment Impact Assessment (EIA) for both commercial and residential development
- Ministry of New & Renewable Energy and National Building Code are promoting Green Rating for Integrated Habitat Assessment (GRIHA) for buildings.

Both the government and private sector have launched initial programs designed to promote energy efficiency in buildings. These programs are expanding to include larger segments of the building sector and overcome roadblocks to wide-scale adoption of efficiency measures. The key programs—the Energy Conservation Building Code, the National Mission for Sustainable Habitat, and the labeling programs LEED and GRIHA.

Drivers/Opportunity in energy efficiency in buildings

Successful implementation of energy efficiency in building sector depends on the following drivers –

- Policy push towards this initiative
  - States are in phase of adopting ECBC leading to open window of opportunity for implementation.
  - Commitments by States to have energy reduction targets can create huge opportunity for existing as well as new buildings.
- Growth in infrastructure/urbanization
  - 70% of the buildings are yet to be developed till 2030 so there is huge opportunity.
  - Urbanization would lead to need of efficient buildings/housing
- Awareness generation among consumers
  - Builders/Occupier would demand energy efficient houses/buildings.
  - Energy efficiency could be a key selling point.
- Availability of viable technology/options
  - Need for technology interventions to improve energy efficiency.
  - Inflow of energy efficient products in the market
  - Need of energy service companies to drive the market.

Stakeholders in energy efficiency in buildings

The different stakeholders in energy efficiency in buildings are identified below:

Challenges for EE Implementation

Significant barriers to increased energy efficiency persist in current design, construction, and/or operation practices. Table below summarizes the challenges faced by the major stakeholders in the Indian Building Sector in implementation of Energy Efficiency in India.

Table 5 : Stakeholders in Building energy efficiency sector

Authority/Policymakers	Technical Support/ Technologies	End User
Bureau of Energy Efficiency (BEE)	Architects (ECBC expert architects)	Building Owner
State Designated Agency (SDA)	Engineers	Tenant
Municipal/Urban Local Bodies (ULBs)	Energy Service Company (89 ESCOs accredited by BEE)	
National Building Organization (NBO)	Construction Firms	
CII/TERI	Material Suppliers	

Barriers through implementation ESCO Route in Existing Buildings

The ESCO market in India has operational experience in India of more than a decade old which started in 1994-95. There are 89 BEE empanelled ESCOs in the country, but the status of implementation through ESCO route is not very good. Implementing energy efficiency through ESCO route faces many barriers in India which are listed in the table 7 along with possible discussion points.

Key Discussion Points

- Need of State level targets to reduce energy consumption in government buildings
- Need of Pilots to promote implementation through ESCO route
- Mechanism for effective implementation of ECBC

Table 6 : Overview of challenges in implementing energy efficiency in buildings

Barriers	Examples	Possible Remedies
Financial Barriers/High Initial Cost	Higher up-front costs for more efficient equipment, Lack of access to financing Energy subsidies	Fiscal and economic instruments such as tax rebates, subsidized loans, regulatory instruments.
Hidden Costs and Benefits	Costs and risks due to potential incompatibilities, performance risks, transaction costs etc.	Appliance standards, building Codes, standardization of audits and standard monitoring & verification procedures.
Complexities in Building Supply Chain/Misplaced Incentives	• Limitations of the typical building design process • Fragmented market structure Landlord/tenant split and misplaced incentives • Limited information • Unavailability of energy efficiency equipment/ materials locally	Creating sufficient capacity in the market in producing/ supplying energy efficient products. Mechanisms for Technology transfer
Awareness	• Lack of awareness amongst consumers and building owners	Creating awareness through campaigns, advertisements , Stakeholder interactions
Behavioural and Organizational Constraints	• Tendency to ignore energy saving opportunities • Organizational failures (e.g. internal split incentives) • Non-payment and electricity theft Tradition • Behaviour and lifestyle	Support, information and voluntary action: Voluntary agreements Information and training programs
Information Barriers	Lacking awareness of building managers, construction companies, politicians	Awareness raising campaigns, Training of building professionals,

Table 7 : Important barriers for ESCOs

Barriers	Reasons	Possible Solutions
Lack of willingness to go for energy efficiency project	No mandatory energy reduction targets.	Targets at State level for all government buildings /Private operators would initiate implementation in these buildings and in a way, would set pilots for larger demonstration in all segments.
Lack of Confidence and trust in ESCOs	Customers are suspicious of the "win-win" solution, don't believe in success of saving	Appliance standards, building Codes, standardization of audits and standard monitoring & verification procedures.
Limited knowledge/ dissemination about successful case studies	Limited demonstration/sharing of experiences	More number of case studies to be created and shared through programs for pacing EE implementation in buildings.
ESCOs not interested in small projects	Transaction costs high (i.e. profit is too low and risky)	Need to create business case for ESCOs to invest.
Financing problem: ESCOs have insufficient internal funds and do not get access to grants	Especially small new ESCOs	Guarantee fund if high perceived risk, loan schemes, preferential loan schemes

Demand Side Management - Agriculture

Electricity is the primary source of energy consumption in Indian agriculture pumping sector. Transformation of electricity sector with commitments to sustained energy efficiency on national level is essential to improve the energy security of this nation. The Indian agriculture pumping sector is the third highest consumer of electrical energy with a total consumption of 92.33 billion kWh in 2007-08[1]. This accounts for 20% of the overall electricity consumption in India. Twenty five years ago electricity sales to irrigation pump set consumers was less than 10% and today it is about 20%[2]. Managing agricultural load has been a key challenge to all electric utilities in India. HP-based flat rate tariffs that are paid irrespective of the electricity use perceive zero marginal cost for electricity use and hence disregard efficiency in consumption. This is reflected in purchase preference for cheap but inefficient pumps.

Background

Various pilot studies undertaken by World Bank (2001), WENEXA (2007) have revealed the poor level of efficiency of the agriculture pump sets. A recent study by NPC estimates a total saving potential of 27.79 billion Kwh in Indian agricultural pumping sector.

This accounts for 37% of the overall energy saving potential and about 40% of the overall energy deficit reported in the country during 2007-08.

Apart from the energy savings, the benefits derived from reduction in subsidies are also significant. Subsidised tariffs for agriculture consumers are supported partly by budget subsidies from respective state governments. In 2007-08, this was estimated to be Rs.141.6 billion (GOI, 2008).

With this huge untapped potential, it is quite clear that investments in energy efficiency measures are often more cost effective and socially beneficial than to increase power supply or transmission capacity. Demand-side management (DSM) has often been considered as one of the key strategies capable of offering unique opportunities to implement energy efficiency measures. Agriculture DSM programme could offer a unique way to influence and change the equipment buying habits of end use consumers so that they prefer to adopt efficient technologies. Pump set efficiency up-gradation is one the key aspects of DSM measures in agriculture sector. The replacement of existing inefficient pump sets with energy efficient star rated pump sets would unlock the market for investments of very large scale.

Opportunities in Ag-DSM in INDIA

The Bureau of Energy Efficiency which is nodal agency for promoting energy conservation programs in India has initiated a national Ag DSM programme in which pump set efficiency up gradation would be carried out through Public Private Partnership mode. The primary beneficiary of this program will be the state governments that provide financial support to the utilities for subsidizing electricity tariffs in agriculture pumping sector. Significant reduction in state government subsidy for agriculture pumping would allow the governments to channel the funds to other social sectors including education, primary health and rural infrastructure. The Ag DSM scheme of BEE is currently initiated with pilot scale demonstration projects in 11 Discoms of eight states which are agriculturally intensive and account for more than 70% of electricity consumption

1 *National Productivity Council, 2009*
2 *Agriculture demand side management pilot project in BESCOM – USAID/DRUM*
3 *BEE, Ministry of Power, Government of India*

in this sector. The scheme covers about 20,000 pump sets with 11 investment grade energy audit reports[3].

Apart from this, there are about 13.38 Million agricultural pump sets currently being used in the country with a total investment potential of INR 26,800 crores for tapping the huge energy saving potential in the agriculture sector. The total annual benefit to Discoms and State Governments is estimated at INR 14200 crores. The State Governments may derive estimated annual subsidy reductions to the tune of INR 4200 crores, through energy efficient savings measures in agriculture sector.

Table 8 shows a simple cost benefit analysis for implementing DSM measures in Indian Agriculture sector.

Table 8: Cost benefit analysis for nationwide replication of Ag DSM projects

No. of agriculture connections in the country	13.4 Million [4]
Total investment envisaged (INR crores)	26800
Conservative estimate of Energy savings (in MU)	27790
Avoided generation capacity (in MW)	8604
Avoided power purchase (in MU)	32694
Annual gain due to reduction in power purchase (INR crores)	11443
Loss of sale to agricultural consumers (INR crores)	1390
Annual gain due to reduction in subsidy from state govts. (INR crores)	4169
Total annual gain to Discoms and state govts. (INR crores)	14222
Simple payback period (Years)	2

**All calculations in the above table are based on the energy audit studies of BEE*

Drivers of Ag DSM

Identification of drivers for Ag DSM empowers the policy makers as well as the implementing agencies to identify and mobilise resources. The importance of key drivers for implementing a nation-wide policy for pump set replacement would also assist in identifying benefits to various stakeholders and thus seek their cooperation and commitment. The most important drivers that support implementation of the suggested policy are identified as:

- Enormous scale of Energy savings
- Reduction in subsidy burden on state governments
- Enhanced transparency and accounting of energy consumption
- Improved Financial stability of Discoms
- Reduced pressure on groundwater reservoirs

It is important to note that benefits of the policy go beyond the power sector and has other environmentally benign outcomes, like by easing pressure on groundwater reservoirs. Due to lack of consumer metering and energy accounting, system losses have been camouflaged as high consumption in the agricultural sector. Improved transparency and energy accounting would not only plug revenue leakages, but may also reduce the tariff subsidies from state governments[5].

Challenges in Ag DSM

Six major challenges faced in implementing Ag DSM are as follows:

Financing	Economic
Technical	Monitoring
Institutional	External/Political factors

Table 9 describes the challenges in each of these aspects and also presents the degree of likelihood and impact of these barriers. The table also presents the mitigation strategies for overcoming these barriers. These strategies are developed based on the experience of developing and implementing Ag DSM pilot projects in various states under the AG DSM programme of BEE.

