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WORLD ENERGY COUNCIL
India

Background for India Energy Congress 2015

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Contents

Integrated Energy Planning

"The need to have an integrated policy arises because different fuels can substitute for each other in both production and consumption. Alternative technologies are available and there is substantial scope for exploiting possible synergies to increase energy system efficiency and to meet requirement for energy services. If the energy system is to be efficient, our policies must be integrated."

- Intergrated Energy Policy, Government of India

Executive Summary

International Energy Outlook and its Impact on India

India and China to lead the primary energy consumption growth with fossil fuels being dominant source of energy

Fossil fuels – oil, coal and natural gas – will continue to meet most of the world's energy needs. Fossil fuels, which represented 81% of the primary fuel mix in 2010, will remain the dominant sources of energy through 2035, although their share of the mix in 2035 varies markedly. China and India will experience a fairly rapid expansion in their energy consumption. By 2020 India's energy consumption is forecast to reach 1,133 mtoe, at a CAGR of 4.7%, one of the highest growth rates across the globe.

Growing population & low per capita income in the Asian countries will lead to huge import dependencies

Population growth in India and China has outpaced the rest of OECD and will continue to do so, putting pressure on the limited resource availability in these countries. According to Integrated Energy Policy estimates, with an 8% GDP growth rate, import dependence for energy in 2031-32 could be as low as 29 percent and as high as 59 percent.

India, the fourth largest consumer of oil in the world, relies heavily on imports

While steady growth is expected in global oil demand, emerging economies in Asia, Latin America and the Middle East will account for almost all of the forecasted increase in oil demand till 2035. India was the fourth-largest consumer of oil and petroleum products after the United States, China, and Japan in 2013. In 1990, India imported only 37% of its oil demand. However, oil imports reached 2.7 million bbl/d or 75% of demand in 2012, and 6.8 million bbl/d or 92% in 2035 under the WEO 2012 New Policy Scenario.

As the engine of coal demand moves to Asia, coal production will remain key to India's energy mix

Coal demand continues to rise, driven by economic expansion in emerging economies, especially China and India. With demand outstripping domestic supply, these two countries are expected to become increasingly import-dependent, with China importing 278 MT and India, 158 MT in 2012. While China relies on coal to generate more than 80% of its power, coal contributes around ~60% of India's total power generation installed capacity.

Significant RE potential in India, coupled with drop in solar PV module prices will lead to significant capacity additions in the near future

As per IEA estimates, the share of renewables in the global power mix rises from 20% in 2011 to 31% in 2035. Wind, with gross capacity additions of almost 1,250 GW, makes the largest contribution to the growth, followed by solar PV (750 GW) and hydro (740 GW). India has a tremendous amount of potential for renewable energy capacity, estimated at more than 240 GW, of which only 10% has been exploited till date. At present, India is the second largest wind market in Asia, presenting substantial opportunities for both international and domestic players. Technology improvements and reduction in module prices have aided solar energy's competitiveness as compared to conventional fuels.

Integrated Energy Policy in the new environment

Access to Energy, Energy Security and Sustainability remain the key challenges in the Energy Planning Process

Growth does not come without challenges, including poverty alleviation, income distribution, urban planning, and environmental degradation. India faces tough challenges in meeting its energy needs of desired quality at competitive prices and in a sustainable manner. The Integrated Energy Policy, 2008, has highlighted Access to Energy, Energy Security and Sustainability as the three main objective for the planning process.

Coordinated energy planning is a challenge: The energy sector in India traditionally has been governed by respectively ministries for Petroleum, Coal, Power, Water Resources (in the case of hydroelectricity), Atomic Energy and New & Renewable Energy. To address the exponential growth in energy demand and concerns of energy security the government in 2005, established the Energy Coordination Committee (ECC) under the chairmanship of The Prime Minister. The Integrated Energy Policy provides a broad overreaching framework for guiding the policies governing the production and use of different forms of energy from various sources. Although all the energy policies initiated by various ministries since then have been within the overall framework of the Integrated Energy Policy the fallout of some of them have been controversial in the recent time. Issues with related to Coal block allocation, underutilization of new power projects due to non-availability of adequate fuel, risk allocation in case of private sector participation resulting in tariff disputes, huge import dependence etc. have been some of the key issues which have been preventing the overall development of the energy sector.

Rapid growth of sustainable energy is currently facing multiple road blocks

Factors such as non-availability of adequate transmission and physical infrastructure, delays in land acquisition, clearances and approvals, disconnect between SERC and CERC Regulations, access to financing, non-compliance of RPOs and financial performance of utilities are a major road block for the development of the sector.

Implementation Strategies

High oil & gas imports, stagnant coal production, declining gas production and lack of long term energy planning are issues which require immediate attention, if India plans to be energy secure in the future. An integrated approach is required for overcoming the challenges in energy security, which ideally have to be a mix of 'supply and demand' side measures. Few of the initiatives needed to fast-track growth in the sector include, Strengthening O&G Exploration, Tapping huge RE Potential, Increase domestic Coal Production, Strong Integration with Neighbors, Developing of Unconventional Fossil Fuels, Strengthening T&D Network and Promote Energy Efficiency

Developing the Coordinated Action Plan

Our choices about how energy is produced and consumed in the country will have far reaching effect on the overall future of the nation and the world as a whole. Energy planning in today's environment needs to be multi-dimensional, sustainable and viable, encompassing the three key pillars namely social, economic, and the environment. This should conform to the broad level activities like, conforming to national, regional, and local development objectives; maintaining reliability of supply; minimizing the short term or long term economic cost of delivery; minimizing the environmental impacts and provide local economic benefits.

International Energy Outlook and its Impact on India

The global population has witnessed one of the highest growth from early 1950 and has touched 7 billion in 2013. It peaked in 1980 and continues to grow at over 1% annually. The global population is expected to reach between 8.3 and 10.9 billion by 2050 as per UN estimates. Living standards have advanced significantly in many parts of the world, supported by modern technologies and access to energy. The pace and scale of such progress has been remarkable. As an indicator, energy consumption worldwide is now about 25 times higher than in 1800.

According to the International Energy Agency (IEA-2013), 2011 saw the number of people without access to electricity reduce by 50 million and those without access to clean cooking fuels reduce by 40 million. This reduction took place despite the growth in global population which means that significantly higher number of people got access to clean energy sources in 2011. Most of this decrease took place in the developing countries of India, Indonesia, Brazil, Thailand, South Africa and Ethiopia. However despite this increase in access to energy, the IEA still projects that almost 1.3 billion people lacked access and electricity and 2.6 billion lacked access to clean cooking fuels (still relying on traditional use of biomass for cooking, which causes harmful indoor air pollution) at the beginning of 2012. Fossil fuels to remain the dominant source of energy Short-term changes in energy demand and the composition of the fuel mix are largely a function of economic conditions, energy prices and the weather. But longer term trends, can be significantly changed by the manner in which governments intervene in markets to tackle energy related challenges.

According to IEA World Energy Outlook, fossil fuels – oil, coal and natural gas – will continue to meet most of the world's energy needs. Fossil fuels, which represented 81% of the primary fuel mix in 2010, will remain the dominant sources of energy through 2035, although their share of the mix in 2035 varies markedly.

Fossil fuels to remain the dominant source of energy

According to Economist Intelligence Unit (EIU), in terms of world energy demand, the decade to 2020 will see a gradual transition to natural gas from other fossil fuels (oil and coal). This shift will be driven by a number of factors, including the proliferation of delivery options

Figure 1: World Primary Energy Demand in Mtoe, IEA Forecasts, 2012

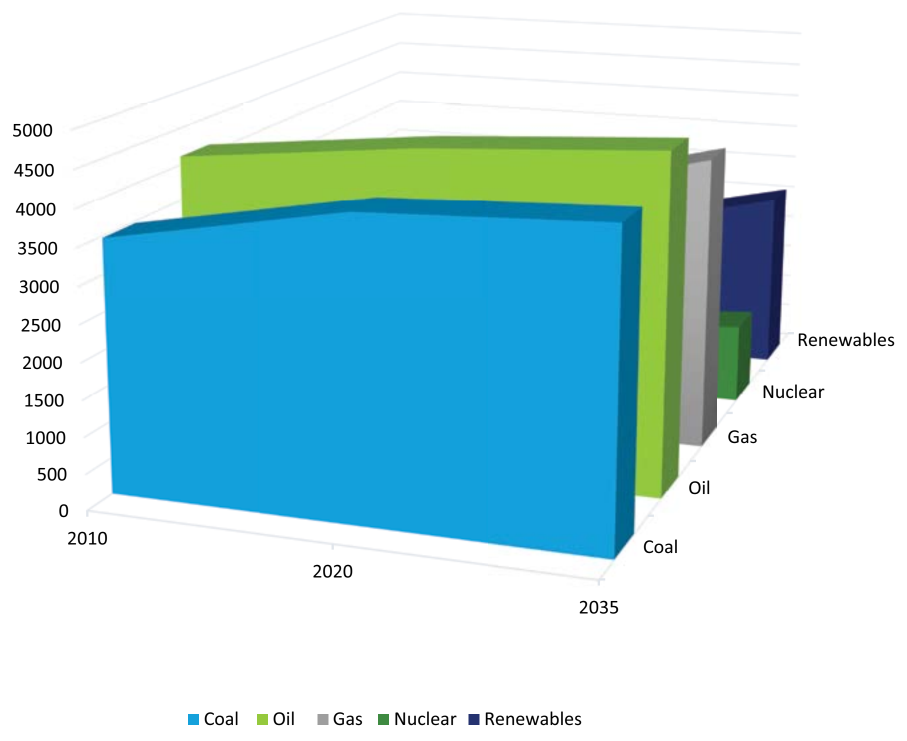
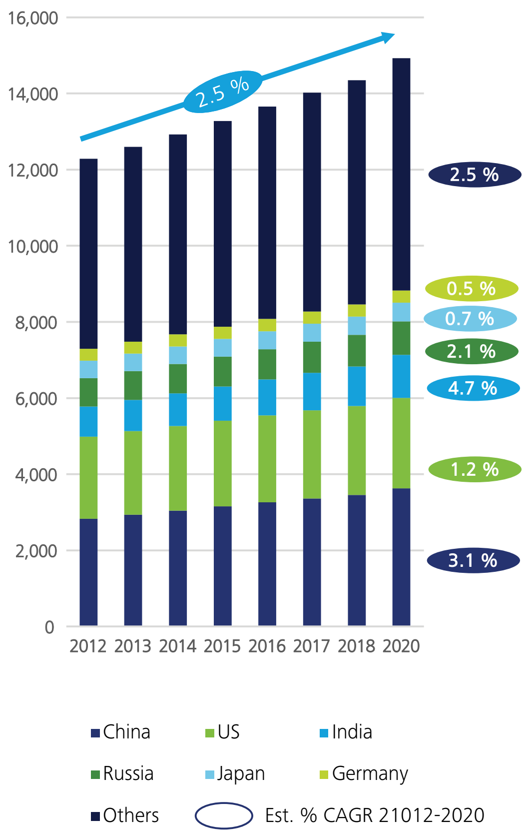


Figure 2: Energy Consumption in Mtoe, forecast till 2020



Source: EIU World Energy Outlook 2014

for natural gas, especially liquefied natural gas (LNG); the development of "unconventional" gas resources, particularly shale gas; and the promotion of gas as a relatively low-carbon "transition" fuel (compared with coal), which can be used for power generation while renewable energy alternatives are being developed. According to the forecast by EIU, in absolute terms, there will be impressive growth in wind and solar power generation globally, although by the end of the forecast period (2020) they will still account for only a small fraction of total energy consumption.

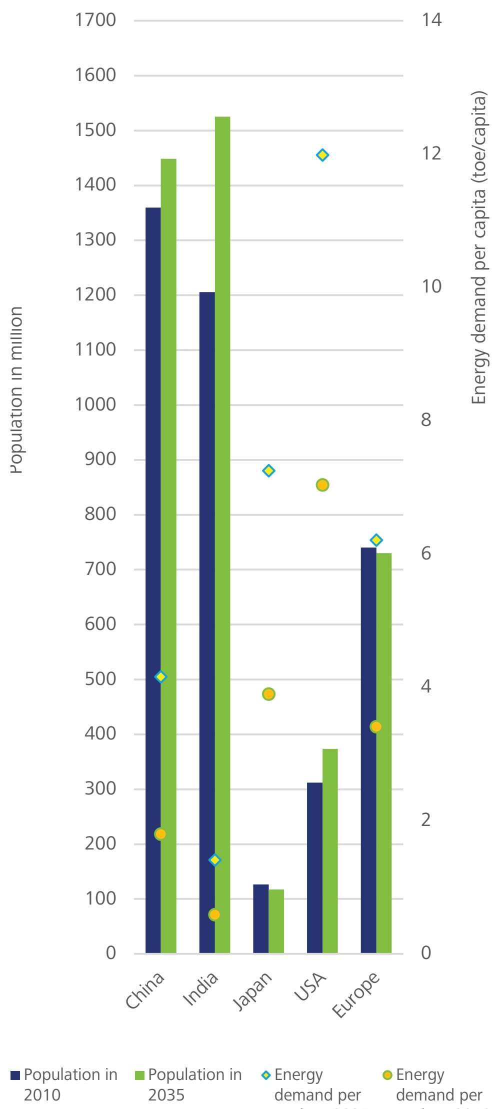
India and China to register highest growth in Primary Energy Consumption

China and India are forecast to remain in first and third place respectively, while experiencing fairly rapid expansion. By 2020 India's energy consumption is forecast to reach 1,133 mtoe, registering a CAGR of 4.7%, one of the highest growth rates across the globe.

But Asian Countries would face pressure from growing population and low per capita energy demand

High population growth and the burden of high energy demand (largely due to subsidies) create pressures on Asian (particularly India and China) countries. Population growth in India and China has outpaced the rest of OECD and will continue to do so, putting pressure on the limited resource availability in these countries.

Figure 3: World primary energy demand per unit of GDP and per capita (IEA)

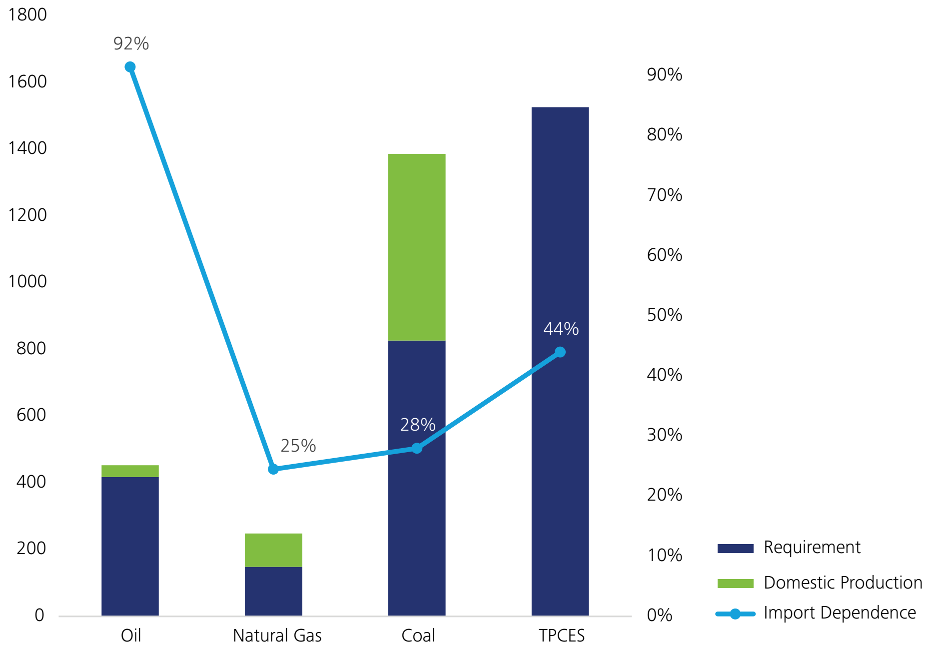


This will lead to huge Import dependence in India

Integrated Energy Policy, 2008, forecasts the total commercial energy requirement for India in 2031-32 to be between 1351 – 1702 Mtoe range.

Thus, with an 8% GDP growth rate an import dependence for energy in 2031-32 could be as low as 29 percent and as high as 59 percent.

Figure 4: Commercial Energy Requirement, Domestic Production and Imports in 2031-32, Mtoe (IEP, 2008)*



* calculated based on avg. of range values
TPCES: Total Primary Commercial Energy Supply

"The global energy map is changing, with potentially far-reaching consequences for energy markets and trade. It is being redrawn by the resurgence in oil and gas production in the United States and could be further reshaped by a retreat from nuclear power in some countries, continued rapid growth in the use of wind and solar technologies and by the global spread of unconventional gas production. Perspectives for international oil markets hinge on Iraq's success in revitalising its oil sector."

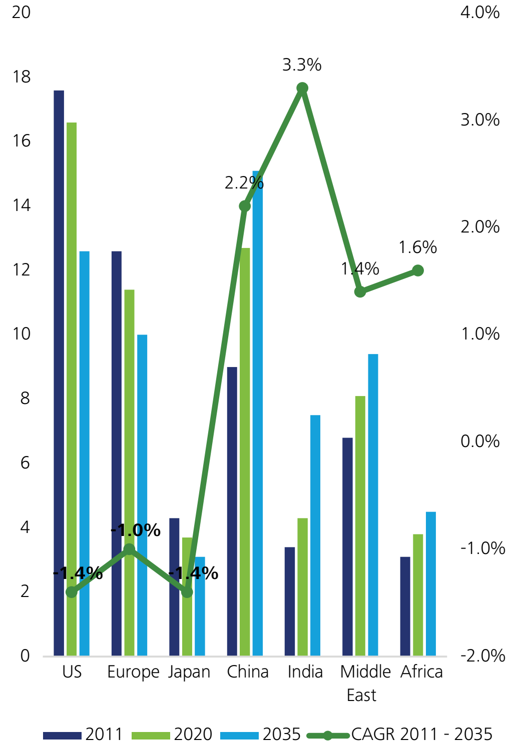
– World Energy Outlook, IEA

Oil and Gas

Growth in Oil consumption will come from outside OECD

While steady growth is expected in global oil demand, emerging economies in Asia, Latin America and the Middle East will account for almost all of the forecast oil demand.

Figure 5: Oil Demand by Countries 2011-2035 (in million barrels/day) (IEA Estimates)



In contrast to the projected 8.8 mb/d decline in the OECD, the non-OECD countries in aggregate see their demand rise by 18.8 mb/d between 2011 and 2035 in the New Policies Scenario of IEA forecasts. As a result of their faster demand growth, total oil use in the non-OECD countries overtakes that of the OECD before 2015. It is about 70% higher by 2035, with the non-OECD countries accounting for 63% of world oil use, compared with just under half today. Strong economic and population growth in the non-OECD countries, coupled with the huge latent demand for personal mobility, more than offsets important efficiency gains in transport. Oil demand growth in India is particularly large, registering a CAGR of 3.3% between 2011- 2035.

India – Fourth Largest Consumer of Oil & Petroleum Products

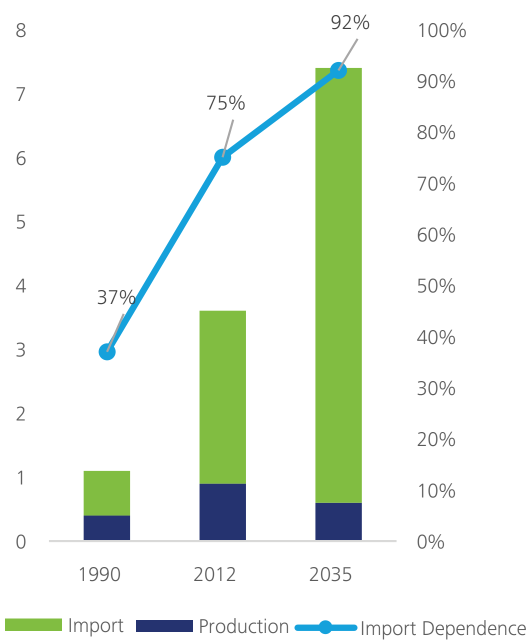
India was the fourth-largest consumer of oil and petroleum products after the United States, China, and Japan in 2013, and it was also the fourth-largest net importer of crude oil and petroleum products. The gap between India's oil demand and supply is widening, as demand reached nearly 3.7 million barrels per day (bbl/d) in 2013 compared to less than 1 million bbl/d of total liquids production. IEA projects India's demand will more than double to 7.5 million bbl/d by 2040, while domestic production will remain relatively flat, hovering around 1 million bbl/d.

Relies heavily on Imports

To meet fast growing demand, India's crude oil imports are increasing strongly. In 1990, India imported only 37% of its oil demand. However, oil imports reached 2.7 million bbl/d or 75% of demand in 2012, and 6.8 million bbl/d or 92% in 2035 under the WEO 2012 New Policy Scenario.

India spent a staggering $ 160 Billion to import crude oil in 2011-12, an amount equivalent to more than half of country's export earnings during the same period.

Figure 6: India's Oil Supply and Import Dependence

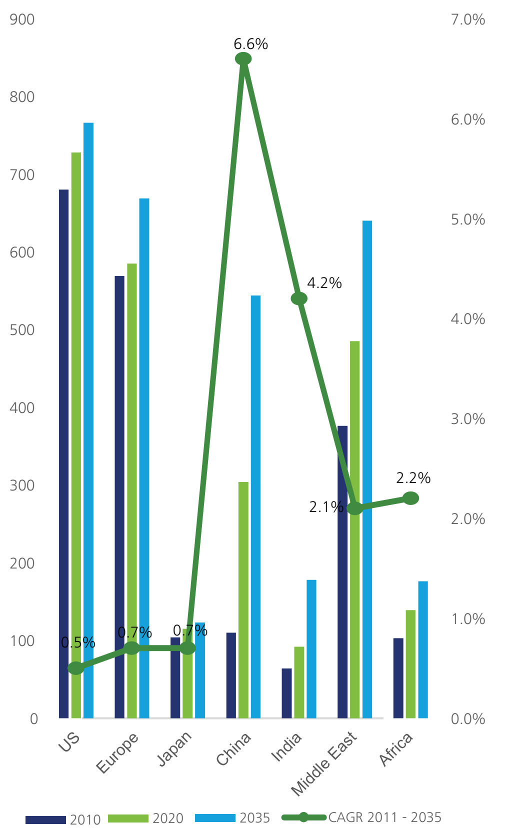


Natural Gas

Gas demand will grow faster than demand for coal and oi

Consumption of natural gas is set to continue to expand in the future, regardless of the direction that government policies take. It is the fastest growing fossil fuel and reflects the likelihood that ample supplies will keep gas prices competitive and the fact that it is the least carbon intensive fossil fuel and its use is affected less by policies to curb greenhouse gas emissions.

Figure 7: Gas Demand by Countries 2011-2035 (in bcm) (IEA Estimates)

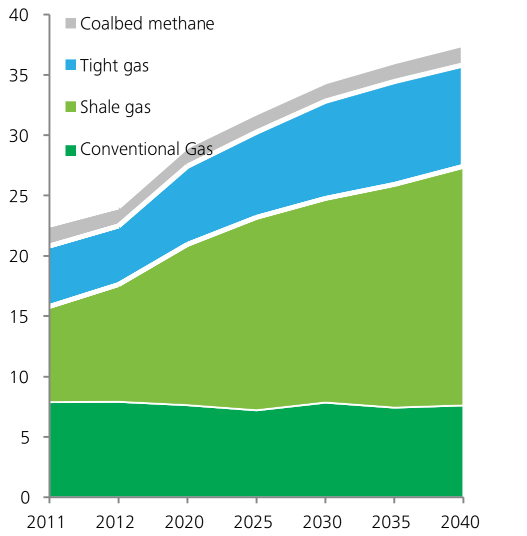


Non OECD countries will continue to drive changes in future global gas demand, reflecting their more rapid rates of economic growth and the relative immaturity of their gas markets.

Impact of Rising Availability of Unconventional Gas Sources

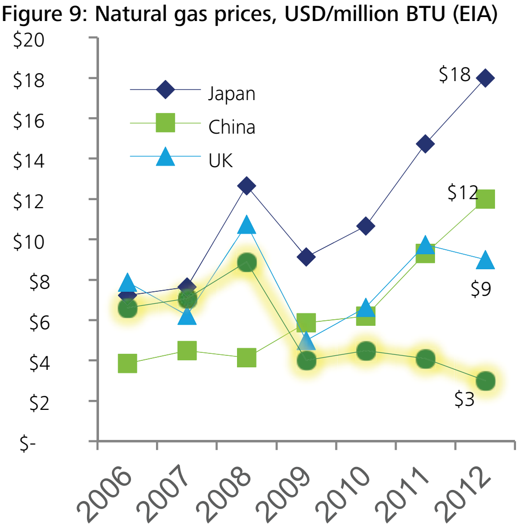
Favorable policies have supported shale gas boom in the U.S. as the country will lead the global production of unconventional gas over the next 4 decades. Australia and China will continue to develop their, currently nascent unconventional gas resources, by partnering with IOCs. China in particular has announced flexible policies to encourage participation from foreign players in its domestic shale reserves. With the increasing availability of shale gas in the USA, supplies dedicated for exports to USA are now being diverted to other markets — Asia and Europe.

Figure 8: US Shale Gas Production in tcf (US EIA)



Natural gas price in the U.S. has declined at an annual rate of about 23% during 2008–12. However, price in Asia continues to be the highest in the world, owing to its linkage to high crude oil prices.

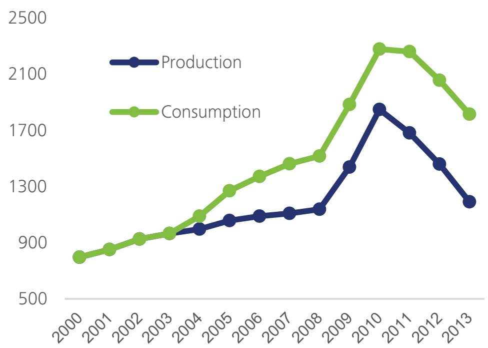
Figure 9: Natural gas prices, USD/million BTU (EIA)



Asia has significant buying power as a prominent LNG importer due to the sheer scale of its imports. With low-cost gas supplies expected from the U.S., Asian buyers are increasingly putting pressure on price by adopting short-term agreements and even seeking contracts that have weaker correlations with oil.

India became a net importer of Natural Gas in 2004 Natural gas mainly serves as a substitute for coal for electricity generation and as an alternative for LPG and other petroleum products in the fertilizer and other sectors. India was self-sufficient in natural gas until 2004, when it began to import liquefied natural gas (LNG) from Qatar. The production of gas in India has declined substantially in the past two years. In fact, the production levels have fallen far below the projected levels largely on account of decline in the production from the KG-D6 block.

Figure 10: India Dry Natural Gas Production and Consumption (in bcf) (EIA)

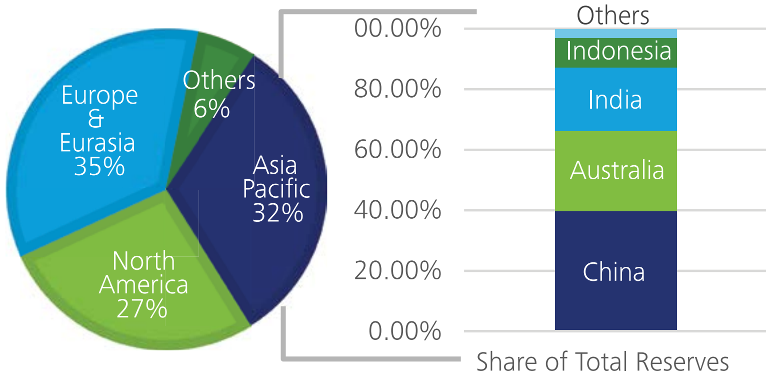


The majority of natural gas demand comes from the power sector (44%), the fertilizer industry (25%), and the replacement of LPG for cooking oil and other uses in the residential sector. (MoSPI, 2013)

Coal

Globally, proved coal reserves have been estimated at over 891 billion tonne. While India accounts for 286 billion tonne of coal resources (as on 31 March 2011), other countries with major chunk of resources are USA, China, Australia, Indonesia, South Africa and Mozambique. Since coal will maintain its role as a major fuel in most large economies, significant coal producers, such as China, India, Australia, South Africa and Indonesia, are expected to ramp up output. Australia, Indonesia and South Africa will remain key exporters, focusing on markets in Asia. In the US, depressed domestic demand will continue to force US coal exporters to look to Europe and Asia instead. Russia will also increase output, being a major exporter of coal to European markets. According to IEA forecasts, by 2035 global coal production is forecast to reach 7,889 mtce, up from 5,124 mtce in 2010.

Figure 11: Coal - Proved Reserves 2013 (BP Statistical Review 2014)



The Engine of Coal Demand will move to Asia
Coal demand continues to rise, driven by economic expansion in emerging economies, especially China and India. With demand outstripping domestic supply, these two countries are expected to become increasingly import-dependent. China now accounts for nearly 50% of global coal consumption, according to the IEA. It relies on coal to generate more than 80% of its power, although natural gas and renewables will assume a greater share in future. In India's case, coal consumption is expected to exceed that of the US by 2020.

