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YOJANA

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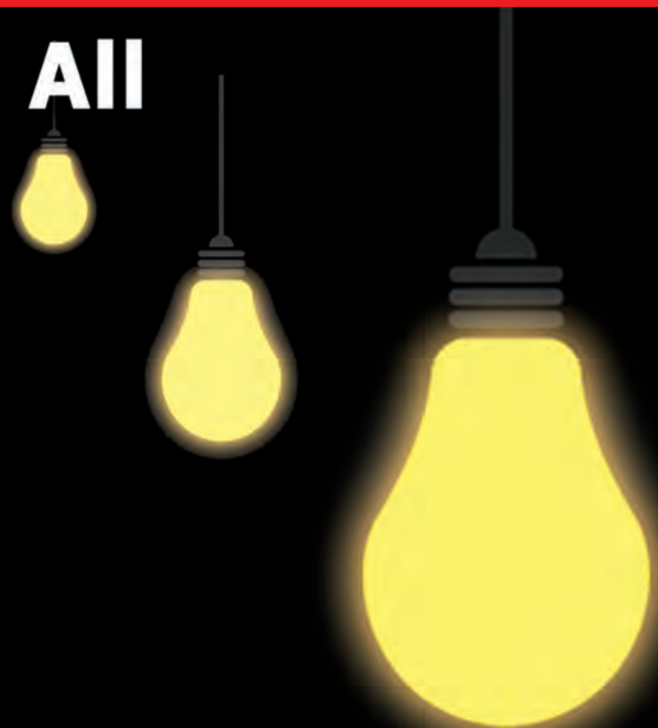
Power for All



Promoting Solar Energy

With a view to promote solar energy globally, a declaration was signed and exchanged by Ministry of New and Renewable Energy and ISA (International Solar Alliance) cell and World Bank recently.

Major areas identified for working jointly include;

a) Developing a roadmap to mobilize financing

b) Developing financing instruments including credit enhancement, reduce hedging costs/currency risk, bond raising in locally denominated currencies etc., which support solar energy development and deployment

c) Supporting ISA's plans for solar energy through technical assistance and knowledge transfer;

d) Working on mobilization of concessional financing through existing or, if needed, new trust funds; and

e) Supporting RE-INVEST events. In addition, both sides decided to work in other areas and themes.

This Joint Declaration by the ISA cell and the World Bank is expected to help in accelerating mobilization of finance for solar energy. World Bank will have a major role in mobilizing more than US $1000 billion in investments that will be needed by 2030, to meet ISA's goals for the massive deployment of affordable solar energy.

ISA has been envisioned as a specialized platform and will contribute towards the common goal of increasing utilization and promotion of solar energy and solar applications in its member countries. The Paris Declaration on International Solar Alliance states that the countries share the collective ambition to undertake innovative and concerted efforts for reducing the cost of finance and cost of technology for immediate deployment of competitive solar generation, financial instruments to mobilise more than 1000 Billion US Dollars of investments needed by 2030 for the massive deployment of affordable solar energy and to pave the way for future solar generation, storage and good technologies for countries' individual needs.

ISA is India's first international and inter-governmental organization headquartered in India.ISA will be dedicated to promotion of solar energy for making solar energy a valuable source of affordable and reliable green and clean energy in 121 member countries. The foundation stone of the the International Solar Alliance (ISA) Headquarters and the interim Secretariat of the ISA in National Institute of Solar Energy (NISE), were laid in Gwalpahari, Gurgaon in January 2016.

Government of India has dedicated 5 acre land in NISE campus for the ISA Headquarters and also has contributed Rs 175 crore for ISA corpus fund and also for meeting expenditure for initial five years.

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Let noble thoughts come to us from all sides

Rig Veda

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YOJANA

Chief Editor's Desk

Energy Sufficiency and Energy Independence

When India attained Independence, most of the country did not have sufficient electricity to light up its homes. The iconic lantern and the oil lamp were the only sources of light after dark. In most homes, all chores were completed by sunset and it was 'lights off' by 7.30 p.m, because very few could afford even a lantern, as kerosene was expensive and scarce. The oil lamp lit and placed at a window served as guide for travelers or those yet to return home.

More than six decades after Independence, though one still gets to see the iconic figure of the little child studying under a street light, it is an exception rather than the rule. The situation has become much more 'brighter'. Electricity has reached most urban areas. According to Census 2011, there are 167.8 million households in rural areas out of which about 92,808,181 are electrified.

This is thanks to the systematic planning by our policy makers, who have continuously worked to create energy sufficiency since Independence. Thermal and hydro power plants were set up in the first few decades after Independence adding capacity to our energy requirements. The situation was, however, not improving as much as necessary, as India was still dependent on imports for its petroleum and natural gas requirements. Petroleum pricing and availability was linked to West Asian politics and the massive fluctuations resulted in a heavy strain on India's balance of trade position. It is then that the policy makers began to think in terms of curtailing dependency on fossil fuels and replacing them by more renewable energy sources. Given India's huge thorium reserves, nuclear energy was thought of as a potential replacement. However, India's nuclear energy programme was stalled for years due to intrusion by international, political and security concerns. It is only in recent times that India has been able to resume the programme. India is, thus, still highly dependent on traditional energy sources like coal and hydro power plants for its energy needs.

In its endeavor to tap unconventional energy sources like wind, solar and bio mass energy, the government of India created a new Ministry called the Ministry of New and Renewable Energy whose mandate was to work out modalities for schemes and programmes on these renewable energy sources. While wind energy, and to some extent solar energy, are gaining acceptability and bio mass has become popular in rural areas, this programme has still a long way to go before it can replace the major energy sources like coal and water.

Former President, Abdul Kalam in his 59th Independence Day speech had said. "Energy Security, which means ensuring that our country can supply lifeline energy to all its citizens, at affordable costs at all times, is thus a very important and significant need and is an essential step forward. But it must be considered as a transition strategy, to enable us to achieve our real goal that is - Energy Independence or an economy which will function well with total freedom from oil, gas or coal imports". Putting energy as our nation's first and highest priority, he had called for determination to achieve this within the next 25 years i.e by the year 2030. The present Government has set the target to provide affordable, 24 x 7 power to all households by 2019.

While our policy makers are striving hard to achieve the goal of energy sufficiency and energy independence, it also behooves on us, the citizens to contribute to this effort by using energy efficient appliances; ensuring that energy is not wasted in terms of not leaving lights and fans switched on in empty rooms or while leaving the house; teaching children to use sunlight and natural air instead of lights and air conditioners. All these little steps can go a long way in saving energy for a better tomorrow and achieving the target of "Power for All". ❑

PERSPECTIVE

Energy Sector: The Challenge of Power for All

Anil Razdan

With India's given resources, the energy sector has performed well in recent years. It is a capital intensive sector, and the public interface is large. For the sector to be on the right path, political sagacity at the Centre and the States, is imperative. Substantial synergy and momentum has been achieved over the last two years through a horizontal integration of the Ministries of Power, Coal and New Renewable Energy. Coupled with dynamic policies and a vision it should be possible to meet the national commitments given at CoP 21 in Paris

Energy use, its availability and affordability, will continue to be crucial ingredients of development, growth, employment and poverty alleviation. Given its key role in households, farms, factories, offices, business places, transportation and construction it is not surprising that an intrinsically economic activity has found a prime place in the political agenda of democratically elected governments in developing countries. Human Poverty cohabits with energy poverty. Nearly two decades back we had a motivational slogan "Power for All". It has now graduated to 'Power for all 24X7', and will soon transform to Quality Power, and on to Green Power. The twist in the slogan only indicates the successful journey we have traversed, and the aspirational imperatives of the future.

With the growth in income, education, awareness, global interaction and the demographic shift to a bold new aspirational generation, the paradigm of development will also shift from mere development and existence, to sustainable development and existence. The State will be expected to provide not only the basic freedoms enshrined in the Constitution, with current sources of commercial energy, but also the basic Right to Clean Air and the Right to Clean Water. This is in keeping with the global energy agenda, which is moving beyond equity and efficiency, and getting firmly locked into environmental, health and climate change implications. Such laudable agendas have serious cost implications with questions of affordability. Unfortunately, most energy projects are capital intensive, having long gestation and financial pay back periods. However, the silver lining is that there has been a dramatic fall in prices of new renewable solar energy in recent years. The good news is that India has already launched on an accelerated trajectory in new renewables, and a lot of capacity is yet to be constructed. The worrying part is that the demand for power is not growing at the expected pace, leaving a large unutilised capacity. It could be on account of subdued manufacturing demand, or the un-serviced distribution sector having a suppressed demand. If this has come about largely on account of efficiency improvements, or aggressive demand side management initiatives, we are blessed. More unsold power, or under-recoveries from consumers, would put a strain on the financial institutions

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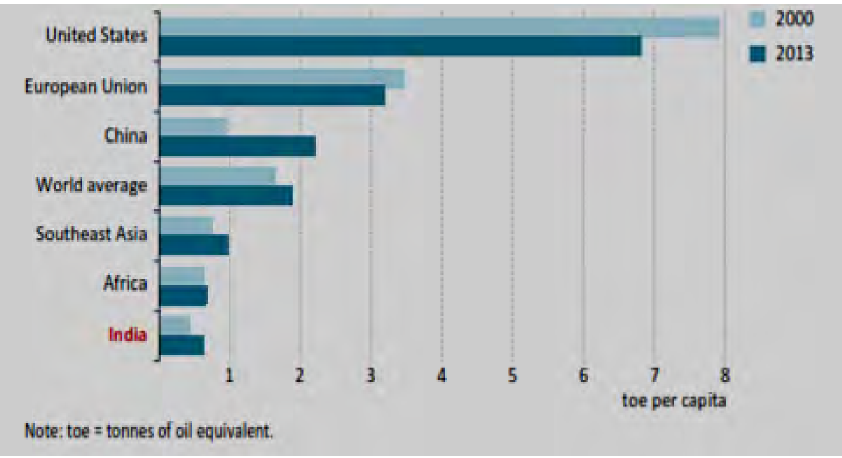
and stressed assets. Governance of the power sector has passed substantially to statutory independent regulatory commissions, which have to conduct vigilant independent audits to ensure that the substantial reported achievements in power satisfaction at the distribution end are not tainted by unscheduled outages and brown outs, forcing hapless consumers to alternate expensive sources of supply, largely polluting diesel sources. This would be an unfortunate paradox.

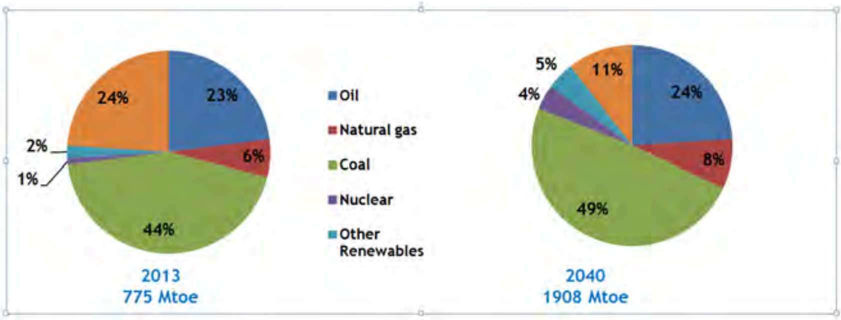
Though, the achievements in the Indian energy sector have been commendable, there is no scope for complacency. India's energy security is coal and substantial sunlight. We are going to be stressed for water. Keeping in view our population, we could have wished for much more. Maybe, the oceans will come to our rescue. The transportation system is almost entirely dependent on fossil fuels, essentially crude oil. We import nearly 75 per cent crude oil at present, and this figure is projected to reach 90 per cent by 2040. India is home to 18 per cent of the world's population, but uses only 6 per cent of the world's primary energy, inspite of being the third largest economy. Although energy use in India has almost doubled since 2000, it is still about one-third of the global average, and nearly 240 million remain without access to electricity. It is estimated that 840 million use primary fuels. Access to electricity is 81 per cent and clean cooking fuels 33 per cent. CO_2 emissions as a share of global emissions are 6 per cent, CO_2 emissions per capita are 30 per cent of the global average, and the share in fossil fuel consumption is 5 per cent. Figure 1 gives a comparison of per capita energy demand in select countries in tonnes of oil equivalent, in 2000 and 2013.

Figure 1: Per Capita Energy Demand in Select Countries



Source: IEA India Energy Outlook 2015

Figure 2: India's Primary Energy Demand Outlook



Source: IEA India Energy Outlook 2015

The primary energy demand in India in 2013 was 775 million tonnes of oil equivalent (MToe). It was dominated by coal at 44 per cent, oil at 23 per cent (out of which 40 per cent was for transport), Natural Gas at 6 per cent, Bio Fuels 24 per cent, Nuclear 1 per cent and Renewables 2 per cent. The International Energy Agency (IEA) projections for 2040 give a total demand of 1908 Mtoe. Coal is projected at 49 per cent and oil at 24 per cent. The significant shift will be a jump to 5 per cent of Renewables and a drop in the share of biomass to 11 per cent. Hopefully, renewables should rise higher than the projections if their use in transport and power increase substantially. The comparative depictions from IEA analysis are at Figure 2.

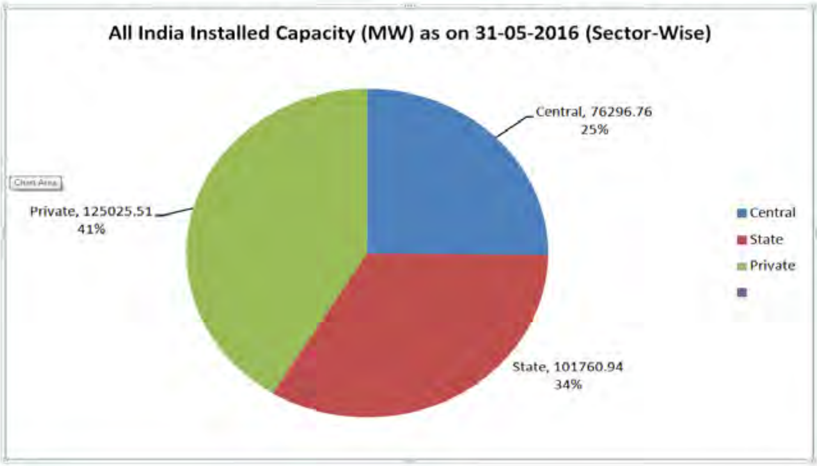
A major thrust in India's energy access programme has been to ensure that power/electricity reaches all households. This translates into capacity to generate electricity, provide the wire and the transformation infrastructure from higher voltages to lower levels, and manage the efficient operation of distribution entities to make the distribution of electricity, a viable business. With the assistance of the Central Government, a total number of 5,86,948 villages have been electrified on 31-05-2016 against a total number of 5,97,464 villages in the country. Only the most inaccessible ones remain. Unless the distribution function, within the jurisdiction of the respective states, is able to pay the transmission and generation entities, in the central, state and private sector, there would be cash flow problems, throwing the entire sector in distress, along with financial institutions which have a huge exposure to the power sector. The mainstay of India's power generation is coal thermal. It accounts for 61.4 per cent of the total grid connected installed capacity, with gas at 8 per cent, diesel 0.3 per cent, (total thermal 69.8 per cent), Nuclear 2 per cent, Hydro 14 per cent, New Renewables 14 per cent out of a total grid connected installed capacity of 3,03,083 MW.