Key discussion points

Agriculture Demand Side Management has proven its importance in the overall power scenario of the country with an enormous potential yet to be tapped. Financing and institutional challenges seem to be the most critical barriers shielding the investments in large scale Ag DSM projects. Accountability is another pressing challenge for the institutions to gather and collate reliable data related to energy consumption/savings in this sector. Several Ag DSM pilot projects across the country have been initiated by BEE with detailed projects reports studying the baseline consumption, energy saving potential and other critical project parameters. These pilot projects should be further taken up for implementation by BEE/EESL after consulting the various stakeholders in the states. The findings of these pilot projects may form the basis for large scale replication and the following strategies may be adopted for market transformation in agriculture pumping sector.

- Utilities must take primary responsibility to improve accountability and further pursue DSM measures in the agriculture pumping sector.
- Innovative financing mechanisms should be developed and utilised to plan, design and implement the Ag DSM options periodically.
- Sound policy and regulatory framework must be put in place to provide adequate payment security to the investors and incentives to all the major stakeholders.
- Star labeled energy efficient pump sets must be made mandatory for all the newly applied connections in all the states. The regulatory commissions and the state nodal agencies should develop a case for such regulations under the guidance of BEE and further pursue with the state governments for effective implementation.

4 National Productivity Council; BEE, 2009

5 A Policy for Improving Efficiency of Agriculture Pump sets in India: Drivers, Barriers and Indicators by Anoop Singh, 2009

Table 9: Risk assessment in Ag DSM projects

Risk Type	Risk description	Likelihood	Impact	Mitigation strategies
Technical	Reliable power supply for better performance – voltage fluctuations may threaten the safety of pump sets	Medium	High	High voltage distribution (HVDS) system should be put in place The energy efficient pump sets should be Wide-voltage operating pump sets capable of performing at low voltage conditions
Economic	Discontinuation of state subsidy for saved electricity – potential revenue risk	Low	High	Institutional support from BEE, MoP to propose a gradual reduction mechanism of subsidy corresponding to the saved electricity
Financial	Payment security for private investors	High	Medium	ESCROW accounts should be set up for payments made to the investors Innovative business models like 'Hybrid mode' which guarantees the establishment of regulator approved fund for payments to be made to the investor
Monitoring	Un-metered connections ; Measuring and monitoring baseline consumption, savings and other critical project parameters	High	Medium	Agriculture Feeder segragation from other category of consumers Metering of consumers
External	Deviation of expected savings due to variations in ground water and cropping pattern	High	High	Deemed savings approach – freezing of pump set operational hours
Monitoring	Disputes among stakeholders in the Measurement & Verification of energy savings – absence of a standardised protocol	Low	Medium	Development of comprehensive M&V protocol Third party appointment by BEE for Measurement & Verification of energy savings - implementing the M&V protocol
External	Theft and safety of energy efficient pump sets	Low	Medium	Contractual obligations between farmer and AgIA must incorporate a hefty penaly to the pump set operator (farmer) for compromising on the saftey of pump sets Insurance for energy efficient pump sets must be made mandatory for while procuring pump sets by AgIA
Technical	Performance of energy efficient pump sets	Medium	Medium	4 star and above should be a mandatory specification Selection of appropriate sizing based on the head and flow parameters Significant penalty in the contract for under performance
Political/ External	Resistance from farmers	Low	Medium	Open house sessions, awareness programs to be organized with significant community participation Project inaugurations through Local influential Politicians New pump set to provide the same or more water discharge ESCO to provide after sales service
Institutional	Project development risks	Low	Low	BEE to provide resources for DPR development, awareness generation, training of local specialists and development of contract documents associated with the project. BEE to undertake step-wise project development; beginning with thorough feasibility report; developing a business model to implement the project
Institutional	Illegal connections Size of pumps higher than that of the sanctioned load Deceased legal utility	High	High	The utility should increase the sanctioned load of such consumers when informed by AgIA and collect the dues/fees at a later date The utility should allow the AgIA to sign the agreements with the present legal owner of the pump

Combined Heat and Power (CHP)

Combined heat and Power also known as Cogeneration is simultaneous generation of useful heat and power using a heat engine or in a power station. Cogeneration can be defined as the sequential generation of two different forms of useful energy namely electrical energy and thermal energy from a single primary energy source.

All thermal power plants or heat engines produce large amount of heat during generation of electricity which is wasted/ released into the atmosphere in the form of flue gases. In a combined heat and power some or all the waste heat is captured and changed into useful heat which can be used either for direct process applications or for indirectly producing steam, hot water, hot air for dryer or chilled water for process cooling.

Conventional thermal power plants and heat engines do not convert all their thermal energy into electricity and are only about 30%-35% efficient. By capturing the waste heat a CHP uses the heat that would be otherwise wasted in a conventional power plant increasing it efficiency up to 80%-85% consequently reducing fuel needs.

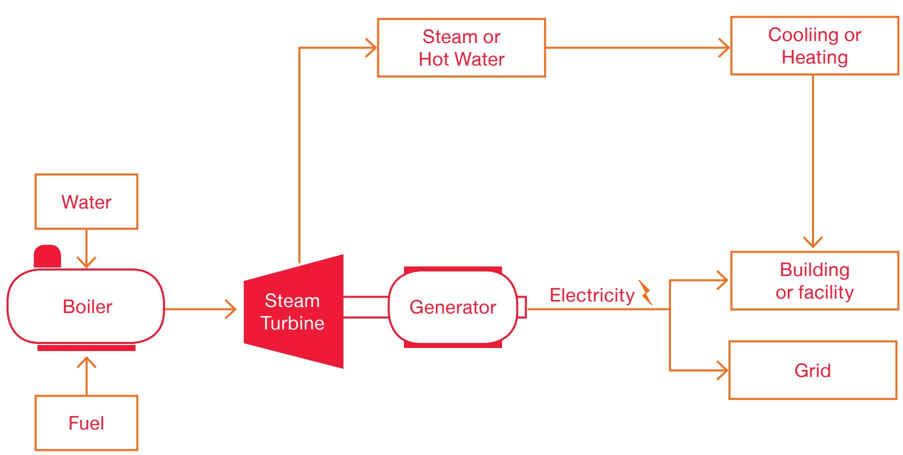
Benefits of CHP

CHP has wide array of advantages ranging from economic to environmental benefits; first and foremost it is a proven energy efficient technology. CHP can achieve significant cost savings, environment benefits by reducing carbon emissions, enhanced energy security and overall efficiency in excess of 80%.

A summary of benefits are listed below:

1. High overall efficiency in excess of 80%
2. Cost savings of between 15% and 40% over electricity sourced from the grid and heat generated by on-site boilers
3. Flexibility to use bio-mass and other environmental friendly fuels
4. Enhanced security of supply, making energy go further, through more efficient use of fuel – regardless of whether the fuel is renewable or fossil
5. Flexible and responsive heat supplies – the thermal energy (heat or cooling) produced by CHP can be easily stored and later delivered to meet demand
6. More towards decentralized form of electricity generation thus avoiding high transmission losses, increased flexibility, high reliability and less dependency on grid

Figure 13: Simple Schematic of Combined Heat and Power



Global Scenario

The global average share of CHP share of total national power production is 9% with countries like Finland and Denmark being the most intensive cogeneration economies. Europe has actively incorporated cogeneration in its energy policy as CHP has been identified a proven energy efficient technology.

European Union generates 11% of its electricity using cogeneration, saving Europe an estimated 35 MTOE per annum a day.

CHP potential identified by different countries using different assumption is as below:

1. European Union has CHP directive as part of their policy and requires member states to undertake comprehensive national studies of the potential for CHP. Studies present more than 150 - 250 GW CHP potential up to 2025
2. Current CHP share in Canada is 6% and plan to take it to 12 % of project national capacity by 2015 under a "CHP Promotion" scenario.
3. The UK CHP economic potential study undertaken by the UK government identified an economic potential for CHP of 17% of total national power generation by 2010 (currently 7.5%), with a potential for an additional 10.6 GWe of CHP on top of the current level of 5.4 GWe by 2015
4. The German CHP target was in 2007 raised to 25% (a doubling of the current share) in 2020, based on a National Potential Study conducted by the government under the European Union's CHP Directive. This study also cites economic CHP potential to be up to 50% of electricity capacity
5. CHP potential in Japan for 2030 has been identified as up to 29.4 GW, around 11% of projected total capacity for that year
6. In India, the additional potential for industrial CHP alone has been identified as exceeding 7,500 (MWe).

(Source: IEA, DEFRA, Germany Ministry for Environment, BMU, METI, 2005)

Figure 14: CHP Share of Total National Power Production (Source: IEA, CHP: Evaluating the Benefits of Greater Global Investment 2008)

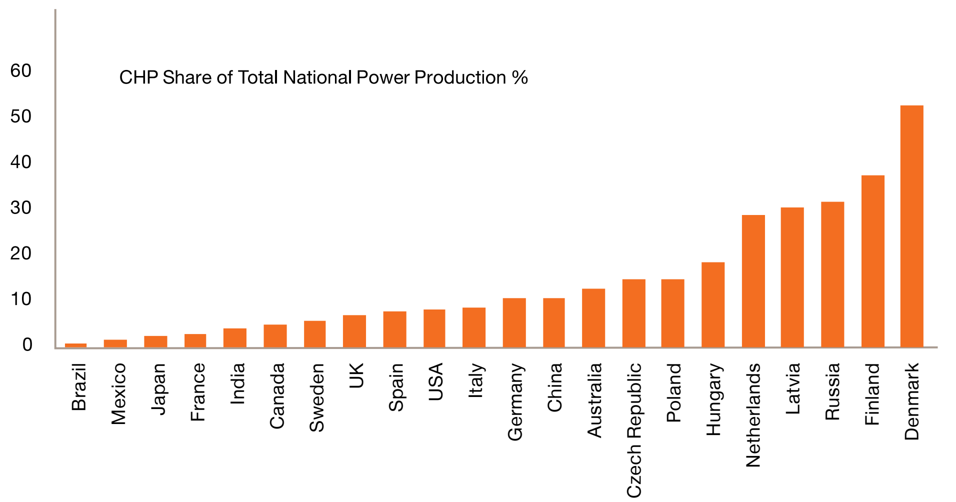


Figure 15: Current and Projected CHP capacities under ACS, 2015 and 2030 (Source: IEA data and analysis)