Net Importers, 2012	Million Tonnes
China	278
Japan	184
India	158
Korea	126
Others	442
Total	1188

Source: WEO, IEA 2013

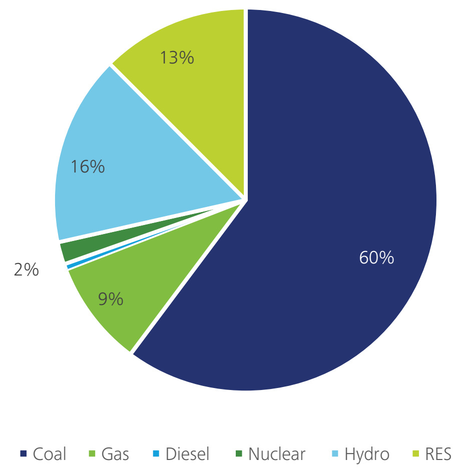
Global coal imports touched 1188 MT in 2012, of which India and China accounted for nearly 40%.

Coal Production Remains Key to Energy Mix

Coal is the mainstay of India's energy sector and accounts for over 50% of primary commercial energy supply and its availability or otherwise can hugely impact the energy balance of the country. Of the total power generation capacity in the country, 60% comes from coal based thermal power stations.

Coal in India is produced by Coal India Limited (CIL), Singareni Collieries Company Limited (SCCL) and captive coal producers. CIL is the majority producer of coal having a share of 81% of the total production.

Figure 12: Fuel Mix in India's Installed Capacity (MW) - CEA Sept 2014



Alternative Energy

According to IEA, in 2013, global renewable electricity generation rose by an estimated 240 terawatt hours (TWh) (+5.0% year-on-year) to reach nearly 5,070 TWh and accounted for almost 22% of total power generation. Globally, renewable generation was on par with that of natural gas, but remained behind coal, which was almost double the size of renewables. This result stems from the strength of the continued renewable expansion as well as difficult economics for gas generation in many member countries of the Organisation for Economic Co-operation and Development (OECD) in 2013 and difficulty to access affordable gas supplies in non-OECD regions.

Share of Renewables based Generation to be over 30% by 2035

IEA's Renewable Energy Outlook forecasts, renewables power generation would expand by over 7,000 Terawatt-hours (TWh) between 2011 and 2035. This is equivalent to around one-third of current global power generation, and almost half of the projected increase in total power generation to 2035. The share of renewables in the global power mix rises from 20% in 2011 to 31% in 2035. Collectively, renewables become the world's second-largest source of power generation before 2015 and approach coal as the primary source by the end of the period.

Figure 13: Renewables based Electricity generation (in TWh)

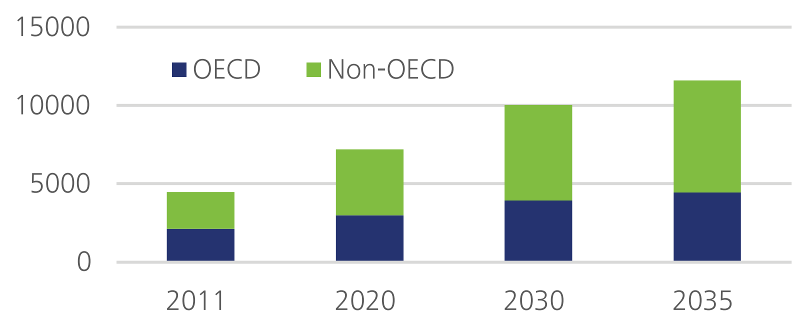
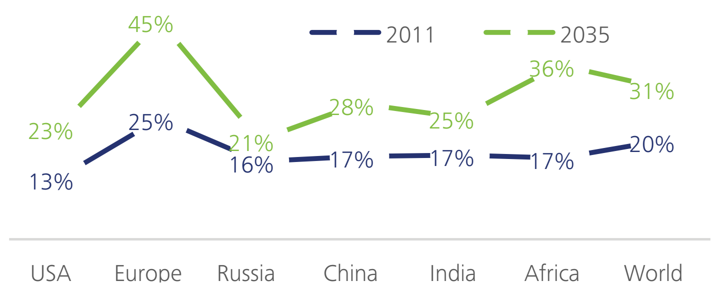


Figure 14: Share of Renewable based generation of total generation (Renewable Energy Outlook – 2013)



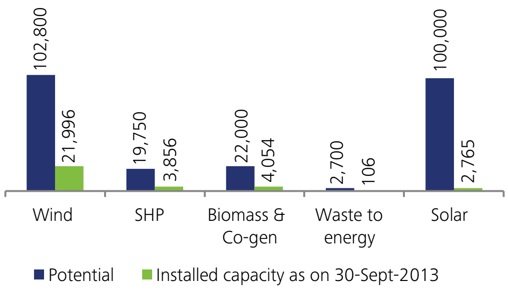
While considerable growth is seen in India, Africa and Europe, mainly driven by policy interventions, China alone accounts for 28% or 1990 TWh, of total growth in generation from renewables.

Wind, with gross capacity additions of almost 1,250 GW, makes the largest contribution to the growth, followed by solar PV (750 GW) and hydro (740 GW).

Significant potential remains untapped in India

India has a tremendous amount of potential for renewable energy capacity, estimated at more than 240 GW, of which only 10% has been exploited till date.

Figure 15: RE Potential of India v/s Installed Capacity in MW - MNRE



Wind

According to Global Wind 2013 Report of GWEC, more than 35 GW of new wind power capacity was brought online in 2013, but this was a sharp decline in comparison to 2012, when global installations were in excess of 45 GW. By the end of last year six countries had more than 10,000 MW in installed capacity including China (91,412 MW), the US (61,091 MW), Germany (34,250 MW), Spain (22,959 MW), India (20,150 MW) and the UK (10,531 MW).

Country	MW	% Share
China	91,412	28.7
USA	61,091	19.2
Germany	34,250	10.8
Spain	22,959	7.2
India	20,150	6.3
UK	10,531	3.3
Italy	8,552	2.7
France	8,254	2.6
Canada	7,803	2.5
Denmark	4,772	1.5
Rest of World	48,332	15.2
World Total	318,105	100

China and India lead capacity additions in Wind based generation sources

In terms of annual installations China regained its leadership position, adding 16.1 GW of new capacity in 2013, a significant gain over 2012 when it installed 12.96 GW of new capacity.

Everyone has been surprised by the astonishing growth of China's wind sector since 2006, but it is now entering a more steady development and refinement stage.

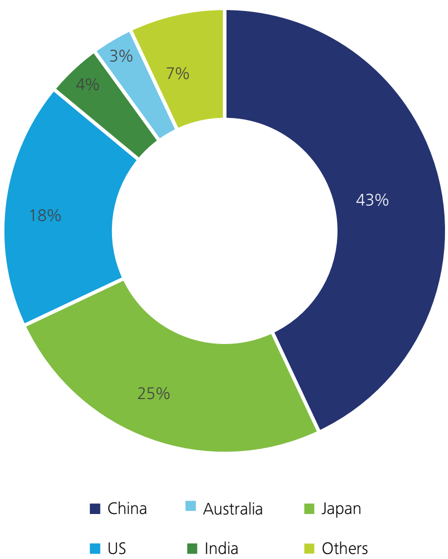
India today is the second largest wind market in Asia, presenting substantial opportunities for both international and domestic players. The Indian wind sector has struggled in the last couple of years to repeat the strong market in 2011 when over 3 GW was installed.

Solar Photovoltaics

Solar PV generation expanded by 50% per year worldwide over the last decade, reaching almost 100 TWh in 2012. In this year, total installed capacity of solar PV increased by 43%, or 29.4 GW, representing 15% of the total growth in global power generation capacity.

Germany alone, under the impetus of strong government support, accounted for more than one-quarter of the increase with 7.6 GW of additions. More than 27 GW of new installations of PV systems occurred outside Europe in 2013, compared to 13.9 GW in 2012, 8 GW in 2011 and 3 GW in 2010. The rapid development of China's PV market allowed it to take the first position among these countries, followed by a booming Japan (6.9 GW), the USA with 4.8 GW and India installing more than 1 GW.

Figure 16: PV Market Share outside Europe (2013 (EPIA Global PV Market Outlook 2014)



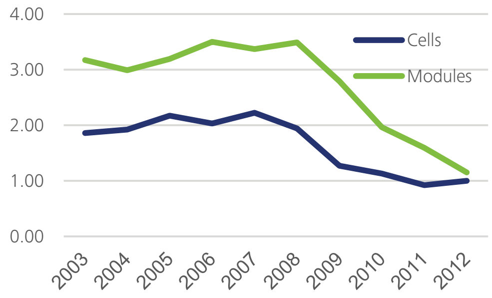
Technology Improvements and Reduction in Module Prices have aided Solar Energy's Competitiveness

As per International Energy Agency, the average efficiency of commercial silicon modules has improved in the last ten years by about 0.3% per year, reaching 16% in 2013. The best-performing commercial modules, based on backjunction, interdigitated back-contact (IBC) offer efficiencies of 21%, with heterojunction (HTJ) technologies close behind at over 19% efficiency, and excellent performance ratios. Modules are usually guaranteed for a lifetime of 25 years at minimum 80% of their rated output, and sometimes for 30 years at 70%. TF modules also saw increases in efficiencies, with commercial CdTe TF, in particular, reaching 15%.

Even more impressive progress has been made with respect to manufacturing. The amount of specific materials (silicon, metal pastes, etc.), the energy consumption and the amount of labour required to assemble modules were all significantly reduced.

The emergence of the global PV market has coincided with rapid reductions in the costs of modules and systems. The levelised cost of energy from PV systems is already below retail electricity prices (per-kWh charge) in several countries,

Figure 17: Average Price of PV Cells and Modules, $/Wp (US EIA)



and rapidly approaching the level of generation costs from conventional alternatives, especially new coal with strict air pollutant emission standards, new nuclear plants with increased safety standards, or new gas plants in areas with high gas prices.

Integrated Energy Planning in the New Environment

India is the fourth largest economy and energy consumer in the world. India's macroeconomic outlook, political and business environment, and focused policy direction play an important role in driving growth. India made substantial headway in the past decade, recording an annual average growth rate of 8.3 percent from 2004 to 2011. Robust growth, combined with strong demographics, helped India emerge as a new global economic player and brought recognition as one of four emerging nations with the potential to become an economic powerhouse by 2050.

Over the past two years, the economy has been burdened with high inflation and fiscal deficits, currency and capital account volatility, and poor business investment and sentiments

Figure 18: Inflation Index, Reserve Bank of India

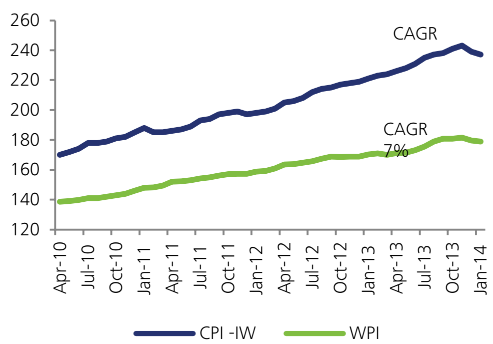
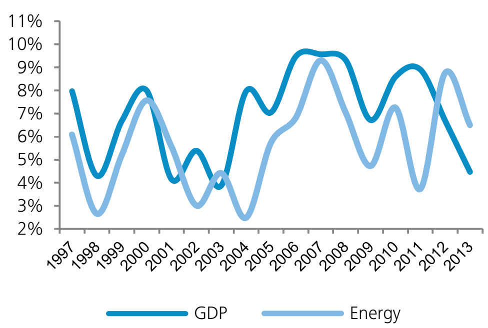


Figure 19: India GDP Growth (%) Ministry of Finance



Although the energy sector has attracted substantial interest and investment in last decade, particularly with the public private partnership (PPP) model. However, more recently, difficult financial scenarios, stalled projects, policy paralysis, shorter project pipelines, and reduced market capacity have impacted the sector's growth. As of 31 March 2014, more than US$100 billion worth of energy and infrastructure projects were stalled.

Growth does not come without challenges, including poverty alleviation, income distribution, urban planning, and environmental degradation. Policymakers also face greater demands and scrutiny from a more-educated population, especially a vocal middle class, which has been redefining India's economic, political, and social space.

Key Challenges in Energy Planning Process

India is faces tough challenges in meeting its energy needs of desired quality at a competitive prices and in a sustainable manner. The overall economic growth should be over 8-10% over the next 25 years to meet the poverty reduction and human development targets. The integrated energy policy, 2008, Planning Commission has highlighted three main objective for the planning process.

Access to energy is the foremost goal in India's energy policy. Nearly one-quarter of the population lacks access to electricity. This implies ensuring the supply of adequate and reliable energy to the Indian population amid growing energy demand, support by economic growth.

Second, energy security is driven by increasing dependence on imported fuels, which is crucial to meet the India's huge energy demand. Increased import dependence also exposes the country to greater geopolitical risks and international price volatility. Finally, India is dedicated to the mitigation of climate change, and developing low carbon renewable energy sources remains a top priority. However, considering income disparity across different social strata and Government's commitment to provide continuous and affordable fuel source implementation is a challenge in near term.

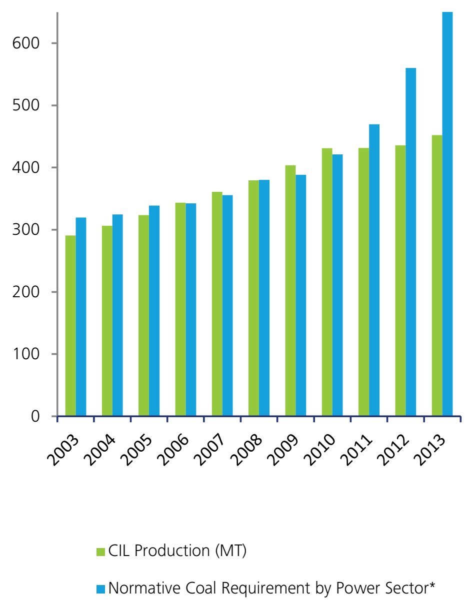
High import dependence in the O&G sector and depleting domestic resource is a key challenge

India's import dependence in oil consumption is over 75% presently. As per BP Energy outlook 2035 energy consumption in the transport grows by 215% and oil remains the dominant fuel source with a 93% market share in 2035. This poses serious threat to our energy security. India spent a staggering $ 160 Billion to import crude oil in 2011-12, an amount equivalent to more than half of country's export earnings during the same period and given the amount of Current Account deficit ($ 7.8 billion in Q2 FY 14) in India.

In addition to a substantial reduction of output from KG-D6, the question of overall reserves in KG-D6 is now being posed. The uncertain medium-term future of Indian domestic gas production has cascading effects on the overall role of gas in the country's energy sector. The first impacts have already been felt in the power sector where the PLF of gas-fired plants averaged only 50-55% in the last year due to unavailability of gas.

Global competition in acquiring resources, both for oil & gas is making it all the more difficult for Indian companies to source energy at a competitive price.

Figure 20: Historical CIL Coal Production & Coal Requirement by Power Sector



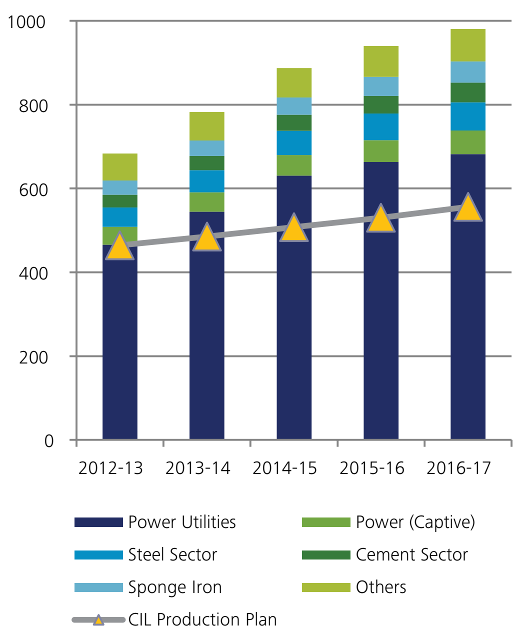
Source: CEA, Ministry of Commerce, Assumption: 1000MW consumes 5 MTPA

Coal Availability Remains a Concern

Coal will remain the dominant fuel produced in India with a 66% market share in 2035. However, going forward, availability of coal remains a serious matter of concern. Although there is thrust to maximize generation from other conventional and non-conventional sources, coal based generation is likely to be the main stay of electricity generation for 12th and 13th Plan to support the targeted GDP. CIL being the major producer had shown a stagnated production from FY10 to FY 12. In FY13 the coal production of CIL increased from 435.8 MT to 452.2 MT. However the production from SCCL and other Captive players has not significantly increased from FY10. The total coal production had increased at a CAGR of 6.55% from FY03 to FY10. However the stagnation of coal production between FY10 and FY12 has led to a drop in this CAGR to 5.23%. There is a mismatch between CIL coal production and the increase in the coal dependent power capacity, as is evident in the figure.

Going forward the production plan of CIL is significantly lower than the demand of coal in the XIIth Plan period, thereby increasing reliance on captive coal production & imports.

Figure 20: Sector wise Coal demand vis-à-vis Coal Production Plan of CIL in XIIth Plan (in MTs)



Source: Working Group Report on Coal & Lignite 2011, CEA

Coal companies in India have been facing issues in keeping up with the demand of coal from the industries and is experiencing shortfalls in increasing production and achieving the production targets. With only the exception of a few, most of the expansion projects and development of new mines face similar project development challenges pivoted around issues around Forest Clearances and Environment Clearances and challenges faced during Land Acquisition and Rehabilitation & Resettlement. It is noted that nearly close to 56% of the projects in numbers contributing to 58% of the incremental capacity over the Twelfth Plan Period is stuck due to Land, R&R issues and clearance issues. The major reason seems to be Land Acquisition and R&R which alone contribute to around 37% of the total delay in projects taking off.

Inefficiency in domestic coal production remains a challenge

Stagnating domestic production: Total Coal production of CIL has stagnated at about 400-450 MTPA registering a CAGR of 4% during 2006-2012 period. CIL production CAGR has been significantly lower than the Electricity consumption and generation capacity addition growth.

New Mine Development Issues: With only the exception of a few, most of the expansion projects and development of new mines face similar project development challenges pivoted around issues around Forest Clearances and Environment Clearances and challenges faced during Land Acquisition and Rehabilitation & Resettlement.

Poor Capacity Utilization: As cited in the Working Group Report on Coal & Lignite, 2011, the capacity utilization of equipment with CIL are lower than norms prescribed CMPDIL, resulting in significant cost & time overruns coupled with loss of productivity.

Infrastructure: There is a pressing need for a well-integrated infrastructure for coal supply chain, which includes railroads, importing ports and washeries. Delayed construction of railways by Indian Railways to connect mines, dispatch centres and end-use destinations, has already created a considerable bottleneck in coal supply in recent years (Tori – Shivpur railway line in North Karanpura in Jharkhand is an immediate example where rail linkage is yet to come after several years). Further, there are concerns that there are very limited manufacturers of quality mining equipment and machinery – there are two PSUs, BHEL and BEML (Bharat Earth Movers Limited) who are major suppliers to CIL.

Import dependence is increasing to meet the overall coal demand in the country

Production from CIL, SCCL and captive blocks has not been sufficient to meet the coal demand for the country. In FY13, close to 142 MT of coal was imported in order to meet the domestic requirement. Though the captive production is expected to increase by 2017, it is still expected that there would be a deficit of about 265 MT which would have to be met through coal imports. The Demand Supply scenario after taking Business as usual scenario (4-5% production growth) for coal production augmentation is shown below:

Large coal imports would drain the country's foreign exchange reserve which ideally would have contributed to other growing sectors. The coal import has increased substantially over the last two years. In FY13 the cost of coal imports was close to 16 billion USD.

Table 1: Demand Supply Projections (Million Tonne)

	XI FYP (MT)	XII FYP (MT Projected)	XIII FYP (MT Projected)
Demand	696.03	980.50	1373
Supply	554	715	950
Gap (Imports)	142.03	265.5	423

Private Sector participation in the Coal Sector and coal block de-allocation

In September this year the Supreme Court quashed allocation of 214 out of 218 coal blocks which were allotted to various companies since 1993. The Coal Mines (Nationalisation) Act 1973 was amended in June 1993, allowing companies which were in the business of producing power and iron and steel, to own coal mines for their captive use. Hence, the coal that these companies produced in these mines was to be used to feed into the production of power, iron and steel and other industries.

This amendment was used to allot coal blocks for free to private and public sector companies to the condition that the coal produced was used for captive mining. The Supreme Court judged the process of allocation of these coal block to be arbitrary.

Currently 40 out of the 218 coal blocks that were allocated produce coal. The Supreme Court has cancelled all these allocations except one mine belonging to SAIL and two mines which feed coal into Sasan Power, which is an Ultra Mega Power project. Central government vide its ordinance have classified all mines in 3 schedules and is expected to auction schedule 2 & 3 blocks (74) before March 2015.

Challenges in Development of Sustainable Energy Sources

Wind Resources

According to GWEC, annual wind installations fell from over 3 GW in 2011 to 2.3 GW in 2012 to 1.7 GW in 2013. 2013 has been one of the toughest years for the Indian wind industry since the economic recession of 2008. The decline in wind investment due to withdrawal of AD coincided with healthy growth of close to 60% in Solar Power in 2012-13 and 2013-14. The wind industry has faced various challenges including the withdrawal of accelerated depreciation benefits (reinstated in July 2014), challenges in transmission, scheduling and forecasting, lack of an integrated energy plan among others which precipitated a significant drop in capacity additions.

Launching of National Wind Energy Mission and Restoration of Accelerated Depreciation could partially help in reviving the Wind Industry in India

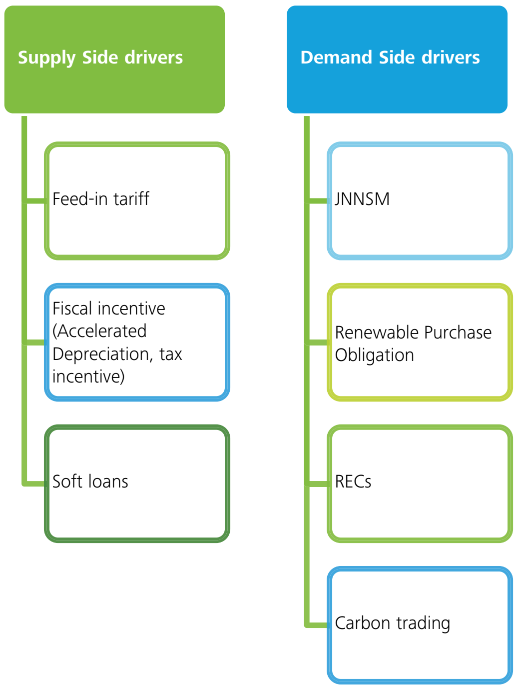
The government of India is planning to launch a National Wind Energy Mission (NWEM) sometime in 2014. This is expected to give a boost to wind power. It is widely expected that a NWEM will help streamline the support mechanisms and enhance development in the win sector. Through this mission, the government aims to have a generating capacity of 100 GW of wind power installed by 2022, from the present 20 GW. The proposed mission draft would include large-scale promotion of onshore and offshore wind power as well as small (<100 kW) wind turbine systems.

The Government earlier this year also announced the restoration of Accelerated Depreciation benefit for the wind industry. We believe that the investment momentum will shift again to wind due to more mature policies and attractive tariffs. However, the strength of the recovery will be closely linked to how effectively the NWEM and its contents can be made operational and how well it is designed.

Demand and Supply Side Drivers are improving investment climate in solar sector in India

Supply Side Drivers: Enable and motivate solar generators to supply electricity, regardless of its actual, commercial demand. By ensuring a guaranteed rate of return, such policies take away some of the risk associated with solar based generation.

Demand Side Drivers: Create a distinct and measurable commercial demand for such electricity. These drivers do not incentivize solar generators directly, but create a market for solar electricity.



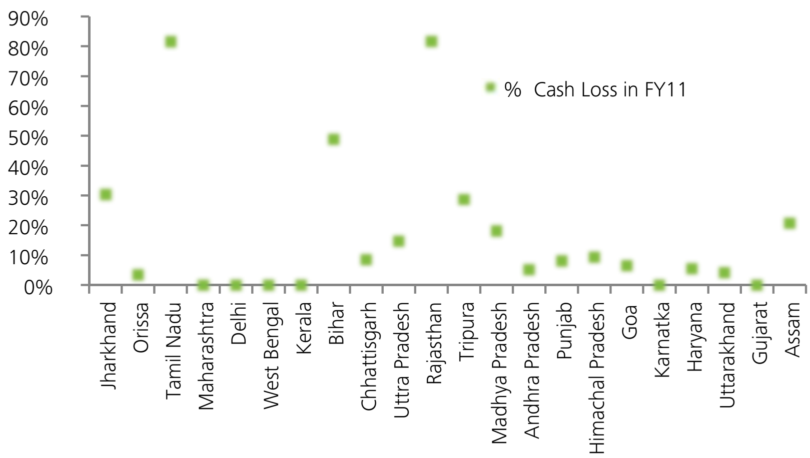
Rapid growth of sustainable energy are currently facing multiple road blocks

- Non availability of adequate transmission and physical infrastructure: Inadequate grid infrastructure is another key issue. Wind generators in TN are asked to back-down during peak wind season due to inadequate transmission capacity. TN is facing this issue due to huge wind capacity additions planned by investors leading to disconnect between investors and transmission planners. Transmission lines along with future distribution infrastructure take about

2 – 3 years to commission whereas wind power plants are commissioned within a year. This leads to a mismatch in timelines and creates evacuation bottlenecks.

- Delays in land acquisition, clearances and approvals: In most states, availability of land is a major issue. Even if private lands are available, conversion of land use status from agricultural to nonagricultural is a time consuming process. Further if the land is close to a protected area or forestlands then obtaining clearance from forest authorities for using the forestland for wind/solar power generation adds to the timelines.
- Disconnect between SERC and CERC Regulations: The electricity regulatory framework consists of the Central Electricity Regulatory Commission at the national level and a State Electricity Regulatory Commission at the state level. The CERC issues guidelines for determining the feed-in-tariff for renewable energy based power generation. However, the power producers are covered by the tariff determined by the SERCs. The tariff determined by the SERCs may or may not be equivalent to that of CERC tariffs. Tariffs vary across states and remain fixed for a long control period which could impact returns for new projects commissioned under this tariff regime and negatively impact new project development activity.
- Access to financing: Another barrier to the growth of the renewable energy sector is the inordinately high borrowing costs. In India, a significant majority of RE power projects are financed with a 70:30 debt-equity ratio. Since most states sign PPAs after the project is commissioned, the banks require promoters to provide corporate guarantees until such PPAs are signed. This lack of project financing slows down development.
- Non-compliance of RPO: Most of the states have set RPO targets; but very few are meeting their obligations. Certain states like Tamil Nadu, Karnataka are meeting their RPO targets of over 10% whereas states like Madhya Pradesh even after having high renewable potential are meeting only 0.4% of the total requirement. States like Delhi and Haryana which are not rich in renewable sources do not procure renewable power from other states nor purchase RECs to meet their RPO targets.
- Financial performance of utilities: Poor financial health of majority state utilities is also impacting the sector. The paying capability of utilities in the wind rich states of Tamil Nadu and Rajasthan are impacting investor confidence. These state utilities have large working capital loans and have long payment cycles. However these states have already signed for the short term debt restructuring package and their financial position is expected to improve.

Power Distribution Sector efficiency needs to improve



Many of the state utilities were reeling under severe huge financial loss

The financial predicament of state DISCOMs is mainly due to AT&C losses. The AT&C includes not only the technical losses incurred during transmission, but also revenue losses at the distribution/ retail end due to various causes.

The nation-wide AT&C were 31% in FY 2010/11 (PC, 2011b). Losses are very high compared to the most efficient countries including South Korea (4%) and Japan (5%), and other emerging economies such as Brazil (17%), China (5%) and Indonesia (10%) in 2009 (WDI, 2012). The total AT&C loss is estimated to be equivalent to 1.5% of India's GDP (CEA, 2010) or approximately USD 17 billion in terms of 2010 GDP.

The Accelerated Power Development & Reform Programme (APDRP) was launched in 2001 to strengthen the sub-transmission and distribution network and to reduce the AT&C losses to 15% in five years. Without achieving this target, the ARDRP was restructured by the MOP (called RAPDRP) and re-launched in 2008 as one of the main policy initiatives of the 11th Plan. Focusing on building baseline data and adopting IT applications, it aims to reduce AT&C losses by 3% per year for utilities having over 30% AT&C losses and by 1.5% per year for those who having less than 30%. However the benefits of these investment are still to be realized.

New Political & Economic Environment in the country needs to revitalize the economy and investor confidence

It's a new era for India's economic and political environment. After decades of coalition government the country has chosen a single party with a majority in the lower house.