Table-1: All India Installed Capacity (MW) as on 31-05-2016 (Sector-Wise)

Sector	Thermal				Nuclear	Hydro	RES	Grand Total
	Coal	Gas	Diesel	Total				
Central	51390.00	7555.33	0.00	58945.33	5780.00	11571.43	0.00	76296.76
State	64130.50	7210.70	363.93	71705.13	0.00	28092.00	1963.81	101760.94
Private	70722.38	9742.60	554.96	81019.94	0.00	3120.00	40885.57	125025.51
All India	186242.88	24508.63	918.89	211670.40	5780.00	42783.43	42849.38	303083.21

The same is Depicted in a pie chart at Figure 3

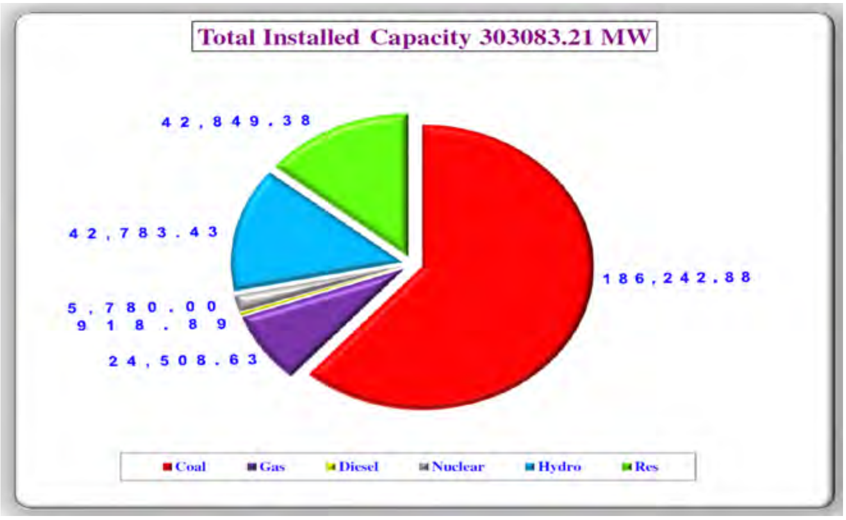
Figure 3: A pie chart indicating the generating capacity ownership on 31.05.2016



Source :CEA May, 2016

Figure 4 is a pie chart indicating the fuel wise total installed generating capacity on 31-05-2016.

Figure 4: All India Generating Installed Capacity (MW) (As on 31.05.2016)



Source :CEA May, 2016

The quantum jump in capacity addition and the rise of private ownership to 41 per cent from around 10 per cent, in just a decade has been a remarkable success story. From a five year capacity addition of only around 20,000 MW till the Tenth Plan, the figure jumped to 54, 084 MW (besides Captive capacity addition) in the Eleventh Plan, and is likely to rise to 1, 00,000 MW in the Twelfth Plan. (The fuel-wise and ownership break up is at Table 1.) While this capacity addition has been dominated by coal based thermal, there has been a setback to gas thermal owing to shortage of domestic gas and higher prices. Hydro power, a vital segment of clean and balancing power has progressively slipped from a high of 7, 886 MW in the Tenth Plan to 5,544 in the Eleventh Plan and could be even lower than 5 per cent of the total capacity addition in the Twelfth Plan. The share of hydro is 14 per cent of the overall installed capacity. In the wake of the tremendous spurt in New Renewables capacity in the Thirteenth Plan through solar and wind, which are intermittent in nature, the absence of this balancing power could be severely felt in grid management. A performance review of capacity addition from the Eighth Plan to the Twelfth Plan in given at Table 2.

It takes 4 to 5 years for a coal thermal project to fructify, unless it is held up. It would take 8 to 10 years for a large hydro project to be commissioned. It is necessary to have a large shelf of projects in the pipeline, if future capacity addition has to be smooth, keeping in view our projected GDP growth rate of around 8 per cent. It is estimated that at present, a total of

Table 2: Capacity Addition : Performance Overview

	During VIII[th] Plan (5 yrs)	During IX[th] Plan (5 yrs)	During X[th] Plan (5 yrs)	During XI[th] Plan (5 yrs)	During XII[th] Plan (4 yrs)
Central	7,717	3,624	11,085	14,340	15,142
State	6,835	9,450	6,245	16,732	19,291
Private	1,431	5,061	2,670	23,012	49,558
	15,983	**18,135**	**20,000**	**54,084**	**83,991**
Thermal	13,555	13,597	12,114	48,540	80,180
Hydro	2,428	4,538	7,886	5,544	3,811
Cumm. (Th + Hyd)	**15,983**	**18,135**	**20,000**	**54,084**	**83,991**

Source: MoP

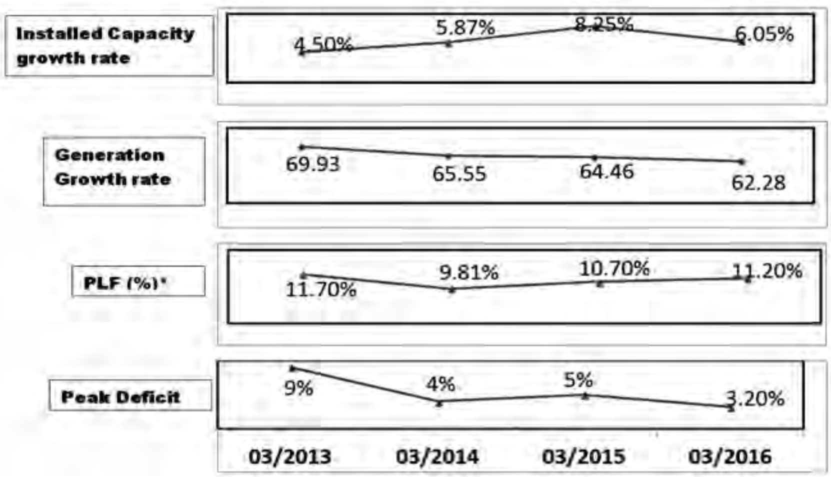
65,185 MW thermal and hydro projects are under construction, out of which hydro projects are 9,289 MW. Projects having a capacity of 30, 070 MW are held up for various reasons.

India has a world class indigenous manufacturing capability of super critical coal based thermal power. The annual capacity ranges from 20,000 to 30,000 MW annually. A substantial portion of this capacity is idling at present. This asset cannot be wasted. The imperative is to generate thermal power efficiently and in an environmentally safe manner. Those generating stations which are nearly 25 years old are not only inefficient, but they are also polluting the environment. Generation companies are not scrapping them, as the cost of running them is only the fuel cost. This inefficient use of coal cannot be permitted. The government could impose an inefficiency tax on such generation, directly proportional to their efficiency parameters. Recent moves within the Power Ministry are in the right direction. No funds should be sanctioned for the Renovation and Modernisation of these plants. They should be replaced with energy efficient super critical plants immediately. Simultaneously, we should aim at commercialising higher efficiency ultra super critical plants with stringent SOx and NOx emission norms, and much higher water consumption efficiency, as water availability is going to become a major constraint for future thermal power plants.

While the growth in installed capacity has varied between 9.81 per cent and 11.70 per cent from 2013 to 2016, which is very impressive, the growth of generation has been around 6 per cent on an average, and the Plant Load Factor (PLF) of coal and lignite stations has progressively declined from 69.93 per cent in 2013 to 62.28 per cent in 2016. The PLF of gas and diesel stations is worse. The capacity utilisation of these machines should improve for lower generating costs. Figure 5 gives a graphic depiction of the worrying situation.

The power supply position as reported by the power distribution entities to the Central Electricity Authority has shown a very significant improvement. The reported figures for April 2016 to May 2016 across the country show an energy deficit of 1 per cent, with the highest deficit of 2.3 per cent in the Northern Region. Only the figures for J&K at 17.3 per cent and Andaman & Nicobar at 25 per cent are alarming aberrations. The peak demand deficit for the same period across the country was only 2.1 per cent, with the highest of 3.5 per cent for the North East Region. This is a transformational change from double digit deficit a decade ago. Obviously, massive capacity and transmission additions are showing up. Grid power across power exchanges is also available above Rs. 2 a unit. This situation warrants that there is no place for power cuts and stand by generation, unless distribution

Figure 5: Comparative Trends in Supply Position



Source: Ministry of Power

companies are misreporting. The onus falls on the state electricity regulatory commissions (SERCs) to carry out a credible on-line audit.

The high voltage transmission sector is one of the biggest in the world. It connects all the five Electricity Regions in the country with EHV AC and HVDC capability. The overall transmission capability is 6,66,884 MW with an Inter-Regional Transmission Capacity of 59, 550 MW. The AC Sub Stations Transformation Capacity is 6, 51,884 MVA. For the evacuation of intermittent new renewable solar and wind power, an ambitious Green Energy Corridor Plan is under execution with Intra State and Inter State Corridors. The intra-state and inter-Region transmission capability brought about for the first time in the nation's history a single price of electricity on Dec 29, 2015 at Rs. 2.30 per unit. No mean achievement after nearly two decades of hard work.

The distribution segment of the electricity sector is the one in need of a major financial and technical overhaul. The Aggregate Technical and Commercial Losses of Distribution entities in 2010-11 were 26.35 per cent, despite an aggressive Restructured Accelerated Power Development and Reform Programme (APDRP) in 2008-09. The last provisional figure for 2012-13 was 22.70 per cent as reported by the CEA. The problem was more acute in the state owned 48 distribution companies (Discoms). In the year 2013-14, unfortunately 14 Discoms had AT&C loss figures between 25 per cent and 40 per cent, 9 discoms had AT&C losses above 40 per cent. No wonder, their finances were in a mess, and they were threatening to bring down the edifice of the power sector in a number of states. Besides poor efficiency, many state electricity regulatory commissions (SERCs) were to be blamed for setting inadequate tariffs, ostensibly at the bidding of the state political leadership, and creating the vice of regulatory assets, to be encased in a never reached future. In the face of staggering debts and losses, the previous government came out with a Discom Restructuring Plan in 2012, which was too close to the General Election, and did not attain success. The present government, unveiled an ambitious and aggressive comprehensive UDAY scheme of Discom restructuring in 2015, which envisaged a state takeover of 75 per cent state owned Discom debt as on March 31, 2015, over 2 years. The interest burden on Discoms was reduced. However, the real success of the scheme will lie in 100 per cent consumer and distribution transformer metering, billing and collection efficiencies. The success of this scheme will depend on the technical and financial efficiency of Discoms, the sagacity of the state political leadership, and the prudence and capability of SERCs. The Government of India on its part would do well not to make exceptions and grant concessions.

The reported exposure of the financial institutions to the power sector, as assessed from different sources could be an aggregate of Rs. 10,75,421 crore as in March 2016. The same is summarised in Table 3.

Table-3: Exposure to Power Sector (Mar'16)

Exposure to power	**In Rs. Cr.**
Banks	5,79,875
PFC	2,38,920
REC	2,01,278
IDFC (@ 40 per cent of advances)	18,280
L&T infra	15,443
IREDA (Sep'15)	8125
PFS	8500
Others (approx.)	5000
Total	**10,75,421**

Sources: RBI Data, Annual Reports, estimates

In March 2014, the average revenue gap of Discoms was Rs. 0.73 per unit of electricity sold. The debt of SEBs/ Discoms was about Rs.6 lakh crore, with the losses of individual SEB/ Discoms as high as Rs. 1,76,800 Cr. The situation certainly needed a live or die surgery. The UDAY initiative could not be more timely.

The concentration of the Ministry of Power has to be on a massive Distribution transformation, even though the action lies in the State jurisdiction. The way to move forward is to turn the distribution function aggressively SMART. Self healing grids, with Supervisory Control and Data Acquisition (SCADA), Distribution Management System (DMS), GIS Mapping, Consumer Indexing, Demand Side Management (DSM) and Smart Meters will turn grid management into a data analytics platform, ready to induct the unprecedented new renewable solar and wind energy into the grid, and herald the advent of the PROSUMER (Producer Cum Consumer). The Government of India has made a beginning by announcing the country's first major smart grid city projects for Gurgaon on July 11, 2016 at a total cost of Rs. 7,000 crore. Such projects would need to be commissioned in quick time. The most appropriate source of fund support would be from the Clean Energy Cess (Fund), now the Clean Environment Cess (Fund).

India's basic energy security lies in abundant availability of coal. Indian coal is high in ash content, nearly 40 per cent, but low in Sulphur. The new mines in Odisha could have even higher ash content. In spite of their abundant deposits, coal availability was a problem for coal based power plants, leading to a large scale surge in imports over a decade. The situation has eased considerably over the last two years. Coal India (CIL) is a monopoly player. It produced 538.75 Mt of coal and showed an off take of 534.50 Mt. in 2015-16, an increase of 9 per cent over the previous year. Coal is transported largely by rail. Wagon Loading average went up to 212.7 rakes a day, an increase of 9.3 per cent over 2014-15. For the first time, coal fired power stations had a stock for 28 days. Coal India also had a stock of 58 Mt end March 2016. The slackening of demand from the power sector has led to CIL seeking to export steam coal. There are various issues related to coal mining like environment clearances, land availability, rail connectivity to new areas, productivity, and coal washing. In recent years, the improvement in production is commendable, environment clearances and exploration have improved, though coal quality and permissions for exploratory drilling are still an issue. New rail connectivity is in the works, coal washeries are yet to take off, and land acquisition could be better. The production and off take targets for 2016-17 are 598.61 Mt each. There is much better coordination between the coal and power sectors. Coal blocks have been auctioned in a transparent manner, undoing the grimy reputation of coal block allocation. The success of the aggressive bidding for coal blocks, defying logic, is yet to be proved. Linkages have been made dynamic, and the formal introduction of commercial mining is awaited. Coal mining in India is essentially open cast mining. The Minister has announced a target of one billion Mt of domestic coal production.

India's coal resources stood at about 306 billion tonnes as on 01-04-2015, upto a depth of 1200 metres. Nearly 60 per cent is at a depth of 300 metres, economically exploitable by open cost mining. The resource position is comfortable. Besides meeting the needs of the power sector, the abundance of coal can be a game changer for India, even though there is a global clamour against the use of coal owing to SOx, NOx and Particulate Matter emissions. We need to operationalise the commercial production of Coal to Liquid and Coal to Fertilizer, keeping in view our heavy dependence on oil imports. Cheap oil is giving us a window to work on these technologies urgently. Coal can become a game changer for India. CO_2 emissions from coal fired stations have been identified as a major cause of global warming. Carbon Capture and Storage is not a solution to the problem. We have to work towards Carbon Capture and Utilization. Technologies are now available in India for converting CO_2 emissions to baking soda, urea, plastics, chemicals and many other products driving profitable decarbonisation.