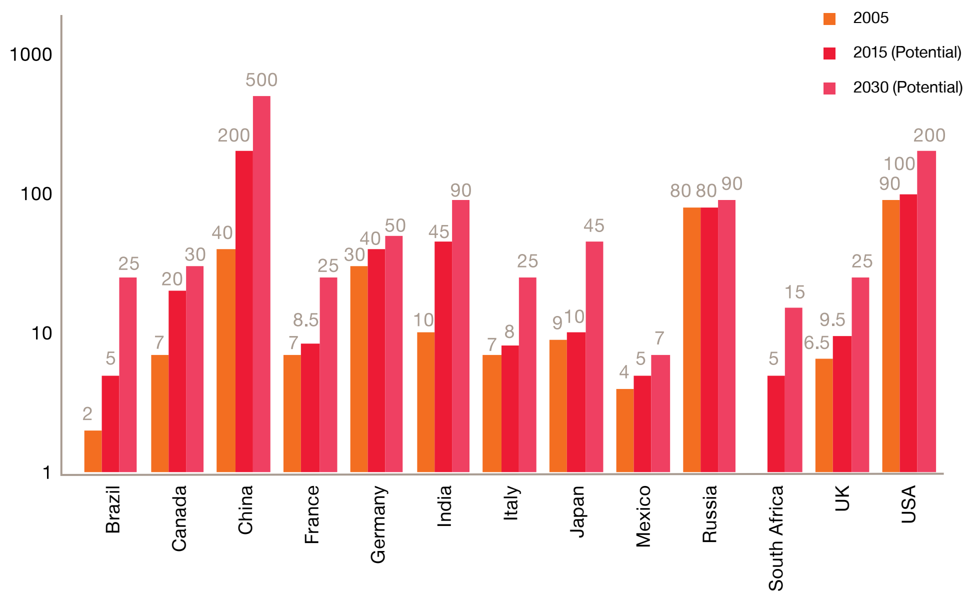


Figure above gives global estimates by IEA on CHP potential by 2015 and 2030 based on the rates of CHP development that approach the rates seen over the last three decades in countries like Denmark, the Netherlands and Finland under the Accelerated CHP Scenario (ACS).

Indian Context

Estimates of CHP in India have been lacking and those that exist have been based on differing definitions of CHP. The GOI estimate is restricted to bagasse-based cogeneration, where the current capacity is estimated to be over 700 MW, predominantly in the states of Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and Uttar Pradesh.[6]

However, this is likely to strongly underestimate the total use of cogeneration in India. Using the best available data, the IEA estimates that in 2005, CHP capacity in India was over 10 GW from over 700 units, with a heat-generating capacity of 170MW.[7] This is about 5%of the total electricity generated. This demonstrates that a good first step would be to commission further work in India to improve cogeneration/CHP definitions and improve data quality.

CHP Policies-India

1. 1993 Policy for Cogeneration

- Set methodology for fixing tariffs for sale of CHP power to State Electricity Boards

2. Energy Conservation Act 2001 enacted to provide for energy efficiency and conservation

- Bureau of Energy Efficiency (BEE) created with mandate to promote energy efficiency, including CHP and demand-side management

3. Electricity Act 2003

- A number of market liberalisation provisions
- Creates district level committees to promote EE
- Includes non-fossil fuel obligation

4. National Electricity Policy 2005

- Enacted to promote non-conventional energy source and cogeneration

5. Tariff Policy 2006

- State can mandate % of power from non-fossil resource (including CHP); also feed-in tariff

6. Central Electricity Regulatory Commission (CERC) Discussion Paper [8]

- Proposes preferential treatment (exemption from inter-state open access charges for transmission, wheeling, standby power, grid connection, and scheduling) to renewable energy sources for arranging inter-state transmission when open access is used
- Allows reactive energy charges to be applied by the host utility under the Indian Electricity Grid Code

Key stakeholders for the program

- Ministry of Power (MOP)
- The Ministry of New and Renewable Energy (MNRE)
- Central/State Electricity Regulatory Commission
- State/Local Departments
- Industry
- Equipment Suppliers

Barriers and Challenges in India

In India, most industrial facilities are connected to the main grid for their power needs. High energy costs and lack of available power has led some industrial plants to invest in on-site generation via CHP. While this is a start, there appears to be substantial additional potential for CHP but to exploit the benefits of cogeneration, barriers at different levels (policy, financial, technology etc.) need to be addressed. Some critical barriers are listed below:

1. Lack of a clear definition of CHP (Cogeneration is often assumed to be limited to bagasse-fired CHP)
2. Sale of surplus CHP power through open access rules which is currently expensive due to high surcharges and the imposition of duplicative transmission that appears to be unnecessary.
3. Standby charges, while justified may present an economic barrier to the use of CHP.
4. Substantial investment difficult to justify on basis of sale of power
5. Import of critical equipment is required as it is not available indigenously
6. Power generation in parallel operation with grid faces design and implementation issues

Key Discussion Points

1. Future Policy needs with respect to Cogeneration
2. Role of stakeholders in promoting CHP
3. Financial support mechanism
4. Strengthening indigenous capacity with respective to technology
5. Methods to raise awareness about CHP

6 *Annual Report 2007-08,Ministry of New and Renewable Energy (MNRE), GOI, Tables 1.1 and 5.4.*

7 *Combined Heat and Power: Evaluating the Benefits of Greater Global Investment," IEA 2008, http://www.iea.org/Textbase/Papers/2008/CHP_report.pdf.*

8 *" Arranging Transmission for New Generating Stations, Captive Power Plants and Buyers of Electricity," CERC Staff Paper, July 2008*

Supply side energy efficiency

Efficiency improvement in Generation

Improvement in Power Plant efficiency improvement is an imperative in today's high energy price regime and carbon constrained world. Increasing power plant efficiency can reduce the amount of fuel used and thereby the amount of carbon dioxide emitted. Global power plant efficiencies improvement over time is projected. These expected improvements will mainly come from the substitution of old plants with new plants that have better efficiencies. The existing plant efficiency is flat. This indicates some efficiency improvement since many of the existing units will likely install environmental controls. Installation of environmental control systems will add internal energy requirements reducing the efficiency of the plant. There are a few changes that can be made to make an existing plant more efficient. Typically these changes will only result in a few percentage point improvements to efficiency.

The efficiency of a new power plant is largely a function of economic choice. The technology is well understood in order to produce a highly efficient plant. In order to produce higher efficiencies, higher pressure and temperatures are required. This increases the cost of the plant as special alloys will be needed. Technology improvements could assist by lowering the cost of these special materials through discovery and better manufacturing process.

Power plants can have useful life of 40 years or more, so it becomes important to introduce the efficient units early in the development of the infrastructure. In India we have this opportunity as we build infrastructure for tomorrow.

Factors Affecting Efficiency

The following factors affect the efficiency of new power plants.

Design choices: Designs for natural gas and coal-fired power plants represent a trade off between capital cost, efficiency, operational requirements, and availability.

A steam turbine system that operates at a higher temperature and pressure can achieve a higher efficiency. The higher temperatures and pressures, however, require specialised materials of construction for both the boiler and turbine, thus pushing up the capital cost.

Operational practices: Efficiency can be improved by increasing the air to fuel mix, fully utilizing heat integration systems, remedying steam leaks and exchanger fouling, and a large number of other practices. Operating at full load capacity continuously will enhance efficiency. However the reality is that load is ever changing and the requirements of market based systems focus on reliability and leads to the inability to always run at full load.

Fuel: Among coals the higher ranking coals enable higher efficiency because they contain less ash and less moisture.

Pollutant control: The level of pollutant emission control (including thermal) effects efficiency. NOx (nitrogen oxides) reduction units and SOx (sulphur oxides) scrubbers represent parasitic loads that decrease net generation and thus reduce efficiency. This issue is further discussed in latter parts of the report.

Ambient conditions: Colder water and ambient air achieves higher efficiency. Additionally, higher altitudes have lower ambient pressure which affects compression and expansion. For example, gas turbines produce lower power at elevations above sea level. The power output loss is a function of the loss in ambient pressure. All else equal, lower altitude enables higher efficiency.

Parasitic Load: With campaigns for SOx, NOx, and mercury reduction gaining strength, the number of units with scrubbers and/or SCRs (selective catalytic reduction) is expected to rapidly increase over the next 10-15 years. The obvious environmental benefits of these emission abatement programs come at the detriment of power efficiency. Scrubbers and SCRs, like any auxiliary equipment in a power plant, require electricity to run. This electricity is obtained from the generating unit that is being controlled. This power loss is known as parasitic load. Just as heat rate is a measure of efficiency by calculating the amount of fuel needed for each kWh (kiloWatthour) of power, parasitic load is an efficiency loss because a certain number of kWhs generated must be used for internal power plant use and cannot be sent to the grid for sale.

Water Utilization Energy Penalty: Water is used in large amounts as the method to cool the effluent from the steam turbine. Cooling water is used from an external source such as a river or lake to condense this exiting steam. The temperature of the cooling water as it enters the condenser can have significant impacts on turbine performance by changing the vacuum at discharge from the steam turbine. In general terms, cooler water will create a larger vacuum allowing more energy to be generated. Conversely, warmer water creates lower vacuum and impedes generation. This effect is known as the energy penalty.

In tropical climates like India and specially in some of the hot climates, use of air cooled condensers consume extraneous energy further reducing the overall energy consumption of plant and reducing net efficiency of plant.

Possible means to achieving efficiency Improvement

Existing coal-fired power plants worldwide do not achieve the highest efficiency possible based on their design. The loss of efficiency can be categorized as controllable or noncontrollable. Controllable losses are generally due to poor operation and maintenance practices. Non-controllable losses are due to environmental conditions (i.e. cooling water temperature, etc), dispatching requirements (i.e. customer demand) and normal deterioration. Deterioration naturally occurs, and if left unchecked it can become substantial. Therefore, some amount of deterioration, normal deterioration, will always be present and is noncontrollable. Most of the normal deterioration can be recovered with regularly scheduled maintenance intervals, the frequency of which determines the average based on the resulting saw-tooth curve. As the unit ages, there is a gradual increase in the unrecoverable portion which would subsequently require a replacement rather than a refurbishment to restore efficiency. Poor maintenance practices regarding the timing of the intervals and the amount of refurbishment may result in excessive deterioration and is controllable.

Poor operation is a controllable loss. It includes operating off-design (i.e. temperatures too low), running redundant equipment, particularly at part load, excessive start-ups due to poor reliability, unit controls not properly tuned and off role operation. Off role operation may be using a unit designed for load following (with a control stage) for base load or one designed for base load (without a control stage) for load following.