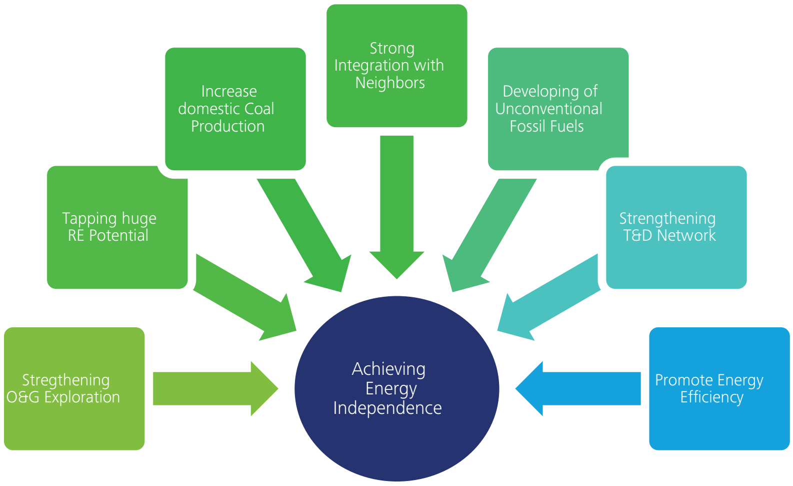
In recent years India, has been caught in a cycle of rising inflation and flagging growth. Trapped up in the worst post-liberalization economic phase, the country slowed from blazing, double-digit GDP growth rates to half that, around 5%, in recent years. The new government will have to immediately kick start the reform process in an economy that has been paralyzed for some time due to lack of proper policy direction.

Some of the key areas which will be very important from the energy planning perspective will be to create a friendly policy environment which will encourage energy security, sustainability and affordability for the general population of the country.

Other key aspect will be to increase the investor confidence which had substantially decreased over the last couple of years.

Looking from the overall energy security point of view India needs to invest greatly on the relationship with its energy rich neighbor.

Implementation Strategies



Achieving Energy Independence

India's dependence on imported energy sources, pose significant risk to its energy security. High oil & gas imports, stagnant coal production, declining gas production and lack of long term energy planning are issues which require immediate attention, if India plans to be energy independent in the future. An integrated approach is required for overcoming the challenges in energy security, which ideally is be a mix of 'supply and demand' side measures.

Tapping the huge RE potential in India

Conventional modes of power currently constitute majority of India's total power generation, but going forward the impact of burgeoning demand coupled with strict emission standards, would put pressure on them. Given its huge potential in India, renewable energy sources will be an important part of India's long term energy security plan. Accelerating the use of renewable energy is also inevitable if India has to reduce its carbon intensity. Currently India exploits around ~13% of 250 GW RE potential in the country, thereby leaving significant growth opportunity for its development. Some initiatives might include:

- Decentralized Distributed Generation or Off-grid renewable generation sources for lighting villages in far flung areas.
- Strengthening the RPO compliance mechanisms as very few states are meeting their obligations.

Development of Unconventional Fossil Fuel

EIA estimates that India holds enough shale reserves to meet the country's domestic energy demand for the next 26 years. With the approval of the shale gas exploration policy in 2013, India took its first step towards developing its domestic shale gas resources. Though the policy aims to attract foreign capital and technological investments to India, it lacks any special fiscal incentive to stimulate the rapid development of shale gas resources. High population density, stressed freshwater availability, and difficult geographical formations also stand in the way of India's shale gas development plans. Some initiatives might include:

- While we are dependent on imported technology, the answer to challenges lie in developing technologies which can cater to specific Indian issues.
- Proving enabling environment for participation of global E&P players, as shale development in India currently is undertaken only by the two state-owned players—ONGC and Oil India Limited.

Increasing domestic coal production

Domestic coal production in India hasn't kept pace with the growing demands of the energy sector. This has led to stranded capacities and large amount of forex being paid for import of coal. Given India's vast coal reserves, it is reasonably sure that in the next 2-3 decades India will be increasingly relying on coal for fulfilling its primary energy needs a perspective. 80% of domestic production is carried out by Coal India Limited which faces huge road blocks in development of its new mines pivoted around issues of Forest and Environment Clearances and challenges faced during Land Acquisition and Rehabilitation & Resettlement. The coal sector needs significant amount of intervention in terms of opening up the sector and bringing suitable technologies:

- Providing enabling environment for entry of mining juniors, which are dedicated exploration companies that target promising mining areas with economically viable preposition.
- Coordination between various government agencies for speedier clearances and implementation of essential infrastructure for new mine development and evacuation.
- There is a need for adopting latest technologies for mines (especially underground), which currently has significantly lower Output per Man-shifts (OMS) as compared to global standards.

Strong Integration with neighbors and increasing the reach of Indian Energy Companies

We are surrounded by resource rich nations along our border. While Nepal and Bhutan are rich in hydro resources and Myanmar offers excellent opportunity for developing gas based resources. While some progress has been made in Nepal and Bhutan, where Indian companies have established hydro based power generating stations, significant amount of work needs to be done on the Myanmar front. Some initiatives might include:

- Planning for dedication transmission corridor for evacuation of power from Nepal and Bhutan.
- Developing transmission pipelines for importing gas from Myanmar.
- Fast tracking the planning and implementation of Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline for gas transportation.

Strengthening Transmission & Distribution (T&D) Network

Average T&D losses in India are around ~23%, as compared to sub-10% levels in most developed countries. Inadequate investment over the years and overloading of the existing systems have contributed towards the high technical transmission losses in the country. The commercial losses are primarily due to theft, low billing and metering efficiency and pilferages. Reduction in T&D losses could lead to significant energy saving, thereby reducing the burden on existing systems. Some initiatives for T&D loss reduction could be:

- Formulating long term plans for strengthening of transmission & distribution systems.
- Uniform guidelines and implementation of energy accounting in the power systems.

Strengthening Domestic Oil & Gas Exploration and Production

As stated earlier, India relies heavily on oil & gas imports, which according to forecasts, will only increase going forward. To reduce such heavy reliance on imports India needs strong measures to be taken for enhancing domestic exploration and production. Some initiatives might include:

- Providing enabling environment for participation of global Oil E&P companies to participate in the upcoming NELP bidding.
- Providing market based pricing for domestically produced gas.

Promoting Energy Efficiency and Smart Grid

Energy Intensity in India, which is a measure of how efficiently energy is being used in the country, is around 2-3 times that of developed countries. This pronounces the need for having energy efficiency measures in the country, where one-fourth of the population still has no access to electricity. Areas such as buildings, transport, industries etc. offer significant scope for incorporating energy efficiency measures and also reduce reducing carbon emissions. Some of such measures could be:

- Policy guidelines for incentivizing investments in energy efficiency
- Operationalizing Perform, Achieve and Trade scheme for energy intensive industries.
- Promoting the use of electric vehicles can help improve the road side quality and reduce greenhouse gas emissions.

Improve Access to Financing through Private Sector Participation

According to Asian Development Bank, India will need around ~$ 2.3 trillion investment in the energy sector by 2035. Such huge investment need will require private participation, to meet the domestic energy demand. As such India has initiated some PPP activity in power and transport sector, but with limited success. The success of such partnerships depend on proper risk-sharing mechanism and speedier implementation of projects. Few initiatives could be:

- Designing suitable risk-sharing mechanism between the government and the private parties.
- Coordination among ministries and other government agencies for fast tracking the clearance approval process.

Addressing Bottlenecks in Energy Supply

Executive Summary

Bottlenecks in Energy Supply

Presently, the Installed capacity of the country is dominated by coal fired plants. Given the incapability of distribution companies to absorb high cost of RLNG, risk perception around nuclear plants and significant risks in development of hydro resources, the choice of coal as fuel comes naturally to the developers. As on Sep 2014, thermal generation capacity is around 70% of the total generation base, followed by hydro, which has a share of 16%. Currently, gas, hydro and nuclear capacity addition programs have almost stagnated.

While there has been a marginal increase in production by CIL and its subsidiaries, usage of imported coal for thermal generation has shown an increasing trend in the recent past on account of domestic coal shortages. Besides the issues faced by the cost plus stations, even most of the competitively bid out projects have met hurdles on account of coal related issues. CERC has allowed compensatory tariff to several successful bidders in the recent past. Perceiving high risk in the issues over supply of domestic coal, the recent rounds of bids submitted by the bidders have seen tremendous increase in levelised costs in comparison to the initial tariff rates quoted by the bidders.

Besides, the coal industry recently witnessed the historic judgment by the Supreme Court which has cancelled allocation of 214 out of 218 coal blocks made over the past two decades, on the grounds that it was done in an arbitrary manner. In order to ensure that coal is supplied to the power plants without disruption, the Ministry of Coal has passed the Coal Mines (Special Provisions) Ordinance, 2014 on 29 November 2014, to facilitate e-auction of coal blocks for private companies for captive use and allot mines directly to state and central PSUs. In the first phase, 42 operating coal mines and 32 mines nearing commencement of production will be offered to developers with notified end-use projects in the power, cement and steel sectors.

Despite the manner of allocation, the mining of coal has witnessed several bottlenecks pertaining to delay in seeking approvals and clearances, land acquisition, R & R, geological investigations and approval of mining plan that needs to be addressed in order to ensure reliability of energy supply to the end users.

In the oil and gas sector, domestic gas availability may improve going forward due to commissioning of production in ONGC- South (KG) Basin, GSPC-Cambay and GSPC – KG. Deep water and Ultra deep water are the next frontiers for exploring the Indian hydrocarbon scenario. Besides, the LNG supply scenario in India is expected to improve going forward, with long term contracts being done with RasGas, Qatar, Exxon Mobil, Gorgon, Australia, Chenire Energy, GAZPROM, Sakhalin, Russia.

Despite the fact that distribution companies are facing power shortages, the demand for peaking power from RLNG does not find enough buyers due to poor absorption capacity of distribution companies at the given tariff and availability of power from alternative coal based sources at relatively cheaper price. Despite being a clean fuel, presence of comparatively cheaper industrial fuels and insensitivity towards environmental impact makes the demand for RLNG very sensitive

Despite the fact that Hydro Power is a cost effective renewable source of power generation, however, as on 31st October, 2014, only 25% of the assessed Hydro capacity in the country has been exploited. Hydropower generation has failed to keep pace with the thermal generation and has remained unexploited due to Environment and social Constraints, High investment and long gestation period.

India has a third of the world's thorium, which can be converted into uranium-233 for further utilisation in a nuclear reactor to produce energy through nuclear fission. India is propagating a three stage program for large scale deployment of nuclear energy. However, Nuclear capacity addition faces several hurdles related to Project economics, Financing issues, Reactor technology and safety etc. that needs to be addressed before successful implementation of the program.

Points for discussion and suggestions to address the bottlenecks

India will have to follow a balanced approach to address the bottlenecks in energy supply to cater to growing demand of the economy. The foremost of the tasks would be to address the operating efficiency of Distribution Utilities which is currently on a lower side. Measures to be taken to promote efficiency in distribution function would help in absorption of imported coal and RNG based generating costs. On the domestic front, logistic issues for movement of coal from designated mines to the power stations needs to be addressed. One of the alternatives could be to promote coal swapping between power stations to bridge the gap between requirement and availability in the most optimal manner.

Besides, it is important to reduce the reliance on imported fuels by expediting coal block allocation/ allotment process to bring certainty in the process and creation of enablers for expeditious development of mines.

On the usage of RLNG, there is a need for rationalization of transmission tariff for Gas pipelines. Pooling of gas prices and reconsideration of Gas Distribution Policy to lower the operating cost of power plants and make them more viable for peak loads could be considered. Sensitivity towards environmental impact of industrial fuels would lead to increase in demand for cleaner fuels. Promoting development of shale reserves by opening the market to global players will boost investments and will reduce reliance on RLNG.

Key consideration for removing the bottlenecks for hydro sector would be to address governance issues related to basin wise development of projects and mechanism for allocation of projects to the developers. The government needs to streamline the land acquisition process, evacuation constraints and other procedures involved in development of hydroelectric plant especially the R & R related aspects.

Post the Fukushima disaster, there has been a lot of public apprehension on safety of nuclear power and India has also seen public resistance at several proposed nuclear power plant sites. Besides public awareness, India will have to overcome the hurdles of financing, fuel dependency and reactor technologies to harness the potential and make it self-sufficient in its energy requirements.

Strategic Context

Electricity Act 2003 – The legal framework & outcomes

The Electricity Act 2003 (and subsequent amendments), provides the legal framework within which the electricity sector of the country operates. Key objectives of the Act are to consolidate laws relating to all activities in the sector, promoting competition and consumer choice, protection of consumer interests, expanding coverage, rationalising tariff and ensuring transparency in subsidies, mandatory creation of Federal and State regulators and promoting efficient and environmentally friendly policies.

Sector response to legal mandate, policy focus and regulatory scrutiny has been significant, as evidenced by the expansion in capacity across generation, transmission and distribution, resulting in expansion of access and availability of power. To varying degrees, tariffs rationalization has happened and separation of cross subsidy and subsidy has been effected.

Key performance indicators

	Units	2002	2013	Increase
Installed Capacity	GW	105	223	113%
T&D Lines	Ckt kms	6,030,148	8,970,112	49%
Per capita consumption	kWh	559	917	64%
Villages Electrified	No	81%	95%	17%
Electrified HHs	Millions	107	166	55%

Source: MoP, Deloitte research

Approximately 55 GW of generation capacity was added during the 11th Plan. This momentum appears to have carried on into the 12th Plan with addition of approximately 38 GW till end of FY14. Schemes like RAPDRP and RGGVY have been instrumental in driving network investments and accelerated the pace of reforms in distribution.

There has been significant private sector participation especially in generation and transmission sector. Participation in distribution has been limited and through the distribution franchisee model. Over the period FY06 – FY14, private sector generation capacity has increased from 14 GW to 83 GW, at a CAGR of 25%. Private sector participation in transmission and distribution has been less pronounced

Figure 1: Generation capacity addition

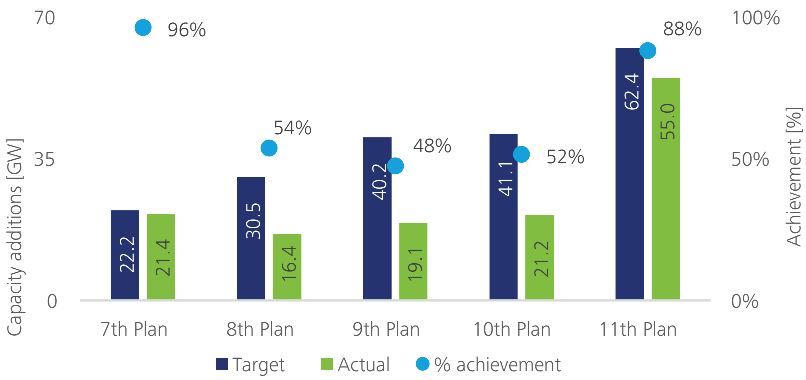
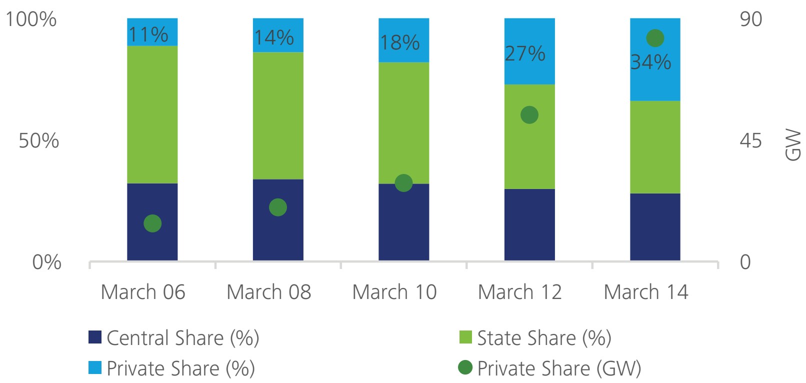


Figure 2: Growing PSP in generation



Installed capacity dominated by coal fired plants

As on Sep 2014, thermal generation capacity is around 70% of the total generation base, followed by hydro, which has a share of 16%.

In the current scenario gas, hydro and nuclear capacity addition programs have almost stagnated. Environmental clearances, R&R issues and long gestation periods have delayed plans to harness the hydro power potential of river basins. Further, lack of adequate domestic gas and expensive RLNG has resulted in stranding of gas power plants.
Therefore, bulk of capacity addition has been from coal fired plants even though challenges exist around domestic coal supply.

This domination of coal is expected to continue in India's capacity mix. Capacity addition from gas and hydro is expected to remain muted. However, capacity addition from renewables is expected to be significant enough to increase its share of installed capacity.

Figure 3: Fuel-wise break-up of installed capacity

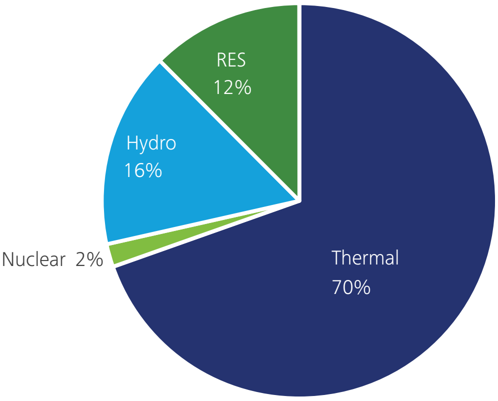
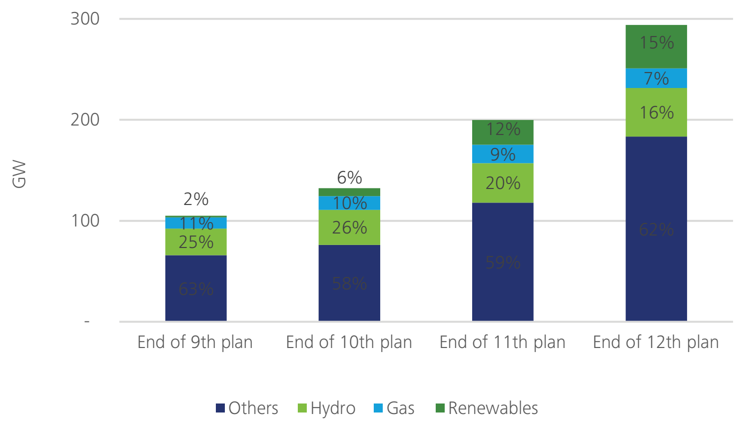


Figure 4: Reducing share of hydro & gas capacity



Bottlenecks in Energy Supply

Coal Based Generation

Domestic coal production

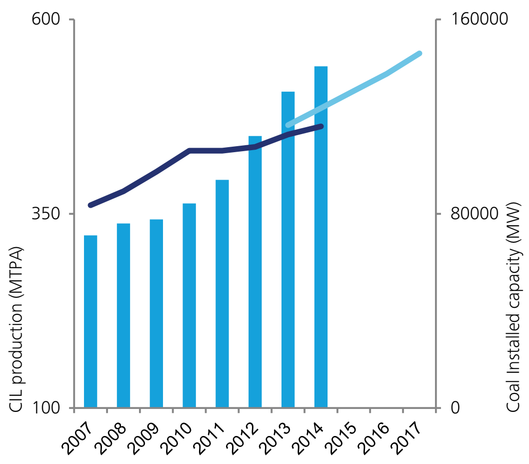
In the year 2012-13, the total production of raw coal in India increased by 3.0% (from 539.950 MT in 2011-12 to 556.402 MT in 2012-13). The production of non-coking coal in 2012-13 in India was 504.820 MT, up by 3.4% over 2011-12. The contribution of Coal India Limited in the coal production in 2012-13 was 452.200 MT (81.27%) and that of SCCL 53.190 MT (9.56%). Altogether, Government sector contributed around 92% of total coal production against private sector. Import of Non-coking coal was 110.228 MT in 2012-13 against 71.052 MT in 2011-12, an increase of 55.14% over 2011-12.

During 2012-13, despatch of indigenous raw coal was 567.136 MT against the corresponding figure of 535.299 MT during 2011-12 an increase of 5.95% over 2011-12. Despatches of non-coking coal grew to 511 MT in 2012-13 from 483 MT in 2011-12, registering an increase of 5.73% over previous year. CIL despatched 464 MT and SCCL 52 MT of coal in 2012-13.

Low CIL production leading to incremental usage of imported coal

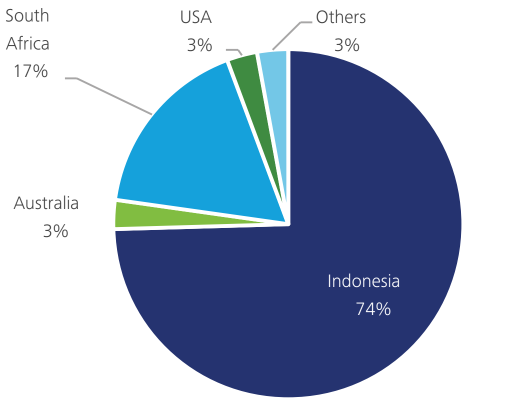
On account of constraints in domestic production,

Figure 5: Increase in coal fired capacity vs increase in coal production



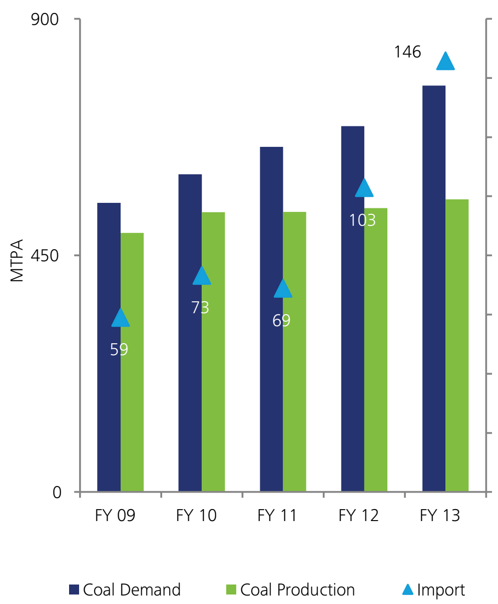
restrictions are imposed on coal supply to power plants and only power plants that have long term PPAs are provided coal supplies. For the new FSAs being signed, coal supply is restricted to only 65% of the allocated linkage quantum and remaining is to be met by imported coal.

Figure 6: Coal import sources



As is evident from market sources, incremental quantum of coal required by generating companies is largely getting sourced from Indonesia and South Africa. Currently, coal is mainly imported through Paradip and Krishnapatnam ports. However, given the quantum and growth rate of imported coal requirement, non-commensurate development of railway logistics will further deter the usage of imported coal by inland enerating companies. Usage of imported coal has shown an increasing trend in the recent past on account of domestic coal shortages

Figure 7: Coal - Demand, supply & imports



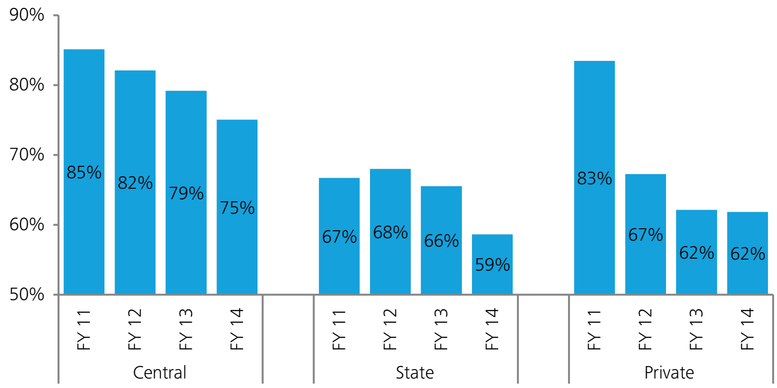
For plants not able to source imported coal or having constraints in usage of imported coal due to logistics, boiler issues, blending constraints etc. the PLF is showing a declining trend.

Disputes under competitive bidding process – Supply & price of coal

In order to be competitive, most of the bidders quoted fixed (non – escalable) charges for all 25 years. Even in the case of bids based on international coal, bids were either fixed or partly escalable, considering that developers owned mines internationally in Indonesia or Australia. Some developers submitted their bids on the basis of captive coal blocks assuming that requisite clearances for such blocks would be received in a timely manner.

Most of the competitively bid out projects have met hurdles on account of non-availability of coal block clearances, international changes in coal prices and changes in linkage coal provided to bidders at the time of bid submission. CERC has allowed compensatory tariff to several successful bidders in the recent past. However, these orders are being challenged in Supreme Court by distribution utilities

Figure 8: Declining trend of thermal plant PLF



Judgment of the Supreme Court on cancellation of coal block allocations – uncertainty in fuel supply

Recently, the Supreme Court cancelled allocation of 214 out of 218 coal blocks done over the past 2 decades, on the grounds that it was done in an arbitrary manner. Only two allocations made to the UMPPs and two allocations made to Central

Parties	Issues	Impact
Mundra UMPP	Increase in coal costs due to change in law in Indonesia and bid under un-escalable component	About 52ps increase in tariff
Sasan UMPP	Increase in capital costs due to exchange rate variation	To be decided
Sasan UMPP	Increase in variable costs due to increase in price of diesel	Disallowed
Adani Tiroda plant	Increase in coal costs due to delay in coal block allocated due to lack of environmental clearance	Compensatory mechanism decided by Committee
Adani Mundra	Increase in coal costs due to change in law in Indonesia and bid under un-escalable component	About 70ps for PH 3 and 43ps for PH 4
JSW Ratnagiri plant	Increase in coal costs due to cancellation of mining license of its coal supplier in Indonesia	Disallowed

Government public sector undertakings not having a joint venture, were not cancelled.

The operating mines will be handed over to Coal India from 1st April 2015 until the Government decides to re-allocate the mines or invite bidding process for allotment of mines to the developers.

Allocation of Coal Mines for E-Auction

Pursuant to Supreme Court quashing allocation of 214 coal blocks, the Ministry of Coal passed the Coal Mines (Special Provisions) Ordinance, 2014 on 29 November 2014, to facilitate e-auction of coal blocks for private companies for captive use and allot mines directly to state and central PSUs.

In the first phase, 42 working coal mines and 32 in line to start production will be offered to developers with notified end-use projects in the power, cement and steel sectors.

Government entities, including public sector units such as NTPC and State Electricity Boards, however, will not have to go through the auction route as a pool of coal mines will be reserved for allocation to them from the cancelled blocks.

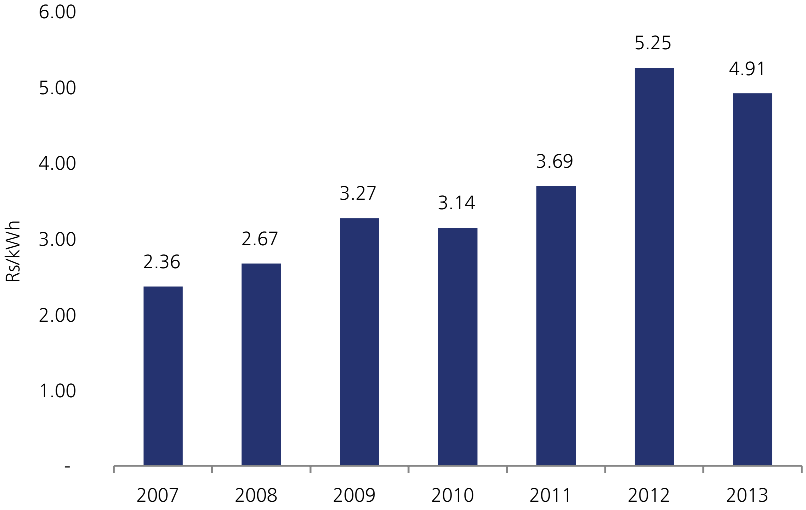
Uncertainty in fuel supply – higher risk perception & tariffs bid

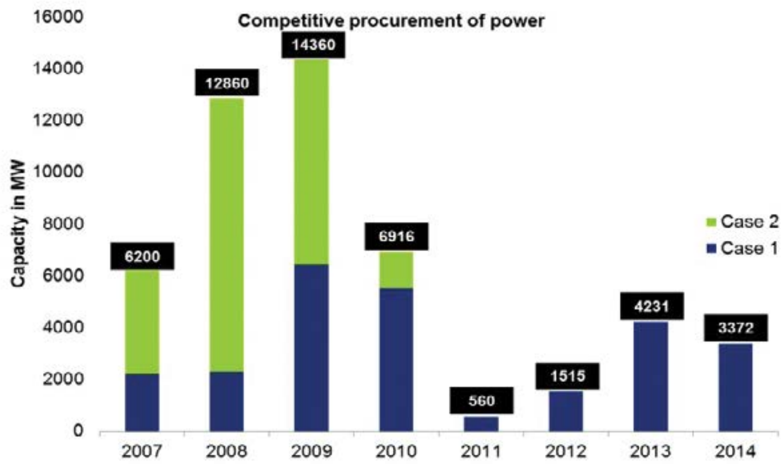
Going by the present cases of litigation in the initial bidding processes run by the state utilities, the bidders have started factoring in the issues over supply and price of coal in their bids. The recent rounds of bids submitted by the bidders have seen tremendous increase in levelised costs in comparison to the initial bidding processes. Tariffs discovered in recent Case 1 indicate bidders are passing on all fuel related uncertainties in input costs

Increase in cost of competitively bid out projects is shrinking the quantum of power purchased by discoms

Discoms have not agreed on the compensatory tariff provided by CERC to the bidders and have challenged such orders. Factoring such uncertainties in the recent competitive bid process has led to shrinking of capacity being procured by the discoms. Eventually this means that either the discoms will resort to procurement under short term or undertake load shedding in order to optimise the demand supply scenario in their geographical areas. Absence of non-APM gas based peak load plants has further added to the issues.