A cess on coal mining at the rate of Rs. 50 per tonne was introduced by the previous government to form a Clean Energy Fund. This has been progressively raised now to Rs. 400 per tonne and designated as Clean Environment Fund. As it is sourced from coal and its collection runs into tens of thousands of crores, the first candidate for its utilisation should be clean coal technologies, and coal to liquid, gas, and fertilizer technologies.

Transportation has undergone a massive expansion in recent years. It is a necessary consequence

Coal can become a game changer for India. CO_2 emissions from coal fired stations have been identified as a major cause of global warming. Carbon Capture and Storage is not a solution to the problem. We have to work towards Carbon Capture and Utilization. Technologies are now available in India for converting CO_2 emissions to baking soda, urea, plastics, chemicals and many other products driving profitable decarbonisation.

of development, rising incomes, employment, new roads and urbanisation. Vehicle ownership has risen sharply. In 2013, India had a vehicle ownership figure of 90 against 1000 population. This was small as compared to a figure of 550 for Japan, 520 for EU, and 350 for China. However, given India's burgeoning population, this is an enormous statistic. The rising number of motorised vehicles puts an enormous strain on oil demand and quality of air in cities. The present vehicle population in Delhi is over 8 million, and 1100 new personal vehicles are being added every day. Owing to price distortion in earlier years, the share of diesel vehicles had increased disproportionately.

Keeping in view India's large dependence on oil imports, it would make perfect sense to make a strong pitch for electric vehicle mobility for urban local transport, electric bus or tram lines, and urban metro rail services. This could even be linked to the aggressive urban renewable energy program. Electric rickshaws, two wheelers, and people's electric car need mass production. They could get funding from the Clean Energy/ Environment Fund as the source of electricity would be from coal thermal power or solar PV power. Electric vehicles could also resolve the day time excess solar power availability and substitute for storage batteries for solar power. This could drastically reduce urban air pollution.

Hydro carbon availability in India is increasingly falling short of demand. Our proven reserves are limited, and the deep water reserves may not be economical for extraction. There are 26 sedimentary basins in India, covering an area of 3.14 million sq km, comprising 1.39 million sq km (44 per cent). The deep water territory is largely unexplored.

In 2014, it was estimated that ultimately recoverable resources (URR) were 34.4 billion barrels, out of which, 10.2 was the cumulative production and the remaining percentage of URR was 71 per cent. We are already importing 75 per cent of our requirement. The position in Natural Gas is slightly better. In 2014 we had 8810 bcm of ultimately recoverable resources, out of which 850 bcm had been extracted, with 90 per cent URR remaining. The import of crude oil is expected to grow to 90 per cent, that is, 7.2 mb/day in 2040, from 3.7 mb/day in 2014. The government's decision of 10 per cent reduction in import dependency by 2022 seems an uphill task. India has a very mature downstream petroleum sector with world class refineries and oil marketing companies and infrastructure, though gas supply pipelines need to increase dramatically, particularly for city gas distribution. Despite harnessing shale and tight gas and Coal Bed Methane, natural gas imports could touch 50 per cent by 2040. India's strength would lie in becoming an oil refining hub. It would be a struggle to keep oil production at present levels.

The sharp decline in global oil prices has brought foreign exchange relief to India and has led to a spurt in consumption. Retail price correction of diesel and kerosene need to be pursued aggressively. The government has launched an ambition UJWALA scheme to provide clean cooking LPG fuel to rural households, removing a major health hazard for women and children. However, care should be taken to ensure that the LPG subsidy scheme does not become a burden for the oil marketing companies, in place of the destructive Kerosene subsidy scheme. Gas is transported most economically through pipelines.

Now is the time to acquire oil assets abroad. In view of its commitment to clean air, the government has announced that Bharat Stage VI Emission norms are to be enforced by 2020, skipping Stage V. Refineries would need to entail enormous expenditure to upgrade the fuel. Automobile engines would also need modification or retrofit. Here again, the Clean Energy/Environment Fund could be a contributor. Otherwise the entire burden will fall on the consumer.

Keeping in view its national commitments at COP 21 in Paris, India has declared to reduce its Carbon Intensity in Energy use by 33 per cent in 2030 compared to 2005. This will require a strong push in Nuclear and New Renewable Energy. This is necessary if we are to contain global temperature rise within 2 degrees Celsius. There is an aggressive bid to invite foreign nuclear power developers, besides promoting the indigenous programme. The ultimate test will lie in power price affordability. The Indian power market is extremely price sensitive, and base load power above Rs. 4.50 or Rs. 5 per unit would be difficult to sell. The 500 MWe Prototype Fast Breeder Reactor at Kalpakkam should be commissioned soon, and the indigenous 300 MWe Advanced Heavy Water Reactor design using domestic thorium is ready. An exciting prospect in the nuclear industry is the Low Energy Nuclear Reactions (IENR) technology which seems to be resurrecting itself from the forced premature exile of cold fusion technology. It has to prove itself.

The flavour of the season, and rightly so is New Renewables. Encouraged by the steep fall in Solar PV prices, India has announced a 175 GW Capacity Addition of New Renewables till 2022. The break up is:

- 100 GW Solar
- 60 GW Wind
- 10 GW Biomass/Cogen
- 5 GW Small Hydro

In projects with assured land availability, competitively bid tariffs well below Rs. 5 per cent have been received. This thrust is accompanied by a Renewable Purchase Obligation (RPO) being imposed by all SERCs on Discoms. MNRE plans to add 15 GW and 16 GW of solar power capacity in 2017-18 and 2018-19. For 2019-20, the capacity addition target has been set at 17 GW, and for 2021 and 2021-22 it has been pegged at 17.5 GW each.

Keeping in view its national commitments at COP 21 in Paris, India has declared to reduce its Carbon Intensity in Energy use by 33 per cent in 2030 compared to 2005. This will require a strong push in Nuclear and New Renewable Energy.

During 2015-16, the solar segment added 3019 MW, taking the cumulative capacity to 6,763 MW. The target for 2016-17 is 10,500 MW. This is a very happy development, as India has plenty of sunshine and the fuel is inflation free. However, what has to be borne in mind is that this source is intermittent, and the PLF is about 20 per cent as against an expected 70-80 per cent for conventional sources of power. Renewable Power has to be accompanied by storage, and the manufacture of PV kits has to be indigenised with assured warranty of performance. Green Energy Corridors will have to be vastly strengthened. In this area, the thrust has also to be on shallow water pumps. The financing requirement at Rs. 5 crore/MW assessed by CERC for solar PV, gives a funding requirement of Rs 4,50,000 crore. For grid integration, smart grids would be most appropriate. At least the metering infrastructure would change to smart meters. Land use has to be minimised. Multi-array panels with solar tracking devices would be strongly recommended. For wind power projects, a minimum tariff of about Rs.5 per unit could emerge for efficient machines. A hybrid combination of solar and wind, particularly in peninsular India, could work.

In any energy source scenario, the key watch words are Energy Efficiency and Demand Side Management. We are fortunate to have an aggressive and well thought out National Mission for Enhanced Energy Efficiency (NMEEE). It has four components, namely:

- Perform Achieve Trade Scheme (PAT);
- Market Transformation for Energy Efficiency (MTEE);
- Energy Efficiency Financing Platform (EEFP);
- Framework for Energy Efficient Economic Development (FEED);

PAT Cycle I was from 2012-2015 and included eight high energy consuming sectors. PAT Cycle II from 2016-17 to 2018-19 has included Refineries, Railways and Discoms, with an overall savings target of 8.869 MToe. Taking off from the Bachat Lamp Yojana for CFL, the LED programme has been a resounding success. A future road map for energy efficiency to meet the objectives of India's declared INDCs at COP 21, has also been adopted. A similar focus has to be placed on architecture and bundling industry to save energy and aim for Net Zero Energy Buildings (NZEB) in the future. Energy efficient homes will be a necessity in multi-storey apartment blocks.

With India's given resources, the energy sector has performed well in recent years. It is a capital intensive sector, and the public interface is large. For the sector to be on the right path, political sagacity at the Centre and the States, is imperative. Substantial synergy and momentum has been achieved over the last two years through a horizontal integration of the Ministries of Power, Coal and New Renewable Energy. Coupled with dynamic policies and a vision it should be possible to meet the national commitments given at CoP 21 in Paris. Reducing energy intensity, enhancing energy security, ensuring Quality Power for All 24X7, and adopting cleaner and more efficient energy transformation would be the guiding principles. Being a capital intensive sector, it has been assessed that India needs an investment of US$ 2.8 trillion till 2040. The more difficult task would be to keep short sighted political gains out of an expensive economic activity. Substantial cesses in the nature of Clean Energy/ Environment Fund and Oil Cess have been collected and accumulated. They need to be ploughed back into the sector to make it cleaner and greener, without hurting the consumer to the extent possible.

The Energy Sector is undergoing rapid transformation. While ensuring that the gains of commercial energy reach all segments of society, its transformation and use has to become environmentally benign and commercially sustainable. The Right to Commercial Energy has to co-exist with the Right to Clean Air in the future. ❑

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Solar for Healthcare Initiative

The Indian Council of Medical Research (ICMR) has signed an MoU with the Council on Energy, Environment and Water (CEEW), a policy research institution, to launch a new 'Initiative on Solar for Healthcare'. The collaboration will focus on providing effective health care delivery at the last mile by reducing uncertainty in critical infrastructure, particularly electricity supply via cost effective solar-based solutions.

Under this collaboration, on a pilot basis, solar systems will be installed at select PHCs in partnership with three state governments and evaluate its impact on healthcare delivery and health outcomes. The aim of the collaboration is to create resilient health systems in rural India, benefitting primarily women and children.

As of 2015, nearly 35 million citizens in rural India rely on un-electrified PHCs for primary health services. In the absence of electricity, services catered by health institutions such as institutional deliveries, paediatric emergencies, and administering of vaccines get severely affected. Electricity access in health centres is also imperative as a means to facilitate communication services, tele-health applications and to retain skilled health workers.


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India's Energy Challenges & Sustainable Development

Ritu Mathur

Attaining energy efficiency across all sectors is one of the key elements to manage India's growth appropriately. More so, developing innovative methods to better manage India's growing urban energy demands – especially across efficient mobility, savings in built-up environments and generating energy from waste would become increasingly important

The understanding of energy security has changed over the years, more so, in the Indian context. In the early 1970s, energy security was more about safeguarding the economy from a situation of energy shortages and consequent spurts of high energy prices. The 12th Five-Year Plan defined energy security as ensuring uninterrupted supply of energy to support economic and commercial activities needed for sustained economic growth. Today, this has evolved further to include broader aspects such as those of ensuring energy access to all sections of society and the need for diversifying the energy basket to hedge against economic and non-economic risks.

More than five decades after independence, 23.6 per cent[1] of India's population still lives below $1.25 per day, the 2004 extreme poverty line based on purchasing power parity. At present, India houses about 18 per cent of the world's population but consumes only 5.7 per cent of the global energy. Per capita energy demand has grown modestly since 2000, but continues to remain about a third of the global average and slightly lower than the levels in Africa. About 75 million households, a third of the total, are still not connected to grid electricity, and 80 per cent of rural households use traditional biomass as a primary source for cooking.

The challenges to India's energy security at this juncture are, therefore, unique and formidable. On one hand, India faces the pressure of having to provide higher levels and better quality of energy, infrastructure and services to its people and fulfil the aspirations of a growing economy. On the other hand, it faces pressure to try and fulfil these aspirations of a growing economy within a constrained environmental space – that has been taken up by countries whose development preceded ours. Further, constraints of land, water and material resource availability may further compound and jeopardise the ability to adopt options that could provide the requisite flexibilities needed for rapid growth. Recognising the implications on human health, discussions regarding the high and increasing levels of local air pollution have also moved from being a subject of limited reach at conferences to becoming common dinner-table conversations. At the global level, the latest IPCC report clearly indicates that the chances of containing global temperature increases to within 2 degree increase is increasingly becoming less likely, and therefore, greater likelihood of climate change related extreme events. With a considerable population dependent on natural resource based livelihoods, and with poor coping capacities,

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India is also highly vulnerable to climate-change related impacts and must remain proactive to be part of the solution. Following the historical Paris Agreement of December 2015, an analysis of the Intended Nationally Determined Contributions (INDCs) submitted by all countries indicates that the combined targets are clearly insufficient to keep the world within the safe limits of 2 degrees increase[2].

Poverty eradication and inclusive growth remain an important agenda for the country. Accordingly, the Indian Government aspires to maintain a high GDP growth rate, so as to double per capita incomes every decade and improve the welfare of its people. Therefore, with a large population base aspiring for growth over the next couple of decades, India's energy sector is on the verge of a huge transformation as the economy expands, incomes rise, energy access improves, manufacturing becomes a bigger part of the economy and the country sees greater urbanisation. India already has the world's third largest electricity generation capacity, and rapid economic growth coupled with a rising share of manufacturing in GDP is likely to spur this growth further. As indicated in Fig 1, there is a strong and inexorable link between energy and the Human Development Index. Therefore as India improves its HDI level, it would be a challenge to contain per capita power consumption levels to reasonable levels by adopting an appropriate suite of technologies and not following the inefficient paths that some of the developed countries have earlier moved along.

Population growth and economic development are the two main drivers of energy demand. Between 2001 and 2011, India's population grew from about 1 billion to 1.2 billion, with economic growth averaging 8 per cent a year. Total primary energy demand grew at 5 per cent a year. Of the total primary energy demand in 2011, 70 per cent was met through fossil fuels. Coal and petroleum were the main fuels on the supply side, contributing 39 per cent and 23 per cent to the primary energy supply respectively, and natural gas contributing another 8 per cent. In terms of energy consumption, the industrial sector was the largest consumer followed by residential and commercial and then the transport sector. India's total useful energy consumption was around 478 million tons of oil equivalent (Mtoe) in 2011.

India's Energy Scenario till 2030

India is among the countries with INDC targets set for 2030. The INDC submitted by India has proposed unconditional target to achieve reduction in emission intensity of GDP by 33 per cent to 35 per cent below 2005 levels and creating cumulative additional carbon sequestration of 3GT by 2030. Further, a conditional target of increasing cumulative share of non-fossil fuel based power generation capacity to 40 per cent has also been given.