Dispatching requirements determine the generation level of the unit and is not controllable. Since efficiency drops with load, this loss can be substantial (5-10% at half load).

Excessive Deterioration and poor O&M practices are controllable and are recoverable through routine refurbishment and correction of poor O&M practices. These categories are generally acknowledged to be on the order of 500 Btu/kWh for an average plant and can reach 1000+ in some of the more poorly run plants. Beyond refurbishment, replacement is the next step. This resets normal deterioration loss to 'as-new' values and addresses maintenance reliability problems that can impact heat rate. Replacement opens up the possibility of upgrade. Why not replace a part that may be 20 to 60 years old with today's technology and end up better than the original design? Turbine upgrades are prime examples. Controls, condensers and air heaters are other popular upgrades.

Advancement in design opens up another possibility, modifying the original design of a unit. This can be as "simple" as resizing the backend of the turbine to increase flow capability or reduce losses due to being undersized in the original economic analysis (low fuel prices) or as complicated as totally replacing major pieces of equipment and modifying the cycle. In some cases, such as turbine nozzles, the replacements can be designed to have a lower rate of deterioration. In the extreme, this type of upgrade can become a repowering option where the boiler is replaced by combustion turbines, a new boiler or converted to CFB (circulating fluidised bed). Significant efficiency and fuel changes are possible. To summarize, deterioration can be addressed as follows:

- Refurbishment
- Replacement in kind
- Upgrade with advanced design
- Modify original design
- Repowering
- Retirement with replacement by new construction

Given the large aggregate capacity of existing coal-fired power plants and their long useful life, efforts to improve the average efficiency of the existing stock by one or two percent could have a significant near term impact on fuel consumption rates and greenhouse gas emissions. Every plant, based on age, condition and economics will fall at one of the levels on the above list, with most of them in the top 3 categories. Different pieces of equipment might be at different levels for the same plant. The amount of gain is also a function of the plant's design and situation. Finally, when all is considered, most plants will fall in the 3-6% range of possible improvement. The practical or economic values will be lower. The newer plants might be in the 2-4% range and a certain population might be 2% or less because they were already upgraded.

The EIA is forecasting moderate improvements in the coal fleet heat rate, achieving 9,700 Btu/kWh by 2030. In terms of percentage improvement it is approximately the same trend as gas units. This indicates many more new coal plants as compared to new gas plants in the projection. To see any appreciable improvement in fleet heat rate, a large number of new, efficient units would need to replace a large number of old, inefficient units and/or existing units would have to be retrofitted. With 40 year life spans and high capital costs (vs. gas plants) to construct, and risk of a CO2 constrained environment, this is not achieved very quickly. The difference in fuel price (coal vs. gas) is another major driver for increased efficiencies in gas plants compared to coal plants. Major increases in combined cycle efficiencies will make those units more competitive with coal in dispatch. With coal's current fuel pricing advantage, there is less incentive to make wholesale improvements in efficiency versus focusing on availability.

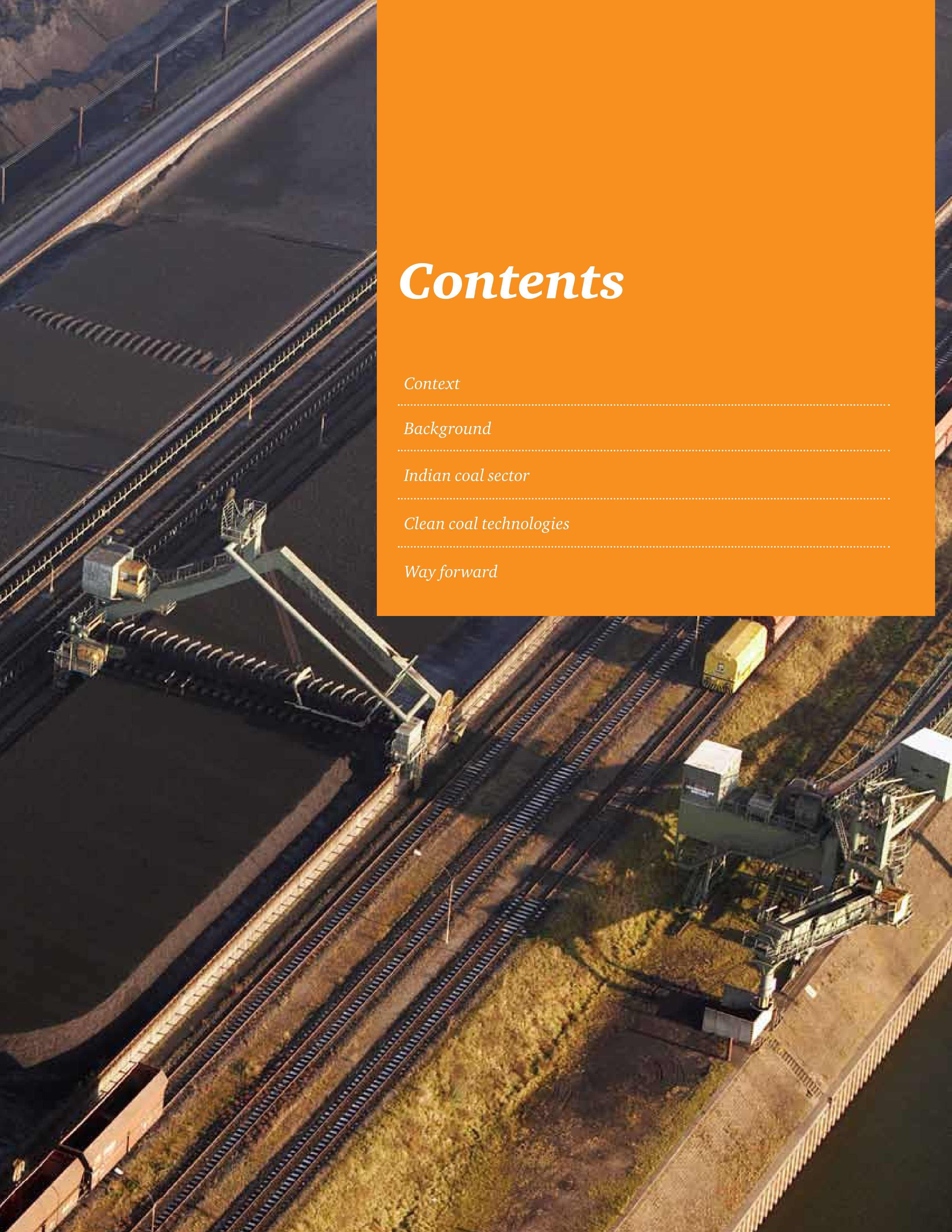
References:

1. Bellman, David K. 2007. "Electric Generation Efficiency" National Petroleum Council Power generation efficiency subgroup of the Demand Task Group of the NPC Committee on Global Oil and Gas
2. APEC Energy Working Group. 2005. "Costs And Effectiveness Of Upgrading And Refurbishing Older Coal-Fired Power Plants In Developing APEC Economies"

Emerging opportunities and challenges

Coal

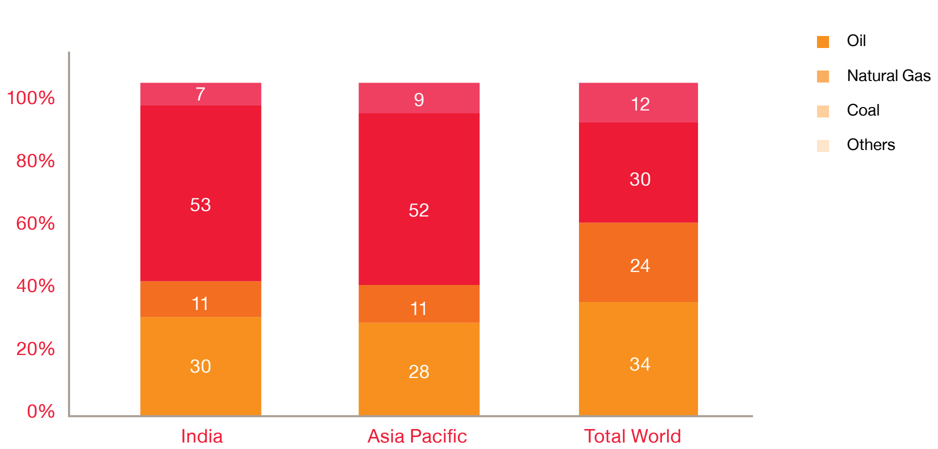
Contents



Context

India is among the top five global economies with a GDP of over 4 trillion USD based on purchasing power parity[1]. It is one of the fastest-growing economies at growth rate of around 7 to 8%. The high level of economic growth is likely to have a strong impact on the infrastructure and energy consumption levels in the country. These sectors will require specific attention to sustain the growth momentum. Presently, India largely depends on coal to meet its commercial energy demand. Coal account for 53% to the commercial energy sources in the country which is high compared to the world average of 30%. The 11th Plan projected India's coal demand to grow at 9.7% per annum against 5.7% during the 10th Plan -- almost a two-fold increase. Also, the mid-term appraisal of the Planning Commission envisages that the demand of coal by the end of the 11th Plan will be 713 million tonnes (MT). However, there is a demand supply gap in the sector and the country is presently facing challenges in meeting the demand of coal. Thus, it is essential to optimally utilise these natural resources and simultaneously look for overseas assets to increase the resource base.