Figure 9: Weighted average levelised tariffs bid





Hurdles in bringing Coal Mines into Production

Ministry of Coal had earlier allocated captive mines to bulk users of Coal. However, very few of the coal blocks has started production. Some of the key issues in bringing the Coal Mines into Production are as follows:

Key Drivers	Bottleneckss
Delay in seeking Approvals and Clearances	• In the present legislative and regulatory framework, the allottee of a captive coal block has to obtain multitude of clearances and approvals as provided under the provisions of the Coal Mines Act. • Single window approach not being followed in spirit.
Land Acquisition process is time consuming	• The existing procedure on land acquisition is lengthy and is prone to litigation. • The procedure for land acquisition needs to be made less time consuming by the Government.
Rehabilitation of Project Affected People (PAP)	• The state and Central Government have their separate R&R Policies. States R&R Policies are more stringent on the project developers. • Providing employment to all PAP may not always be possible as new technology driven mining methods is less labour intensive.
Delay in Geological Investigations and Mining Plan	New agencies with the competence to perform geological investigations need to be set up and accredited by the Government of India.
Inadequate infrastructure facilities	Many of the mining areas are in remote locations and cannot be properly developed unless the supporting infrastructure (Rails/ Ports) is set up.

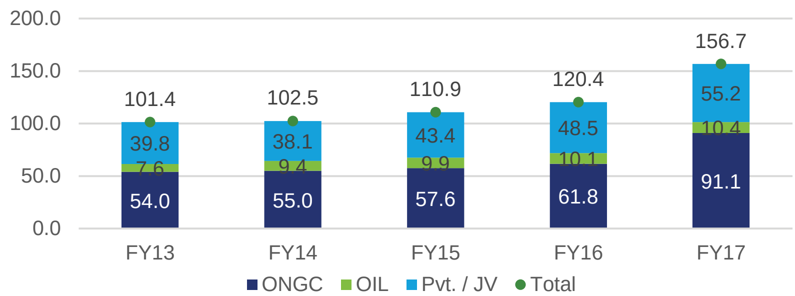
Gas based Generation

Gas Availability- showing signs of improvement?

Domestic Gas - Short to Medium Term Gas Availability

Domestic gas availability is expected to improve going forward. PNGRB, in its document - 'Vision 2030' has projected the expected domestic production profile based on discussions with National Oil Companies and other major exploration & production players. The estimates put together by the sub-committee comprising of key upstream players in India such as ONGC, Reliance, BG India, etc. and government bodies such as DGH, Planning Commission, etc. is as shown

Figure 10: Projected gas availability



The increase in the domestic production could be attributed to some of the following fields which are expected to come in production in the next 2 to 3 years

Particulars	Gas Production in FY16 (mmscmd
ONGC-South (KG)	7
GSPC-Cambay	5.9
GSPC - KG	3

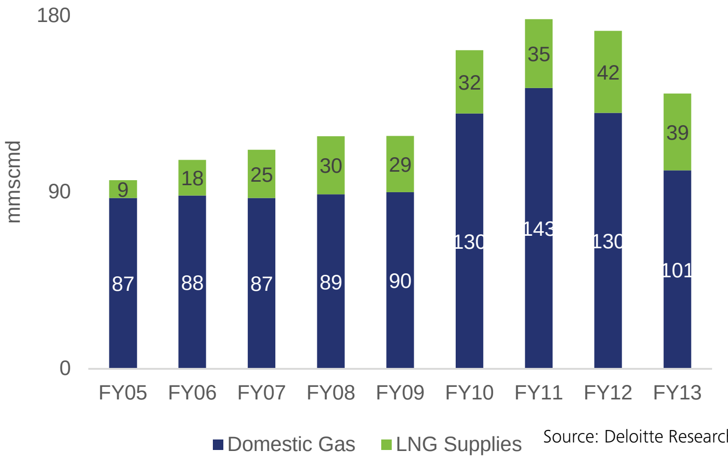
Source: Deloitte Research

Domestic Gas - Long Term Outlook

1. Conventional Production: - 642 million tonnes of oil equivalent (mtoe) of oil and gas reserves have been established from 87 discoveries through 9 rounds of New Exploration Licencing policy over the period 1999 to 2010. Deep water and Ultra deep water are the next frontiers for exploring the Indian hydrocarbon scenario. Additionally, Enhanced Oil Recovery/Increased Oil Recovery (EOR/IOR) programs have been initiated to bring into production new marginal areas while improving the recovery from depleting assets.
   - EOR and IOR – Oil E&P companies such as ONGC have undertaken/planning to undertake many Enhanced Oil Recovery (EOR) and Improved Oil Recovery (IOR) schemes. The performance of EOR, IOR and Redevelopment schemes being implemented currently is expected to a have major impact on maintaining production levels from existing large fields, while also bringing into production more marginal hydrocarbon plays
   - Deep water and Ultra deep water – India has deep water potential with estimated sedimentary area of about 1.35 mn sq km. Deep water exploration has witnessed increased interest in the last 10 years. Around 80 blocks in deep water areas have been awarded since NELP I. ONGC, RIL and a clutch of other players are active in the eastern offshore deep water prospects.
   - In order to seek more participation from international bidders, GoI is in the process of finalizing new policy for bidding based on reports submitted by 'Rangarajan Committee' and 'Kelkar Committee' for the 10th NELP round, in which 86 blocks are expected to be put up for bidding.
2. Unconventional Production: - Though unconventional gases like Shale and CBM have proved to be successful in many countries, it will take some time for unconventional gases to have a significant impact on the gas supply scenario of India.
   - Coal Bed Methane: Since India has large coal reserves, there is significant potential for developing Coal bed Methane as a resource. The projected CBM reserves in the country are around 92TCF. Until now, four CBM rounds have been carried out wherein most of the blocks have been offered in Jharkhand, West Bengal, Madhya Pradesh and Rajasthan. Currently production is around 0.3 mmscmd and is expected to exceed 4mmscmd by 2016-17.
   - Shale Gas: In India, shale deposits are expected in 4 basins, namely Cambay, Krishna-Godavari, Cauvery and Damodar across the states of Gujarat, Jharkhand, West Bengal, Andhra Pradesh, Tamil Nadu, Assam, Rajasthan and a few other areas. A MoU was signed between MoPNG and Department of State, USA to provide assistance in the area of resource assessment, regulatory framework, training and investment promotion, etc. Subsequently, Shale Gas policy was announced in 2013. ONGC did a pilot project in the Damodar basin and has tied up with ConocoPhillips to explore and develop the Cambay, Krishna Godavari (KG), Cauvery and Bengal basins. Shale gas blocks in Damodar and Cauvery basins are expected to be put up for auction shortly. However, supplies from shale blocks are expected only after 2018. Indian companies, such as RIL, have acquired acreages in US shale plays, in order to gain experience.
   - Gas Hydrates: India has an estimated 1894 trillion cubic meters of predicted resources of gas hydrates found in Krishna Godavari, Mahanadi and Andaman offshore waters. National Gas Hydrate Program (NGHP) was launched by MoPNG which is a consortium of National E&P companies and National Research Institutes to explore the potential of gas hydrates in India

Long term RLNG Outlook for India looks encouraging

Figure 11: Domestic LNG supplies in India



Source: Deloitte Research

In India, gas demand has continuously exceeded production, leading to LNG imports. In addition, other factors such as increase in prices of alternate fuels such as Naphtha, petrol etc, falling domestic supplies from mature fields such as Bombay High and PMT and problems with securing domestic supplies (KG D-6) are adding to import requirements. Natural gas demand is expected to reach 473 mmscmd by FY17 and with growing imbalance in domestic supply and demand, the reliance on RLNG usage is expected to increase. The past trend in domestic and LNG supplies is shown in the graph alongside.

The LNG supply situation in the Asia Pacific region is expected to improve going forward due to increased supplies from the following regions: -

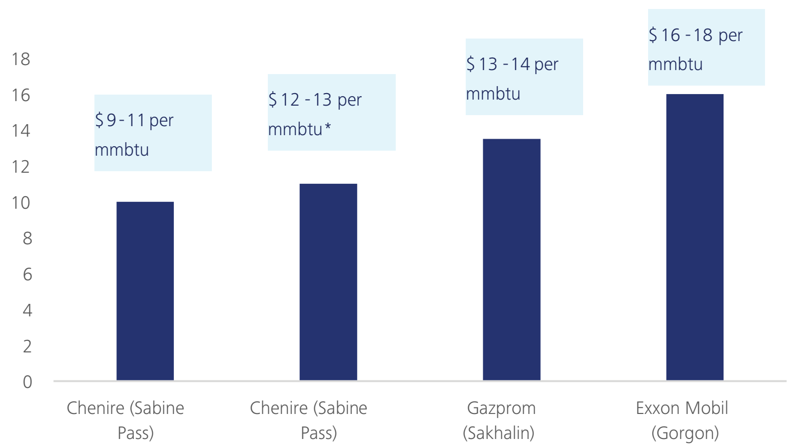
1. Mozambique/ Tanzania: Possibility of attractive Pricing and logistically favorable (East Africa)
2. Russia : Price advantage (NBP linked), large portfolio
3. US & Canada: Price Advantage (indexation to HH etc)

Further, expansion of existing projects and new projects in the region, with 7 new conventional LNG liquefaction plants with nameplate capacity of 47.4 mmtpa scheduled to be commissioned in next 4 to 6 years, is expected to improve the situation.

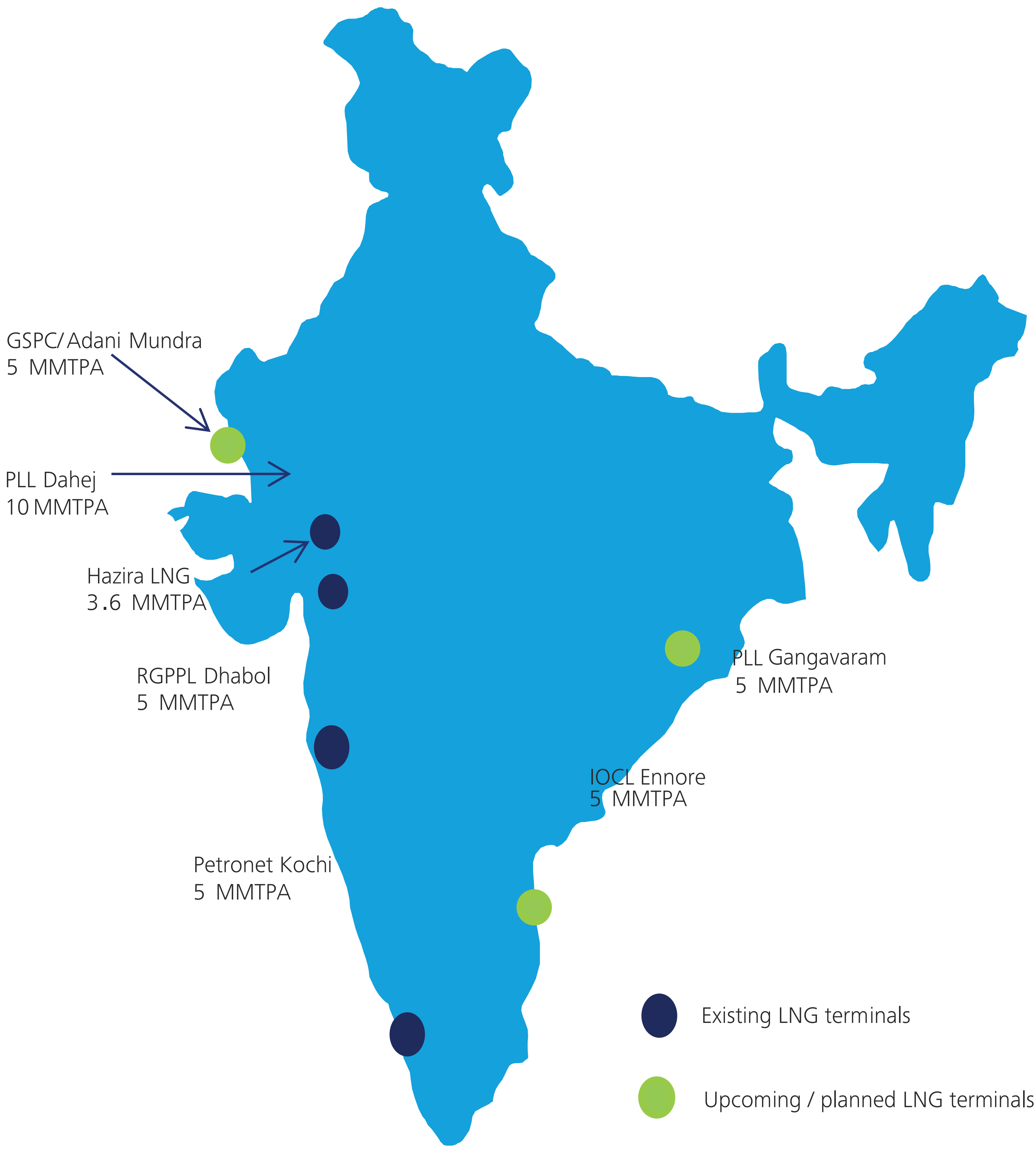
The LNG supply scenario in India is expected to improve going forward, with long term contracts being done by Indian companies: -

1. PLL contract with RasGas, Qatar: - 7.5 MMTPA and supplies commenced in 2004. The contract is indexed on 12.67% of 60 month average of JCC till 2014. The prices of supplies from RasGas, Qatar are expected to move up, as it will be on float basis and linked to JCC, from April, 2014
2. PLL contract with Exxon Mobil, Gorgon, Australia: - 1.5 MMTPA with supplies to commence from 2014 for 20 year. The price is linked to JCC and increases gradually from 12.6% to around 14.5% with a cap to $70/ bbl for initial years. PLL's contract with Exxon Mobil, Gorgon is expected to be highest priced so far with landed price in India expected to be higher than $16/mmbtu
3. GAIL contract with Chenire Energy: - The contracted quantity is of 3.5 MMTPA, with supplies to commence from 2018. However, GAIL is looking at the option of time swap in order to bring the HH (Henry Hub) based supplies to India faster. It is based on Henry Hub index with 17% premium and may get a delivered price of in less than $10/mmbtu, if HH sustains at current levels
4. GAIL contract with GAZPROM, Sakhalin, Russia: - The contracted quantity is of 2.5 MMTPA, with supplies to commence from 2020 for 20 years and prices are linked to NBP (National Balancing Point)
5. GSPC contract with British Gas, Global Portfolio: - The contracted quantity is of 1.25 MMTPA with supplies to commence form 2015 and prices are linked to NBP

Figure 12: Expected landed gas prices for long term contracts



The following shows a pictorial representation of the existing and upcoming LNG Infrastructure across India.



As evident from the above map, significant regasification infrastructure is being developed both on the western and eastern coastline. Apart from the existing regasification capacity at PLL (Dahej & Kochi), Hazira LNG (Hazira) and RGPPL (Dabhol), following capacities are at an advanced stage of development: -

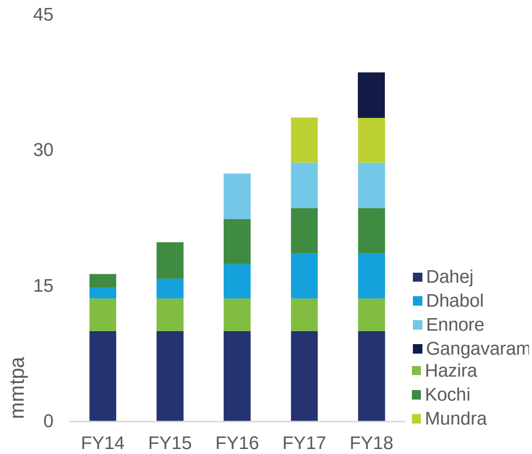
1. IOCL, Ennore: - EPC contract has been awarded; Expected commissioning FY16
2. GSPC/ Adani, Mundra: - Front End Engineering Design and other pre-project activities completed; PMC awarded. Expected completion in FY17
3. PLL, Gangavaram: -Pre-project activities; Commissioning in FY18
4. GAIL, Kakinada: -Floating Storage & Regasification Unit of 3.5 MMTPA

Apart from the above, the following LNG terminals are in various stages of planning: -

1. H-Energy (West Coast – 8MMTPA);
2. ONGC (Mangalore – 5 MMTPA);
3. MMTC (Managalore – 2.5 MMTPA);
4. Haldia – 5 MMTPA;
5. Kandla – 2 MMTPA;
6. Shell – East Coast – 5 MMTPA
7. Pipavav – 5 MMTPA

However, development of LNG import capacity in India is facing issues such as lack of capital, difficulties in securing new supplies, pipeline infrastructure constraints and competitiveness of LNG prices. It is unlikely that all the above planned LNG terminals would become operational. The expected capacities for regasification in the medium term are given below

Figure 13: Expected LNG regasification capacity



LNG Demand Potential

The total gas supplies to various sectors (Including both domestic and imported LNG) are given below (FY13, in mmscmd)

Total gas supply to various sectors (FY13)

Sector	Domestic Supplies	RLNG Supplies	Total Supplies
Fertilizer	31.02	8.37	39.4
Power	30.36	5.80	36.2
Refinery	2.07	8.62	10.7
CGD Sector	6.69	7.28	14
Sponge iron	1.11	3.49	4.6
Petrochemical	3.5	1.37	4.9
LPG	6.02	0.37	6.39
Others	4.11	6.19	10.30

The tentative allocation of LNG to the aforesaid industries in the coming years is detailed in the following section: -

1. Fertilizer Sector: - This sector is expected to see demand based on capacities that are expected to switch from existing feedstock of Naphtha/ FO to LNG. Such demand is estimated to be around of 13.3 mmscmd. Capacity addition to the extent of 5 to 8 MMTPA is expected based on New Urea Investment Policy (2012) announced by the government.

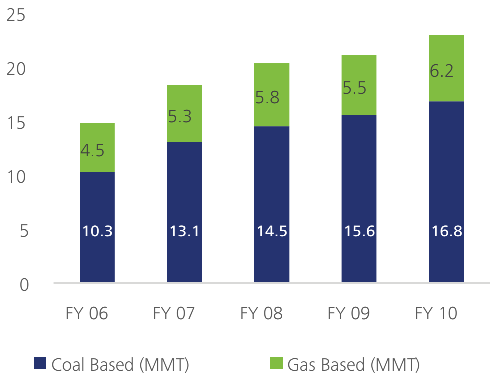
Plant wise additional requirement	Domestic Supplies	RLNG Supplies	Total Supplies
Naphtha based		Fuel Oil based	
ZIL – Goa	1.28	NFL- Panipat	0.9
MCFL – Mangalore	1	NFL- nangal	1
SPIC – Tuticorin	1.66	NFL- Bathinda	0.9
MFL – Manali	1.54	GNVFC- Bharuch	0.95
DIL – Kanpur	1.7	Sub- total of FO based plant	3.75
Sub- total of Naphtha based plant	7.18	MATIX fert & Chem, Burdwan	2.4
Total			13.33

2. Refinery Sector: -The refinery sector has the potential to go upto 42 mmscmd, if only gas/ LNG is used as feedstock. The existing capacity of refineries in India is 198 MMTPA which is expected to go upto approximately 215 MMTPA till FY16 after the upcoming refineries such as NOCL/ HPCL Bathinda are commissioned

Refinery	Location	Capacity (MMTPA)	Gas Demand	Refinery	Location	Capacity (MMTPA)	Gas Demand
IOCL	Koyali	13.70	1.92	BPCL	Bina	6.00	1.3
	Mathura	8.00	0.81	HPCL	Mumbai	6.50	1.6
	Panipat	12.00	3.85		Vizag	8.30	N/A
	Barauni	6.00	1.3	CPCL	Chennai	9.50	N/A
	Paradip	15.00	N/A		Narimanam	1.00	N/A
	Haldia	7.50	N/A	NRL	Numaligarh	3.00	N/A
	Bongaigaon	2.35	N/A	ONGC	Taptika	0.08	N/A
	Guwahati	1.00	N/A	MRPL	Mangalore	11.82	2.5
BPCL	Mumbai	12.00	2.6	Reliance	Jamnagar	62.00	11.23
	Kochi	9.50	2	Essar	Vadinar	20.00	2.8

3. Power: - While there are offtake constraints in running the plants on RLNG, however following considerations that may result in higher LNG demand from the sector are
   - Peaking Power Policy: - The policy is presently under consideration by Ministry of Power. It is expected that higher tariff during peak hours are expected to improve the affordability of high priced LNG in power sector.
   - Combined Heating and Power (CHP) applications: - CHP applications provide the opportunity to increase energy efficiency at lower costs.
4. CGD Sector: - Existing consumption of gas/ LNG in the CGD sector is ~15 mmscmd with potential to go upto 20 mmscmd in the next 5 years. PNGRB has recently announced the bidding rounds for 14 cities including south, west and northern region. The city gas distribution sector has potential for LNG, especially in terms of transport, industrial and commercial sector.
5. Sponge Iron: - There are approximately 700 small, coal based units are in operation in Orissa, Chhattisgarh, West Bengal, Jharkhand, Karnataka and Maharashtra. These have the potential to convert to gas/ LNG as gas usage in Sponge Iron plants enhances the product quality and enables the plant to manufacture both long and flat products. The future consumption of Gas in the Sponge Iron industry is dependent on the pipeline penetration in the clusters. Gas pipeline penetration in the Coal-based Sponge Iron clusters of Orissa, Chhattisgarh, Jharkhand and Karnataka is presently negligible or very low

Figure 14: Sponge iron capacity

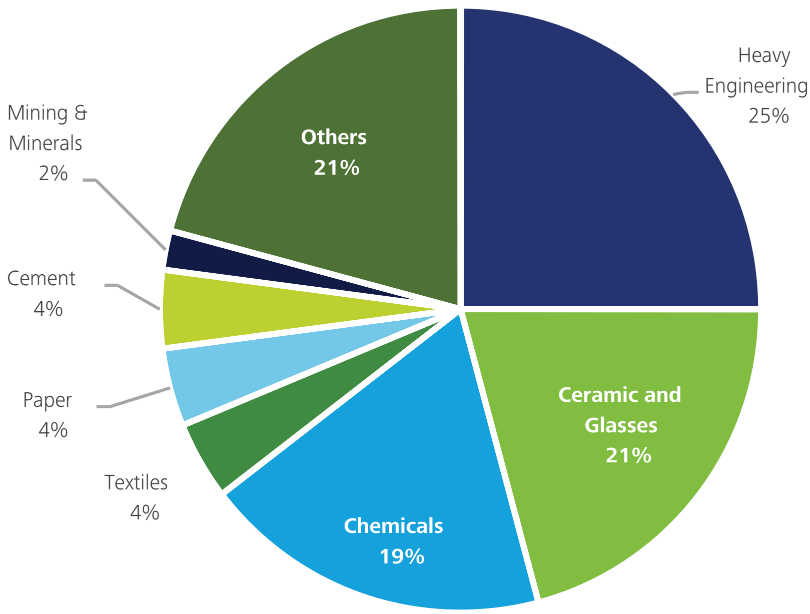


Source: Deloitte research

6. Petrochemicals: - Presently India has three gas-based and three naphtha-based cracker complexes with a combined annual capacity of ~2.7 MMTPA of ethylene. Besides this, there are also 4 aromatic complexes with a capacity of 2.9 MMT of Xylenes (IPCL Vadodra, BPCL Mumbai, Bongaigaon Refinery and Petrochemicals). Existing supplies are around 4.9 mmscmd with a potential to go up to 22 mmscmd

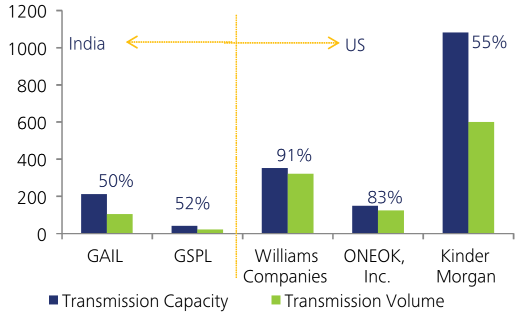
7. Other Industries: - Industries such as ceramics, glass, textiles, cement, heavy engineering, paper, etc. which are currently using alternative fuels such as Naphtha, FO, diesel, etc. have large potential of shifting to LNG based supplies. Natural gas prices are relatively more stable compared to fuel oil and Naphtha prices

Figure 15: Gas demand by industries



Real Time Demand for Gas at current prices is much lower than anticipated

As may be observed in the figure, the overall utilisation of transmission network of GAIL is barely 50%. This is significantly lower than the transmission volume for US companies



An underutilized pipeline network results in significant cost under recovery for the transmission agency which may jeopardize future capacity addition in pipeline network. Lack of willingness to shift to cleaner fuels may also have a cascading impact on the development of LNG terminals which may not find enough throughput to make them viable in the long run.

Power customers not willing to offtake power from costly RLNG

Despite the fact that distribution companies ae facing power shortages, the demand for peaking power from RLNG does not find enough buyers. Gas plants power plants are operating at barely 50% load factor using APM gas and remain underutilised. This is on account of poor absorption capacity of distribution companies at the given tariff and availability of power from alternative coal based sources at relatively cheaper price.

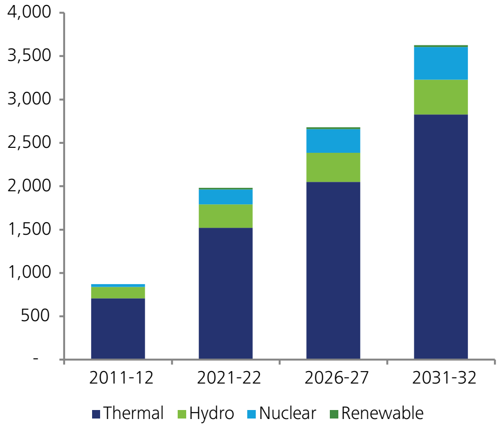
Nuclear Generation

Nuclear Generation to play a critical role in future energy scenario in India

Integrated Energy Policy (IEP) estimates that energy demand in India will increase four times to 3880BU in FY32 and considers that in the base scenario, around 63GW of nuclear capacity will be added by 2031-32.

The key concern which forms the basis of the expectation of nuclear capacity addition is that of coal availability. It is assumed that domestic coal production will be 1400 MT in FY 2032. However, India would still require around 700 MT of imported coal. Unloading at ports, inland transportation and ash disposal of 700 MT of imported coal will be a daunting task

Figure 16: Fuel-wise generation mix in India (2031-32, BU)



Given the fact that India would have to depend on imported sources of fuel for 45% of energy requirements, posing significant fuel security risk, Nuclear power has the potential to reduce this reliance on imported fuels, at least in future, if Thorium based addition route is successfully implemented.

India's three stage nuclear program

India has meagre reserves of uranium, the only naturally occurring fissile element that can be directly used in a nuclear reactor to produce energy through nuclear fission. However, a third of the world's thorium, which can be converted to a fissile material, uranium-233, is in India. India's strategy for large scale deployment of nuclear energy based on a three stage program was formulated keeping this under consideration. The 3 stages of the programme are;

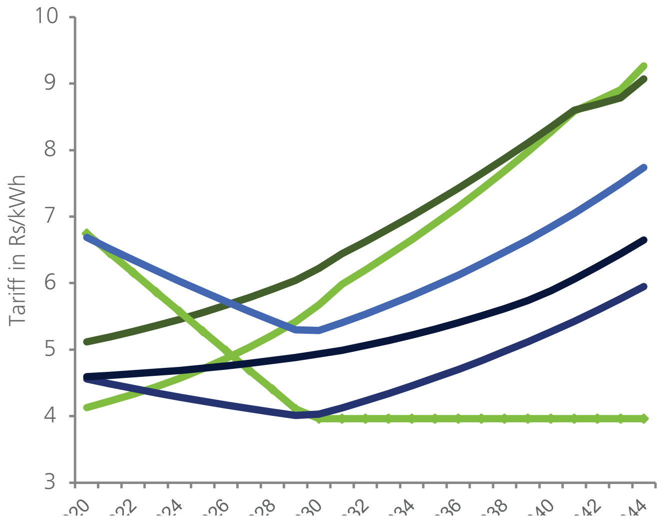
- Natural uranium fuelled Pressurized Heavy Water Reactors (PHWRs),
- Fast Breeder Reactors (FBRs) utilizing plutonium based fuel, and,
- Advanced nuclear power systems for utilization of thorium.

This sequential program is based on a closed fuel cycle, where the spent fuel of one stage is reprocessed to produce fuel for the next stage. The closed fuel cycle thus multiplies manifold (in the range of 20 – 50 times) the energy potential of the fuel and greatly reduces the quantity of waste generated. This saves on import requirement of fuel as well as the spent fuel disposal problems faced by countries following once through mode of use of nuclear fuel.