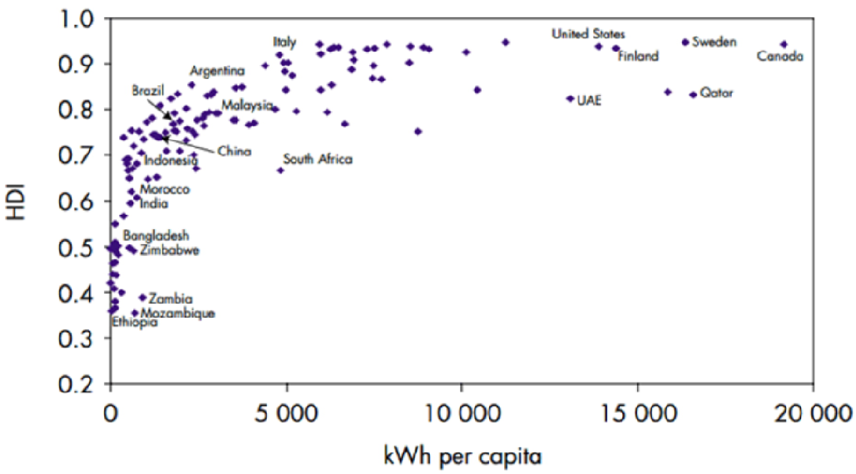

Fig 1.Per capita electricity consumption and Human Development Index

It must be noted that India's INDC targets of emissions intensity reduction are related to greenhouse gases (GHGs) as a whole, but given that CO2 accounts for the largest share in total GHGs and energy sector accounts for the largest share of total CO2 emissions, if we consider this level to be broadly in line with energy sector related CO2 emissions intensity reduction, this translates to a requirement of containing CO2 emissions to a level of around 5 Gt by 2030, depending on the lower/upper range of 33 per cent or 35 per cent emission intensity reduction.

It is also important to understand that India's emission intensity target, is based on the assumption that India achieves and maintains a high average economic growth rate of 8.3 per cent. However, achieving a high economic growth rate should not be seen as being important merely to be able to arrive at the required emission intensity reduction ratio, but more so in terms of a high GDP growth rate being able to provide an impetus to investments in the economy and the ability to push up gross capital formation across appropriate sectors.

By channelising investments in appropriate sectors which have high value addition, and/or those which can generate a stream of additional investments and employment, India could progress towards its intended emissions intensity targets. On the other hand, if India were to progress at a much lower GDP growth, achieving the INDC target would become much more difficult as investments in advanced efficient and clean technologies would also tend to dampen and slow down. Therefore, a closer look at the future structure of the economy and provision of appropriate nudges to create the requisite investment climate is an important aspect in planning ahead in this context.

A range of scenario based modelling studies have been undertaken across research groups to represent India's energy scenarios over the next few decades. Most of the scenarios set up to examine alternative low carbon pathways for India, converge in terms of the large takeaways from the analysis.

First, that the increase in India's energy requirements and consequent emissions in absolute terms is imminent given its development needs, and that there is no likelihood of India being able to peak within the next couple of decades at least.

Second, that fossil fuels would continue to retain a significant share in the overall primary energy mix of the country even by 2030. Even with very ambitious plans for renewable energy, in the absence of storage technologies being mature/economically viable, the intermittent nature of renewable resources requires that conventional fossil based options continue to be around to provide the base loads and balance the grid supply.

Third, that renewables and energy efficiency are both crucial elements in India's energy transition story and no one single silver bullet can work as a panacea in this sector.

Fig 2 shows the direction of what an INDC scenario for India may look like till 2030, if the country were to move along the lower/higher range of emission intensity reduction INDC target.

Using TERI's MARKAL model[a] to depict possible energy scenarios under the INDC-L (low or 33 per cent emission intensity reduction) and INDC-H (high or 35 per cent emission intensity reduction) scenarios, we observe that even by 2031, India's primary energy mix is likely to rely fairly heavily on fossil based energy.

In the INDC-L scenario, total primary energy increases to around 2044 Mtoe by 2031 from 551 Mtoe in 2006. Coal continues to remain the dominant fuel with its share rising from 33 per cent in 2006 to 53 per cent by 2031, while the share of oil in the supply mix rises from 24 per cent in 2006 to 26 per cent by 2031. Even though the magnitude of natural gas in the supply mix increases from 36 Mtoe in 2001 to 110 Mtoe by 2031, its share remains around 6 per cent. Thus, by 2031 in the INDC-L scenario, 84 per cent of the primary energy comes from coal, oil and gas, 10 per cent from traditional biomass, 1 per cent from nuclear energy, 5 per cent from renewables and large hydro.[b]

In the INDC-H scenario, a further reduction of 4 per cent in primary energy terms is required, which is largely on account of the reduction in consumption of coal and oil which are replaced by cleaner non-fossil options.

Total power generation in the INDC-L and INDC-H scenarios is 3989 TWh and 3927 TWh respectively in 2031 based on differences in energy efficiency levels that need to be undertaken across sectors in the two scenarios.

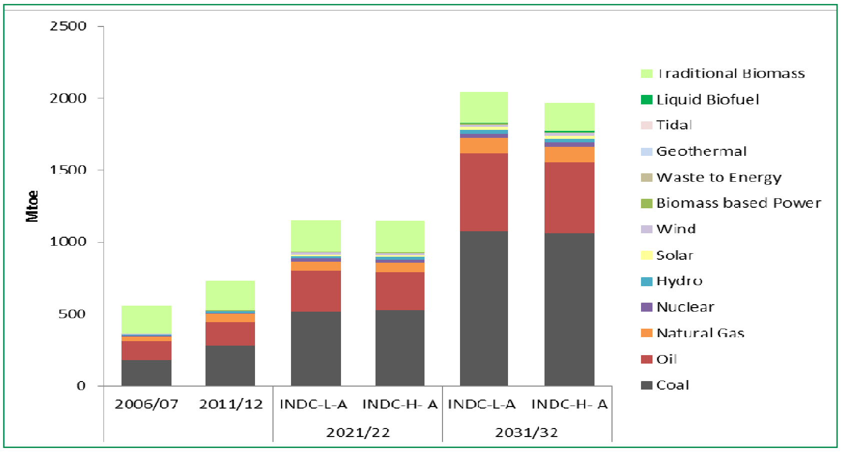

Figure 2: Primary energy supply, across the INDC-L and INDC-H scenarios

Source: Model results

Under the INDC-L and INDC-H scenarios, the generation capacity needs to increase from around 138 GW in 2006 to 843 GW and 829 GW respectively by 2031, increasing by around 6 times in 25 years. Even in 2031, around 57 per cent of this generation capacity is based on coal in comparison to 52 per cent in 2006. Diesel-based generation is, however not, favoured and seen to slowly disappear. As a result of the aggressive push required for inclusion of non-fossil based generation capacity, the share of renewables needs to increase from 6 per cent in 2006 to around 30 per cent in 2031.

The power sector is likely to need the greatest level of transformation in India's energy system until 2030. Moving from minor levels of renewable capacity today to a sizeable share by 2030 requires adequate attention to be focused on understanding future energy demand patterns, planning for appropriate demand-supply matching in a dynamic manner, and planning for appropriate base loaded generation and storage options to manage the intermittent nature of renewables.

While the transformation to low emission pathways requires energy efficiency to play out in a major way across all sectors –implying a strong push to encourage development and adoption of efficient appliances, green buildings, efficiency in industry processes and transportation systems etc., the economy needs to ascertain that adequate injection of capital in appropriate sectors is also mobilised to create the necessary demand for absorption of power generation, both in the short and medium term. This concern is also reflected in the current situation of India's power sector wherein thermal power plants are facing a situation of Plant Load Factors (PLFs) being at an all-time low of 60 per cent and falling over the past few years.

India's Fuel and Technology Choices

The energy choices that India will make in the next couple of decades are critical from several perspectives

– viz. the lock-ins of infrastructure and fuels the country will face over the next 30 odd years, the implications this would have on the emissions (of GHGs and other local air pollutants), and the ability of the fuel-technology combinations to respond to changing demand patterns in the future. There is no single fuel or technology option that seems to be a game-changer to India's energy future at this juncture, and a multitude of options need to be a part of the solution in the long term. However, careful planning is required to manage the transitions in the immediate short term and over the longer term, keeping in mind that most energy infrastructure have fairly large gestation periods and are generally associated with lock-ins of at least 20-30 years if not more.

While coal based power generation remains the most viable option for India as of now, internalisation of the costs of externalities associated with coal may in fact make advanced cleaner coal technologies more viable or indicate gas to be a preferred switch fuel subject to its availability. In any case, given the long term goal of moving towards low carbon options, investing in deep underground mining of coal and washeries with large lock-ins, may not be the best option and it may be preferable to import coal in the short term, specifically to eliminate environmental externalities. Moreover, with water becoming scarce at several locations, leading to disruptions and shutting down of some thermal plants in the past few years, technologies for re-furbishing thermal power plants with air cooled systems instead of water based cooling may gain increasing relevance. Use of integrated analytical methods to better evaluate the life cycle costs, better include the costs of externalities and evaluate the infrastructure lock-ins is desirable to make informed decisions for the future.

India has large markets and the country's growth story in fact needs to be viewed as an opportunity rather than as a challenge – wherein new technologies, innovation and development of new business models need to play a key role in enabling switches to clean and efficient technologies that are most suited to the Indian markets. The example of the market based initiative for LED lighting is a case in point. EESL has, through a model of mass procurement, been able to bring down the costs of LED bulbs to a significant level, resulting in replacement of over 100 million incandescent bulbs, thereby saving around 25 million tonnes of carbon dioxide till now.

India also has the second mover advantage in many cases whereby it can take advantage of technological leapfrogging and move to options that are already mature and tried out in other parts of the world. The Perform Achieve and Trade (PAT) initiative launched by the Bureau of Energy Efficiency is another initiative which mandates the most intensive industrial plants to reduce their energy consumption over a 5-year cycle. With successful completion of the first phase, which led to a CO2 mission saving of over 30 million tonnes, learning needs to be applied across other sectors to scale up such efforts.

The energy choices that India will make in the next couple of decades are critical from several perspectives – viz. the lock-ins of infrastructure and fuels the country will face over the next 30 odd years, the implications this would have on the emissions (of GHGs and other local air pollutants), and the ability of the fuel-technology combinations to respond to changing demand patterns in the future.

In the renewables sector, there are numerous technologies available in the market today but their viability is contingent largely on their cost, ease of implementation, resource availability and scalability. The Government has laid out very ambitious targets, and had announced a target of adding 175 GW through solar, wind and hydro by 2022.Here again, with the cost of renewable technologies coming down rapidly, it already makes business sense to invest in renewables across certain user groups, especially where there is high reliance on diesel based power generation. Understanding the role of fossil fuels (coal and gas) in providing base load power with intermittent renewables is also pertinent. Given that gas is a cleaner and more efficient fuel, careful evaluation of the domestic coal expansion plans vis-à-vis use of imported coal or gas is also relevant. Simultaneously, technologies for integrating intermittent renewables into the grid need to be adopted while working towards making storage technologies viable.

Again, the provision of clean cooking fuels to all households in the country is an area that requires attention. Although the share of households using LPG as a primary fuel for cooking has increased from 18 per cent in 2001 to 60 per cent in 2011, 65 per cent of the consumers belong to urban households while only 11 per cent of households in rural India use LPG[3]. The continuing use of firewood among rural households has largely been attributed to its easy access to firewood (from nearby forests and farm lands), high costs and difficulty in securing LPG connections and availability of cylinders from LPG outlets[4]. Here again, while the Pradhan Mantri Ujjwala Yojana (PMUY) is making efforts to increase the reach of LPG to BPL households, examining the potential of alternative options such as electrical induction cookstoves, and enhancing piped gas supply in urban centres to release larger number of cylinders to rural areas could further supplement the efforts to move ahead in providing cleaner cooking energy solutions to a larger population.

Attaining energy efficiency across all sectors is one of the key elements to manage India's growth appropriately. More so, developing innovative methods to better manage India's growing urban energy demands – especially across efficient mobility, savings in built-up environments and generating energy from waste would become increasingly important.

In the transport sector, rail based movement is more efficient than road, but has been losing share due to the convenience that road based transportation offers. Similarly, within road based passenger movement, the use of personal vehicles has been increasing rapidly, eating into the shares of public transport. Here again, innovative models to increase the share of public transport need to evolve.

The Road Ahead

Several policies, measures and schemes headed in the right direction have already been launched over the past few years in the energy sector. However, there is a need for careful planning both in terms of the choices we make and in terms of the timing of adoption and scale-up of alternative options, in order to bring in careful balance between options that may be more optimal in the shorter or longer term. Planning in this sector therefore needs to be dynamic and flexible over time, making best use of options as they become available and viable both domestically and globally.

Learning from international experiences and practices in other countries can be useful in this regard. At the same time, India should focus on bringing together real-time data to better understand and analyse the options that exist and may become available over time across sectors, develop human and institutional capacity to ensure that appropriate skill sets and capacities exist at all times to manage the transitions in India's energy future; and be open to innovative thinking and development of business models that work in the Indian context.

Last, but not the least, careful planning is also required to direct investments to appropriate sectors of the economy, such that larger benefits of growth and employment can be harnessed to move along a long-term sustainable pathway.

Endnotes

a. MARKAL is a dynamic Linear Programming energy system model that has been used to represent India's energy system and depict alternative energy pathways over the period 2001-2051.

b. Even though the generation mix is 40 per cent non-fossil because of the conversion efficiency of fossils, the primary energy mix is much higher in percentage

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Rural Electrification: A Development Challenge

Shirish S Garud, Prerna Sharma

For rural electrification to be achieved in a sustainable way, we need a massive focus on creation of income generation activities to boost the rural economy. This will bring in affordability for rural masses who will be willing to pay for services which bring in wealth and sustainability

India has around 80 per cent (Census 2011) of the population living in the rural areas with 167.8 million households out of which, only 92,808,181 are electrified and 839,133 households are unelectrified. Remaining 74,179,414 households are using either kerosene or other sources of lighting. Rural electrification is often considered to be the backbone of the rural economy. In today's context, rural electrification has five major facets:

1. Setting up of rural electricity infrastructure;
2. Providing connectivity to households;
3. Adequate supply of desired quality of power;
4. Supply of electricity at affordable rates;
5. Providing clean, environmentally benign and sustainable power in efficient way.

Village Electrification: Current Status

Access to reliable energy is a major developmental challenge in India. While India has extended the electricity grid to around 98 per cent of the inhabited villages[1], the last mile connection has not reached all households in the country and there are many habitations, mostly in the remote areas, where the grid has not yet reached. According to the Government of India's latest data (April 2016)[2], around 58.5 million households still lack access to grid electricity. Many households are underserved by current services, receiving less than four hours of electricity per day. In 2001, 55.8 per cent of total households and in 2011, 67.2 per cent of total households were electrified. The slow pace of electrification is because of irregular policy focus in the past. Besides, other issues such as political economy concerns and constraints at the institutional and organisation levels also have contributed to the slow progress of rural electrification in India.