Mix of Commercial Energy Sources: Comparison



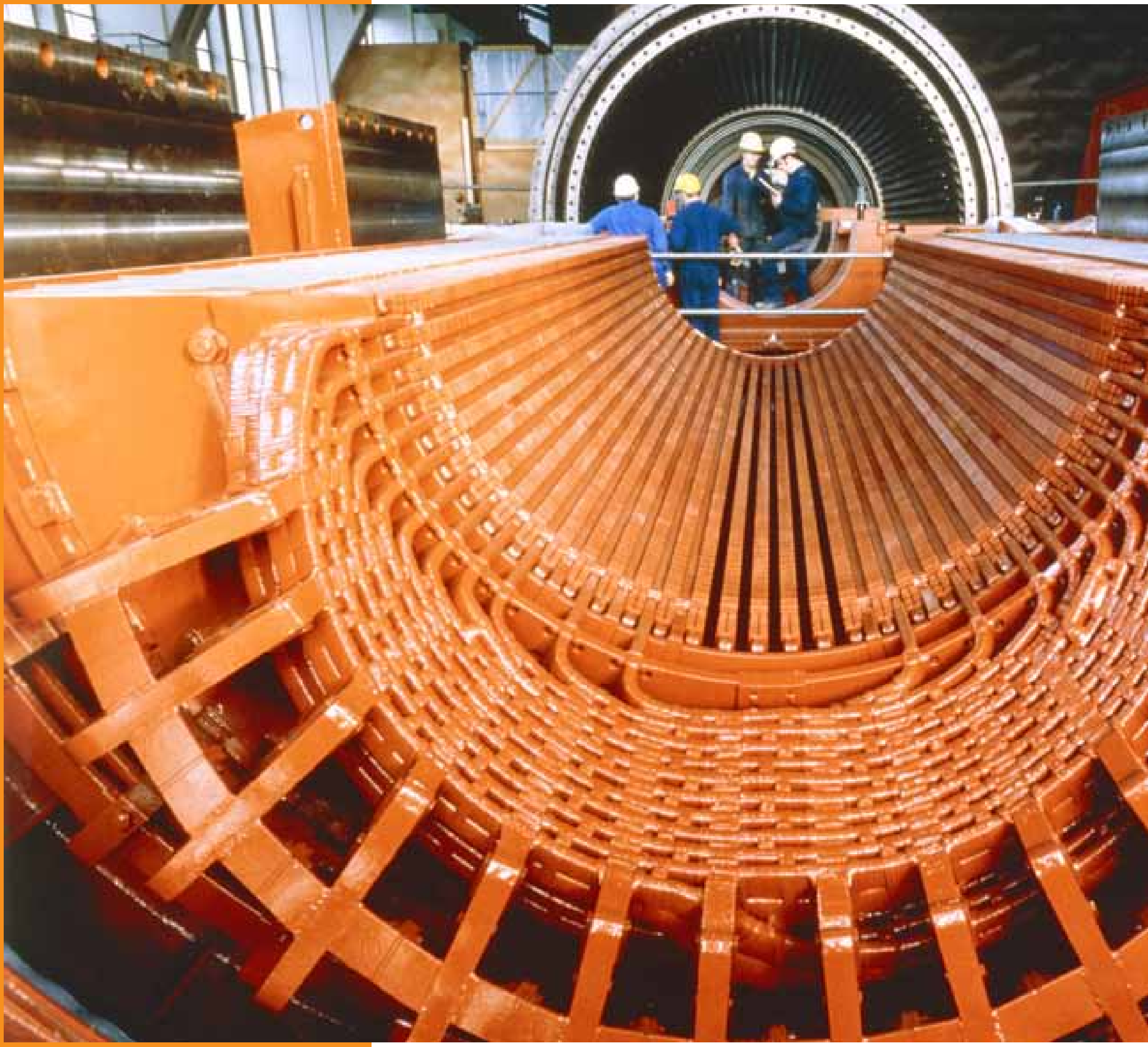
Source: Statistical Review of World Energy, 2011

1 *(Source: IMF WEO)*

Background

Reserves and resources

Global consumption trend



Reserves and resources

Economically recoverable reserves of coal are found in more than 70 countries worldwide spread across all major geographical regions. World's proven coal reserves is estimated at about 860 billion tonnes[2] which is expected to last up to 120 years at the current production levels. The global coal reserves consist of 53% anthracite and bituminous coals, 30% sub-bituminous coals and 17% lignite[3]. The largest reserves of coal are found in China, USA, Russia, Australia and India.

India has the fifth largest coal reserves in the world. Of the total reserves, nearly 88% are non-coking coal reserves while tertiary coals reserves account for a meager 0.5 % and balance is coking coal. Indian coal is characterised by high ash content of up to 45% and low sulphur content.

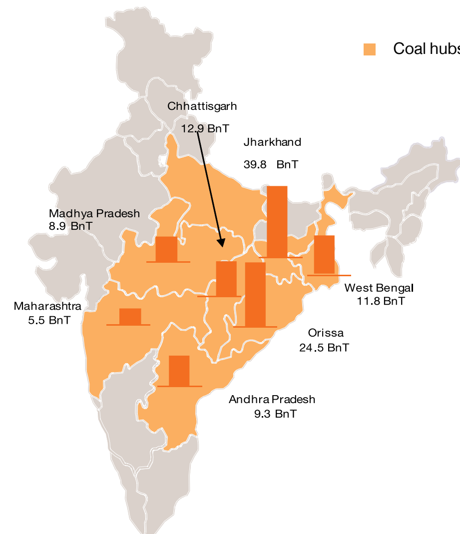
The table reflects the coal resources in India as on 1 April, 2011:

Resources in MT	Proved	Indicated	Inferred	Total
Coking coal	17,669	13,703	2,102	33,474
Non-coking coal	95,739	12,368	31,488	250,895
Tertiary coals	594	99	799.49	1,493
Total	**114,001**	**137,471**	**34,389**	**285,862**

Note: This does not take into account the already mined out **resources**. Total coal extracted from the coalfields of India since 1950 upto 2009-10 is around 10 BT[4]

Source: Geological Survey of India

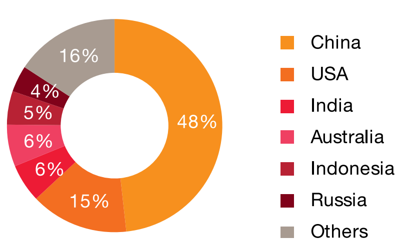
India's Gondwana Coal Reserves



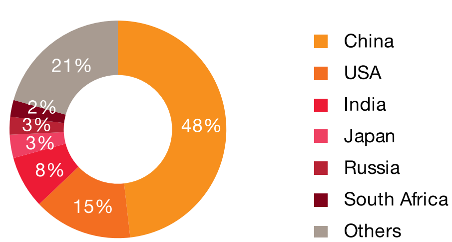
Global coal production and consumption trend

In the last year, the global coal production was more than 7 billion tonnes. Of these, China accounted for approximately half of the production as well as consumption. The Asia Pacific region continues to be the key demand driver which is highlighted by the fact that over the last 20 years, consumption by Asia Pacific region has increased at a CAGR of 5% which is approximately double the average world consumption growth rate.

Coal Producers



Coal Consumers



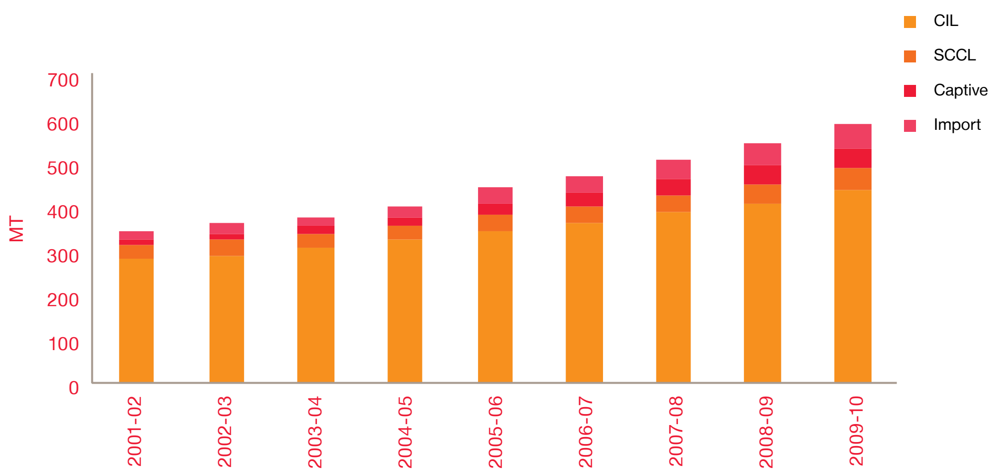
Source: Statistical Report of World Energy, June 2011

2 *(Source: BP Statistics 2011)*
3 *(Source: EIA, US Department of Energy)*
4 *(source: Coal Controller's Organisation, Ministry of Coal, Govt. of India)*

Indian coal sector

The country's demand for coal has grown at a CAGR of more than 7% in the last decade. Currently, the demand has reached beyond 600 MT. The demand is primarily met through indigenous production while the shortfall is met through imports. The share of imported coal in the total coal consumption has risen from 7% of total consumption in 2002-03 to about 10% in 2009-10.

India's coal supplies



Source: MoC, Planning Commission, Ministry of Commerce

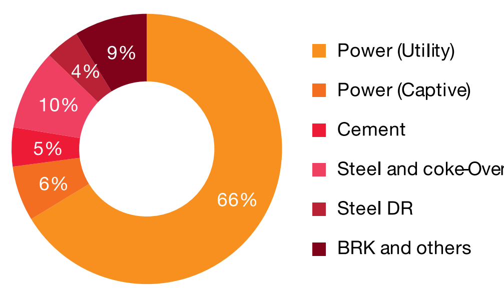
Consumption pattern

The commercial coal in the country is mainly consumed by the power, steel and cement sector. Other industries have a marginal impact on the long-term demand for coal as they are relatively small players and can resort to alternative fuels.

Power

The power sector is the largest consumer of coal in India. It accounts for nearly 66% (72% including Captive) of the demand. Of 185.5 GW[5] (November 2011) of installed power generation capacity, coal-based capacity constitutes 55% while contribute to more than 70% of power generated. The Integrated Energy Policy projects an almost four- fold increase in the total energy requirement by 2031-32 with a peak demand of 733GW which will require augmenting total installed capacity to 960GW. Thus, the power sector is expected to remain the key driver for coal demand in future also.

Estimated sector-wise coal consumption in India in 2010-11



Source: Ministry of Coal, Annual Report 2010-11

Steel

The second major consumer of coal is the steel industry accounting for about 14% of the total consumption. India has limited reserves of coking coal with only 16% of proven coal reserves are coking which is a key raw material for steel production. India's crude steel production grew at a CAGR of 8.4% during the five year (2005-06 to 2009-10). In 2009-10, 60.9 MT of the total finished steel was produced for sale. Further, about 70% of the DRI production is based on coal. For 2011-12, coal demand is estimated at 69 MT of coking coal and 29 MT of non-coking coal for the steel industry (Planning Commission). The per capita steel consumption is only 49kg which is about one-fourth of the world average[6]. It suggests that the demand has significant headroom to grow as India invests in infrastructure and as the penetration of consumer durables increases which in turn will drive demand for both coking as well as non-coking coal.