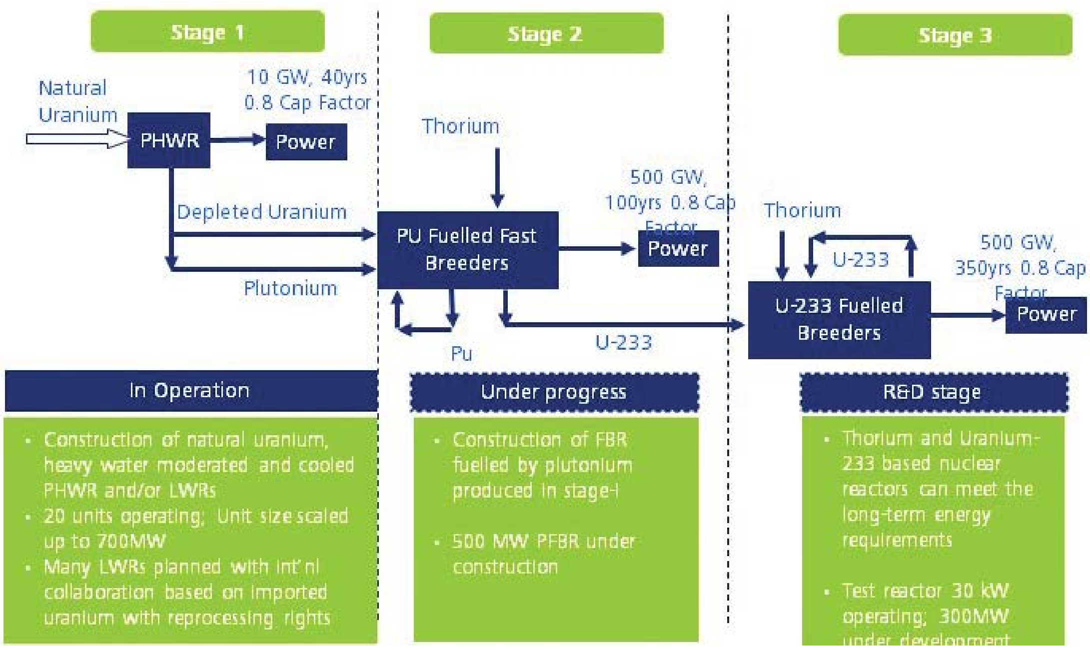
As India has limited resources of uranium, additional projects based on imports are planned in parallel to the three stage program to fast track nuclear power capacity addition. As capacity addition through the indigenous route is guided by the fuel cycle linkages of the sequential three-stage program, faster capacity addition in the near term to meet the electricity needs of the country will be possible through these additionalities. It will also increase the availability of Uranium238 which can be fed into FBR, thereby helping in faster inventory piling up of Plutonium239. It can be inferred that this will cut short the time required by the country to commercially exploit Thorium232 for energy production.

Reducing cost of nuclear plants through capital subsidies

Energy security of a country is not only about securing adequate quantities of supply to meet its internal demand, but also about making this available at affordable costs. In this context it will be pertinent to evaluate the cost of generating a unit of electricity from various sources. As per analysis of DTTIPL, tariff for



Imported LWRs will play a key role in reducing the time required by India to implement the third stage of strategic nuclear power program

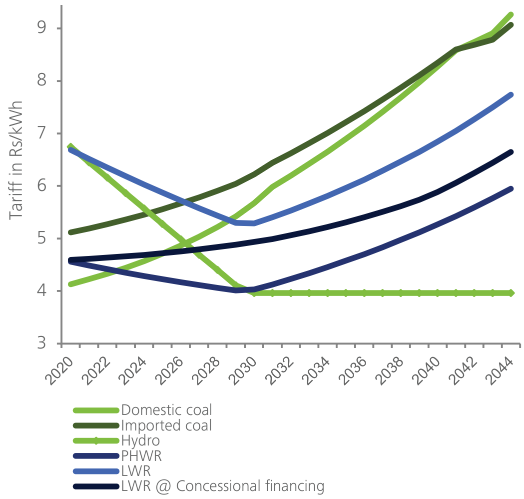


various generating stations (considering assumptions and CERC/DAE norms)for different fuel categories are presented below.

In the long run, hydro will be the cheapest source of electricity. Affordability of Gas and LNG will depend on the fructification of contracts and realisation of contracted qualities together with the stabilisation of the HH index. Therefore, these have not been considered in the comparison above. All other fossil fuels will converge to an equilibrium price as market imperfections get sorted out and domestic coal and imported coal will cost almost the same. Due to the high capital costs of LWRs (Light water reactor) and the high interest regime in India, the resulting tariff is high and will not be competitive with rupee financing from Indian institutions. However, if the LWRs are funded with longer duration and cheaper debt then the tariff becomes comparable to PHWRs and will be able to compete with fossil fuels. Hence, nuclear power with low fuel cost escalation will be competitive to meet the energy requirements of India, provided suitable financing mechanism is in place.

NPCIL plans to form JVs for its capacity addition
As of now, 4780 MW of nuclear capacity is operational in the country and NPCIL is aggressively pursuing capacity addition by undertaking several LWRs under foreign collaboration and indigenously developing 700MWe PHWRs. In order to meet these requirements, NPCIL is actively seeking joint venture partners as tabulated below for pursuing the capacity additional

Figure 17: Year on year tariff comparison



Due to lower price escalation of nuclear fuel, nuclear power may emerge cheaper than fossil fuels in the longer run

program:

No	JV partners	Area
1	NPCIL with Nalco	Nuclear power generation
2	NPCIL with NTPC	Nuclear power generation
3	BHEL with Alstom	Supply of conventional island
4	Bharat Forge with Alstom Group	Super-critical turbine/generator sets for thermal and nuclear power plants
5	NPCIL with L&T	Special steels and ultra heavy forgings
6	L&T with Westinghouse (MoU)	Supply of nuclear power reactors
7	BHEL with NPCIL (MoU)	EPC projects within and outside India
8	Thorium Power with Punj Lloyd (MoU)	Provide Thorium fuel technology for light water reactors

Nuclear Capacity Addition currently faces several hurdles

Currently, there are several issues in development of nuclear power generation that needs to be addressed before successful implementation of the program. Some of the key issues are tabulated below:

Key issues	Drivers
Project economics and competitiveness	• Long gestation period for the project • Cost uncertainty and no consideration of full cycle cost of nuclear power plant • Regulatory delays • Licensing & technology changes • Long learning curve
Financing	• Capital cost contribute 70% of the total cost of power • High level of sensitivity to interest rates, construction delays and cost overruns • Mismatch of loan tenure to life of the power plants • Treatment of insurance and liability of nuclear plants • Factoring of decommissioning cost upfront • Cost of managing the waste and intermediate spent fuel storage facility
Licensing process uncertainty	• Design certification- Each reactor design is licensed under different requirements in different countries • Construction and operation permits • Regulatory inspection during construction, commissioning and operation of reactors • Changes in the regulations
Reactor Technology	• Selection of reactor technology & sizing of reactor units • Safe operation of nuclear plants
Fuel Dependability	• India has poor grade and low uranium reserves resulting in dependence on imported uranium
Existing industry capability	• Lack of qualified personnel in nuclear energy operations, engineering, radiation protection. • Small number of contractors, engineering companies with personnel, skills and experience in nuclear design, engineering and construction • Availability of manufacturers who can meet the multiple codes required for different nuclear reactors sourced from different countries

Hydro Based Generation

Untapped Hydro Potential in the Country

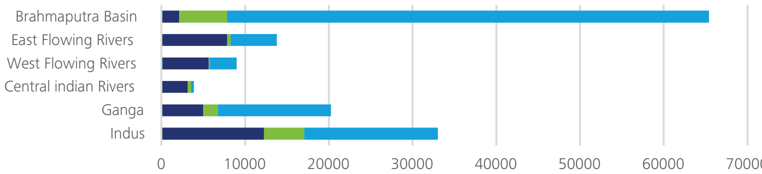
Hydro Power is a renewable and economic source of Power generation. Since Hydro stations can be started and stopped quickly, they are ideally suited for meeting peak load requirements.

Hydroelectric involves a clean process of power generation as it does not involve any emission as produced in case of thermal generation (low carbon energy). It is also considered as one of the most cost effective option of power supply as the fuel used in Hydroelectric power generation is not subject to market fluctuations. Further, the operation and maintenance costs of hydropower plants are generally much lower than those of other major plants for electricity generation.

Despite the obvious benefits of hydroelectricity over other generation sources, out of the existing Hydro Potential of the order of 145320 MW, the exploitation has been of the order of around 36,000 MW (25%) as on 31.10.2014.

The North Eastern region has the highest hydro potential followed by the northern region .The basin wise assesses Hydro Potential of the Country as on 31st October, 2014 is as follows:

Figure 18: Basin Wise H.E. Potential Development Capacity (MW) as on 31.10.2014



	Indus	Ganga	Central indian Rivers	West Flowing Rivers	East Flowing Rivers	Brahmaputra Basin
Under operation	12254.6	4987.2	3147.5	5660.7	7843.2	2120
Under construction	4809.7	1751	400	100	410	5736
Yet to be taken up	15963.7	13513.6	320.5	3236.3	5521.9	57544

12th Five year Plan has witnessed a Hydro Capacity addition to the tune of 1826.34 MW, with maximum contribution from the Central Sector (85%) as shown below:

S.No.	Sector	Capacity Addition (MW) in 12th Plan Period		
		FY 2012-13	FY 2013-14	FY 2014-15 (till 31.08.2014)
1.	Central	374	914	267.34
2.	State	57	45	l Con
3.	Private	70	99	l Con
4.	Total	501	1058	267.34

Status of Hydro Electric Power Potential as on 31.10.2014

Region	Identified Capacity above 25 (MW)	Capacity under operation (%)	Capacity under construction (%)	Capacity yet to be taken up (%)
Northern	52263	31.86	12.55	55.58
Western	8131	68.28	4.92	26.8
Southern	15890	59.33	3.21	37.46
Eastern	10680	29.39	26.05	44.56
North Eastern	58356	2.13	5.06	92.81
All India	145320	24.78	9.09	66.13

However, Hydropower generation has failed to keep pace with the thermal generation in the country.

Harnessing of Hydroelectric Power Generation currently faces following hurdles

The large Hydropower potential of the country has remained mostly unexploited for a variety of reasons as enlisted below:

Issues	Key Drivers	Issues
Environment and social Constraints	Adverse Impact on Environment	• Hydroelectric projects create environmental issues emanating from submergence of large areas also involving forest. Hydroelectric facilities have a major impact on aquatic ecosystem as well. • Continuous assessment and planning is critical to mitigate adverse impact of hydro electricity generation on environment.
	Rehabilitation & Resettlement (R&R) issues	• Large land area is required to construct a Hydro project. This may create disturbance to local habitat. • Rehabilitation & Resettlement (R&R) of Project Affected People is another major issue affecting the smooth execution of Hydroelectric projects.
	Power Evacuation issues	• A number of the hydropower projects are located in remote sites and the home states do not have adequate demand. • Supporting Infrastructure by way of strong inter-state and inter-regional transmission system needs to be built in to evacuate the planned generation capacity
Technology Constraints	Complexity in development of Hydroelectric projects	• The process of development of a Hydroelectric plant is complex. • Procedures needs to be streamlined to facilitate faster permissions and clearances.
High investment and long lead time	Long gestation period	• Construction time is another area of concern for Hydroelectric Project, which needs to be compressed. Most hydroprojects takes at least five to six years for construction.
	Financing	• Hydro Power Project is capital intensive. • The initial high cost is a serious barrier to rapid growth of hydroelectricity. • The financial challenge of hydroelectric power generation can be met by improving the environment for private sector development and encouraging new combination of financing instruments
Political Constraints	Intra-State dispute	• Under the constitution of India, the water is a state subject. Many major rivers flow through more than one state and its water is being used in all such States. • Some of the hydro projects in the country have faced significant delays on account of such inter-state aspects.

Points for discussion and Suggestions for Addressing the Bottlenecks

India has an increasing energy requirement to cater to a growing economy. Taking into account India's energy security, affordability and climate change, India will have to follow a balanced approach in order to address the bottlenecks in energy supply.

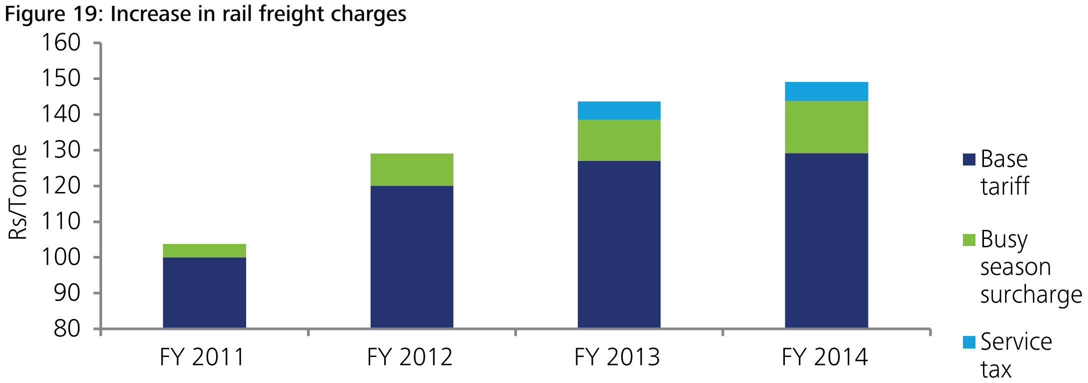
Poor Financial Health of Distribution companies impose restrictions on absorption of costly power
Increased reliance on imported coal/RLNG needs to be optimised. Currently the distribution utilities are not profitable and operating efficiencies are still on the lower side. In order to promote efficiency in distribution functions, the State Regulatory commissions impose disallowances which lead to cash flow issues and as a result the affordability of imported coal based generation gets further skewed.

Formation of the Coal Regulatory Authority by the Government of India
The Government of India through an executive order on March 4, 2014 constituted the Coal Regulatory Authority (CRA) under the overall administrative control of the Ministry of Coal. It was supposed to function as an interim non-statutory body till the approval of the Coal Regulatory Authority Bill, 2013 tabled by the Ministry of Coal in December 2013. However till now, the regulator remains as a non-operational entity, and no appointment has been made in the organization. It is critical to appoint the Regulator to address the issues impacting the development of coal mines, pilferages, quality, quantity and pricing related matters.

Rationalization of Coal Transportation
The cost of rail transportation has increased tremendously over the years as shown in the figure below. Currently the rail networks can cater to movement of coal from designated mines to the power stations only. Such constraints often cause the coal to be stalled at the mine end since there is no logistics available to transport the coal. The same is especially true in case of e-auction coal. Given the above constraints, it will be increasingly difficult to supply the required imported coal to the stations in case the domestic coal supply does not pick up at the desired pace. Even if such logistics constraints are removed, cost of transportation for non-pit head station needs to be rationalised/regulated since at times the transportation component in landed cost of coal is even more than the base price. Incremental cost of generation creates issues in merit order dispatch leading to frequent backing down resulting in inefficient plant operations.

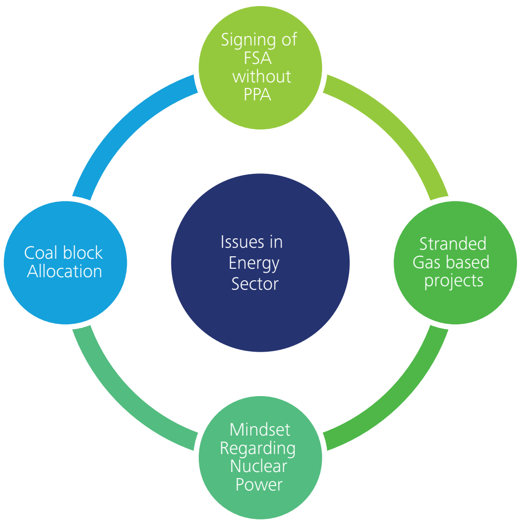
Coal swapping between power stations
Standing Linkage panel has recently approved the proposal for exchange of sources of coal supplies between NTPC and Gujarat State Electricity Corporation Ltd to bridge the gap between requirement and availability. The swapping results in bridging the gap between requirement and availability, reduces transport costs and avoids criss-cross movement in the congested railway network. The committee is in the process of setting up a mechanism for adjustment in the prices of such swapping of coal. The regulatory issues, capital expenditure requirement for modifications in the plants, consent of Railways and incremental cost of coal to be borne by the generating company are some of the challenges that needs to be addressed. Further, it also needs to be debated whether such swapping mechanism can be allowed between a government company and a private player.

Figure 19: Increase in rail freight charges



Coal Block Allocation/Allotment Process

There are several issues that Government is reviewing to implement the allocation/allotment process. Draft parameters for allocation/allotment of mines have been released for stakeholder comments. The process needs to be expedited in order to bring certainty in the process. The current market sentiments in the coal space have increased the risk perception of India and timely resolution of issues emanating from the Supreme Court judgment will help in restoring the investors and lender confidence



Rationalization of Transmission tariff for Gas pipelines

Current PNGRB regulations considers 100 percent utilization of pipeline from the fifth year of operations irrespective of the actual utilization of pipelines. Such a consideration leads to under recovery of tariff and constrains the funding capacity of pipeline operators to invest in future infrastructure. The tariff regulations may therefore require some rationalization given the significant elasticity in consumer demand.

Pooling of Gas prices and Reconsideration of Gas distribution policy

Currently, the allocation of gas from domestic sources is decided by the GOI as per the defined priority. Power generating stations compete with fertilizer industry for higher allocation of gas. Given the shortage in gas availability, usage of higher proportion of RLNG makes the power plant operations unviable. Consideration of pooled price of gas may reduce the overall impact of RLNG in the operating cost and make them more viable for meeting the peak requirements. The Regulatory commissions, based on the load profile of their respective states, may further introduce peak load stations as a separate class of generating stations for which the tariff may be determined in a different manner.

Development of Shale Gas Resources

As per EIA estimates, India holds enough shale reserves to meet the country's domestic energy demand for the next 26 years. Development on this front is currently undertaken only by the two state-owned players—ONGC and Oil India Limited. Given the potential and the scale of investment/technology involved, it may be important to promote enabling environment for participation of global E&P players.

Improving power evacuation infrastructure for smooth grid integration of RE technologies

The development of proper power evacuation infrastructure for the renewables has not kept pace with the additions in renewable capacity in several states. This has led to sub optimal utilization of assets and back-down of generation during peak season. This is specifically true in case of states like Tamil Nadu which has very high contribution of renewables in their energy mix. The STUs have not been able to provide the requisite focus as a result of their poor financial condition and low priority being given to renewable resources in some of the states. Thus it is important to delve on the measures required from the government and other stakeholders to help adopt better and more accurate forecasting tools.

Removing the constraints in development of hydro power projects

Key consideration for removing the bottlenecks would be to address governance issues related to basin wise development of projects and mechanism for allocation of projects to the developers. The government needs to streamline the land acquisition process, evacuation constraints and other procedures involved in development of hydroelectric plant especially the R & R related aspects. An enabling framework has to be framed for absorption of power by the distribution companies and having peaking power policy could be explored as an option. Besides the above, the recent calamities in the northern states has raised concerns about the environmental impact and safety which needs a special focus going forward.

Removing the constraints in development of nuclear power projects

Post the Fukushima disaster, there has been a lot of public apprehension on safety of nuclear power and India has also seen public resistance at several proposed nuclear power plant sites. Department of Atomic Energy and NPCIL have been undertaking several public awareness programmes to familiarize general public with nuclear power plant and its safety features. The apprehensions on nuclear power need to be allayed by familiarizing general public on India's approach to safety standards, its policies and regulations on safety and its spectacular safety record.

Besides public support, India will have to overcome the hurdles of financing, fuel dependency and reactor technologies to harness the potential and make it self-sufficient in its energy requirements.

Quantum Leap in Renewable Energy

Executive Summary

Recognising the importance of energy independence for holistic socio-economic development, the Government of India has over the years made consistent efforts to develop power infrastructure in the country. As a result, the country has achieved an installed capacity of 253 GW (as on 31-August-2014) from a meagre base of 1,362 MW (as on 31-Dec-1947). India is well endowed with both conventional and conventional energy resources but coal has by far been the main source of power generation. However, the installed generation capacity mix has undergone significant change in the recent years with renewable energy capacity steadily increasing to 12.57% by August 2014. Although the share of RE technologies has increased significantly, there still is a very large untapped potential for specific technologies in the country, particularly in wind power (approximately 102GW) and solar power (approximately 749GW).

Wind energy continues to occupy the largest share in installed capacity contributing close to 67% of total RE capacity. Solar energy which currently stands at just 2765 MW (MNRE-30-9-2014) is projected to contribute significantly to India's RE mix. The govt. had planned a capacity addition of 30,000 MW of Grid connected renewable power in the 12th plan period, out of which 15,000 MW is envisaged to come from wind, 10000 MW from solar and 5000 MW from other types of renewable sources. However, the Govt. recently proposed to revise the goals to set ambitious targets of adding 1lakh MW from solar.

Acknowledging the role that renewable energy technologies can play in enhancing sustainability, access to energy and security of supply, the Government of India (GoI) has introduced various policy and incentive measures to promote the growth of Renewable Energy (RE) in the country. The policy and regulatory support mechanisms (prominently Electricity Act 2003, National Electricity Policy 2005, National Tariff Policy 2006, Indian Electricity Grid Code, and Integrated Energy Policy) have evolved over the years in line with the changing requirements of the energy sector. Finally, the establishment of the National Action Plan on Climate Change in 2008 has been a major push in creating a policy & regula¬tory regime to help main¬stream renewables based sources in the national power system. The NAPCC advised that starting 2009-10, Renewable Purchase Obligation to be set at 5% of the total grid purchase and be increased by 1% each year for 10 years. To meet the RPO targets, market based instrument in form of REC was introduced to addressing the mismatch between availability of RE resources in a state and the requirement of the obligated entities to meet the RPO.

Wind power has by far been the highest contributing RE technology in India also making India 5th largest wind power producer globally. The sector has received major push under the presence of Accelerated Depreciation policy which provided the required financial benefit to attract private sector investment in the wind sector, and facilitated small scale captive investors to install wind power plants to offset their high energy costs. The GBI scheme (announced in 2009 and reinstated in 2013 provided an incentive of Rs. 0.50 (0.8 US cents/kWh) per unit of electricity fed into the grid over and above the tariff fixed) in parallel to the AD facilitated the entry of large IPPs and foreign direct investors to the wind power sector who could not avail the AD benefit. The technology has seen huge adoption in resource rich southern states of Tamil Nadu, Karnataka and Andhra Pradesh among others. However, due to limited grid evacuation infrastructure, wind power plants during peak windy season are forced to back down causing lost generation. With progressive targets, high potential, favourable policy regime and yearly installations exceeding 1000MW, a number of global and domestic wind equipment manufacturers set up their facilities in India. The country has developed enough WTG manufacturing capacity to meet the domestic target requirements but Indian manufacturers face challenges to be competitive in the international market.

Unlike wind energy, Solar power sector has started receiving industry interest only in recent years mainly after the launch of Jawaharlal Nehru National Solar Mission in 2010. Since its launch, the program has received significant market response and with solar power holding the highest potential amongst all RE technologies, it is projected to become the highest contributing technology in India's RE mix. The mission has provided the impetus to development of MW scale solar parks under a MNRE scheme for development of Solar Parks and Ultra Mega Solar power. Solar power is one of the fastest growing RE technology in terms of technology innovation and within a short span there has been steep fall (approximately 60%) in Solar PV capital cost and tariff. Favourable state level policies, feed-in-tariff regime, viability gap funding mechanism, capital subsidies, progressive net-metering arrangements and the solar specific RPO obligations have created a favourable environment for development of solar technology in country. However, the lacking in administrative and institutional readiness, like cumbersome land acquisition process, long approval and clearance process, limited knowledge and capacity of key stakeholders and limited data availability have created bottlenecks in the enabling environment. In addition, financing institutions still indicate to perceive several risks in lending to solar projects, in the absence of any risk-reducing mechanisms. In addition, leniency in imposing penalties in the event of non-compliance of RPO, despite having specific provisions in the regulations for imposing such penalties has not helped in providing the intended policy push from the RPO mechanism.

Apart from wind and solar energy, Bio-energy with an installed capacity of 5020MW (as on 30.9.2014) and Small Hydro with 3857MW (as on 30.9.2014) are the other major contributing technologies. As per current estimates, with an installable potential of around 23GW Bioenergy segment has the highest potential for improving energy access in rural areas in addition to generating additional rural income, reducing environmental impact of burning agri-waste, scalability and employment opportunities for local population. The proposed Bioenergy Mission targets to achieve around 10,000 MW by year 2022, with emphasis on promotion of biomass based IPPs as well as decentralized systems based on bio-energy. Despite the potential, the sector faces major challenge in form of supply chain issues of fuel transportation, information dissemination amongst sparsely located farmers and uncertainty in fuel availability in addition to lack of low cost financing options due to high perceived risks.

Small-Hydro power sector in the country has seen steady growth in the last decade with its installed capacity increasing more than 150% in the last decade, making it the second highest contributing technology after wind. Despite the progressive growth, the sector still faces several bottlenecks which hamper its growth towards attaining its realisable potential. SHP plants are mostly located in difficult terrain remote hilly areas increasing not only technical difficulty but also the cost of development cost. Delays in acquiring land and clearances, in absence of reliable hydrological data and adequate grid connectivity arrangements further reduce the investor sentiment. The increased risks diminish the chances of availability of low cost financing options to the developers. The sector has good potential to increase energy access in remote hilly areas which cannot be tapped unless these difficulties are overcome under a favourable policy environment.

One of the key issues marring the spread of RE technologies in the country is inadequate grid infrastructure in the country. RE technologies unlike conventional technologies hold potential specific to a region and their generation is dependent on seasonal (if not unpredictable) resource availability. Evacuation of RE from resource rich states to other states would not only solve the energy deficit issues but also help in ensuring better RPO compliance. Intermittency in power generation from RE technologies poses a major technical challenge for grid integration and a weak grid further impends smooth grid integration of RE. Recognising the issue, MNRE and CERC in support from PGCIL released the "Green Energy Corridor Report" in Sept 2012 which discussed the grid integration of RE technologies and proposed and investment of approximately \$8 billion (~ INR 42,557 crores) for the development of this corridor by 2017. The task faces a number of critical managerial, technical and policy issues. Establishing an institutional arrangement with defined roles & responsibilities of various agencies/developers with long term planning would greatly ease and fasten the development of grid infrastructure for RE integration. In addition, establishment of standard regulations would help establish the specific grid up-gradation procedures that need to be undertaken would be critical for integration.

Given the ambitious targets and supportive policy landscape, it's foreseen that in the coming years renewable energy will hold an important share in the overall energy mix of the country. However, there are a number of critical issues that need to be addressed by the policy makers & regulators, along with other market players for optimum realisation and development of high potential RE technologies in India:

- **Implementation of RPO mechanism to create the intended market based support of RE development**- RPO mechanism was introduced to ensure that the obligated entities procure certain minimum percentage of RE to support the purchase of otherwise high cost renewable energy. Subsequently, in line with the NAPCC, several states have issued RPO obligations. However, due to high financial implications and absence of a penalty mechanism, debt ridden distribution utilities have persistently failed to comply with the obligations. In addition, there is a need to create more cohesion between the central and state level policies for smoother and easier implementation of the mechanism to derive the intended outcome.

- **Steps to deepen the REC market and also provide the long term certainty for the development of REC based instruments**- The REC mechanism was developed to complement the RPO mechanism and address the mismatch between availability of RE resources in a state and the requirement of the obligated entities to meet the RPO. However, in absence of strict policy and regulatory enforcement mechanism the REC market has seen low trade leading to accumulation of RECs jeopardising the current and future of REC based projects. Short-term price forecast (CERC has determined the REC prices upto 2017 only) has led to difficulties in financial closure of projects which are coming up solely on REC trading. These enforcement issues have defeated the purpose of introducing the instrument and have not created the desired market based push for RE.

- **Availability of low cost and easily available financing for RE projects**- Due to the high costs and associated risks, there is lending institutions continue to stay reluctant in providing low cost financing to RE projects. The problem is more sever in case of less adopted RE technologies as bio-energy, small- hydro due to lower technical advancements and higher return uncertainty. There is a need to review the steps needed to be undertaken not just for increasing the availability of financing options but also to increase the viability of RE projects to increase the lender's confidence from long-term perspective.

- **Development of a strong institutional framework for coordinated development of RE sector**- The lack of cohesion and coordination between the center and states is partly reflected in ineffective implementation of the RPO & REC mechanism. Another example is the mismatch between the central and state level targets and plans which diffuse clarity and fail to provide a clear roadmap for development of the sector. For increased effectiveness and smoother implementation it is necessary that a strong institutional framework is developed for coordinated development. There is a need to clearly define the roles and responsibilities of the established institutions and the key requirements for empowering the state institutions under the umbrella of central bodies.

- **Accurate resource assessment**- Renewable energy potential assessment is critical to establish not just the targets but also to increase the investor market sentiment by establishing certainty. However, high-quality resource assessment is lacking in renewable power technologies in India. Also, different agencies using different models predict different potential inducing confusion. There is a need to establish high quality resource assessment which should be periodically conducted, especially for technologies as bio-energy whose potential may change over the time depending on the fuel generation and availability.