Unelectrified Households

It would be important to throw light on where these aforementioned large numbers of unconnected rural households are likely to be located. The population without electricity

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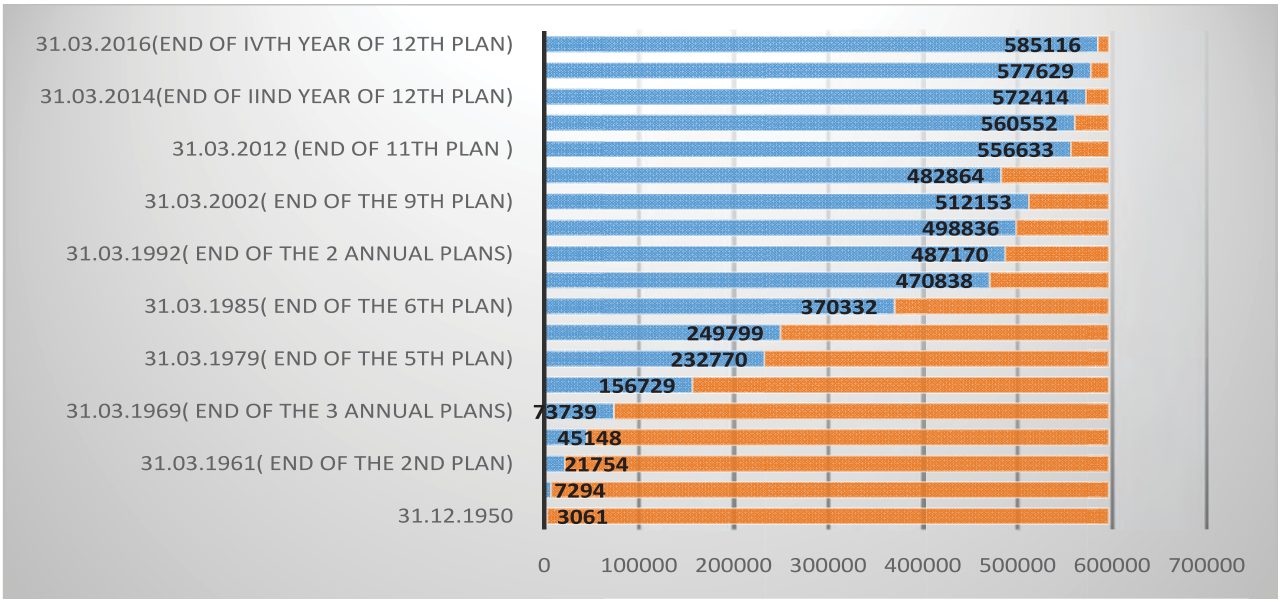
Figure 1:- Village Electrification in India (Blue line indicates cumulative electrified villages)



Source: - Ministry of Power as on April 2015

access in India can be categorised into three groups of consumers, namely (Palit, 2015).

1) Those residing in remote inaccessible villages where extending the central grid may be technically-economically infeasible;
2) Those residing in unconnected hamlets of grid connected villages; and;
3) Non-electrified households in villages where the grid has reached.

Some of the estimates by studies[3] show that, less than 10 million[4] of the total non-electrified population of around 300 million are in villages where central grid has not reached. The other 290 million are in villages that already may have electric grid or in non-electrified hamlets of electrified census villages. Most of these hamlets are located in the states of Assam, Bihar, Jharkhand, Odisha and Uttar Pradesh i.e. the eastern region of the country. While the government has announced electrification of all non-electrified villages over the next 3 years by 2018, it is crucial to recognize that a no less important task is to connect households that are in the non-electrified hamlets of electrified census villages.

Policy, Schemes and Initiatives

While the need for rural electrification was recognised in 1950s, the first major initiative was the establishment of Rural Electric Corporation in 1969. Its main objective was to finance and promote rural electrification all over the country. Apart from providing loan assistance to SEBs/ state power utilities, equipment manufacturers and so on, it was also managing the rural electrification programmes of the Ministry of Power (MoP). Government has issued many policies/programs to improve the rural electrification status some of which are discussed below.

Amendments in National Tariff Policy

Recently, amendments were made in the National Tariff Policy 2006. The amendments have now specifically included mini-grids as an option to provide power supply to remote unconnected villages with provision for purchase of power into the grid as and when the grid reaches there.

Section 8 of the Amendment of the Tariff Policy states that- "…*Micro-grids supplying renewable energy are being set up in such areas where the grid has not reached or where adequate power is not available in the grid. Investment involved in setting up of such micro grids is substantial. One of the risks of investment is grid reaching the area before the completion of the project life and thereby making power from micro grids costly and unviable. In order to mitigate such risk and incentivize investment in micro grids, there is a need to put in place an appropriate regulatory framework to mandate compulsory purchase of power into the grid from such micro grids at a tariff to be determined under section 62 of the Act considering depreciated cost of investments and keeping in view industry benchmark and with a cap if necessary, as approved by the Appropriate Commission. The Appropriate Commission shall notify necessary regulations in this regard within six months.*"

The amendment also appears to have taken cognizance of concerns of private investors by mentioning about creating the necessary regulatory framework for the sector.

There appears to have been interests by some states in accelerating the process of deploying mini-grids/

micro-grid as an instrument to address the energy access problems. Uttar Pradesh has published its mini-grid policy in February and the Uttar Pradesh Electricity Regulatory Commission has issued Draft Mini-Grid Renewable Energy Generation and Supply Regulations, 2016 (MREG&S Regulations, 2016) on March 4, 2016. MNRE has also issued its Draft National Mini/Micro-grid Policy 2016.

Rural Electrification Policy, 2005

Initially, when announced in 2005, Rural Electrification Policy (REP) aimed at providing access to electricity to all households by year 2009, quality and reliable power supply at reasonable rates and minimum lifeline consumption of 1 unit per household per day as a merit good by year 2012.However, as can be seen from the data, these targets are yet to be achieved. Rural Electrification Policy also changed the definition of electrified villages. According to the REP, a village would be classified as electrified based on a Certificate issued by the Gram Panchayat, certifying that basic infrastructure such as distribution transformer and distribution lines are provided in the inhabited locality as well as a minimum of one Dalit Basti / hamlet where it exists; and electricity is provided to public places like schools, panchayat office, health centres, dispensaries, community centres etc., and the number of households electrified are at least 10 per cent of the total number of households in the village.

This definition when applied in 2005 suddenly increased the number of unelectrified villages.

Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY):

In line with the goal set in Electricity Act (EA) 2003 and Rural Electrification Policy of 2005 to provide connection to all households by 2009, the "Rajiv Gandhi Grameen Vidyutikaran Yojana" (RGGVY) was launched in April 2005 to electrify all un-electrified villages / habitations and to provide access to electricity to all rural households in un-electrified and electrified villages in the entire country. The scheme was implemented through the Rural Electrification Corporation (REC) which was the designated Nodal Agency of the Ministry of Power.

Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY):

The scope of RGGVY was further expanded and the new Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY)[5] was launched in December 2014. This programme is one of the flagship programmes of the Government of India and also aims to facilitate 24x7 supply of power to all. The scope of the programme includes the following:[6]

The UDAY is a path breaking reform and is aimed to restructure the way state-owned discoms operate, currently reeling under a mountain of debt and mounting operational losses every year. The bulk of the restructuring focus has been around the financial plan with the state governments to take over their DISCOM's debts in a pre-defined fashion

- Separation of agriculture and non-agriculture feeders facilitating judicious rostering of supply to agricultural and non- agricultural consumers in the rural areas;
- Strengthening and augmentation of sub-transmission & distribution (ST&D) infrastructure in rural areas, including metering at distribution transformers, feeders and consumers end;
- Rural electrification, as per CCEA approval dated 01.08.2013 for completion of the targets laid down under RGGVY for 12th and 13th Plans by subsuming RGGVY in DDUGJY and carrying forward the approved outlay for RGGVY to DDUGJY.

Specifically, the DDUGJY has two major components i.e. feeder separation and Power for All by 2019, that were not there in the RGGVY. The government is working towards providing power to the last mile standing in the country and has commenced taking various measures for the same. The target is to complete all village electrification by 2019. The DDUGJY scheme also aims to improve the power supply in rural households as well as reduction of the peak loads.

Ujwal DISCOM Assurance Yojna (UDAY):

To make the electricity distribution sector better equipped and efficient, the Government of India has initiated the Ujwal DISCOM Assurance Yojna (UDAY)[7]. The UDAY is a path breaking reform and is aimed to restructure the way state-owned discoms operate, currently reeling under a mountain of debt and mounting operational losses every year. The bulk of the restructuring focus has been around the financial plan with the state governments to take over their DISCOM's debts in a pre-defined fashion – 50 per cent of the debt outstanding as of September 2015 by the last quarter of the financial year 2015-16, and 25 per cent by June 2016. It thus, empowers the DISCOMs with the opportunity to break even in the next 2-3 years through four initiatives, namely.

- Improving operational efficiencies of DISCOMs;
- Reduction of cost of power;
- Reduction in interest cost of DISCOMs;
- Enforcing financial discipline on DISCOMs through alignment with State finances.

Ten states have signed agreements (Bihar, Chhattisgarh, Gujarat, Jammu & Kashmir, Jharkhand, Haryana, Punjab, Rajasthan, Uttar Pradesh, Uttrakhand) and 8 states and 1 union territory have agreed to join UDAY. In line with the financial restricting and taking over the accumulated debts by state governments, UDAY bonds worth one trillion were issued during 2015-16 by different states.

Unnat Jyoti by Affordable LEDs for All (UJALA):

The Government of India has also launched the National Programme for LED-based Home and Street Lighting for energy conservation by reducing energy consumption. Along with this programme, Energy Efficiency Services Ltd (EESL), a Government of India organisation, has launched the scheme for Light Emitting Diode (LED) bulb distribution under the Domestic Efficient Lighting Programme (DELP) in March 2015. On March 2016, National Led LED Bulbs Scheme got a New Face in 'UJALA' (UnnatJyoti by Affordable LEDs for All). The main objective is to promote efficient lighting, enhance awareness on using efficient equipment which reduces electricity bills and help preserve environment. Under this programme, LED bulbs are being distributed in a phased manner from March 2015 onwards. Currently, the DELP scheme is on-going in nine states—Himachal Pradesh, Uttarakhand, Delhi, Rajasthan, Uttar Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Jharkhand. As on June 28, 2016, a total of around 123 million LED bulbs had been distributed that is equivalent to saving of around 43 million kWh/day of energy and avoiding 3205 MW of peak demand.

Challenges and Way Forward:

There are some challenges faced in rural electrification. The grid extension based rural electrification promoted through DDUGJY and other programmes suffered major hurdles which include high cost of grid extension and low recovery due to highly subsidised tariff, low level of tariff collection resulting in negative return, supply rationing due to non-availability of power and high operation and maintenance costs. For rural electrification to be achieved in a sustainable way, we need a massive focus on creation of income generation activities to boost the rural economy. This will bring in affordability for rural masses who will be willing to pay for services which bring in wealth and sustainability. The National Solar Mission should also not lose its focus on rural electrification and integration of mini micro grids with conventional grid as envisaged.

Rural Electrification program needs to focus on sustainability and bringing in economic development of the rural communities. It, therefore, should get linked with other social programs and also part of overall rural development agenda.

1 As per Ministry of Power, Government of India, 2016
2 http://garv.gov.in/dashboard Accessed on July 4, 2016
3 Palit (2015)
4 http://www.ddugjy.gov.in/mis/portal/memo/DDUGJY-OM.pdf Accessed on July 4, 2016
5 http://www.ddugjy.gov.in/mis/portal/memo/DDUGJY_Guidelines.pdf
6 http://pib.nic.in/newsite/PrintRelease.aspx?relid=130261
7 http://www.ujala.gov.in/ Accessed on June 28, 2016 ❑

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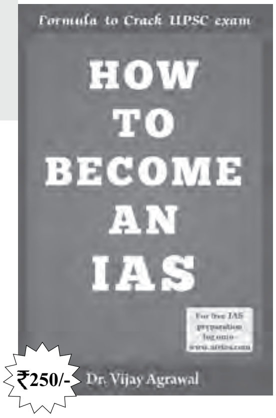

FISSION ENERGY

SPECIAL ARTICLE

Perception Management: A Big Challenge in the Growth of Nuclear Power

S Banerjee

...several enabling technologies have been developed for thorium utilization. Focused developments in solar and thorium energy can lead us to a stage when we do not have to look outwards for meeting our energy demands for several centuries, that too without straining the environment. Thus, a long term energy security and a clean environment for the country can be achieved

The subject of energy options is a hot discussion topic in many countries all over the world. On one side, the aspirations of the people of the developing world can be met only if their energy production is scaled up several times. The resulting strain on the environment on the other side may lead to an extensive and irreversible damage to the environment and climate of this planet. There is a general consensus today that the energy production by burning of fossil fuel and other carbonaceous matter (including biomass) must be minimized for mitigating the impact of generation of CO_2 and other green house gases to the global climate change.

Nuclear energy has given us a viable energy option due to the following:

a) It is a safe and reliable energy source which has a minimum carbon foot print and its steady and uninterrupted supply makes it ideally suitable for meeting base load requirements.

b) It is associated with a very high energy density and the compactness of its energy source translates into easy transportation of fuel and smooth operation of large size power plants capable of supplying uninterrupted electricity to large metropolis and high power consuming industries.

c) With a steady and significant rise of fossil fuel price, nuclear energy has become one of the most commercially attractive energy options.

d) Countries who had rapidly grown their nuclear power generating capacity in the second half of the last century have demonstrated a very impressive capacity factor and reliable and safe operation over a period of several decades.

e) The nuclear energy option, if exploited to its full potential can provide sustainable energy for the world for several centuries to come.

Many of the readers of this article will not further proceed thinking that this is an article based on biased arguments from a promoter of nuclear energy. Let me, therefore, bring out the major concerns which come up whenever we discuss the nuclear energy option. The frequently asked questions are:

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a) Isn't that the environment around a nuclear installation has a much higher radiation level which affects human health and results in an increase in cancer incidences and genetic disorders?

b) Isn't that the higher radiation level or a higher temperature in the surroundings responsible for adverse effect on agriculture on land and on fish catch in the water bodies?

c) Is it really necessary to have nuclear power? Can we not manage without it by having increased installation of renewable energy sources particularly solar and wind energy?

d) Is nuclear power really economic or is it through government subsidies that it is made to appear cost competitive?

e) A large nuclear reactor has an inventory of fissile material which can make hundreds of nuclear weapons. Is it really safe to draw energy, though in a regulated manner, from such a source of intense energy? What happens if their regulation mechanism fails?

f) Are nuclear reactors safe under intense natural catastrophes like flood, earthquake and tsunami?

g) What is the extent of damage if a severe accident happens?

h) How to deal with the long lived radioactive waste?