Cement

The cement industry accounts for about 4% of the coal consumption. For FY 2011-12 the assessed coal requirement for the sector is 33 MT. In the last few years, the consumption of coal to produce cement has reduced because of the dry process adopted to improve efficiency in cement kilns and increased use of fly ash and granulated slag in the production of cement. However, being queued after power and steel, the cement industry faces problems of inadequate coal supplies.

Domestic supplies

India's total domestic coal supply is about 550 MT of which more than 80% comes from Coal India Limited (CIL). The other major supplier of domestic coal is Singareni Collieries Company Ltd (SCCL) accounting for about 10% of the total supply. Apart from the two major companies, the rest of the supply is from captive sources.

The CIL produced 431 MT of coal in 2010-11 against the targeted production of 460.5 MT. On the other hand, SCCL was able to achieve its target production in the same year. One of the key reasons for the non-achievement by CIL was locking of some of the resources in 'no-go' areas earlier declared by MoEF.

Performance of domestic coal suppliers

Production (MT)	2006-07	2007-08	2008-09	2009-10	2010-11
CIL	361	380	404	431	431
SCCL	37.5	40.5	43.56	50.4	51.3
Total	399	421	448	481	482

Supplies from captive blocks

More than 200 coal blocks with geological reserves of over 46 BT stands allocated. Of these, till December 2010 production had commenced only in 26 allocated coal blocks (14 belonging to the private sector and 12 to public sector companies). The production achievement from the captive blocks has been dismal compared to the planned production. Some of the reasons for the delay in development are issues related to exploration, land acquisition and R&R, obtaining environment and forest clearance etc. Efforts are required to be made to streamline the grant of permits, licenses and clearances and having a comprehensive and acceptable land acquisition and R&R policy with government support.

Supply deficit

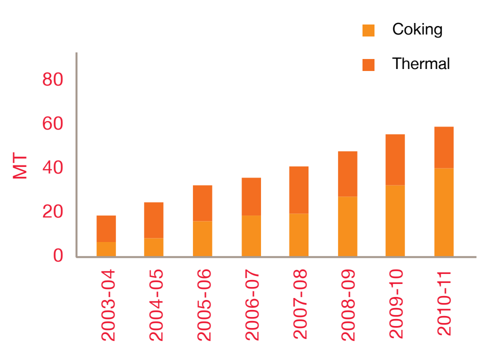
Over the last few years the demand of coal is increasing at a higher rate than the domestic supply. This has widened the demand-supply gap. While the target coal production in the country was 572 MT for FY 2010-11, the demand was projected at 656 MT leaving a gap of about 84 MT to be met from other sources. As per CIL estimates based on the LoA's granted by SLC (LT) and other commitments, the future coal balance for CIL shows supply deficit of more than 300 MT in medium term, if all the LoAs are materialised.

The option to mitigate growing demand and supply gaps lie in enhancement in domestic production and importing coal at competitive prices.

Coal imports

Since FY 04, India's coal import has grown at a CAGR of 15% with the country importing 42 MT of thermal coal and 20 MT of coking coal (2010-11). During the same period the thermal coal import grew at a CAGR of ~25% due to high demand from power sector. According to projections by various agencies, India's coal import requirement will be more than 200 MT by the end of the 12th Five Year Plan.

India' coal import trend



Source: Ministry of Commerce and Industry

The major import sources of thermal coal are Indonesia and South Africa. Indonesia contributes about 70% to the India's thermal coal import. Geographical proximity of Indonesia and the suitability of its coal for power generation make it competitive.

6 *Ministry of Steel, Annual Report 2010-11*

For coking coal import Australia is the prime destination. It accounts for more than 80% of the total coking coal import by India. Even if India augments its production capacity, the import of coking coal seems to be inevitable as the country has small reserves of coking coal and production is insufficient to meet demand from the steel sector. Besides, the poor quality of domestic coking coal requires it to be blended with imported high quality coking coal to make it useful for the steel industry.

Increasing challenges for coal import

While the coal import is inevitable for India, challenges and risks in the coal import market are increasing due to the changing regulatory scenario in the source countries and competition from other Asian nations. In the recent past, there have been regulatory changes in key coal exporting nations like Indonesia and Australia which are likely to impact India. Indonesia has recently adopted new mining law and under which market linked benchmark pricing and Domestic Market Obligation (DMO) provisions are important posing new challenge for importers by controlling export quantity as well as prices.

Under the DMO obligations, miners need to prioritize meeting domestic demand and a minimum percentage of coal or minerals are mandated to be sold locally as may be notified by the energy ministry. Thus coal quantum available for export from Indonesia is expected to face a hit. Further, Indonesia has been publishing a monthly coal reference price (HBA index) since February 2010 to be used by coal producers for all future spot and term contracts. This market linked benchmark pricing is reducing the negotiating power of buyers which in turn is expected to increase the import coal prices.

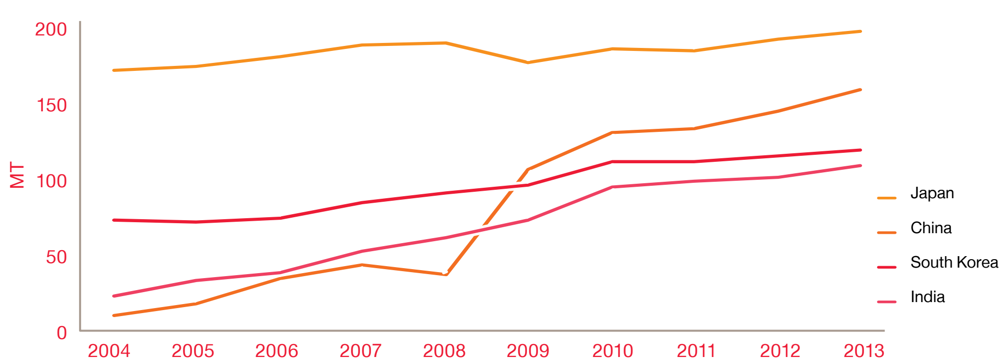
On the other hand, Australia has recently proposed Mineral Resources Rent Tax (MRRT) which will apply to coal and iron ore projects in Australia from 1 July 2012. The effective rate for MRRT is 22.5% (being a headline rate of 30% reduced by a 25% "extraction allowance"). Further, Australia has also proposed a bill to implement Carbon Tax of AUD 23 per tonne of carbon. Both the provisions will increase cost of Australian Coal which is expected to have impact on steel industry in India.

Presently, India ranks fourth in the coal import demand, being led by Japan. India accounts for about 10% of the world's import coal demand[7]. India is facing stiff competition for coal imports from other Asian economies like Japan, South Korea and China. The graph below presents the increase in the total coal import from the key demand driving economies. It may be noted that although Japan has continued to lead the import demand, China is fast catching up and its demand is estimated to rise at significantly high rate (CAGR 29%) between 2008 and 2013. Looking at the scenario, it may be assumed that imports by these economies are likely to impact the supply to India, as the key sources of imports remain the same i.e. Indonesia and Australia.

Thus, it is important for India to continue intensive efforts in identifying new avenues for imports from countries like Mozambique and others.

While the alternate sources for coal import beyond Indonesia and Australia are identified, the challenges in these countries (like Mozambique, Columbia) are numerous ranging from lack of infrastructure to export coal out of country, concerns over stability of political and fiscal regime etc. Thus beyond acquiring mineral assets, huge investment in developing surrounding infrastructure and government support to secure stable fiscal regime would be necessary to ensure long term sustainable coal imports from these countries. Coface, an international Credit Management services company has rated Mozambique as "B"[8] in the overall country rating and "C"[9] in business climate. These ratings are not very much favorable. In Mozambique the rail and port infrastructure is inadequate which act as a deterrent for coal mining projects. The Sena line project undertaken in Mozambique is important for exporting coal from Tete province. But presently it does not have sufficient capacity due to which companies already in production have to transport coal by trucks. Further, Beira port is used for export of coal companies i.e. Vale and Riversdale. However, currently the Beira port is shallow and is only able to accommodate vessels of 30,000 to 40,000 tonnes capacity. Due to this, companies are not able to ship planned quantum. Similarly, Colombia also faces challenges in infrastructure sector. It ranks 72 in the Logistics Performance Index[10] which is not very encouraging.

Coal import demand



Source: AME

7 Source: AME

8 Rating B: The business environment is mediocre. The availability and the reliability of corporate financial information vary widely. Debt collection can sometimes be difficult. The institutional framework has a few troublesome weaknesses. Intercompany transactions run appreciable risks in the unstable, largely inefficient environment.

9 Rating C: The business environment is difficult. Corporate financial information is often unavailable and when available often unreliable. Debt collection is unpredictable. The institutional framework has many troublesome weaknesses. Intercompany transactions run major risks in a difficult environment

10 Source: World Bank

Coal off-take and logistics

While demand centres are distributed across the country, supply of coal is concentrated in pockets. Most of the Indian coal resources have been concentrated in the eastern and southern zone in the states of Jharkhand, West Bengal, Chhattisgarh, Orissa and Andhra Pradesh.

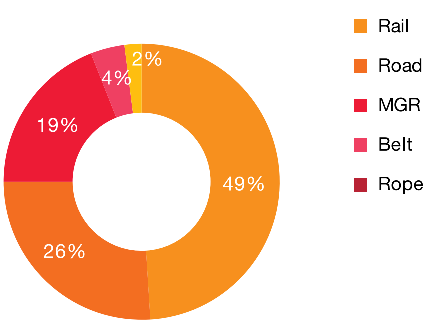
The major mode of coal transportation is railways while small quantity has been transported by road. Other modes used are MGR, belt conveyor, ropeways, etc. About half of the total coal is transported by rail. By 2025, country's coal production is expected to increase to about 1060 million tones. Therefore, railway infrastructure needs to be developed to meet the growing transportation demand.

Ports

India has twelve major ports accounting for almost 90% of the foreign trade. In addition, there are 187 ports which are under the jurisdiction of respective state governments. The major ports handled a total of 561 MT of cargo in 2009–10. It has been observed that Paradip port has large share of coal handling owing to the coastal shipment of coal from MCL to the southern India (Ennore and Tuticorin ports). The quantum handled is mainly for coastal supply (Movement of coal from MCL to TNEB plants). In 2010-11, Paradip port handled more than 13 MT of thermal coal which is about 30% of the total thermal coal handled at all the major ports.