- **Technical support for spread of RE through DDG model**- RE technologies have been projected as possible and most promising solution to address energy access issue in remote locations where grid connectivity is not feasible for various reasons. However, establishing decentralized RE projects is associated with high financial and organizational risks. There is a need to evaluate the policy and regulatory interventions required to promote DDG based proliferation of RE technologies for greater and cleaner energy access in the country.

- **Establishing more focused R&D initiatives for technological innovation and cost reduction**- Focusing on creating a R&D infrastructure for developing appropriate technology for Indian conditions, customisation of products for local needs, developing integrated supply chain and eco-system, and enhancing competitiveness of domestic manufacturing would help in development of a progressive ecosystem for RE technologies which would lead to cost reductions in the long term. A central level approach to creating the infrastructure, technical expertise and financial support needs to be undertaken for a progressive effort in this direction.

- **Enabling domestic manufacturing in line with the international market standards**- Increasing installations have leveraged the establishment of domestic manufacturing facilities (especially in wind sector) in the country which are sufficiently capable to cater to domestic demand. However, the domestic players still depend on imports for complex, more efficient parts and equipment. In addition, the domestic manufacturers face stiff competition from foreign manufacturers who enjoy more favorable policy environment and economies of scale to provide higher quality equipment at lower cost. There is dire need of favorable policy and infrastructure support from the govt. to create a more conducive environment aligned to commercially support the domestic manufacturers.

- **Centralised vs Decentralised approach for RE Development** : To address the issue, self-sustained, fuel independent, low maintenance, decentralized spread of RE power majorly in form of residential rooftop panels and agriculture pump sets has gained significant adoption in the recent past. In addition, decentralized RE based projects would not only increase energy access to remote locations but also complement the centralized grid based electricity system by reducing the burden of power shortfall and cost of grid expansion. However, establishing decentralized RE projects is associated with high financial and organizational risks. There is a need for a multidimensional push addressing technical, financial, policy and regulatory aspects for successful adoption of decentralized model of RE development.

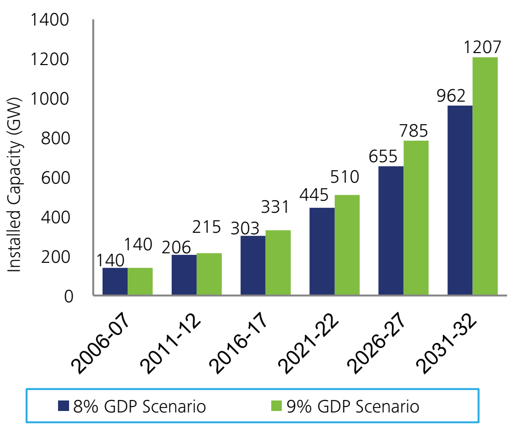
Introduction

India’s Energy Scenario

The Indian economy is one of the growing economies in the world. The GDP growth of India is expected to recover from 4.4% in 2013, to 5.4% in 2014. The demand for energy during the 12th Five Year Plan is expected to increase as the economy grows. The supply of primary commercial energy is projected to increase from 711 mtoe in 2011-12 to 1220 mtoe by 2021-22.

The annual average growth rate of the total energy requirement is expected to accelerate from 5.1% per year in the 11th Plan to 5.7% per year in the 12th Plan and 5.4% per year in the 13th Plan . The availability of energy is a crucial input for sustaining the long term growth in the GDP of the country as shown below

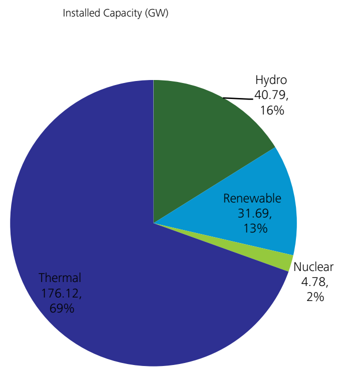
Figure 1 : Installed Generation Capacity – Projections till 2032



The capacity additions during the 11th Five Year Plan period (2007-2012) has been 54,964 MW which is 69.8% of original target and 88.1% of the reduced target of 62,374 MW set in the Mid-term Appraisal (MTA). It is more than 2.5 times that of any of the earlier Plans .

A target of more than 118GW has been set for the 12th plan. The total installed generation capacity in the country, including renewable energy sources, as on 31 August 2014 is approximately 253 GW. The share of renewable energy capacity stands at about 13%. Despite the promising growth witnessed in generation capacity additions in the past few years, continuing peak and energy shortages continue to impose significant constraint to India’s economic development and growth. During FY14, though the total electricity availability increased by 5.6% over the previous year and the peak met increased by 5.3%, the shortage conditions

Figure 2 : Current Installed Capacity August 2014



prevailed in the country both in terms of energy and peaking availability as shown.

During FY15, it is anticipated that there would be electricity shortage of 5.1% and peak demand shortage of 2% respectively .

Figure 2 : Current Installed Capacity August 2014

FY 2013 -14	Energy (MU)	Peak Demand (MW)
Requirement	1,002,25	135,918
Availability	959,829	129,815
Shortage	42,428	6,103
Percentage	4.2	4.5

There are certain areas where the renewable energy sources of energy could play an important role

Huge untapped Renewable energy potential in India

The country possesses vast renewable energy potential. In the early 80s, India was estimated to have renewable energy potential of about 85 GW from commercially exploitable sources, in wind, bio-energy and small hydro. These estimates have since been revised to reflect technological advancements. Estimates from National Institute of Wind Energy (Formerly C-WET) suggest that wind energy potential at 80 metres height (with 2 per cent land availability) could be over 100 GW.

Some studies have estimated even higher potential ranges up to 300 GW. A very significant part of the total Renewable Energy (RE) potential still remains to be exploited. The current installed capacity of renewable energy sources stands at around 32780 MW (as on 30th Sept-2014)

Figure 4 : Renewable Energy Potential in India (GW)

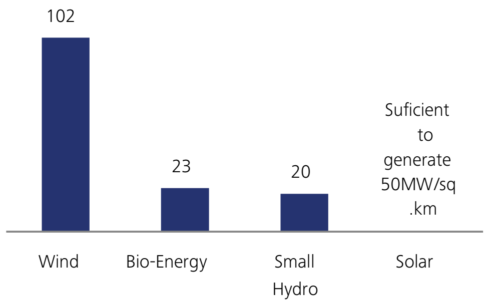
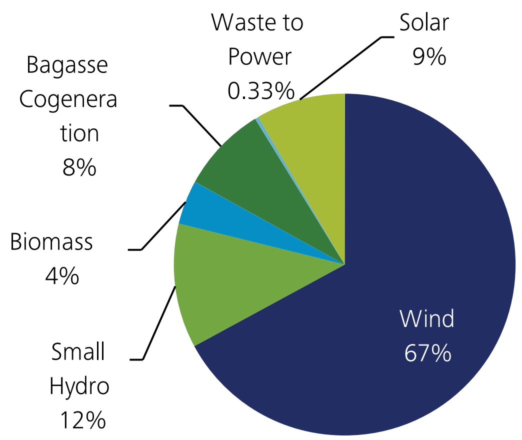


Figure 5 : Renewable Energy Installed Capacity September 2014



Wind dominates the renewable energy capacity with around 67% of the total renewable power capacity in MW terms. The figure shows the break-up of renewable power capacity in MW across different source.
A supportive policy and regulatory framework, flowing from the provisions of the Electricity Act 2003, and institutional mechanism that were introduced have aided in the development of the renewable energy sector.

Renewable can also play an important role in off grid and distributed generation

Besides grid based electrification, Decentralized Distributed Generation (DDG) is an alternate option for rural electrification. The key factors promoting the use of DDG for rural electrification in India are access deficit due to lack of grid extension and availability deficit due to lack of adequate centralized energy generation. DDG projects based on renewable resources are becoming the preferred option for a variety of reasons like local access to energy sources, savings on fuel transportation and reduction in costs of developing fuel supply chains, cleaner generation and local economic impact. These advantages are balanced by disadvantages like higher cost, difficulties in operations and maintenance and intermittency. Despite this, DDG is increasingly seen as a viable option for rapid electrification and long term energy security due to the availability of sustainable local energy resources. Technology advances are making these systems easier to install and more reliable to operate, while at the same time reducing upfront capital costs.

The table below provides break-up of the various capacities for off grid and captive power mode across different renewable energy spectrums:

Table 1 : Off Grid and Captive Power – Installed Capacity Sept 2014

OFF-GRID/ CAPTIVE POWER	MWeq
Waste to Energy(Urban/-Industrial)	136
Biomass(non-bagasse) Cogeneration	556
Biomass Gasifiers - Rural - Industrial	 18 149
Aero-Generators/Hybrid systems	2
SPV Systems (>1kW)	210
Water Mills/Micro Hydel	13
Bio-gas based Energy Systems	4
Total	1088

The state of affairs in rural electrification is making it increasingly clear that while grid extension is required, simultaneous development of large scale DDG projects based on local renewable resources is also critical.

Indian Renewable Energy Sector Roadmap

The Ministry of New and Renewable Energy (MNRE) is the nodal Ministry of the Government of India for the development of new and renewable energy. The broad aim of the Ministry is to develop and deploy new and renewable energy for supplementing the energy requirements of the country. India was one of the first countries to establish a separate Ministry for New and Renewable Energy (i.e. MNRE) at the central level.

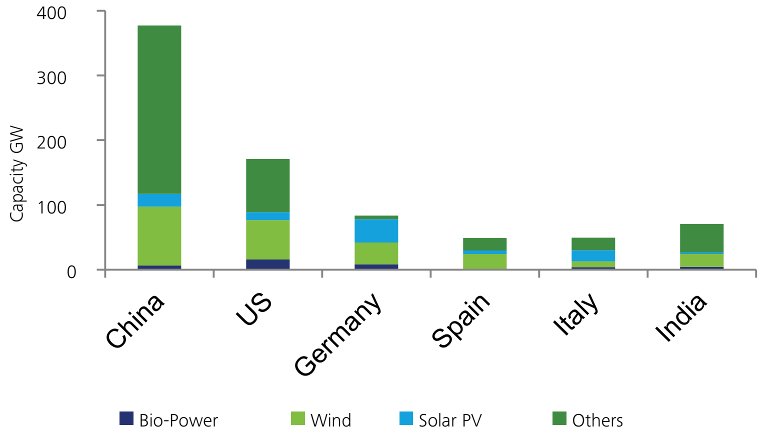
A number of institutions have been created in India for promotion of renewable energy. Institutions like Solar Energy Centre, Indian Renewable Energy Development Agency (IREDA), National Institute of Wind Energy (NIWE) (Formerly Centre for Wind Energy Technology), Alternate Hydro Energy Centre (AHEC), Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE) have been playing a critical role for facilitating the installation of renewable energy in the country. At the State level, State Nodal Agencies (SNAs) were set up to carry out MNRE's mandate and implement projects/ programmes.

Performance of India in encouraging RE development

India's renewable energy installed capacity has grown at an annual rate of around 21%, rising from about 3.9 GW in 2002-03 to about 33 GW in September 2014. Wind energy dominates India's renewable energy industry, accounting for 67% of installed capacity (22 GW). It is followed by small hydro (3.8GW), biomass (4GW) and solar power (2.7 GW), which has just started registering its presence[6]

The total global RE capacity at the end of 2013 stood at 1560GW adding around 120GW in 2013. The top five countries for non-hydro renewable electric capacity in 2013 were China, the United States, Germany, Spain, Italy and India. China's new renewable power capacity surpassed new fossil and nuclear capacity for the first time and all renewables accounted for more than 20% (> 1,000 TWh) of China's electricity generation. Renewable energy provided an estimated 19% of global final energy consumption in 2012, and continued to grow strongly in 2013. India added more than 4 GW of renewable capacity for a total of about 70.5 GW. While hydropower represented most of the total (62%), solar PV and wind accounted for almost 70% of 2013 renewable additions. As India's installed capacity base expands rapidly, renewables accounted for less than 17% during 2013. Globally, India is now the 5th largest wind and 4th largest bio-power producer .

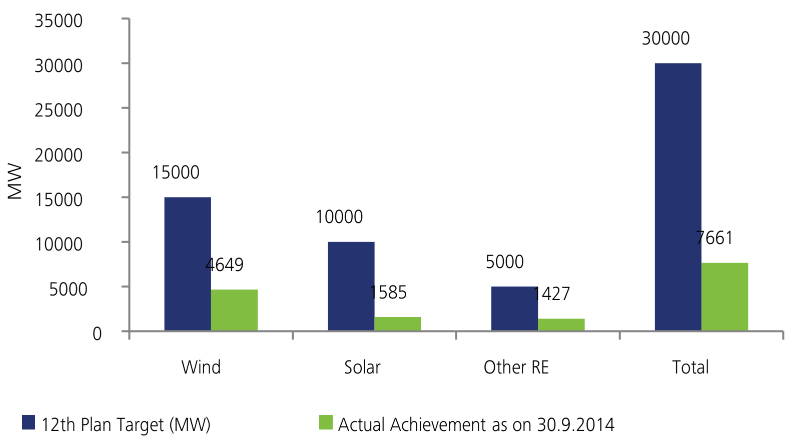
Figure 6: Total Renewable Energy Capacity – 2013



Performance during Twelfth Five year Plan (Year 2012-17)

Renewable energy sector made substantial progress in the 12th five year plan period. Wind technology had a major contribution in adding renewable energy capacity. The sector was able to surpass the overall capacity targets. The figure below details the overall as well as technology wise performance in terms of targets and actual achievement as on 30th Sept 2014.

Figure 7: Renewable Sector - Twelfth Plan Period (2012-17) Performance



With most of the RE technologies missing the annual targets, growth of RE sector has been slow during the first year of the 12th plan period. Total grid-interactive renewable power capacity of 2796MW was added as against a target of 4125MW for the year 2012-13. Though the same pattern continued for 2013-14, the situation improved as compared to the previous year. With an addition of 2085MW during 2013-14, wind energy achieved 83.4% of its targeted capacity and bio-power exceeded its target of 425MW by 95MW. Also, while solar energy too achieved close to 86% of its targeted capacity, SHP sector could achieve only 53% of its targeted capacity.

Role of renewable sector in the energy mix

Given the overall policy & regulatory push, renewable energy is envisaged to play an important role in the long term. Further, if additional capacity created is as part of DDG projects to electrify remote habitations, the utility of the incremental generation will be more than just in terms of additional generation. The change in mix of installed capacity and electricity generation is shown in the figures alongside

Even though the share of renewable energy in the installed capacity mix has been steadily increasing, it was still only 12% as of FY12 and FY17 projections estimate just 17%. It is also worth highlighting that RE share in the generation profile mix (in terms of MU) remained low at 5.52% in FY12..

The current policy and market dynamics limit the extent to which the sector can invest in advanced technology development.

There is a need to introduce policy measures to create a holistic environment supporting adoption of advanced efficient technology by encouraging and incentivising efficiency increase.

Figure 8: Year wise 12th Plan Performance in terms of Capacity Additions against Targets

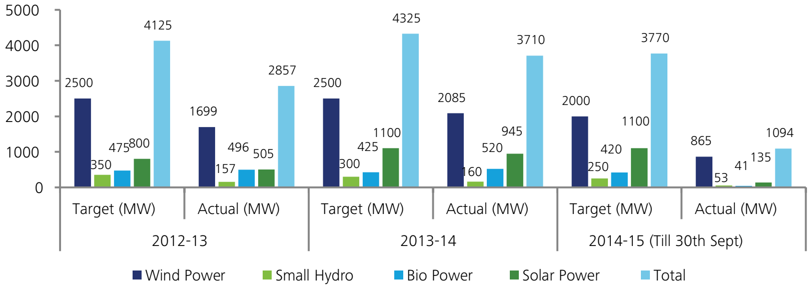


Figure 9: Growth of Installed Capacity & Percentage share of RE

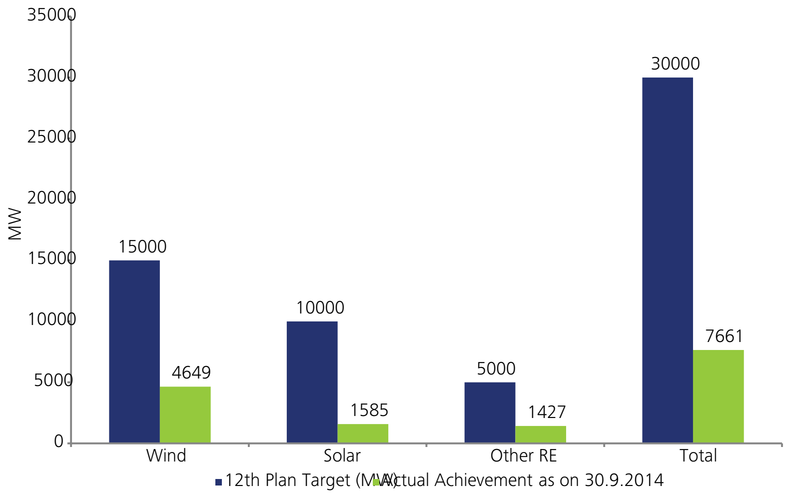
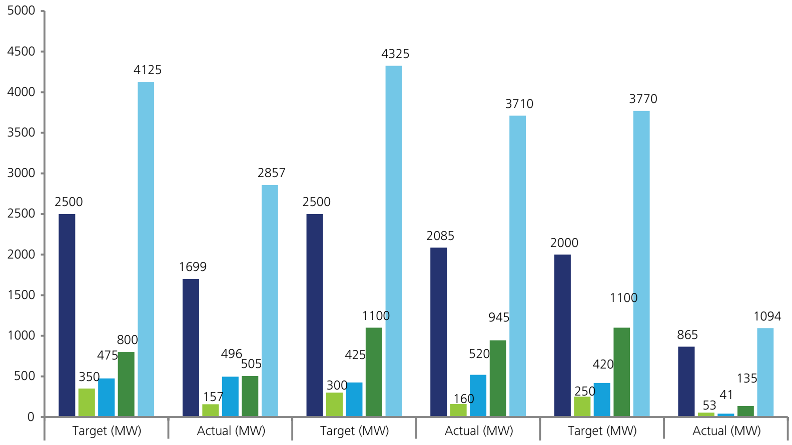


Figure 10: Growth Of Energy Generation & Percentage share of generation from RES



Key Policy initiatives

It is well recognized globally that early commercialization of Renewable Energy (RE) technologies is highly dependent on support from the government through a mix of policy and regulatory instruments. Over the years, the Government of India has introduced a number of policy and regulatory initiatives for promoting RE. Some of these initiatives have been illustrated in the table below.

Table 2 : Key Policy & Regulatory Initiatives

Year	Instrument/Initiative	Key Features and Impact on RE Development
1982	Creation of Department of Non-conventional Energy Sources	An independent department for development, demonstration and application of RE. RE sources were recognized as potential alternative energy sources and received special consideration.
1992	Creation of MNRE	The Department of Non-Conventional energy Sources was upgraded into a full-fledged ministry.
1993	MNRE Policy and Tariff Guidelines	Introduction of RE tariff guidelines by MNRE - states to purchase RE power at Rs 2.25 per unit with 5% annual escalation on 1993 as base year. Introduction of Tariff guidelines offered relatively higher price for RE than what was prevailing, and thus triggered development of RE sector, especially wind.
1993-94	Introduction of Accelerated Depreciation	Introduction of Accelerated Depreciation (100% AD) for promotion of wind projects (altered to 80% AD in 1999). This program led to the successful commercial development by involving the private sector in wind equipment manufacturing as well as its application.
1995-96	National Wind Resource Monitoring and Demonstration Program	This programme was intended to develop a GIS platform for presenting spatial data to prepare a meso-scale modelling and a comprehensive wind power density map of potential sites. This program helped in mapping the potential wind energy sites across India which in turn induced private sector participation for commercial applications.
1999	Establishment of Center for Wind Energy Technology (C-WET)	The Center provided much needed technical support for wind resource assessment, testing, monitoring, certification and R&D. It also helped the Indian wind industry to develop large scale commercial wind farms.
2002-03	Electricity Act 2003	Recognizes the role of RETs for supplying power to the utility grid as well as in standalone systems. Provides an overall framework for preferential tariff and quotas for RE.
2004 onwards	Preferential Tariffs for RE from SERCs	Following the enactment of the EA-2003, states adopted preferential tariff mechanisms to promote RE. Since it provides differential tariffs for the development of different RETs, it brought in a balanced approach to RE development across states.
2005-06	National Tariff Policy	Directed SERCs to fix a minimum percentage of purchase of energy consumption from RE sources (RPO). This created a demand side stimulus for RE development.
2005-06	Integrated Energy Policy Report 2006	Suggested a path to meet energy needs in an integrated manner. Recommended special focus on RE development and set specific targets for capacity addition through RE sources.
2008-09	Introduction of Generation Based Incentives (GBI) for solar and wind energy	This scheme offers fiscal incentives along with tariff on power generation from solar and wind. It shifted investment interest from installation to generation.
2008	National Action Plan on Climate Change (NAPCC)	NAPCC has advised that starting 2009-10, RPO's be set at 5% of total grids purchase, and be increased by 1% each year for 10 years.
2010	Jawaharlal Nehru National Solar Mission (JNNSM)	Targets 20,000 MW of grid-connected solar power capacity and 2,000 MW of off-grid solar power capacity by 2022.

Key Drivers for RE sector in India

NAPCC provides guidance for promotion of renewable energy

NAPCC provides guidance on enhancements in the policy & regula¬tory regime to help main¬stream renewables based sources in the national power system:

- A dynamic minimum renewables purchase standard (DMRPS) may be set, with escalation each year till a pre-defined level is reached, at which time the requirements may be revisited. It is suggested that starting 2009-10, the national renewables standard (excluding hydropower with storage capacity in excess of daily peaking capaci¬ty, or based on agriculture based renewables sources that are used for human food) may be set at 5% of total grid purchase, to increase by 1% each year for 10 years. SERCs may set higher per¬centages than this minimum at each point in time.
- Central and state governments may set up a ver¬ification mechanism to ensure that renewables based power is actually procured as per the appli¬cable standard (DMRPS or SERC specified). Appropriate authorities may also issue certificates that procure renewables based power in excess of the national standard. Such certificates may be tradeable, to enable utilities falling short to meet their renewables standard obligations. In the event of some utilities still falling short, penalties as may be allowed under the Electricity Act 2003 and rules thereunder may be considered.
- Procurement of renewables based power by the SEBs/other power utilities should, in so far as the applicable renewables standard (DMRPS or SERC specified) is concerned, be based on compet¬itive bidding, without regard to scheduling, or the tariffs of conventional power (however deter¬mined). Further, renewables based power may, over and above the applicable renewables stan¬dard, be enabled to compete with conventional generation on equal basis (whether bid tariffs or cost-plus tariffs), without regard to scheduling (i.e. renewables based power supply above the renew¬ables standard should be considered as displacing the marginal conventional peaking capacity). All else being equal, in such cases, the renewables based power should be preferred to the compet¬ing conventional power.

Jawaharlal Nehru National Solar Mission (JNNSM) sets ambitious target for solar promotion

The Jawaharlal Nehru National Solar Mission (JNNSM) was launched to promote power generation from solar energy in the country. The objective of the Jawaharlal Nehru National Solar Mission is to create conditions, through rapid scale-up of solar power capacity and technological innovation to drive down costs towards grid parity.

The Mission has adopted a 3-phased approach, spanning the remaining period of the 11th Plan and first year of the 12th Plan (up to 2012-13) as Phase 1, the remaining 4 years of the 12th Plan (2013-17) as Phase 2 and the 13th Plan (2017-22) as Phase 3. The mission lays down the targets that need to be achieved in the years to come so that India can tap its solar potential to the fullest. The targets set by JNNSM have been summarized in table below:

Application Segment	Target for Phase-I	Cumulative Target for Phase-II (2013-2017)	Cumulative Target for Phase-III (2017-2022)
Grid Solar Power	1,100 MW	4,000 MW	20,000 MW
Off-Grid Solar Applications	200 MW	1,000 MW	2,000 MW
Solar Collectors	7 million sq. mts	15 million sq. mts	20 million sq. mts

Source: MNRE

Renewable Purchase Obligation

In the interest of long term development of renewable energy sector, the Central & State Electricity Regulatory Commissions have taken the initiative to promote renewable energy by specifying minimum renewable energy procurement obligations as per the provisions of Electricity Act 2003 and other policies.

The Renewable Purchase Obligations (RPOs) ensure that the obligated entities procure a certain minimum percentage of their total power requirement from renewable energy sources. The RPO targets have been defined by a number of states in the form of Solar RPO and non-solar RPO targets for obligated entities (Distribution licensee, captive consumer, open access consumer).

Several states have issued RPO obligations but few, if any, are enforcing them. State level RPOs do not add up to national objective as set under NAPCC. There is a lack of cohesion between the States and the Centre. Renewable resource-rich States are reluctant to take higher RPO due to financial implications. Both resource rich and poor states have no incentive to procure, through direct purchase or purchase of RECs, in the absence of penalty mechanisms.

Table 4 : State wise RPO Targets

	STATE	FY 14	FY 15	FY 16	FY 17
1	Andhra Pradesh	5.00%	5.00%	5.00%	5.00%
2	Arunachal Pradesh	5.60%	7.00%		
3	Assam	5.60%	7.00%		
4	Bihar	4.50%	5.00%		
5	Chhattisgarh	6.25%	6.75%	7.25%	
6	Delhi	4.80%	6.20%	7.60%	9.00%
7	Gujarat	7.00%	8.00%	9.00%	10.00%
8	Haryana	3.00%	3.25%	3.50%	3.75%
9	Himachal Pradesh	10.25%	10.25%	11.25%	12.25%
10	Jammu Kashmir	5.00%	6.00%	7.50%	9.00%
11	Goa & UT	3.00%	3.30%	3.55%	3.95%
12	Karnataka	10%/7%	10%/7%		
13	Kerala	3.99%	4.39%	4.83%	
14	Madhya Pradesh	5.50%	7.00%		
15	Maharashtra	9.00%	9.00%	9.00%	
16	Orissa	6.00%	6.50%	7.00%	
17	Punjab	3.50%	4.00%		
18	Rajasthan (Draft)	8.20%	9.00%	10.20%	11.40%
19	Tamil Nadu (Draft)	9.00%	9.00%	9.00%	
20	West Bengal	4.00%	4.50%	5.00%	5.50%

Source: MNRE

Renewable Energy Certificates (REC) Market
Renewable Energy Certificate (REC) mechanism is a market based instrument to promote renewable energy and facilitate compliance of renewable purchase obligations (RPO). It is aimed at addressing the mismatch between availability of RE resources in a state and the requirement of the obligated entities to meet the RPO.

REC market development and setting of the RPO targets by the Regulatory Commissions are two cornerstones of the development of renewable sector in India. While most State Regulatory Commissions have set the solar and non-solar targets for the utilities under their jurisdiction, the REC market has also evolved to facilitate transactions at national level. However, as the table below shows, there is a marked demand-supply gap leading to reduction in cleared volumes. This has further led to accumulation of REC inventory.

Table 5: Summary REC Trading (January-October 2014)

Summary		Buy Bids	Sell Bids	Cleared Volume	Cleared Price (Rs/ REC)
Ave-rage	Solar	2,383	148,755	2,383	9,300
	Non-Solar	77,533	3,447,398	77,533	1,500
Maxi-mum	Solar	7,816	187,483	7,816	9,300
	Non-Solar	361,842	4,766,941	361,842	1,500
Mini-mum	Solar	232	88,895	232	9,300
	Non-Solar	8,994	2,015,377	8,994	1,500
Total	Solar	23,833	1,487,557	23,833	-
	Non-Solar	775,337	34,473,981	775,337	-

There is policy and regulatory uncertainty for REC market which is adversely impacting the current and future REC based projects. Some of the issues relating to REC market which require immediate attention are:

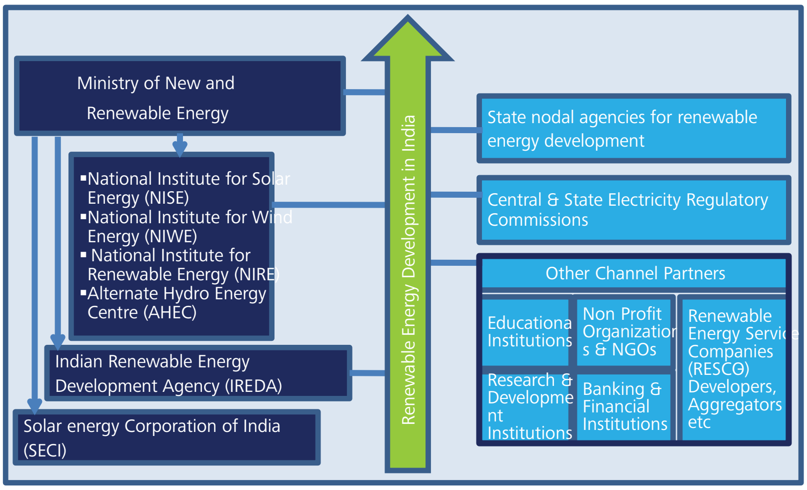
- Declining trend in the REC demand due to non-enforcement of the RPO targets. There is no clear penalty mechanism which is being applied across states for non-compliance.
- CERC has determined the REC prices upto 2017 only and this has led to difficulties in financial closure of projects which are coming up solely on REC trading.
- Issues related to regular monitoring (monthly/ quarterly) of RPO compliance by State obligated entities.