Answering all these questions in a comprehensive manner is beyond the scope of the present article. However, an attempt will be made to address these issues in simple words to have a first level response which can be backed up by some important references where more detailed answers are available.

The focus of this paper is to bring out how one can address these issues, each of which, being a highly involved technical topic, in a language which is precise and technically correct. One of the main problems is in the prevailing trust deficits between public and nuclear power authorities in various countries. Public trust is often an issue with regard to institutions and people rather than in technologies and science. Therefore, for generating that trust, it is necessary to have effective dialogues on the related science and technology at various levels, such as in print and electronic media, in academia, in industry and commerce circles, in local communities and in the policy making plane.

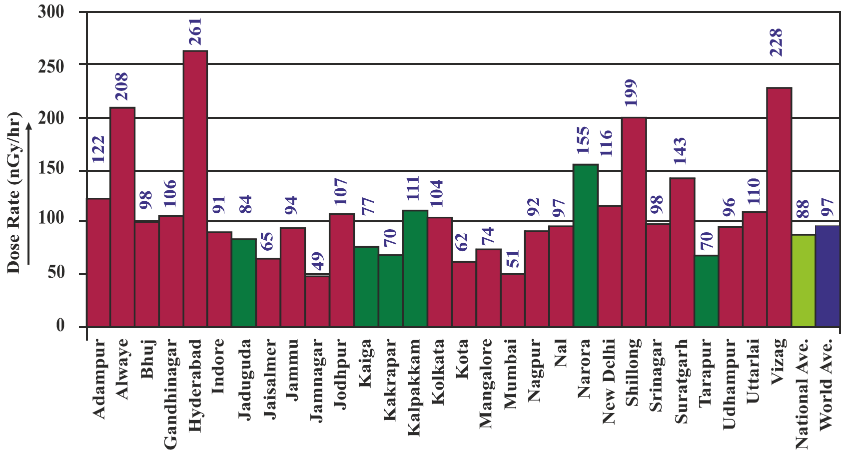

Fig. 1. Background radiation levels at different EIERMON stations. Radiations levels at sites with nuclear facilities and those without any nuclear activities are indicated by green and red bars respective

Fear of Radiation:

Ionizing radiation is present on this planet and all living beings including human population are constantly being exposed to the background ionizing radiation. Presence of radionuclides in the earth's crust and cosmic radiation from space contribute to the background radiation, which varies from place to place and depends on the food and water we consume and the air we breathe. The world wide average background radiation dose is 2400 mSv (mSv is a unit in SI system for average accumulated background radiation dose to any one person) per year. Some of the high background radiation areas in the world are Yaugziang in China (3500-5400 mSv/year, population 100,000), Gurapari in Brazil (3000-35000 mSv/year, population 70, 000), parts of Kolam district in Kerala (1000-45000 mSv/year, population 400,000) and Ramsar, Iran (10000-260,000 mSv/year, population 2000). In some places, excessive background radiation is due to radioactive radon-222 gas with half life of 3.8 days which

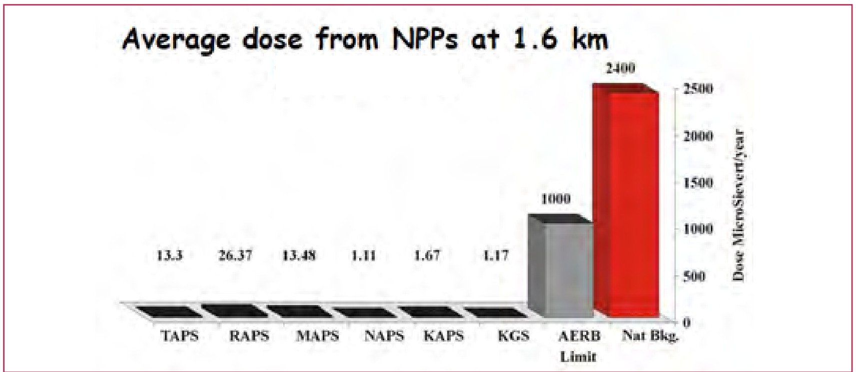

Fig. 2. Average radiation dose over and above the background at the periphery of the exclusion zones around nuclear power stations at Tarapur (TAPS), Kota, Rajastan (RAPS), Kalpakkam (MAPS), Narora (NAPS), Kakrapar (KAPS), Kaiga (KGS). AERB permissible limits and national background are also indicated

forms from the decay of radium-226. In poorly ventilated dwellings in Kerala, the background radiation can be as high as 50000 mSv per year. All these data indicate that human and other living beings can indeed withstand such high radiation dose. In order to make a scientific assessment of the influence of high background radiation on congenital malformations and chromosomal aberrations of newborns and cancer incidences in the population, compared to those in low background areas, long-term surveys have been conducted in the Kollam District of Kerala. Some of the important findings are summarized in Table 1 and 2, which clearly establish that there is no enhancement of the incidence of congenital malformation and chromosomal aberration in the high background areas in comparison with those in normal background areas (Jaikrishan etal, 1999, 2013, Apte, 2013). A similar study by Regional Cancer Centre, Kerala has shown that the incidence of cancer in high background areas are not in excess of that in normal background areas (Kesavan, 2013). The background radiation is monitored in over 500 locations in the country by the Indian Environmental Radiation Monitoring (IERMON) system. The large variation in the background radiation from place to place is illustrated in Fig. 1, which includes locations where there are industrial scale nuclear activities, such as uranium mining and nuclear power generation and those without any nuclear activity. It is clearly evident that background radiation levels near nuclear installations are well within the scatter band. This point can be presented in another way by showing how much additional radiation one receives at the periphery of the exclusion zone (1 Km to 1.6 Km) of nuclear power stations over and above the background level (Fig. 2) and what a small fraction of the permissible radiation doses are these values. Some common human activities such as air travel, medical diagnosis using x-ray or CAT-scan further add radiation exposure, which are much more than what one receives in a life-time at the periphery of a nuclear power station (Fig. 3). The doses received by people around a nuclear installation are constantly monitored by Environment Survey Laboratories which are totally independent of operators of nuclear plants. For estimation of the dose received, all possible sources including the air we breathe, the water and milk we drink, the food we eat are monitored and using the internationally accepted protocol, the dose estimation is done on a regular basis. All these data are compiled and presented to Atomic Energy Regulatory Board (AERB) in order to comply with the regulatory requirements. It is, therefore, quite clear that the dose one receives over and above the average background radiation dose due to one's proximity to a nuclear installation is indeed insignificant. For a more detailed discussion on the effect of radiation on health, one may refer to the book entitled 'Radiation and Reason: The impact of Science on a Culture of Fear' by Wade Alison (2009).

Screening of newborns for congenital malformations

144,504 newborns (143503 deliveries) screened during Aug 1995 – Dec 2011

Congenital malformations (birth defects)	Total (n=144504)	%	HLNRA (n=87847)	%	NLNRA (n = 56657)	%	RR (95% CI)	
Overall CA	3354	2.32	1919	2.18	1435	2.53	0.86*	0.81-0.92
Major CA	1394	0.96	856	0.97	538	0.95	1.03	0.92-1.14
Stillbirth	625	0.43	396	0.45	229	0.40	1.12	0.95-1.31
Down Syndrome	106	0.07	66	0.08	40	0.07	1.06	0.72-1.58

RR = Relative Risk: Risk in HLNRA relative to that in NLNRA.
* Statistically significant at 5% level.
High Level Natural Radiation Areas (> 1.5 mGy/y)
Normal Level Natural Radiation Areas (≤ 1.5 mGy/y)
CA: Congenital Malformations (birth defects)
Jaikrishan et al. Journal of Community Genetics, Vol.4. Pp 21-31, 2013

Table 1. Screening of newborns for congenital malformations in high level and normal level natural radiation areas in Kerala.

Constitutional chromosomal anomalies

	Total (n= 27,285)		HLNRA (n= 17,294; 63.4%)		NLNRA (n= 9,991, 36.6%)	
	No.	Freq /1000±SE	No.	Freq /1000±SE	No.	F /1000±SE
Numerical	81	(2.97±0.33)	50	(2.89 ±0.41)	31	(3.10 ±0.56)
Structural	66	(2.42 ± 0.30)	38	(2.20 ±0.36)	28	(2.80 ±0.53)
Total	147	(5.39 ±0.44)	88	(5.09 ±0.54)	59	(5.91 ±0.77)

The frequencies of numerical and structural anomalies are in agreement with UNSCEAR data.

International Journal of Radiation Biology 2013; 89(4): 259-267.

Table 2. Constitutional chromosomal anomalies in high level and normal level natural radiation areas in Kerala.

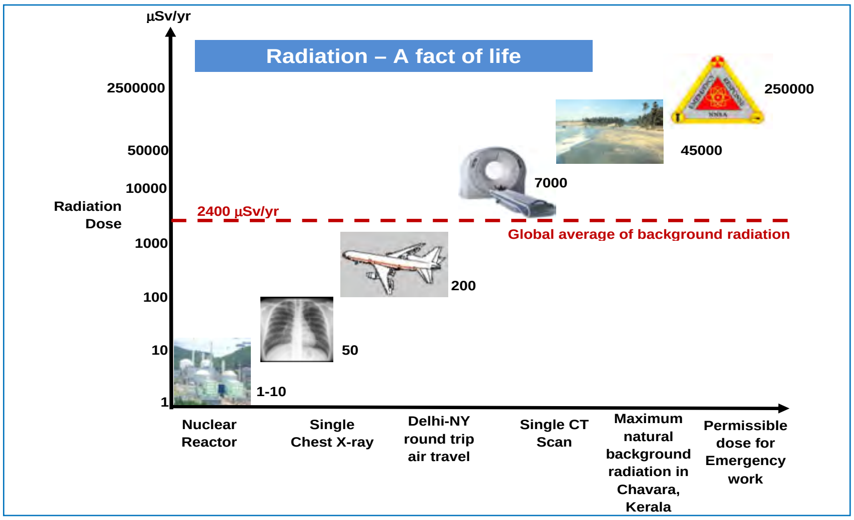

Fig. 3. Standard radiation dose around a nuclear power plant received in a year is compared with those received during several daily life activities.

Impact of Nuclear Power Plant Operation on Thermal Ecology, Biodiversity and Agriculture:

One cannot deny the fact that any power producing unit will be released some part of the heat into the environment as it is not possible to convert the entire heat generated into work (or electrical energy) in a power plant. The reject heat is deposited either in a nearby water body or in the atmosphere through a cooling tower. Very strict laws govern heat dissipation into water bodies. Alarmed by the large scale ocean warming experiences in 1998, regulation regarding thermal effluent discharges were revised and made more stringent all over the world.

Fig. 4. Nuclear Power plants at Kaiga in thick western ghat forest of Karnataka

Considering the importance of a quantitative assessment of the biological impact of thermal discharge in water bodies, a study was initiated in 2002, through a coordinated research undertaken by eight universities and research laboratories. Over a period of four years, they collected and analyzed data on thermal plume and its distribution in the vicinity of the discharge points in two operating nuclear reactor sites, Kalpakkam and Kaiga. While the former represents the plants which discharge the reject heat into the sea, the latter situated close to a fresh water reservoir of Kadra dam at Kaiga on the banks of the river Kali. Data were collected from carefully chosen GPS-fixed sampling sites through regular monthly cruises over a period of three years to cover possible seasonal and spatial variations. These studies provided valuable data on the temperature distribution of the thermal plume, physico-chemical properties of water at specific sampling sites and the abundance and distribution of biological forms at these sites. The observed in- site biological effects of the thermal discharge were further ascertained and validated by additional studies on selected, representative, dominant species in laboratories in the fourth year. Details of these studies are available in individual reports summarised by Apte (2013).

It has been clearly established that the thermal discharge from power plants, while merging with the receiving water body, creates a 'mixing zone', the position and size of which and temperature rise (ΔT) are such that the ecological impact on the water body is restricted to a very small zone. The dimension and the position of mixing zone are very different in summer and winter and the large seasonal variation of ambient temperature allows restoration of parameters to more conducive levels for re-colonization of various species. Typical size of the mixing zone where the maximum ΔT can reach 5^0C is confined within an area of 500m x 200m and a depth of about 3m. Ministry of Environment and Forest has stipulated that the ΔT in the mixing zone cannot exceed 7^0C and the size of the zone should be within 500m diameter. Nuclear Power Plants comply with this regulatory stipulation by suitably designing spargers for effective mixing.

Since fishes are sensitive to thermal fluctuation, it is ensured that the temperature in the outfall regions does not exceed their tolerance limit. In fact, the small temperature upshift has been found to enhance fish hatching. A fish hatchery, established in Kaiga makes use of warm water from the discharge canal to enhance fish aquaculture.

Fig. 5. Agriculture around Nuclear Power Plants

A misinformation has been spread that the operation of nuclear power stations destroys biodiversity in their vicinity. This is totally false as is evident from the observations made in many nuclear power plant sites all over the world. In India, the best example is that of the Kaiga power station, located in the thick forest of the Western Ghats, which is in perfect harmony with its surroundings (Fig. 4). In fact, the exclusion zones around the nuclear power stations are extensively used for agriculture to produce improved crop varieties of groundnut, guava, sapota, mango (Alphonso, Langda and Dasseri varieties) and coconut (Fig.5).

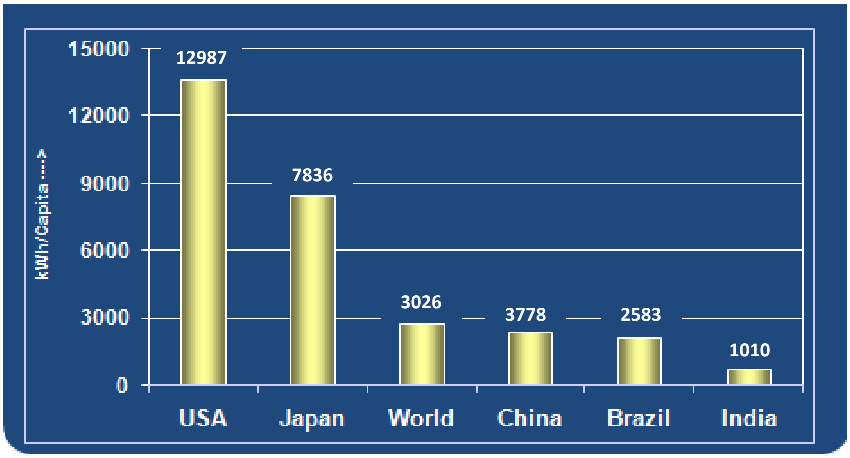

Fig. 6. Comparison of Per capita electricity consumption in some countries and the world average.