In 2010-11 the major ports handled 73MT of coal traffic while the port capacity required for handling both imported coal as well as coastal shipment is expected to be in the range of 100-125MTPA. As per the projections of Drewry Maritime Advisors, by 2020 demand for imported coal (thermal and coking coal) will be in the proximity of 430MT while the coal handling capacity for the major ports will be close to 417MT, if all the planned capacity additions programs are executed. Further, the ports will be required to handle coastal shipments as well. Therefore, it is important to add coal handling capacities at ports either by
creating new ports or adding new berths in existing ports.

Mode of transportation

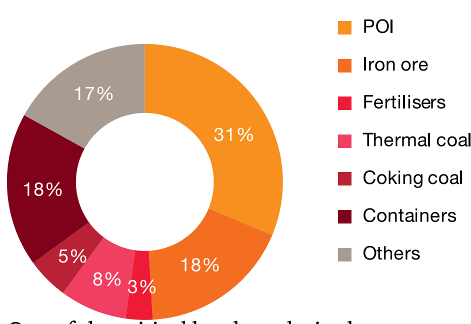


In 2009-10, about 420MT of coal was loaded in rail wagons, which is expected to cross 700MT in the next decade[11]. Heavy congestion in rail network has been observed many times in the coal producing states which lead to delays. The trunk routes of the railways comprising merely 16% of the network kilometers while carry more than 50% of the traffic and are over saturated. The Indian Railways will need to increase capacity in the short-term for handling machineries, equipment and other developmental facilities

Some of the challenges in rail transportation are high transportation cost and delays in development of proposed railways capacity addition projects. Further, the speed of freight trains on Indian Railways has stagnated at around 25 km/h for a long time which is very less compared to international standards (65 km/h or less as per the Norway/Sweden Freight Model). The major hurdle in achieving fast speeds is due to passenger and freight traffic running on the same line.

11 *(Source: Ministry of Coal, Vision 2025)*
12 *Source: Indian Ports Association*

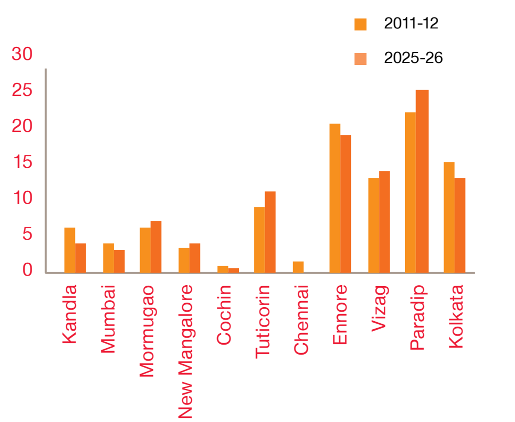
Commodities handled at ports in 2009-10



Source: IPA Publications

One of the critical bottlenecks in the supply chain is the handling infrastructure at ports. There have been congestion issues at ports. For e.g. the average pre-berthing time at major ports during April to September 2011 was 12.4 hours[12]. This is 27% higher than the average pre-berthing time during the same period in 2010. The pre-berthing time at Kandla and Tuticorin almost doubled during the same period. Similarly, there has been increase in the average total turnaround time. The average total turnaround time for dry bulk (conventional) at Kandla increased from 6.3 days in 2010 (April to September) to 10.0 days during the same period in 2011 (60% increase) and in Tuticorin it increased from 6.4 to 8.1 days. Further, the percentage idle time to total time at berth is also high at major ports. For e.g. at Haldia the percentage idle is more than 50%. This highlights that the need of upgrading the evacuation facilities at the ports.

Expected market of major ports in coal handling



Source: Report on Indian Ports Association, Coordination of business plans for major ports in India

The crucial works have begun in existing ports such as deepening and widening of entrance channel to facilitate larger size vessels, building of mechanised coking coal handling facilities as well as mechanised loading facilities, and development of coal handling facilities for captive users on the ports of Paradip, Visakhapatnam, Ennore, Tuticorin and New Mangalore.

Further, some new ports already operational or planned to be developed with modern infrastructure facilities and improved technology with the advanced facilities like ability to handle capesizes, mechanical loading and unloading systems etc. These will ease pressure on the major ports. Some of the important ports are Gangavaram; Krishnapatnam; Dhamra; Machilipatnam, Mundra,Vodarevu, Machilipatnam, Meghavaram , Bhavanapadu etc.

Enhancing domestic production

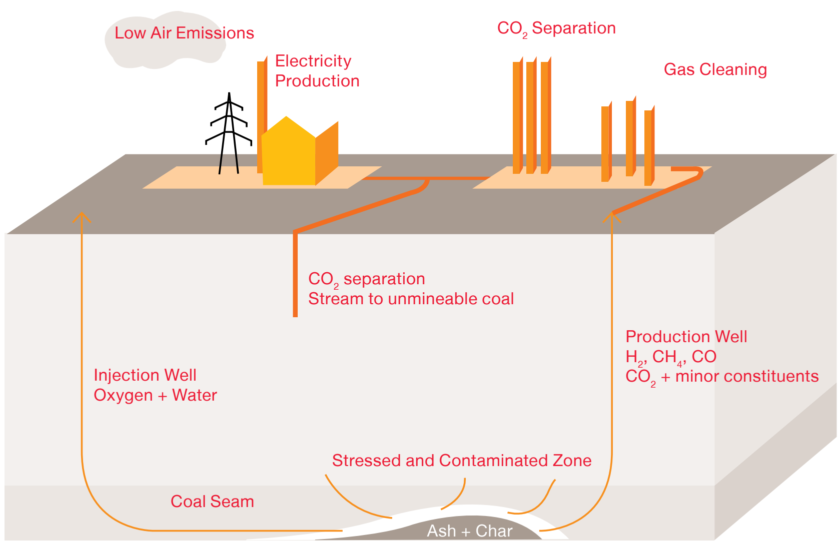
A solution to increase the domestic production lies in the development of mining technology to increase the productivity and capacity. The underground mining currently accounts for about 60% of world coal production although in several important coal producing countries surface mining is more common. In India, more than 35% of the resources are at the depth of more than 300 m which are required to be extracted using underground mining methods or alternate technologies. However, the production from underground is only about 11% which is very less as compared to world average. Also, the productivity from underground mines in India is about 0.8 tonnes per man shift which is about 20 times lower as compared to US coal mines. This signifies the necessity to upgrade the technology in order to reduce the demand supply gap and optimally utilize the locked resources. If we look at the production from underground mines, barring few mines most of them are small capacity of less than 1 MTPA. Thus it is necessary to develop underground mining technologies to develop large scale coal mines. Indigenous technologies will reduce reliance on the technology import as well as potentially reduce cost and encourage underground mine development.

In addition to this the country also need to explore the options to exploit the deep seated deposits by alternative methods such as Underground Coal Gasification (UCG).

Underground Coal Gasification (UCG)

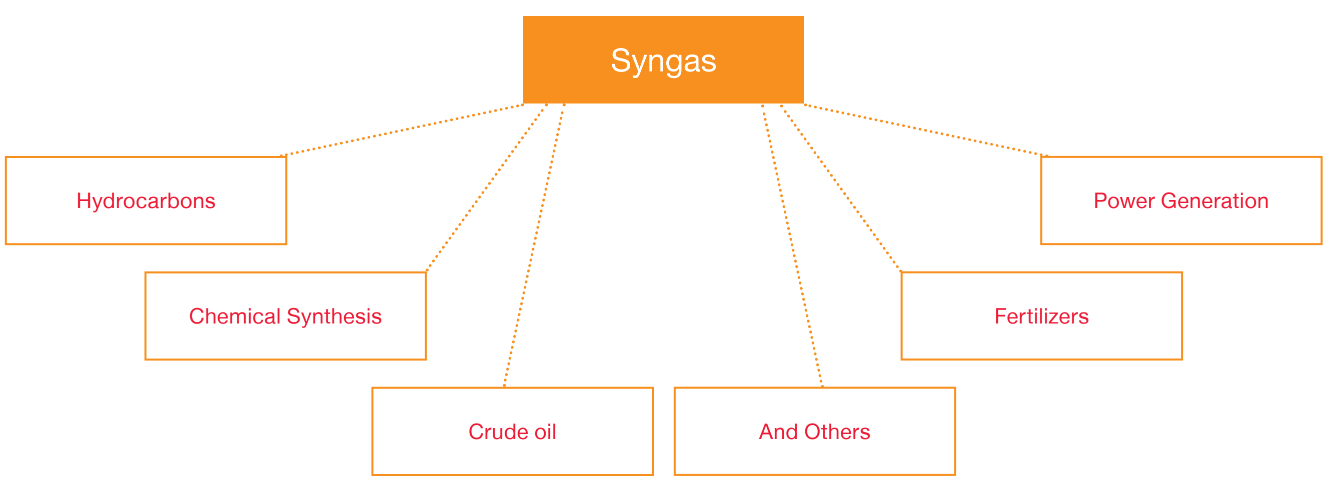
UCG is an in-situ physico-chemical process of conversion of unmineable (deep seated, less thick seam, steep dipping) coal/lignite into a combustible product gas which can be used as fuel. UCG technology allows utilization of otherwise unrecoverable coal deposits in an economically viable and environmentally safe way. The basic UCG process involves drilling two wells into the coal seam which is generally 300 to 600 meters deep, one for injection of the oxidants (water/air or water/oxygen mixture) and another well some distance away to bring the product gas to the surface.

Electricity generation through UCG Process



Source: http://news.sciencemag.org/scienceinsider/2009/09/should-the-us-b.html

The major applications of the Syngas (Coal Gas) are shown in the Figure below:



The advantages of UCG over conventional coal mining and utilization techniques can be summarized as below:

- Lesser capital and operating expenditure
- No surface disposal of ash and coal tailings from coal washing plants
- No scope for Land degradation due to OB dumps; landscape changes; R&R issues; mine accidents; dust & noise pollution
- Smaller footprints for surface installation
- Reduced NOx and SOx production as compared to surface coal processes
- Utilization of deep and thin coal seams, which are not accessible for mining and could provide an efficient carbon capture and sequestration (CCS) possibility
- Good coincidence between sites for carbon storage and UCG
- Increased worker safety

While the UCG technology provides many advantages, it is not a foolproof technology for coal exploitation. The disadvantages of UCG can be summarized as below:

- Migration of VOCs (Volatile Organic Compound) in vapor phase into potable groundwater
- Organic compounds derived from coal and solubilized metals from minerals contaminating coal seam groundwater
- Upward migration of contaminated groundwater to potable aquifers due to:
- Thermally-driven flow away from burn chamber
- Buoyancy effects from fluid density gradients resulting from changes in dissolved solids and temperature
- Changes in permeability of the reservoir rock due to UCG

In India, coal accounts for more than half of the total energy produced. Seeing the current and future demands and the potential depletion of coal reserves in the foreseeable future, alongside the focus on the environment impacts of coal utilization, UCG is one of the most favorable options to mine the reserves which are unmineable with conventional technology. As mentioned above, India has more than 35% of coal resources locked at depth higher than 300m which are potentially exploitable by UCG. In 1981 a protocol for UCG development was signed between the Government of India and the Government of erstwhile Soviet Union. In 1984 the Government of India constituted a National Committee on UCG. ONGC drilled two pilot wells near Mehsana city, in North Gujarat during 1984-86. However, the Pilot Scale Test could not be taken up due to apprehension of contamination of ground water, on which the local population is dependent.