Institutional Set up for Renewable Sector

The institutional ecosystem developed under the aegis of MNRE for the RE development in the country is more focused on the research, design, development, financing and certification. The deployment of RE projects (project development, project construction, operation and maintenance) in the country is essentially taken care of by the private players. The institutional structure is further being strengthened to enable effective execution of the Ministry's policies and objectives.

The figure below details the evolution of Institutions & Policy Support in Indian renewable energy sector:

Figure 11 : Institutional Framework of RE Sector



The institutional support and policy for renewable energy sector has evolved over the years, in order to keep up with the changes in the requirements, capacity addition and technologies.

Ministry of New & Renewable Energy (MNRE)-
MNRE is the nodal ministry in India for all matters relating to new and renewable energy, including design and implementation of policy schemes in the renewable energy sector. The ministry strives to develop new and renewable energy technologies, processes, materials, components, sub-systems, products & services at par with international specifications and standards in furtherance of the national goal of energy security. Key roles and responsibilities initiated by the ministry in managing renewable technology deployment in the country are:

- MNRE issues guidelines relating to preparation of detailed project reports, micro-siting, selection of equipment manufacturers, operation & maintenance, performance evaluation, etc.

- Identify Research, Design, Development and Manufacture thrust areas and facilitate the same for technology mapping and benchmarking
- MNRE through its appointed nodal agencies keeps a track of the sector growth and projected demand schedules, performance of policy incentives, its impact on sector growth and accordingly sets capacity targets and introduces design changes in the policy
- MNRE conducts consultations with stakeholders across the value chain and designs policies

Indian Renewable Energy Development Agency (IREDA)- IREDA is a Public Sector Undertaking for market development and financing of renewable energy in India. IREDA has played a pioneering role in nurturing the RE sector and in supporting the policies of the Ministry of New & Renewable Energy. It has developed norms to undertake its lending functions covering aspects like loan application registration, project appraisal, sanction of loan, security creation, disbursement & recovery of loan. The role of IREDA has been mainly restricted to the financing of the solar & other renewable energy power projects. In solar energy segment, IREDA has also played the role of program administrator for GBI under the Rooftop PV & Small Solar Power Generation Program (RPSSGP) scheme. It is responsible for project allotment and disbursement of GBI.

State Nodal Agencies (SNA)- The SNAs are the nominated agencies by the MNRE and play an important role in the implementation of Central as well as State level policies/programs for renewable energy. SNAs are responsible for coordination at the state level and facilitate project development from resource assessment to final commissioning. They support developers by facilitating development of infrastructure at identified sites and also verify the statutory clearances sought by the developer from different departments.

National Institute of Wind Energy (formerly CWET) - NIWE is an autonomous institute under MNRE, responsible for various initiatives in the wind sector like:

- Research & Development (R&D)
- Wind resource assessment
- Providing Testing, Certification and Training services across the entire spectrum of the wind sector.

NIWE provides all technical support to developers including wind resource assessment and DPR preparations. MNRE has designated NIWE to issue certifications to developers and wind turbine manufacturers. NIWE issues a list of manufacturers of certified wind turbine machines on quarterly basis. The developer has to furnish all the documents as required for setting up of wind power system and obtain certificate of approval from NIWE for commissioning a wind power plant.

Solar Energy Corporation of India- Solar Energy Corporation of India (SECI) has been recently formed to implement the JNNSM program, identify the key opportunities in solar sector in the country and evolve solutions to problems being faced by various stakeholders in solar.

Increasing the penetration of renewable energy technologies will depend upon the ability of different renewable energy focused institutions to overcome the issues and undertake/facilitate implementation of renewable energy projects. Some of the key issues related to the current institutional structure for renewable energy sector are

- Lack of coordination amongst institutions (Centre as well as State) involved in promotion of renewable energy
- Neglect of certain RE sub sectors
- Issue of sustainability of select programmes due to an absence of well-defined implementation roadmaps for select government programmes and schemes
- Limited Capacity of State Renewable Energy Development Agencies

RE Outlook for 12th Five Year Plan & Ahead

A capacity addition of 30,000 MW of Grid connected renewable power is proposed of which 15,000 MW is envisaged to come from wind, 10000 MW from solar and 5000 MW from other types of renewable sources.

Table 6 : Renewable energy - 12th Plan Targets

Proposed Twelfth Plan Targets		Capacity in MW
1	Grid Connected Renewable Power	30,000
	Wind	15,000
	Solar	10,000
	Other Renewables	5,000
2	Off-grid/Distributed Renewable Power (MWe)	3,400
	Cogeneration from bagasse	2,000
	Solar off-grid applications	1,000
	Waste to energy	200
	Bio Gas Based Decentralised Power	50
	Others (Biomass Gasifiers, Micro-hydel)	150

Source: MNRE

Apart from these targets set by MNRE, the Government now also proposes to establish up to 100,000 MW of solar energy generation capacity in India over the next 10 years . As part of the preparatory work, the government has already scrapped a plan to impose additional duties on solar panels imported from the US and elsewhere. The initiative will not only increase RE capacity share in the energy mix but also reduce costs and generate jobs across the sector supply chain.

Wind Energy

Sector Overview

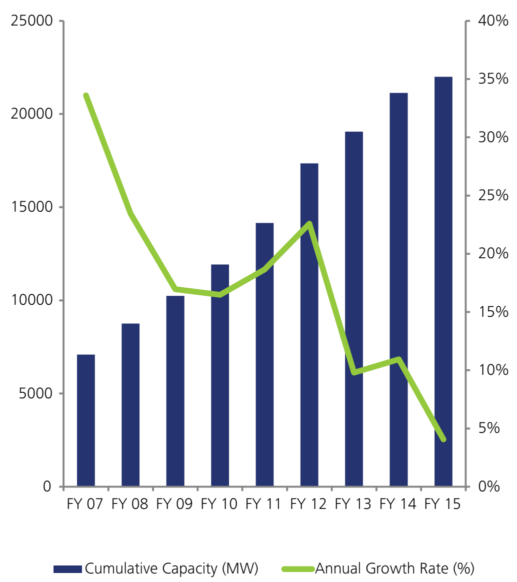
Installed Capacity & Potential

The wind power programme in India was initiated towards the end of the Sixth Five Year Plan, in 1983-84. The installed capacity of wind power was only 41 MW in March 1992, but through sustained and focused effort the present total installed capacity stands at 21,997 MW (MNRE 30.9.2014). Tamil Nadu, Maharashtra, Karnataka, Rajasthan, Gujarat are the key states which have been focusing on wind energy development in India. The state wise potential & installed capacity status is given below:

State	Potential (MW)	Achievement (MW)
Andhra Pradesh	14497	753
Gujarat	3507	3414
Karnataka	13593	2409
Madhya Pradesh	2931	439
Maharashtra	5,961	4098
Rajasthan	5,050	2820
Tamil Naidu	14,152	7276
Others	7,843	55

Source: National Institute of Wind Energy (formerly CWET)

Figure 12 : Wind Sector Capacity Additionsv



India is a major player in the global wind energy market. Wind energy currently occupies the largest share in India's renewable portfolio (67% by installed capacity) making India the 5th largest wind power producer globally. Considering technological advances, increased potential at higher hub heights and repowering potential in the country, estimated potential now stands at approximately 102 GW at 80m hub height. Considering the significant potential remaining to be exploited, the highest target ever for capacity addition (15GW in 12th Plan Period (2012-17)) has been set by the Government of India.

In addition, coastlines of Tamil Nadu, Andhra Pradesh, Gujarat, Maharashtra, Odisha, Kerala, Karnataka and West Bengal show considerable potential for harnessing off shore wind power. According to the Draft National Off-shore Wind Energy Policy (2013), released by MNRE, a preliminary assessment suggests off shore wind potential of around 1 GW capacity along the coastline of Tamil Nadu.

Repowering Potential

The average size of wind energy turbines (WETs) has increased over the years, but the major share of turbines are still in the capacity range of 500-1500KW. This fact can be attributed to the presence of large number of lower capacity turbines installed in the earlier years. These older, lower capacity systems that were installed 10-15 years ago occupy some of the high potential sites in the country, presenting a huge opportunity for repowering.

As per the India Wind Energy Outlook 2012 , the repowering potential study conducted by World Institute of Sustainable Energy (WISE) for MNRE estimated India's current repowering potential at approximately 2,760 MW. However, repowering of wind turbines poses a variety of technical, commercial, policy and regulatory issues and due to the absence of national or state level policy guidelines, repowering of wind stations has not progressed well in India. There is a lack of clarity on issues like disposal of old machines, land ownership and costing, requirement and level of incentive for repowering projects and evacuation of extra power under transmission capacity constraints, amongst others.

Manufacturing Market Overview

The country has enough WTG manufacturing capacity to meet the domestic target requirements but Indian manufacturers face challenges to be competitive in the international market. Presently with over 9 GW of manufacturing capacity , with currently 18 major manufacturers offering over 44 different turbine models in the range of 225 kW to 2500 kW capacities. However, the sector lags behind the global average in terms of turbine size and Indian manufacturers still rely on foreign manufacturers for import of high value complex components.

National Wind Energy Mission

To establish a dedicated approach towards development of high potential wind power in the country, the 12th Five Year Plan (2012-17) recommended establishment of a National Wind Energy Mission. The mission aims to establish a long term, stable policy framework to provide better coordination supporting a proactive deployment of wind technology in the country. MNRE is in process of establishing this and has conducted preliminary consultations with stakeholders to gather industry views.

Key Drivers

As mentioned, the GoI has set the highest target for wind energy sector and to achieve such targets there is a clear need for comprehensive and long-term planning, both at the central and state levels. Policy initiatives and fiscal measures like Accelerated Depreciation benefits have catalysed the rapid pace of capacity addition in the sector. Current policy and regulatory incentives for wind power development are listed below.

Table 8: Policy Drivers and Incentives for Wind Power Sector

Policy Driver	Features
Accelerated Depreciation (AD)	The AD scheme was completely phased out from the beginning of FY . Subsequently, in August 2014, the AD tax benefit has been reinstated.
Generation Based Incentive (GBI)	Over and above Feed in Tariff (FIT) approved by the regulators. Rs.0.50/ kWh (0.8 US cents/kWh) subject to max Rs. 10 Million/MW (1,65,900 USD/MW) (increased from Rs. 62 lakh/ MW(1,02,858 USD/MW))
Renewable Energy Certificates (REC)	Tradable certificate where one certificate is equal to 1MWh of energy generated. The floor and forbearance price of 1 Non-Solar REC is Rs. 1,500 (24.89 USD) and Rs. 3,300 (54.75 USD) respectively.
Fiscal Incentives	Direct Tax Incentives- Exemption on Income Tax on earnings from the project u/sec 80 IA for 10 years. Indirect Tax Incentives- • Exemption of excise duty on WEG. • Custom duty concessions for certain wind turbine components available
Foreign Direct Investment (FDI)	100% FDI is allowed in the wind sector
Incentives in R&D	The income tax department provides for a weighted deduction for in house R&D activity, which entitles wind turbine manufacturers to claim 200% of the expenditure (other than expenses on land and building) incurred for in-house R&D activity

Accelerated Depreciation

The AD scheme was first introduced in the year 1994 when 100% depreciation was allowed in the first year itself. The input based incentive of providing AD for the wind sector was one of the initial initiatives introduced by GoI as part of the measures to incentivise PSP in the power sector. The AD rate was subsequently revised downwards to 80% in 2002.

From 2009 onward, the AD benefit was proposed to be phased out for wind sector and an alternate scheme - the Generation Based Incentive (GBI) - was introduced for wind projects by Ministry of New and Renewable Energy (MNRE). However, the AD benefit scheme was allowed to run concurrent to the GBI scheme up to 31st March 2012.

The AD scheme was completely phased out from the beginning of FY13. However, after the withdrawal of the AD scheme from FY 2013, the wind sector has witnessed a steep fall in annual capacity additions (1699 MW in FY 2013 and 1249 MW in FY 2014). The move to withdraw the scheme was strongly protested by the key stakeholders including the manufacturers, developers, wind associations, etc. and there were regular representations to the government for reinstating the AD scheme. Subsequently, in August 2014, it was announced that the AD tax benefit would be reinstated at the previous rate of 80%.

Generation Based Incentive

In 2009, MNRE announced the Generation Based Incentive scheme in parallel with the AD scheme for period 2009-2012. This scheme was introduced to facilitate entry of large independent power producers and foreign direct investors to the wind power sector. It was aimed at broadening the investor base and creating a level playing field between various classes of investors. The intended objective was to increase actual generation of power by incentivizing higher efficiencies with the help of a generation/outcome based incentive. After its expiration in 2012, the scheme was reinstated after a gap of one year in August 2013. The scheme in its present form provides the same incentive of Rs. 0.5 / kWh with a cap of Rs. 10 Million per MW (USD 0.167 Million per MW) to be available for all projects on or after April 2014 and for the remaining 12th plan period (2012-17).

State-wise Preferential Tariff

At present, thirteen SERCs have declared preferential feed–in-tariffs (FITs) for purchase of electricity generated from wind power projects. All the SERCs have adopted a 'cost plus' methodology to set FIT, which vary across States depending on resource endowment, project cost and tariff regulations.

Land Allocation Policy

To support development of growing number of wind installations in the country, MNRE through its communication dated 15th May 2012 requested all state governments to examine their land policies for wind power installations and formulate a policy for land allocation. The ministry is working towards implementing the best practices in this regard.

Key Issues

Technical

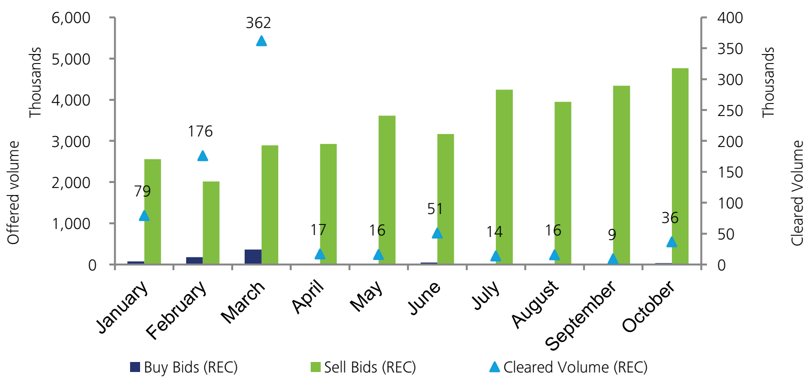
Though there has been a constant improvement in the Capacity Utilization Factor (CUF) over the years (the average CUF has increased from 7-12% in 1988 to 22-25% in 2012) there exists significant scope for improving technical efficiency of wind turbines installed in the country.

For the Indian Wind power market, one of the reasons attributed for such low efficiency levels is the AD policy regime, which incentivized capacity addition, but not necessarily, maximizing generation. Wind mills became more of a financial instrument and consequently some of the windiest sites of the country are occupied with inefficient machines. Another reason for this issue is that a number of wind power farms in India have reached the end of their useful life and require repowering. Repowering is expected to boost capacity and productivity of existing sites. Facilitating and incentivizing repowering requires the design of an appropriate policy framework.

Enforcement of RPO targets:

In October 2014, sellers offered to sell 47,66,941 (non-solar) RECs, but only 36,411 were bought, and that too, at the floor price of INR 1,500/REC. Moreover captive power users in States like Gujarat, Rajasthan, Orissa have challenged RPO regulations that impose obligations on them. State wise Renewable Energy Procurement Obligation (RPO) regulation was an important step towards large scale development of renewables across India, by creating demand for renewable power. However, the present RPO framework is found lacking in terms of compliance and enforcement at the State level. Except for a few, most states are not complying with these obligations. As a result, both investors and

Figure 13: Non-Solar REC Trading 2014



renewable energy deployment are getting impacted.

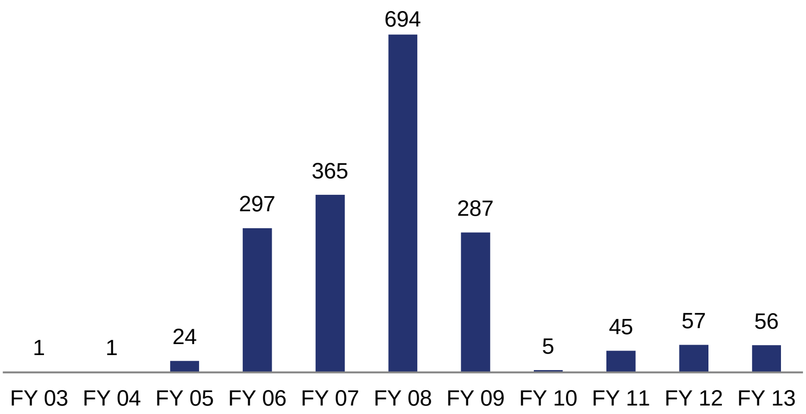
Manufacturing Capability
Leveraging on low input costs, high domestic demand and favourable policy environment, India emerged as a major turbine manufacturing hub and a host of international turbine manufacturers as Enercon, Gamesa, Vestas etc have set up their manufacturing facilities in India.

seen in the graph alongside, the export of WTGs grew exponentially during the mid-decade and domestic manufacturing firms grew to create a global footprint. However, domestic manufacturers have been slow in adapting and keeping pace with international market trends. The sector has persistently lagged in terms of average turbine size (in terms of rated capacity) as compared to the global market. Consequently, the Indian manufacturers have gradually lost their share in the global export market of Wind Energy Turbines (WETs). There is a need to build up the manufacturing capability, not just in terms of available capacity but also in terms of turbine size and technology innovation, at par with international trends and standards.

Grid-Integration Issue
Absence of sufficient grid capacity and spinning reserve to manage intermittency, especially in the states with high installed wind capacity as a proportion of total installed capacity, is one of the key bottlenecks facing the wind power sector. As a result, during peak windy season, wind power plants are forced to back down causing lost generation. The report by PGCIL, Green Energy Corridors, has already identified the transmission infrastructure requirements for the renewable energy capacity addition till 2030.

Specific Policy on Wind Repowering
Substantial potential of wind power can be realized through repowering of the best wind sites with higher capacity turbines. Currently, there is an absence of state and central government policy support and incentives to encourage repowering.

Figure 14: Export of WTGs (US Million $)



Solar Energy

Sector Overview

Potential

India receives solar energy equivalent of over 5,000 trillion kWh per year and has the potential to generate about 700 billion units annually from solar . Most parts of India receive solar radiation equivalent to 4–7 kWh/sqm/day with 250–300 sunny days in a year. Recently a study carried by National Institute of Solar Energy (NISE) calculating the State wise solar potential in the country, estimated a total solar power generation potential of 748.9 GW. The highest annual radiation energy is received in the region comprising of Rajasthan and Gujarat, while the north-eastern region of the country receives the lowest annual solar radiation. This translates to an energy generation potential of about 30-50 MW per sq.km. of shadow-free area covered with solar collectors, for most parts of the country.

JNNSM

To tap this huge solar potential, India has embarked on an ambitious program under the Jawaharlal Nehru National Solar Mission (JNNSM) targeting an addition of 20,000 MW of solar power by 2022. However, realising the huge potential and fast technology growth, the govt. has more recently announced a target of adding 1 lakh MW of solar capacity over the next 10 years.

Table 9: JNNSM Roadmap

Application Segment	Target for Phase I	Target for Phase II (2013-17)*	Target for Phase III (2017-22)*
(2010-13)	Target for Phase II	15 million sq. meters	20 million sq. meters
(2013-17)*	Target for Phase III	1,000 MW	2,000 MW
(2017-22)*	1,000–2,000 MW	4,000–10,000 MW	20,000 MW

Source: JNNSM Policy document

The program has already received significant market response under Phase I and Phase II. Currently, the total installed capacity of solar energy in the country stands at 2766 MW . Under JNNSM phase I, Batch I, a total of 610 MW of solar projects were awarded, while batch II attracted bids for 350 MW of solar PV projects. Apart from these grid connected large scale plants, small rooftop plants of capacity less than 2 MW each were also allotted under GBI scheme in Rooftop PV and small Solar Power Generation Programme (RPSSGP). Under Phase II (Batch I), 36 projects with a capacity of 700 MW opted to bid under the Domestic Content Requirement (DCR) part of the bidding process and the remaining 86 projects with a capacity of 1,470 MW opted for the open bids . Finally, a total of 375MW of capacity was allocated under each category (DCR and Open) in Phase II Batch I of the program . Under the State policy framework, Gujarat has been the key state which has developed around 920 MW of solar power since the announcement of Gujarat Solar Policy in July 2009.

Table 11: Installed Solar Capacities in India (MW) under various schemes

States	Total MNRE Projects MW	State Policy MW	RPO MW	REC Scheme MW	Pvt. Initiative (Roof top) MW	CPSUs MW	Total Commissioned Capacity Till 30-9-2014
Andhra Pradesh	44	95		28	2		169
Arunachal Pradesh	0.025						0.025
Chhattisgarh	4			3			7
Gujarat	0	863	50	6			919
Haryana	7.8					5	12
Jharkhand	16						16
Karnataka	5	40				9	54
Kerala	0.025	224					224
Madhya Pradesh	5	126		76		50	257
Maharashtra	47	5		111	0.15		162
Odisha	12	19		3		10	43
Punjab	9	23		7	0.25		39
Rajasthan	484	3	40	180			707
Tamil Nadu	16	2		80	0.5		98
Uttar Pradesh	12					15.51	27
Uttarakhand	5	5					10
West Bengal	2.05				0.16		2.2
Andaman & Nicobar	0.1					5	5
Delhi	0.34			2	3		5.4
Lakshwadeep	0.8						0.8
Puducherry	0.025						0.025
Chandigarh	2						2
Others	0.8						0.8
Total	674	1405	90	495	5.60	94.51	2765

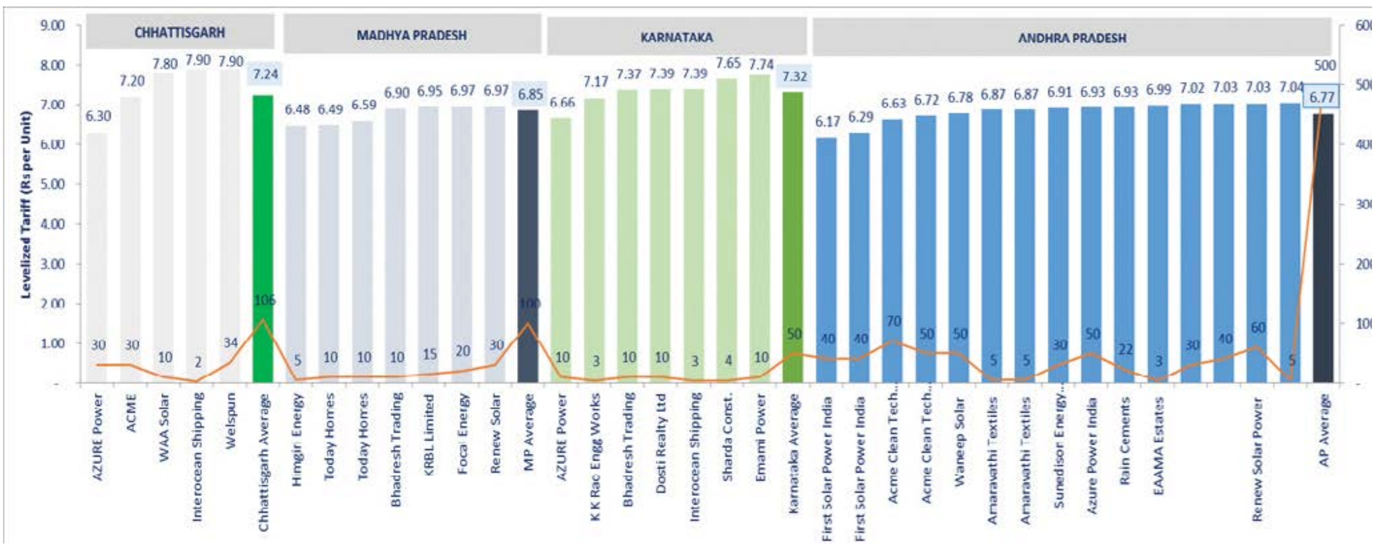
Solar Power Reaching Grid-Parity- With technology innovations and increasing installations, solar power is fast reaching grid parity. As can be seen in the table below, Solar PV capital cost and tariff have decreased approximately 60% (Figure below). A similar trend is seen in solar thermal too, but at a relatively lower magnitude. Over time, as coal prices increase and solar power tariff reduces under improved technology regimes and falling module prices, grid parity is likely to be achieved sooner than anticipated and compete at par with conventional energy sources.

Table 12: Trends in Solar Power Capital Cost and Tariff

Particulars	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Solar PV Capital Cost Rs. Cr/MW	17	16.9	14.42	10	8	6.91
Solar PV Tariff (With out AD) Rs./kWh	18.44	17.91	15.39	10.39	8.75	7.72
Solar Thermal Capital Cost Rs. Cr/MW	13	15.3	15	13	12	12
Solar Thermal Tariff Rs./kWh	13.45	15.31	15.04	12.46	11.9	11.88

The figure below details the results of recent solar bidding across different states :

Figure 15: Solar Power Tariff trend across States



Solar Parks- The JNNSM provided the impetus for development of solar parks in the country. Charanka solar park in Gujarat, with a planned capacity of 590 MW, was one of the first large scale solar parks in India. The development of Charanka solar park which already has an installed capacity of close to 224MW was followed by Bhadla Solar Park in Rajasthan. Considering the cost and environmental advantages of large scale solar parks, MNRE has proposed a scheme for development of Solar Parks and Ultra Mega Solar power projects in the country . The scheme proposes to develop 25 solar parks, each with a capacity of 500 to 1000 MW; thereby targeting around 20,000 MW of solar power installed capacity in a span of 5 years.

Solar Rooftop- Apart from promoting ground mounted solar PV projects, the JNNSM also has a mandate to encourage the rooftop solar segment. Under Phase I of JNNSM, a separate scheme called 'Rooftop PV and Small Scale Solar Generation Program (RPSSGP)' was implemented for developing solar PV projects with maximum capacity of 2 MW. The development can be as rooftop or small scale ground mounted projects. A total of 91MW of rooftop projects have been installed under the program as of January 2014 . it was observed that this scheme garnered enthusiastic responses primarily in the ground-mounted segment, while it received almost negligible responses in the rooftop segment.

States like Gujarat, Madhya Pradesh and Odisha have initiated separate programs to promote rooftop solar power projects. Similarly SECI has allotted a number of rooftop projects as a part of its initiative for promotion of rooftop solar projects in the country.

In order to facilitate rooftop solar, net-metering policies and regulations have been proposed by a number of states. Net-metering based rooftop solar projects would facilitate self-consumption of electricity generated and allow for feeding the surplus into the network of the distribution licensee. However, the implementation of net-metering based rooftop solar system would need to address critical issues like nature of incentives, metering arrangements, interconnection requirements and commercial framework.

Key Drivers

State level Policies

Apart from national level solar mission, several state governments in India have declared solar policies to promote harnessing of solar generation. With high solar potential, Gujarat has been at the forefront and was the first state to award projects under its state solar policy, even before projects were awarded under JNNSM. The state policy received huge response. Currently, Gujarat has higher share of solar power capacity installed under the state policy, compared to under JNNSM.

Feed-in-Tariff

Almost all the states have issued specific regulatory orders for solar power generation based FITs. This paved the way for utilities to procure electricity through solar power projects and formed the basis for having tariff based competitive bidding.

Viability Gap Funding (VGF)

Under Batch I of the JNNSM Phase II, the incentive is offered in the form of VGF. It is provided to the project developers in order to help them reach a viability threshold at a pre-fixed tariff. The disbursement is linked to defined performance measures.

Subsidies

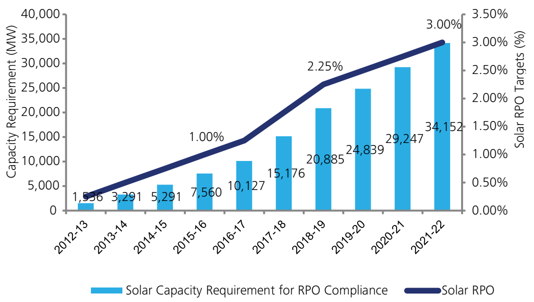
In addition to incentives for utility scale projects, the NSM has set a target of allocating 200 MW of grid-connected rooftop solar projects by offering subsidies. The Ministry of New and Renewable Energy (MNRE) provides up to 30% capital subsidy for roof top systems (off-grid) and for projects up to 500 kW. A few states in India such as Kerala, Tamil Nadu and Uttarakhand have announced an additional state subsidy of 20% on top of the MNRE subsidy, bringing the total to 50%. This can be a significant financial driver for smaller projects.