Role of Nuclear Power in the Energy Mix :

The installed capacity of electric power generation in the country today is about 275 GW and out of that, the nuclear component is 5.5 GW (2 per cent). In terms of the total electrical energy produced in the year 2014-15, nuclear contribution (37000 million units) is about 3.25 per cent of the total, thanks to a much higher capacity utilization in the nuclear power generation compared to all other electricity generation systems put together. Per capita electricity consumption in India is about 1000 kWh, nearly one-third of the world average of 3000 kWh and less than one tenth of the per capita consumption in USA (Fig.6). Since human development index (HDI) has a close linkage with per capita electricity consumption, (Chidambaram 2013) there is no doubt that for an improvement of HDI from the current value of 0.65 to about 0.8 will require at least 4 times increase in our electricity production. Even today, nearly 25 per cent of population does not have access to electricity and in a major part of rural, semi-urban and even urban areas power cuts are for several hours a day.

There are no two opinions on the need for capacity enhancement for electricity production utilizing all forms of energy generation technologies, maintaining a steady pressure on reduction in the relative contribution of CO_2 generating plants. The enhancement of generating capacity from the present level of 275 GW to about 700-800 GW in the next 20 years is an essential prerequisite for an economic growth in the range to 8-9 per cent in this period. This point must be borne in mind when we compare our situation with some developed countries in the west where the electricity demand is saturating (or sometimes falling down) because of decline in population and improvement in energy efficient machines and housing. The projected electricity generation scenario in the country after two decades can also be drawn in a rather simplified manner using a back of the envelope calculation. To provide per capita electricity of, say, 3000 kWh (world average of 2014-15) for a population of 1.4 billion people in 2035, one needs to supply yearly about 4200 TWh (compared to the present electrical energy production of 1200 TWh in 2014-15). For reaching this target within the next two decades, the major share of the additional capacity has to come from the thermal power sector despite an ambitious plan of installing nuclear capacity beyond 60 GW and solar and wind beyond 200 and 100 GW each. The intermittency of the solar and wind power does not allow their capacity factor to be raised above 20-25 per cent and this necessitates installation of about 5 times capacity to obtain the same desired energy output. This point is brought out in Fig. 7 which shows the impressive growth in the installed capacity of renewable energy,

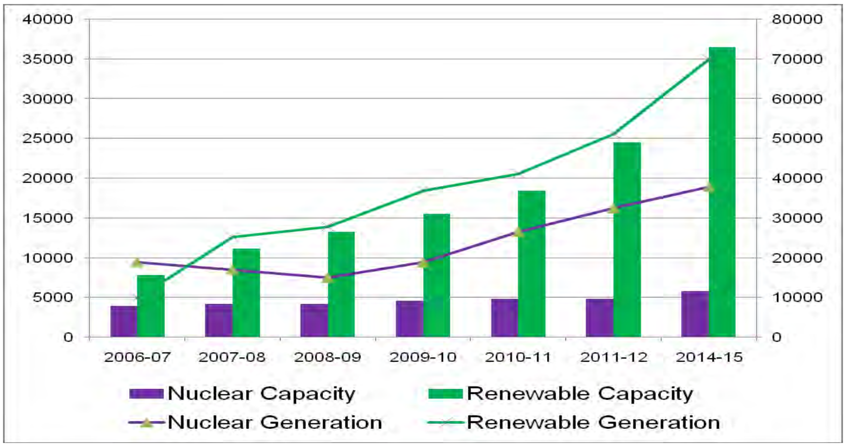

Fig. 7. Comparison of installed capacity in MWe and electricity produced in KWh for renewable and nuclear power

Nuclear Power Tariff Vs Thermal Power Tariff (around same location)

Location	Name of power plant	Tariff (Paise/KWh) (As on Mar-2015)
UP	Nuclear : NAPS at Narora	249
	Coal Thermal at Dadri Stage-I: Stage-2:	478 546
	CCGT (Nat.Gas) at Dadri	502
	CCGT (LNG) at Dadri	1230
Rajasthan	Nuclear-RAPS Units 2 to 4: Units 5 & 6:	278 344
	CCGT (Nat.Gas)-Anta	430
	CCGT (LNG) - Anta	1040
	Kota Thermal Power Station	381 (for 2014 – 15)
Gujarat	Nuclear - KAPS	237
	Coal Thermal Ukai Units 1 to 5 Unit 6	238 324

Sources :CERC, RERC, GERC & NPCIL

Table 3. Comparison of nuclear power tariff versus thermal power tarifs for plants located in the nearby areas

primarily wind and solar and a rather limited growth of nuclear capacity in the recent time in our country and their relative contributions in generation of electrical energy. In-spite of nearly seven times installed capacity of renewables compared to nuclear, the energy production by the former is less than double of the latter. While solar and wind are, by nature, distributed and intermittent energy sources, nuclear is concentrated and continuous. For capturing sufficient energy for a 10 GWe installation, a solar and wind farm will need a foot-print of 400 and 5000 square Km respectively, while the same capacity can be installed by a group of nuclear reactors within a plant area of a couple of square Km (not counting the exclusion zone).

With the capacity factors attainable in solar and wind generating modes of 20 per cent and 25 per cent respectively, these together can provide about 570 TWh while nuclear power generation (with consistent over 80 per cent capacity factor) can exceed 420 TWh. Adding the projected growth of hydroelectric power, non-carbon electricity generation in the country can reach a level of about 35 per cent.

What is being overlooked in the media is that India is gradually becoming a major coal importing country. Fig.8 shows how we will become more and more dependent on import of coal for fuelling the thermal power stations. The main reasons for this increased dependence on imported coal are the poor quality of Indian coal, the uncertainty in their supply and the bottlenecks in the large- scale mining and transportation. The requirement of extensive transportation will be a serious obstacle for distribution of indigenous as well as imported coal from mines and sea ports to power stations. The cost of fuel contributes a major part of the tariff of thermal power. With increasing dependence on imported coal, the tariff of electricity in the country will rise at an unprecedented rate. Nuclear power in which fuel cost is less than 15 per cent will indeed have a stabilizing influence on the power tariff in the future.

For making a comparison of cost of electricity produced by different sources, it is necessary to compare the electricity tariffs of plants set-up more or less in the same zone of the country and at same time. Table 3 which makes such a comparison between thermal and nuclear power clearly shows the cost competitiveness of the latter which does not enjoy any direct or indirect government subsidy. Though the capital cost per MW of solar or wind energy is much lower than that of nuclear, this advantage is offset by their low capacity factors as illustrated in Table 4.

Safety of Nuclear Power:

Nuclear era began on December 2, 1942 within the squash court at the University of Chicago. Chicago Pile 1 went critical demonstrating that the chain reaction of nuclear fission can be made self-sustaining and the energy from such a process can be tapped in a controlled manner. The decades 1960's to 80's witnessed a rapid rise in nuclear power stations, France implementing a rapid growth reaching over 80 per cent share of nuclear power in their overall electricity generation and USA installing about 100 GWe nuclear capacity. The installed nuclear

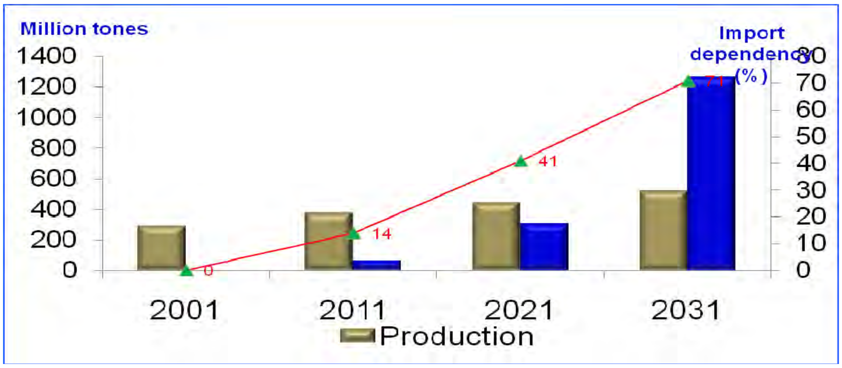

Fig. 8. Projected production and Import of non-coaking coal in India.

Investment required to generate 1 MWh (1000 KWh) Nuclear Vis-a- Vis Wind & Solar

Parameter	Nuclear PHWR	Nuclear LWR	Wind	Solar PV
Capacity Factor	80%	85%	20% -25 %	19%
Capacity to be Installed to generate hourly 1 MWh (MW)	1.25	1.1 - 1.25	4 - 5	5.26
Completion Cost per MW (Rs. Crore)	14.71	20	5.75	5
Investment Required (Rs. Crore)	18.75	20 - 25	23 - 29	26
Additional Investment required to generate power when source not available (*diesel @ Rs. 4 crore /MW*)	0	0	4	4
Total Investment Required (Rs. Crore)	18.75	20 - 25	27 - 33	30

- *PHWRs capital cost based on Haryana 1&2 (under approval) estimated completion cost & LWR based on KK 3&4 sanctioned completion cost*
- *Capacity Factor & Capital costs of Wind & Solar PV based on CERC Order dated 27.03.2012 on Terms and Conditions for Tariff determination from Renewable Energy Sources*

Table 4. Investment required to generate 1 MWh (1000 KWh) electricity from nuclear vis-à-vis wind and solar power

power capacity in the world exceeded 200 GWe by 1984. After the accident at Three Mile Island in 1979 and Chernobyl in 1986, serious questions were raised in the public mind over the nuclear safety and the public confidence in nuclear energy declined. The overall effect was a significant slowing down of nuclear energy's growth and further capacity addition was essentially restricted only in countries with high demand of energy.

During the 1990s and the first decade of the 21st century, the impressive performance of nuclear power stations (over 80 per cent capacity factor and safe operation of about 350 nuclear power plants) all over the world, the increasing concern over CO_2 generation from thermal power plants and their adverse effect on global climate change generated a renewed interest in nuclear power. When a nuclear renaissance was imminent, a major earthquake and ensuing tsunami hit the east coast of Japan on 11 March 2011. Eleven nuclear reactors in the region were affected and shut down automatically, as designed. A tsunami as high as 14m, overran the plant's flood protection dikes and flooded all emergency power supply units at the Fukushima Daichi Nuclear Power Plant, thus preventing the reactor's decay heat removal systems from operating. This led to extensive core damage in three reactors which resulted in the release of radioactive contaminants in the environment. Though no fatality due to this accident has been reported, tens of thousands of citizens had to be evacuated causing unprecedented misery and a large area around the site was contaminated.

The shock of the Fukushima accident has temporarily halted the growth of nuclear power in many countries. A few countries such as Germany, Switzerland and Italy have announced that they will gradually reduce the nuclear contribution in their electricity generation capacity and will abandon nuclear energy in a time bound fashion. The sharp negative reaction has remained only for a short period. The countries which planned to abandon nuclear energy do not require any additional power in the near future and/or have the access to importing electricity from neighboring countries who have excess capacity primarily because of their nuclear power availability. For countries in which the economy is growing, specially China and India, there is an urgent necessity to rely more and more on primary energy sources with negligible carbon foot print. China has taken the right step in this direction by rapidly enhancing their capacity for solar, wind and nuclear energy. By 2020, China will have a capacity of 58 MWe of operating nuclear reactors and additional 38 MWe capacity of reactors under construction.

Today 442 nuclear reactors in the world are contributing 11 per cent of total electricity generation. A total of 16500 reactor-year experience has

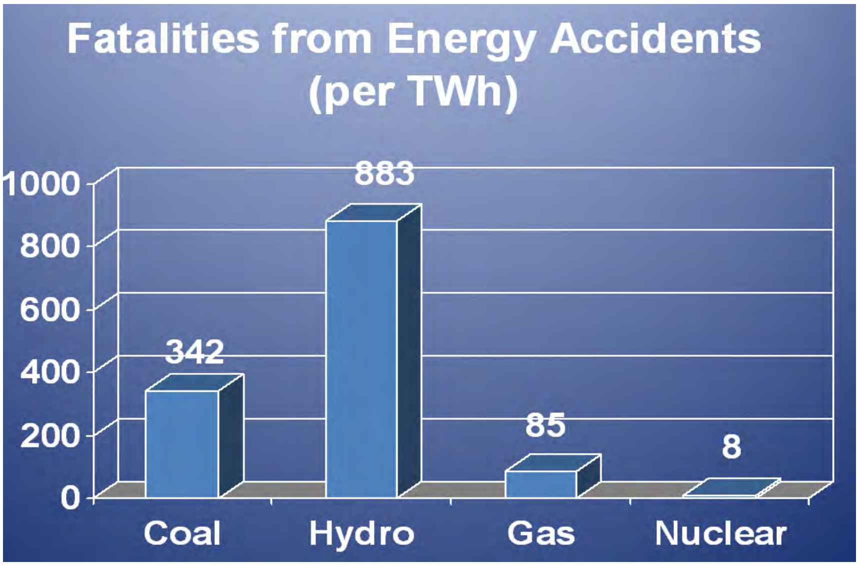

Fig. 9. Fatalities from accidents from electricity generating units-normalized perTWh of electricity

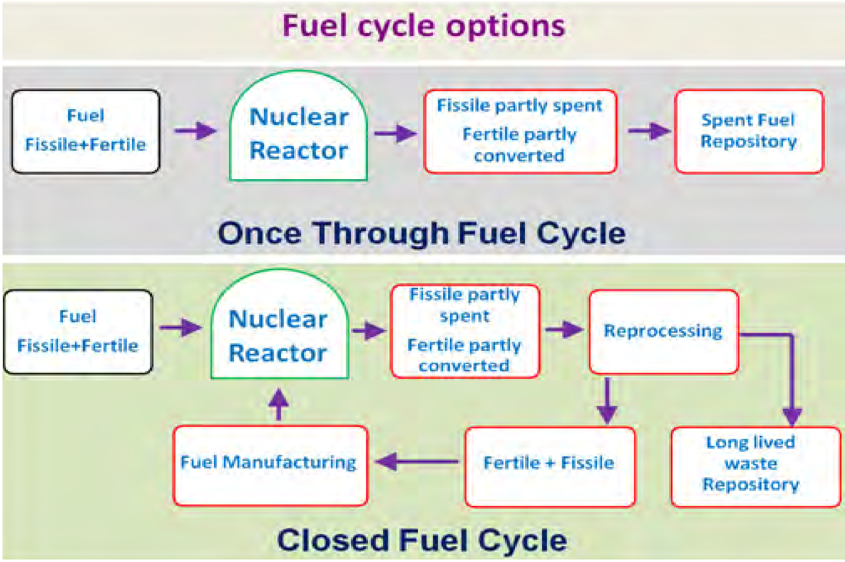

Fig. 10 . Once through and closed nuclear fuel cycle

been accumulated in the world and the corresponding number in India is 432 reactor-year. This record of safe operation with a high capacity factor is the best testimony of the robustness of the technology of controlled energy release from nuclear fission. The three major accidents which took place were all avoidable and the present regulatory mechanisms have been tightened further to avoid recurrence of any such events. The impact of the three nuclear accidents has sometimes been exaggerated. In order to keep the record straight, Fig. 9 is presented which compares the global statistics of fatalities encountered in different accidents in energy production activities (NEA-Report, 2010).