Government of India has already notified UCG as one of the end uses under captive mining policy to facilitate allotment of coal blocks to potential entrepreneurs.

Further, the Ministry of Coal, Government of India, has awarded an S&T study project to the Neyveli Lignite Corporation. ONGC has signed an Agreement for Collaboration with Skochinsky Institute of Mining, Russia in Nov. 2004. ONGC has also signed MOUs with NLC, GMDC, GIPCL, CIL and SCCL. Vastanmine block of GIPCL has been identified suitable for UCG. Five additional blocks are also being studied. Five blocks were found not suitable. GAIL signed MoC with Ergo Exergy, Canada and MoU with Govt of Rajasthan. Land has been earmarked to GAIL. Thus we observe that while the initiatives have been taken for developing UCG, commercial operations are yet to be developed.

For developing UCG at commercial scale, several challenges need to be overcome which are identified below:

- While the large reserve of lignite and sub-bituminous coal indicate potential for UCG, India does not have indigenous technology for the same and thus depends on the technology imports. Thus R&D efforts are required to develop UCG technologies.
- Since the UCG is still not developed, a close participation of Government and Private Entrepreneurs who have expressed desire to bring technology and make investment is necessary. Thus Government may consider developing UCG as separate sector and develop alternate mechanism for co-development than conventional coal resources.
- It is important for the public sector coal companies to have the technology issues studied in detail by undertaking visits to already operating projects outside India for adoption of technology in Indian conditions;
- UCG needs to be tried in our different geological conditions in at least 3 to 4 sites by taking up pilot plants either through private sector, public sector or through PPP mode for establishing the technology

Clean coal technologies

Opportunities in coal washing

Clean coal technology (CCT) is a collection of technologies being developed to reduce the environmental impact of coal energy. When coal is used as a fuel source, the gaseous emissions generated by the thermal decomposition of the coal, include sulphur dioxide, nitrogen dioxide, carbon dioxide and other chemical by-products that vary depending on the type of coal used. These emissions have a negative impact on the environment, contributing to acid rain and climate change. As a result, clean coal technologies are being developed to remove or reduce pollutant emissions. Some of the techniques include washing minerals and impurities from the coal chemically, gasification (IGCC, etc.), treating the flue gases with steam to remove sulphur dioxide, carbon capture and storage technologies to capture the carbon dioxide from the flue gas and dewatering lower rank coals (brown coals) to improve the calorific value.

CCT's can be divided in the following two broad areas:

- Improving coal burning characteristics and reducing emissions during the burning process.
- Using coal in gasification and utilisation.

About 70% of the total thermal coal produced in the world is used in power generation. Primarily, there is a surprising range of coal quality available in both traded and local markets. It implies that there is coal available for a range of applications and the type of coal can have significant impact on boiler performance. International coal is still largely traded based on the heat value. Ash, sulphur and other potential contaminants are important but at present the heat value remains the fundamental value definer.

Opportunities in coal washing

One of the best-known techniques for reducing emission is the washing of coal. The Indian coal has high ash content (15 to 45%) and low calorific value. The basic processes used in India for washing coal are old. Much of the valuable part is lost during the washing processes. The washery rejects or by-products and high ash (about 45% of an average ash) run-of -mine (ROM) coal are major sources of feed to the thermal power plants in the country. As per the current projection, by 2030, India's coal firing power generation capacity will be about 200 GW and share more than 70% of total power generation.

However, problems associated with the supply and use of ROM coal at power plants can be outlined as the following:

- Non-uniformity in sizes
- Presence of boulders, shales, fines and extraneous matter
- Variation in quality in terms of ash content and calorific value
- Increased quantity of handling causes operational problems such as overloading, delays in wagon' clearance, frequent failure, etc. in coal handling plants (CHP), ash handling plants and mills.
- Increased boiler size
- Increased wear and tear in CHP, coal pulverisers and other boiler components. These are resulting in low plant efficiency and utilisation, higher capital, operational and maintenance costs, environmental hazards, high loading on railway coal transportation infrastructure, etc.

A cost-effective step in improving power plant efficiency and reducing the GHG emissions will be to increase the availability of clean beneficiated coals using appropriate technologies. Coal cleaning is widely viewed as the lowest-cost option for India to address these goals. According to the International Energy Agency (IEA) reports, increasing the quality of coal is an essential step to deploy state-of-the-art CCTs in the country. Therefore, use of clean coal after reduction of average ash at least by 10% as compared to high ash ROM coal or washery's rejects (average ash 45%) may result in the following:

- Reduction in transportation cost up to 7 to 8%
- Reduction in GHG (CO_2) emission by at least 15% while transportation
- About 10% decrease in auxiliary power and fuel requirement
- Increase in thermal efficiency by 2 to 4%
- Improvement in PLF up to 10%
- Reduction in operation and maintenance cost by 2 to 3%
- Reduction in CAPEX by 6 to 10% for installation of new power plants
- Reduction in land requirement for storage of disposed ash from coal fired thermal power plants in the range of 10 to 15%
- Reduction in CO_2 emission by 2 to 3% at the power plant site
- Reduced water consumption for ash disposal by 10 to 15%
- Improvement in ESP efficiency by at least 1%
- Improved plant availability by 6 to 12.0%

It is evident that use of new coal washing technologies will play a significant role in the coal fired power generation sector. On the other hand, it will also help in effective utilisation and conservation of the available coal resources in the country.

Way forward

In the backdrop of increasing coal demand and reliance on coal for power generation, collective effort of the government, power producers, coal miners and service providers are necessary to ensure modern and sufficient infrastructure.

Further, to reduce reliance on imported coal and boost the domestic supply, development and expansion of coal mines in the country is necessary. To ensure timely and smooth development of coal mines and for meeting coal demand, following steps should be taken:

- Establishing a single window clearance process for coal mines.
- Support in land acquisition and R&R related issues to ensure timely and smooth completion. Offering projects with secured clearances will boost timely development as well as increase the industry participation.
- Currently, commercial sale of coal is allowed for government companies only. To meet the growing coal demand, it is prudent to consider commercial sales of coal by Private Developers though suitable framework may need to be developed for coal pricing, balance profits to private developers etc.
- Establishing a coal regulator to resolve the conflicts and settle disputes related to coal mines. The coal regulator will also help in monitoring performance of coal miners and utilising capacity.
- The government may consider creating funds to support overseas acquisition to supplement domestic resources. This is required since mining is a capital intensive industry. Further, mining projects often require investment in supporting infrastructure which is more capital intensive than mining as such.
- Steps need to be taken to promote research and exploration activities and modern underground mass production technologies which will also help in dealing with land acquisition related issues as land requirements for UG mining will be lesser.
- Indian Railways, Port Authority and the industry need to work in close collaboration to plan development of infrastructural facilities as per requirements.

About WEC-IMC

WEC-IMC, the Indian Member Committee of the World Energy Council, is a unique platform for synergizing the energy sector in the country having patronage of minister of power and support of all energy sector ministries. Leading energy sector organisations and eminent energy professionals are our members.

We strives to play a pivotal role in shaping the future of energy in India by bringing energy sector together to forge a better understanding of energy issues with a view to identifying and implementing sustainable and effective solutions, providing factual and relevant data and information and reinforcing the energy network in India with a global outreach.

We work towards enhancing awareness of energy issues to stimulate innovative ideas and catalyze transformation of the Indian Energy Sector. We are a vehicle for strategic thinking, networking and action by energy stakeholders.

WEC-IMC offers a "helicopter view", an over-arching, cross-sector perspective to help business make realistic decisions and understand how those decisions fit into the overall energy context and the political, social, environmental and economic framework of the world today.

We also provide the international dimension that adds a vital layer of global information and insight that is invaluable to decision-makers in the energy business and helps companies, government and organizations make wise decisions today that will have positive impacts for the future.

Contacts

WEC-IMC
+91 (11) 6473 5553
+91 (11) 4358 3640
+91 97 160 78080
wec_imc@yahoo.co.in

About PwC

PwC firms help organisations and individuals create the value they're looking for. We're a network of firms in 158 countries with close to 169,000 people who are committed to delivering quality in assurance, tax and advisory services. Tell us what matters to you and find out more by visiting us at www.pwc.com.

In India, PwC (www.pwc.com/India) offers a comprehensive portfolio of Advisory and Tax & Regulatory services; each, in turn, presents a basket of finely defined deliverables. Network firms of PwC in India also provide services in Assurance as per the relevant rules and regulations in India.

Providing organisations with the advice they need, wherever they may be located, our highly qualified, experienced professionals, who have sound knowledge of the Indian business environment, listen to different points of view to help organisations solve their business issues and identify and maximise the opportunities they seek. Our industry specialisation allows us to help co-create solutions with our clients for their sector of interest.

We are located in these cities: Ahmedabad, Bangalore, Bhubaneshwar, Chennai, Delhi NCR, Hyderabad, Kolkata, Mumbai and Pune.

About GRID

PwC's GRID (Government Reforms and Infrastructure Development) SBU is an industry-focussed consultancy team of 250 professionals working for governments, regulators, utilities and investors in infrastructure. Leveraging PwC global experience in these industries, this team advises on policy, regulation, institutional strengthening, performance improvement, financing and other related matters.

Contacts

Kameswara Rao
Executive Director,
National Leader -
Power & Mining
+91 (40) 6624 6688
kameswara.rao@in.pwc.com

Sambitosh Mohapatra
Executive Director
Power & Mining
+ 91 (124) 330 6008
sambitosh.mohapatra@in.pwc.com

pwc.com/india

NJ 274 - January 2012 WEC-IMC.indd
Designed by: PwC Brand and Communications, India