Net Metering

To support distributed generation of solar energy, several state governments are incentivizing rooftop solar systems through net metering schemes. Until May 2014, five Indian states - Gujarat, Andhra Pradesh, Uttarakhand, Tamil Nadu and West Bengal – have finalized net metering policies. Another four states – Delhi, Kerala, Karnataka and Punjab – have net metering policies in a draft stage. Gujarat has announced a gross metering mechanism, under which all units of electricity produced from a solar installation are sold to the grid.

RPO and REC

The government of India, through the Central Electricity Regulatory Commission (CERC), has introduced a Renewable Purchase Obligation (RPO) for all renewables, as per the requirements of the National Action Plan on Climate Change (NAPCC). The tariff policy stipulates Solar RPO target which increases from 0.25 % in 2013 to 3% in 2022. To achieve RPO compliance of 3% by 2022, approximately 35,000 MW of solar capacity is required. In addition, the government has introduced a market for tradable Renewable Energy Certificates (RECs) for fulfilling RPO obligations. Under the REC mechanism, developers are eligible to receive one certificate for every 1,000 kWh of renewable electricity fed into the grid. Obligated entities can buy these certificates to fulfill their



obligation.

Key Issues

Bottlenecks in the enabling environment

The promotion of solar power generation under the JNNSM Phase I witnessed a number of key bottlenecks in the current enabling environment, spanning across administrative and institutional readiness, knowledge and capacity of key stakeholders and limited data availability. Some of the key bottlenecks are:

- Cumbersome land acquisition process
- Long approval and clearance process
- Limited availability of data on solar irradiation level, land availability, water availability, grid loading and availability, etc.
- Timely availability of power evacuation continues to be a concern and has resulted in delay in commissioning of solar power projects. With planned larger integration of renewable energy, especially solar, providing RE projects with deemed generation benefits would reduce the uncertainties of evacuation and transmission and further enhance investor sentiment.
- With no established framework for coordination between the state agencies and MNRE administered institutions like SECI, Solar Energy Center (SEC) and Indian Renewable Energy Development Agency (IREDA), a clear mapping of responsibilities between the various agencies does not exist in the public domain. This has caused confusion amongst other stakeholders and consequently, delays.

Beleaguered local solar manufacturing environment

Indian solar PV manufacturing, restricted primarily to the lower value added segments – namely cells and modules – of the c-Si value chain, has historically catered to exports. With Chinese and Taiwanese manufacturers cornering market share in c-Si solar PV globally through integrated operations and Giga-watt scale installations, Indian exports have declined significantly. Indian manufacturers have struggled to be price-competitive in the current environment.

Lack of adequate participation of Scheduled Commercial Banks in solar financing

Scheduled Commercial Banks (SCB) mostly shied away from financing projects under Phase I of JNNSM. Export credit agencies, multilateral financial institutions and some non-banking financial institutions accounted for the bulk of debt financing over Phase I of JNNSM, as well as for projects under the Gujarat solar policy. The continuing risk aversion of SCBs remains one of the key hurdles for successful implementation and scale-up of JNNSM. SCBs indicate several risks that they continue to perceive in lending to solar projects, particularly in the absence of any risk-reducing mechanisms. Further, the crowding out effect of concessional sources of financing in the form of supplier's credit and direct lending by development banks, without the availability of any concessional lines of credit for SCBs, poses a problem

Enforceability of RPOs and concerns around solar RECs

RPOs are enforced by the State Electricity Regulatory Commissions who have so far been lenient in imposing penalties in the event of non-compliance of RPO, despite having specific provisions in the regulations for imposing such penalties. Apart from lack of strict enforcement mechanism, the poor financial health of the distribution companies restricts their ability to purchase the desired quantum of power, more so the otherwise expensive power from renewable energy sources or for that matter the REC. This factor needs to be long resolved invariably for viability of power sector in general and as one of the solutions to bring the distribution companies in the REC market for creating the demand for RECs.

Also, the pricing of solar RECs still remains a cause for concern in the medium to long term given the uncertainty attached to the downward cost trends in the solar sector and the market-based pricing of RECs.

Technology Risk

Globally, Thin Film (TF) technology, which once accounted for 30% of the market, has been losing share steadily. On the contrary, in India, crystalline silicon technology accounts for most of the market, and currently, the market share of thin film technology, though fast increasing, is very small. This unintended outcome is a result of two factors.

Owing to a low TF manufacturing base in India, domestic content requirement was waived for TFs (Phase I). Domestic manufacturers in the country have struggled to be competitive in a volatile and rapidly declining price environment led by Chinese suppliers. Thus, the domestic content requirement, which was intended to promote local manufacturing industry, has actually resulted in a skewed technology choice and left the Indian manufacturers without much benefit from the program.

Net-metering Issues

Having a clear regulatory and policy framework is an important element for promotion of rooftop solar PV under the net metering arrangement. Currently, very few states have provided clarity on the regulatory & policy framework for installing rooftop solar systems under net-metering, which creates a major bottleneck for promotion of net-metering. This also includes clarity on standards & specifications from CEA on net-meters to be adopted. Consumer segments like domestic consumers may need some initial financial incentive to enhance the viability of rooftop solar under net-metering.

Adequacy of the current approach to developing Solar Thermal Projects

The framework for award of projects under Phase-I of JNNSM, similar to Solar PV, was a reverse auction, which awarded seven projects totalling 470 MW under batch 1. Solar thermal with less than 2.5 GW of installations globally is, however, far from commercial compared with solar PV with over 100 GW installed capacity globally. Solar thermal projects require a range of preparatory activities including several clearances and consents, detailed field studies as well as on-field direct normal irradiance (DNI) measurement. In the above context and given the initial phase of development of solar thermal technologies in India, it is worth examining whether the existing framework for awarding projects is adequate or a different disposition is required.

Institutional strengthening for PPP framework

Renewable energy projects are envisaged to play a bigger role in future energy mix and perceiving the future growth with improved project financials, big private players are entering the sector and projects are increasingly being developed under the PPP mode. Private players bring in their technical and managerial expertise and contribute by delivering quality public services through performance incentive management and innovation. Strengthening the public side of the partnership would make this investment mode a mutually beneficial proposition and further increase the attractiveness of this model for private players. The government may facilitate the projects by alleviating the difficulties in arranging for transmission and distribution infrastructure and establishing a more secure payment mechanism.

Other RE Technologies

Bio-Energy

Installed Capacity and Potential

The current availability of biomass in India is estimated at about 500 million metric tonnes per year. MNRE has estimated surplus biomass availability at about 120 – 150 million metric tons per annum covering agricultural and forestry residues corresponding to a potential of about 18,000 MW or an equivalent of 200-240 million barrels of oil. In addition to this, about 5,000 MW of additional power or an equivalent of 65 million barrels of oil could be generated through bagasse based cogeneration in the country's 550 sugar mills .
The current cumulative deployment of Bio-Energy based power generation is shown below:

Table 13 : Bio-energy Installed Capacity as on 30.9.2014

Grid Connected	Capacity [MW]
Biomass Power	1,365
Bagasse Cogeneration	2,689
Waste to Energy (Urban & Industrial)	107
Off Grid / Captive Power	MWeq
Waste to Energy (Urban & Industrial)	136
Biomass(non-bagasse) Cogeneration	556
Biomass Gasifiers (Rural & Industrial)	167
Family Biogas Plants (in Lakhs)	48
Total	5020

Bioenergy segment has the highest potential for improving energy access in rural areas. There are several benefits of focusing on bioenergy segment given the potential to generate additional rural income, reduce environmental impact of burning agri waste, scalability and employment opportunities for local population.

Bio-Energy Mission- The proposed Bioenergy Mission aims to harness the huge potential available and targets around 10,000 MW by year 2022, with emphasis on promotion of biomass based IPPs as well as decentralized systems based on bio-energy. The mission also proposes to develop captive and cogeneration projects in the SME industry segments based on gasification, combustion, waste heat recovery and bio-methanation technologies.

Government incentives and Subsidies for Biomass Energy Production- MNRE provides Central Financial Assistance (CFA) in the form of capital subsidy and financial incentives to biomass energy projects in India. CFA is allotted to the projects on the basis of installed capacity, energy generation mode and its application etc. Financial support is made available selectively through a transparent and competitive procedure.

Issues

Supply Chain Issues

Small farmers thus fragmented land holdings - Most of the farmers in the country are small/marginal in terms of size of land holdings and quantum of produce. Biomass projects depend on fuel availability from such sources. As these sources are disperse and in the absence of a coordinated fuel supply system, biomass power developers face a number of supply chain issues. Supply chain bottlenecks could result in non-availability of feedstock or limited availability. This can result in operational disruptions or unsustainable price increases.

Transportation costs- In addition, transportation costs account for a significant portion of costs for bio-energy projects. Transportation from more than a particular distance becomes unviable for a power plant of small size. Also, there is need of processing/shredding the biomass onsite before transportation to increase its density when procurement is done from more than a particular distance, further increasing the cost.

Information dissemination- The absence of an established coordination system to disseminate information on fuel availability is another factor creating supply chain problems. A centrally established information dissemination system where fuel availability in sparse locations can be accessed would reduce the high uncertainty associated with fuel availability and price. This system could also be leveraged for plant siting, especially when fuel supply concerns dominate the planning process.

Fuel Price Volatility and tariff linkage- Uncertainty around fuel availability and absence of an organised supply chain are primarily responsible for price volatility, primarily on the upside, of biomass feedstock. The proposed bio-energy mission recognizes that in addition to ensuring year round availability, tariff linkage to the fuel price too is critical. Thus tariffs for energy generated from biomass plants needs annual revision with direct linkage to fuel costs.

Lack of financing mechanism

Amidst supply chain issues which increase the uncertainty on revenue stream, the high initial costs are perceived by many as a key barrier to the penetration of bio-energy. While the govt. has introduced subsidies as an incentive to enhance capacity addition, project implementation has still been slow. Mainstream financial institutions have been reluctant to take risks in lending due to a long history of poor recovery of loans due to falling returns, high fuel risks, and the high costs of servicing in these dispersed and low-volume markets.

Market Barriers

There are only approximately eleven MNRE approved manufacturers and suppliers of biomass gasifiers in the country . The initial investment required for such technology is huge and with financers hesitant to fund bio-energy projects, entering the market is not easy. Government policies on licensing requirements, limits on access to raw materials, pollution standards and product testing regulations make it difficult for new competitors to enter the market.

Small Hydro

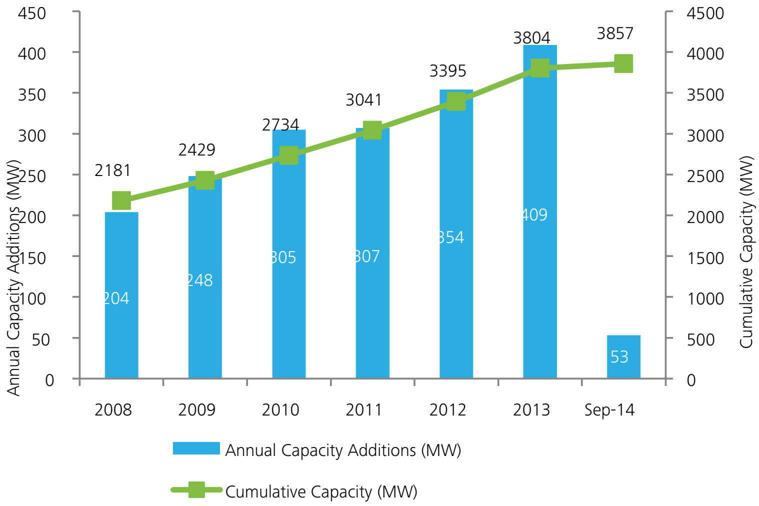
Installed Capacity and Potential

In India, hydro power projects up to 25 MW capacities are classified as Small Hydro. The Ministry of New and Renewable Energy has been vested with the responsibility of developing Small Hydro Power (SHP) projects. The estimated potential for power generation in the country from small / mini hydel projects is 15,380 MW from 5718 identified sites.

Out of this potential, about 50% lies in the States of Himachal Pradesh, Uttarakhand, Jammu & Kashmir and Arunachal Pradesh. In the plain region, Maharashtra, Chhattisgarh, Karnataka and Kerala have sizeable potential. Focused attention is given towards these States through close interaction, monitoring of projects and reviewing policy environment to attract private sector investments.

In the year 2000, the total installed capacity of small hydro projects (up to 25 MW) was 1275 MW. There has been an increase of about 150% in the installed capacity over the last 10 years. Continuous and steady growth can be seen in the SHP sector. During the 9th Five Year Plan, 269 MW of small hydro capacity was added and this increased to 536 MW during the 10th Five Year Plan and 1,419 MW during the 11th Plan . The current installed capacity for Small Hydro is around 3,857 MW, which is around 25% of the identified small hydro potential (estimated at 15,380 MW). This makes SHP the second highest (12%) contributing RE technology after wind. The figure below details the installed capacity trend from small hydro power projects in India.

Figure 18: SHP Capacity Additions as on 30.9.2014



The SHP programme in India is now, to a large extent, private investment driven with 23 states having announced their policies to invite private sector to set up SHP projects. There is renewed interest in the development of micro hydel projects & watermills during the last 3-4 years e.g. state of Uttarakhand has launched a programme for systematically developing watermills.

Issues

Challenges in setting up plants in difficult and remote terrain

The single biggest challenge is the construction risk, given that most SHP projects are located in remote, hilly/mountainous regions with severe infrastructural constraints. The locational hurdles also serve to prolong the gestation period and push up the per-MW capital costs even as the power evacuation and transmission facilities at the sites remain inadequate. In addition, the projects have relatively longer gestation period vis-a-vis other RE sources due to difficult terrain.

Delays in acquiring land and obtaining statutory clearances

The project development challenges faced by SHP plants differ from the challenges faced by other RE technologies due to a number of reasons. The SHP projects are governed by state polices and the projects involve time consuming process for allotment of sites by states and statutory clearances including land acquisition, forest clearance, irrigation clearance etc in the absence of any provision for a single window clearance.

Inadequate grid connectivity

Unlike micro-hydro, SHP plants can be connected to the grid, but the electrical protection and control systems to connect small hydro to the grid may be relatively more expensive (as a percentage of development cost) than for larger plants. Also, SHP plants tend to be in hilly regions where developing evacuation infrastructure is a major issue. Basic facilities as roads, bridges and transmission lines from site to nearest grid station have to be built by the developer increasing the gestation period and per MW cost. In fact most of the economically attractive potential for SHP in Himalayan and Northern eastern states remains untapped because of lack of adequate grid interconnection facilities and approach roads, which increase the risks involved in transporting heavy equipment to the sites.

Tariff

The lack of consistency in SHP tariff norms across states hinders investments in the sector with several states having tariffs which do not ensure adequate returns on investments. The preferential tariff being offered to developers in some states are not attractive. Timely adjustment of power tariffs by regulators to ensure that the tariffs fully cover the capital costs likely to be incurred by developers would remain critical for the viability of SHP plants.

Inadequate financing sources

SHP plants, like other renewable energy technologies, require large initial capital investments, making the levelized cost of generation higher than it is for many conventional sources. The availability of financing options plays an important role in increased adoption. High technology and project risks perceived by financers for renewable projects make access to low-cost and long-term funding difficult. The risks inherent in renewable projects are high and higher risks reflect into higher interest rates in renewable sector lending. Also, awareness amongst financial institutions is also insufficient about the sector-specific risks & opportunities. There is a need for government support in providing project finance for such projects to boost investor sentiment.

Lack of reliable hydrological data

Lack of reliable hydrological data required to assess the viability also remains a major issue and acts as a major deterrent for investment, as it increases the risk factor for the developer. Lack of data may lead the developer to make incorrect estimates about project financials which may cause huge losses. Also, inadequate or inaccurate data lead to faulty design parameters causing underperformance and subsequent financial losses.

Grid Integration of RE Technologies

Overview

Renewable generation from technologies like wind and solar has increased substantially during past few years and forms a significance proportion of the total generation in the grid. This renewable generation is concentrated in a few states, to the extent that it cannot be called marginal generation and serious thought needs to be given to balance the variability of such generation. There is an ambitious programme for increase of such Renewable Generation and therefore, it is imperative to work out a way forward for facilitating large scale integration of such variable RE source keeping in view the security of the grid.

India is a country of large geographical size and this is helpful in balancing the variable output of renewable energy sources located in few states by integrating them into all India grid. The power transmission grid in India is divided into five regional grids; Northern, Eastern, North-eastern, Western and Southern. The inter-state grids in India are managed by the Power Grid Corporation of India (PGCIL) whereas the intra-state grids are managed by the State Transmission Utilities.

Need for Grid Integration of RE technologies

Remotely located sites- The renewable energy (RE) resources are generally located in remote locations and confined to a few potential rich states only. Grid infrastructure is needed that is sufficient to transport renewable energy to the load centers.

Difficult to absorb all RE power locally- Renewable energy potential is spread across states and during peak hours, it is not possible to absorb all the energy locally in the state. For example, wind power sector accounting for majority of RE capacity in the country, has been at the losing end because of inadequate evacuation facility in the country. Across resources rich states as Tamil Nadu, the grid does not have spare capacity to evacuate the high growth potential wind power. The state distribution utilities usually tend to prefer low cost and reliable thermal power and wind power developers are forced to back down during productive windy season.

RPO Compliance- Grid integration of RE would also help in easier RPO adoption and enforcement in future scenarios when home states may not be able to consume high cost RE power beyond their stipulated RPO requirements. Grid integration would not only prevent loss of RE power but also help other resource insufficient states to meet their RPO targets.

Increased investor sentiment- Infrastructural glitches are one of the biggest bottlenecks perceived by investors while investing in RE sector. But, as plants would not have to shut down on grounds of evacuation issues and as RPO compliance would increase with grid integration, investor sentiment would improve. Improved infrastructural facilities would increase the economic incentive for developer, attracting investments in the high potential sector.

Given the above mentioned needs and advantages of grid integration of renewable energy, there is an urgent need to augment general grid capacity. Without capacity expansion and system up-gradation all the renewable energy potential cannot be accommodated in the power system. However, power generation form renewable energy technologies is intermittent which poses a major technical challenge and inadequate and weak grids further act as a barrier to smooth grid integration of power generation from renewables.

Green Corridor

With increased emphasis on development of large scale RE plants as well as distributed renewable sources, solving the grid-integration problem will significantly influence the future growth potential and scaling up of RE technologies in the country. Considering the need to establish a strong and unified link between the state and national grid, MNRE and CERC commissioned PGCIL to study and identify the transmission infrastructure requirement for evacuation of RE power in the 12th Plan. Subsequently, in Sept 2012 the "Green Energy Corridor Report" was released which discusses issues of intra and inter-state transmission system strengthening and augmentation, establishment of a Renewable Energy Management Centre, improved forecasting to address variability aspects as well as grid integration issues of large scale RE generation. An investment of approximately $8 billion (~ INR 42,557 crores) is being planned for the development of this corridor by 2017. Out of this amount, approximately $3.8 billion (~ INR 20,466 crores) is likely to be invested in strengthening intra-state grid network and approximately $4 billion (~ INR 21,867 crores) is likely to be invested in strengthening the inter-state transmission system. This initiative, if implemented successfully, could be a major driver for the development of the renewable energy sector in India.

In addition, Renewable Energy Management Centres are proposed to be established in key states which would facilitate better scheduling and monitoring of RE power. The proposed project also aims to provide central assistance for financing identified projects. In order to ensure speedy implementation, a high level of coordination with the State agencies is required.

India Smart Grid Task Force- In 2010 the Ministry of Power (MOP) set up the 'India Smart Grid Task Force' (ISGTF) to serve as the Government's focal point for activities related to Smart Grid and to evolve a road map for Smart Grids in India. MOP's vision of a smart grid is to bring together the fields of communications, IT and the power sector to establish a comprehensive power grid infrastructure. The task force works on diverse areas of the power sector, including integration of renewable energy sources with the grid and lowering of aggregate technical & commercial losses.

On account of technical, managerial as well financial challenges it poses, grid-integration of RE technologies is a challenging task that needs to be addressed urgently in the country. A few of the issues have been discussed below:

Issues

Long term Planning Process

Transmission capacity and infrastructure needs to be built keeping in view the projected capacity additions and improvements in generation on account of technological advances. Unless the transmission capacity planning process incorporates a long-term vision of planned power additions and involves sector players at the planning stage, bottlenecks related to evacuation capacity are expected to remain.

Institutional Arrangement

The government has set ambitious capacity addition targets for RE. Given the technical difficulties surrounding grid integration of RE, establishing a central repository to work as a single source information repository & coordination point, would help smooth integration of RE into the grid. The green corridor report also emphasizes the need of establishing an institutional arrangement with defined roles & responsibilities of various agencies/developers.

Intermittent & Uncertain Generation of RE technologies
The output of wind and solar based RE plants vary according to the available resources (the wind speed/direction and the sun's insolation level). This fluctuation in power output results in the need for spinning reserve to balance supply and demand on the grid on an instantaneous basis, as well as provide ancillary services such as frequency regulation and voltage support. With increasing capacity base and grid integration, sudden drop in generation due to intermittency would severely impact grid stability. Measures to smooth out intermittency and variability including enlarging the balancing area, load shifting, building in more flexibility in the generation portfolio etc. have to be adopted for better grid stability and risk free integration of RE.

Forecasting and Scheduling

One of the key challenges with renewable generation is intermittency. Ensuring resource adequacy and grid security in systems with significant renewable generation calls for better forecasting. In the Indian system, wind and solar power are expected to be the highest contributing RE technologies and are more difficult to predict than small-hydro and bio-energy based generation. Power generation contribution and evacuation scheduling from these sources will be dependent on accuracy of the forecast. There is a need for adopting better forecasting methods for power generation and demand across the nation.

The current best practice for reliable grid operation is decentralized forecasting with centralized control. Forecasting is done from the plant level and is then integrated/aggregated at SLDC, RLDC and NLDC levels. Ideally, for effective monitoring and control, the forecasting tool should be integrated with the SCADA / EMS system.

Uniform Metering Regulations

Multiple states have established their respective metering regulations for distributed energy sources, which do not align with CEA regulations. In such a scenario, grid integration is likely to prove difficult due to varying standards. Further, regulatory clarity on safe levels of grid-penetration and net metering standards is required for safe RE integration. Establishment of standard regulations would help establish the specific grid up-gradation procedures that need to be undertaken.

Remotely Located Sites

Wind and solar energy resource sites are often in remote locations, and unlike conventional sources they cannot be relocated close to load centers. Developing sufficient transmission to move RE generation to markets is critical to their integration.

Discussion points

Renewable energy will increasingly play an important role in the overall energy mix in the country and will continue to contribute towards addressing the present and future power supply deficits as well as enhancing energy access in remote areas. Policy makers & regulators, along with other market players, need to play a pro-active role in addressing the key issues currently faced by the sector.

Ensuring that RPOs are implemented across states and reflect NAPCC targets

Policy & regulatory frameworks that address the various hurdles facing the sector will remain crucial for sustaining and increasing the growth renewable energy during the 12th Five Year Plan period and beyond. The policy & regulatory framework should provide for clear RPO compliance mechanism to provide market stability, build investor confidence and achievement of targets set under the National Action Plan on Climate Change. The issue of RPO compliance and its impact on the REC market needs to be addressed to strengthen the development of the renewable sector.

Ensuring availability of adequate financing for development of the renewable sector

The 12th Five Year Plan has set ambitious targets for RE capacity addition. One of the key challenges for policy makers and other stakeholders is to address the hurdles in securing adequate and appropriate funding. Emerging technologies like solar may require preferential treatment, even amongst renewable technologies, to develop the sector. What steps needs to be undertaken for not only increasing the availability of funds but also enhancing the viability of the renewable energy projects?
Would creation of dedicated funds for the renewable sector, developing low cost financing instruments, be the options which the policy makers look at over the next five years?

Developing the REC market mechanism

Renewable Energy Certificates (REC) provides a market-linked, alternative source of revenue for renewable based projects. The uncertainty in long term REC pricing and the increasing inventory of non-solar RECs due to non-enforcement of the RPOs could potentially derail the whole mechanism. What would be the immediate steps which need to be taken to deepen the REC market and also provide the long term certainty for the development of REC based instruments?

Institutional framework for coordinated development of RE sector

State government agencies like transmission utilities, renewable energy development agencies, etc would have to play an important role in ensuring coordinated development. For example, most of the states do not have a dedicated renewable transmission plan. The Green Energy Corridor scheme has proposed intra/inter-state transmission system strengthening, flexible generation, establishment of Renewable Energy Management Centres, etc, as measures for managing grid integration of RE. However, the institutional framework for coordinating such effort needs to be put in place.

Are central sector institutions required to play the role of coordination to achieve RE targets? Do some of the established institutions like Solar Energy Centre of India (SECI) have sufficient institutional capabilities to take on the bigger role of coordination and how can the same be enhanced? Similarly, what would be the key requirements for empowering state institutions?

Improving power evacuation infrastructure for smooth grid integration of RE technologies

The development of adequate power evacuation infrastructure to manage renewables based capacity addition has not happened in several states. This has led to sub optimal utilization of assets and back-down of RE and lost generation. This is specifically true in case of states like Tamil Nadu which has very high contribution of renewables in their energy mix. The STUs have not been able to provide the requisite focus as a result of their poor financial condition and the low priority accorded to RE in some of the states. Also, the intermittency of RE generation is one of the key challenges in grid integration of RE. Grid connectivity of RE sources is essential for large scale expansion of capacity and generation, and adoption of advanced forecasting tools is critical for this.

Accurate estimation of resource potential

Due to technological advancements, renewable power potential has changed over time. There are a number of generic estimates based on studies of various institutions that detail the proportion of technological potential that can be utilized economically, based on the present economic boundary conditions. As such, renewable power potential estimates require revalidation and re-estimation. High quality resource assessment is lacking in renewable power technologies, particularly with wind & biomass. It not only hinders robust market development but increases uncertainty .

Enabling and accelerating R&D initiatives in the RE sector

The institutional ecosystem developed under the aegis of MNRE for RE development in the country is more focused on research, design and certification. Institutions like Solar Energy Centre (SEC), National Institute for Wind Energy (formerly Centre for Wind Energy Technology), Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE) and Alternate Hydro Energy Centre (AHEC) focus on enhancing R&D, testing & certification for RE equipment in the country. As a part of Jawaharlal Nehru National Solar Mission, a number of institutions have been formed as Centres of Excellence (COEs) for promotion of basic as well as applied research in the area of solar energy.

The R&D infrastructure for promotion of RE technologies needs to be enhanced to address issues related to appropriate technology for Indian conditions, customisation of products for local needs, lack of integrated supply chain and eco-system, and enhancing competitiveness of domestic manufacturing.

Enabling Domestic Manufacturing Capabilities

The domestic manufacturing capacity and quality of renewable energy equipments has enhanced significantly over the years. However, the growth has not been holistic in terms of technology innovation, upstream and downstream integration and at the same pace and standard as global market.

The wind turbine manufacturing industry has developed sufficient capacity to cater to domestic demand but lags in technology up-gradation and maximum rated capacity range when compared to global trends. Despite India being the fifth largest country globally, in terms of wind installed capacity, the market still depends on foreign imports for more complex parts and equipments. Due to such technical insufficiencies, the domestic wind equipment manufacturers who in the early start of the century started to create to a global foot-print have steeply lost their export market share.

Similarly, the domestic PV module manufacturing market is dominated by Chinese and Taiwanese manufacturers offering low cost integrated solutions. With limited financing options and high interest rate scenario, the domestic manufacturers are unable to compete with their global counterparts who enjoy huge economies of scale further making it difficult for domestic manufacturers to compete. Indian Solar PV manufacturing supply chain is mainly focused on cell and module manufacturing and domestic manufacturers depend heavily on long term supply contracts from dominant Chinese manufacturers at fixed prices for ingots and wafers. Consequently, decline in input prices does not translate into module cost decline for domestic players who thus are unable to out-compete the foreign players. Consequent to above stated reasons there is a big imbalance between installed capacity and consumption and Indian manufacturers have entered a vicious cycle of lower sales realization and non-utilization of installed capacity. The situation calls for a review of the policy and infrastructure support from the govt. to create a more favourable and conducive environment aligned to commercially support the domestic manufacturers.

Centralised vs Decentralised approach for RE Development

The current status of persistent energy deficit and absence of energy access to remote areas is majorly a result of focused centralized approach of energy planning. To address the issue, self-sustained, fuel independent, low maintenance, decentralized spread of RE power majorly in form of residential rooftop panels and agriculture pump sets has gained significant adoption in the recent past. In addition, grid integration of decentralized RE based projects would not only increase energy access to remote locations but also complement the centralized grid based electricity system by reducing the burden of power shortfall and urgency and cost of grid expansion.

Though it is promoted as a way of RE power development and capacity spread to remote areas, the model faces a number of implementation issues at present. Establishing decentralized RE projects is associated with high financial and organizational risks. Such projects can be replicated through learnings from demonstration projects but there is a need of govt. support in form of favorable policy environment, technical assistance and incentive schemes. Advantages of adopting solar powered DDG model in urban areas is also acknowledged which can be more effectively exploited in presence of net-metering facilities provided by utilities under a regulated framework.

There is a need for a multidimensional push addressing technical, financial, policy and regulatory aspects for successful adoption of decentralized model of RE development.