Safety in nuclear technology is given overriding priority encompassing all aspects- siting, construction, operation and decommissioning. The defence in depth approach is taken and several layers of redundancy are introduced for making the design fail-safe and robust (Bhardwaj, 2013). Right from the site selection and design stages, due considerations are given for the occurrence of natural calamities such as earthquake, flood and tsunami. Plants are made robust to withstand such natural events. This may be vindicated by our own experience from Kalpakkam where reactors were safely shutdown during tsunami and from Kakrapar where reactors withstood the severe earthquake at Bhuj. Highest quality and safety standards are adopted in the construction and the operation phase. Periodic inspection and health-check of operating plants are enforced by the safety authorities and they are refurbished and retrofitted as per the evolving safety standards. A very strict regulatory control is maintained all throughout the operating life and safe decommissioning of nuclear plants.

Management of Long-lived Radioactive Waste

One of the major technological challenges in nuclear industry is the safe disposal of long lived radioactive waste. Some transmuted radioisotopes (mainly trans-uranic) in the spent nuclear fuel have very long radioactive lives extending to 100,000 years or more. To ensure safe storage of such materials for a geological time-scale in a manner that they remain totally isolated from the environment is indeed a big challenge. The alternative approach is to separate these long-lived isotopes from the spent fuel and incinerate them in fast reactors or by irradiating them with high energy charged particles in accelerator driven systems. The adoption of closed nuclear fuel cycle (Balu etal, 1998)which involves reprocessing of the spent fuel to separate useful fissionable materials and long lived minor actinides is necessary. As India has adopted the closed fuel cycle (Fig. 10) and has indigenously developed the complete technology including that of the separation of minor actinides, the management of nuclear waste will involve safe storage of a very small fraction of the spent fuel for a period of a few hundred years as shown in Fig. 11. The waste management plants in India convert high active waste into a glassy form which is stored in multi-barrier interim engineered storage facilities.

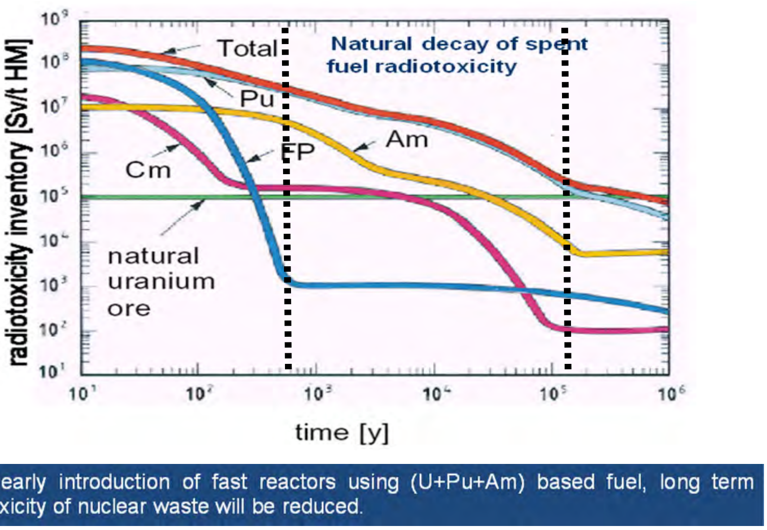

Fig. 11. Decay of Radiotoxicity inventory of nuclear waste with time. Total spent fuel wil take 100000 years to decay to the level of natural uranium ore, waste (after removing actinides) will take about 300 years to come to the same level.

Long-term Energy Security

The energy policy of a country is dictated by the resources available or accessible which ensure long-term energy security. India is blessed with plenty of sunshine and a nearly inexhaustible resource of Thorium. Our future depends on how efficiently we exploit these two gifts nature has given us. It is often asked why energy from Thorium is not being tapped so far anywhere in the world. The answer to this question is that thorium does not have any fissionable isotope in it. Thorium being a fertile material needs to be converted into a fissile material, Uranium-233. The well-known three stage nuclear programme (Kakodkar,etal, 1998) was formulated way back in 1950's to expand the programme in such a way that along with the growth of the electricity generation capacity, there is a growth in the inventory of fissile material in the first and second stages of the programme. This is essential for our entering the third stage where a large-scale power production from Thorium will be possible. With India's recent entry into international nuclear co-operation, the opportunity for a rapid growth in the installed capacity has opened up and this will certainly help in accumulating fissile inventory at a faster pace. In the mean time, several enabling technologies have been developed for thorium utilization. Focused developments in solar and Thorium energy can lead us to a stage when we do not have to look outwards for meeting our energy demands for several centuries, that too without straining the environment. Thus, a long term energy security and a clean environment for the country can be achieved.

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DO YOU KNOW?

Mobile Apps for Energy Efficiency

"Vidyut PRAVAH" Mobile App

This mobile application provides highlights of the power availability in the country on real time basis. The Vidyut PRAVAH mobile application provides date pertaining to market price of power from power exchange, value of current all India demand in GW and all India and State shortage including peak hour and total energy shortage. The main features include dashboard for All India summary, link for each states from All India Map and state specific pages on single click.

The real time data and comparison with previous day/year data is also available. Data from multiple sources, including the States and Power Exchanges, has been made available through a single portal for convenience of all. This app has a user friendly interface, which is based on the Geographical map of India, and facilitates all the consumers /stakeholders in visualization of the power availability and prices at the overall country level and at States/UTs level.

The app will empower common people to demand 24X7 power from the states. It will take transparency to the next level and make state governments more accountable. This app will work as manifestation of Prime Minister's vision of good governance via inculcating transparency in the system and will put pressure on power producers across the country. The Web application can be accessed through vidyutpravah.in. The mobile version will be freely available for download from the Playstore for both Android and iPhones.

"Suryamitra" Mobile App

This GPS based mobile app is developed by National Institute of Solar Energy (NISE) which is an, institution of Ministry of New & Renewable Energy (MNRE) and is involved in demonstration, standardization, interactive research, training and testing of solar energy technologies and systems.This App is a high end technology platform which can handle thousands of calls simultaneously and can efficiently monitor all visits of Suryamitra's. (Suryamitras are the trained youth and professionals who have opted for entrepreneurship and joined the Mobile App in several states. These Suryamitras were sensitized by NISE on soft skills Customer Relations Management, Punctuality and are now ready to deliver the services. As on date more than 3,200 Suryamitra are trained under the program. The target for FY 2016-17 is to train 7,000 Suryamitra's)

This innovative mobile approach will enhance the employment of these trained youth in solar PV technology and also improve the businesses of solar entrepreneurs because of quality servicing, maintenance and repairing professionals are now available to customers at the click of a button on their mobiles. The Surya Mitra Mobile App is currently available in Google play store, which can be downloaded and used across India.

Suryamitra Mobile App can also be utilized for providing a technical platform for of Off grid Solar PV system under NABARD scheme, where few lakhs of off-grid systems have been installed and systems require regular maintenance. Also,this app would be a handy tool with respect to O & M, Repair and maintenance of solar pumps, as MNRE has an ambitious target of installing 100,000 solar PV pumps in several states.Likewise , Suryamitra App would be very useful to maintain the existing system and to install new systems properly as millions of Square meter of solar water heater systems are already installed in various states. NISE has checks and controls in place to ensure that all Suryamitras offer quality service at reasonable price to their customers. NISE has fixed a price Rs 150/- per visit as visiting charges for Suryamitra Services and for installation and O&M Charges Suryamitra's would charge standard charges as per MNRE advised rates.

Urja Mobile App

'URJA'- Urban Jyoti Abhiyaan Mobile app is developed by Power Finance Corporation on behalf of Ministry of Power for Urban Power Distribution Sector to enhance consumer connect with the Urban Power Distribution sector by providing information of IT enabled towns on important parameters which concern the consumers like outage information, timely release of connections, addressing complaints, power reliability etc. The app will work as manifestation of Prime Minister's principle of good governance i.e. People focus, co-operative federalism.

Grameen Vidyutikaran Mobile App

'Grameen Vidyutikaran' Mobile App will ensure real time updation of progress of electrification process through web portal/ Mobile App. The 'Grameen Vidyutikaran' Mobile App can be downloaded from the 'Google Play Store'.

"Star Rating" App

Star Rating' mobile app provides the user a platform to compare personalized energy saving devices across the same class and get a real-time feedback from consumers and other stakeholders so they can make an informed purchase decision. Apart from being a one-stop solution for customers, it's also a valuable tool for policymakers to access the accumulated data and analyse the feedback of the market at any given point in time. The app can be downloaded from the play store of any android and iOS operated smart phones. ❑

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Forthcoming Issue

September
WOMEN EMPOWERMENT

The National Solar Mission: Marching Ahead in Solar Energy

Arun Kumar Tripathi

Power generation through solar will offset conventional power generation, reducing the need to import coal and gas and lead to foreign reserve savings. Revenue to the Government through taxes and duty, etc., from plants in power generation and manufacturing will also increase and solar projects will provide a productive use of abundant wastelands

The National Solar Mission (NSM) launched in January 2010, is a major initiative of the Government of India involving States, R&D institutions, and industries to promote solar energy while addressing energy security and climate change challenges of the country. Thus, it will constitute a major contribution by India to the global effort to meet the challenges of climate change. The Mission is one of the several initiatives that are a part of National Action Plan on Climate Change (NAPCC).

India, with its large population and rapidly growing economy, needs access to clean, affordable, and reliable sources of energy. India lies in the high solar insolation region, endowed with huge solar energy potential with most of the country having about 300 days of sunshine per year with the daily solar radiation incident varying from 4–6 kWh per square metre of surface area depending upon the location and time of the year. The total solar power potential in the country is estimated as approximately 748.98 GW.

Objective of the Mission:

The objective of the Mission is to establish India as a global leader in solar energy, by creating the policy conditions for its large scale diffusion across the country as quickly as possible, abatement of carbon emissions, and creation of direct and indirect employment opportunities for both skilled and unskilled persons.

Goals and Targets

The Mission had set a target, amongst others, for deployment of grid connected solar capacity of 20,000 MW by 2022 to be achieved in three phases (first phase up to 2012–13, second phase from 2013 to 2017 and the third phase from 2017 to 2022).

The first phase (up to 2013) focussed on promoting scale-up in grid-connected solar power capacity addition of 1,000 MW through the scheme of bundling with thermal power operated through NTPC's Vidyut Vyapar Nigam Ltd (NVVN) for minimizing the financial burden on the Government, and a small component of 100MW with GBI support through the *Indian Renewable Energy Development Agency* Limited (*IREDA*).

Recognizing the potential of solar energy to contribute to energy security of the country, and encouraged by the

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falling PV prices and the likelihood of reaching grid parity sooner and rapid increase in solar installation in the country, the Government in July 2015 had enhanced the target to 100 GW solar capacity to be set up by 2021–22. Out of this, 60 GW will come through large scale solar power and 40 GW through Grid Connected Solar Rooftops.

Implementation Strategy

The Ministry of New and Renewable Energy (MNRE) has formulated several schemes for achieving 100 GW by 2022. Few possible options, such as bundling, Generation-Based Incentive (GBI), and Viability Gap Funding (VGF) are being tried. The scheme-wise strategy and achievements are presented below:

Phase-I of the NSM

1,000 MW capacity grid solar projects under Phase-I through NVVN

In the Phase 1 of the Mission, 950 MW solar power projects (excluding 84 MW selected under migration scheme) were selected in two batches (Batch-I during 2010–11 and Batch-II during 2011–12) through a process of reverse bidding. The resulting tariffs in Batch-I for SPV projects ranged between ₹10.95 and ₹12.76 per unit, with average of ₹12.12 per unit and for solar thermal projects the tariff ranged between ₹10.49 and ₹12.24 per unit, with average tariff being ₹11.48 per unit. In Batch-II, for solar PV projects, the tariff ranged between ₹7.49 and ₹9.44 per unit, with average tariff being ₹ 8.77 per unit.

The power from the plants is being purchased by the NVVN and being sold to distribution utilities/ Discoms after bundling with power from the unallocated quota of power from coal-based stations of NTPC on equal capacity basis, thus effectively reducing the average per unit cost of solar power. A total capacity of 420 MW has been commissioned under these batches by the end of Phase-1 (31.3.2013). In addition, a capacity of 50.5MW under migration scheme, 88.8 MW under IREDA-GBI scheme, and 21.5 MW under old Demonstration scheme has been commissioned, taking the total capacity commissioned during Phase-I to 580.8 MW.

Solar Water Heater Installations:

Over 8 million sq. m solar water heaters have been installed in the country.

Installations of Solar Off-Grid Systems:

Around 320 MW capacity solar off-grid systems have been installed in the country.

Phase-II of the NSM

Solar Parks and Ultra Mega Power Projects:

- The Ministry has rolled out a Scheme to set up at least 25 Solar Parks, each with a capacity of 500 MW and above, thereby targeting around 20,000 MW of solar power installed capacity. These solar parks will be put in place within a span of five years starting from 2014–15. However, smaller parks may be considered in Himalayan regions and other hilly States where contiguous land may be difficult to acquire in view of difficult terrain and in States where there is acute shortage of non-agricultural land.
- The solar parks will be developed in collaboration with the State Governments and their agencies. The choice of implementing agency for developing and maintaining the park is left to the State Government.
- The total budget support required for the Solar Park Scheme is ₹4,050 crore.
- Under the scheme, the Ministry provides Central Financial Assistance (CFA) of ₹25 lakh per solar park for preparation of Detailed Project Report (DPR), conducting surveys, etc. Besides this, CFA of up to ₹20.00 lakh per MW or 30 per cent of the project cost, including grid-connectivity cost, whichever is lower, is also provided on achieving the prescribed milestones in the scheme.The approved grant is released by SECI as per milestones prescribed in the scheme.
- Till date, 34 Solar Parks in 21 States with aggregate capacity of 20,000 MW have been approved.

Solar PV Power Plants on Canal Banks and Canal Tops

- This Scheme is formulated so as to encourage the State Power Generation Companies/ State Government Utilities/ any other State Government Organizations/ PSUs to set up grid-connected solar PV power plants of 1 to 10 MW capacity with an aggregate capacity of 100 MW; 50 MW on canal tops and 50 MW on canal banks by providing capital subsidy (upto ₹3 crore per MW or 30 per cent of the project cost, whichever is lower, for canal-top solar PV projects and up to ₹1.50 crore per MW or 30 per cent of the project cost, whichever is lower, for canal-bank solar PV power projects). Besides gainful utilization of the unutilized space over canal tops/unutilized land on canal banks for power generation, the plants will also enable the participating States to meet their Renewable Purchase Obligation (RPO) mandates and also provide opportunities to local population.
- Approvals have been given for 50 MW canal-top and 50 MW canal-bank solar PV power projects. Andhra Pradesh, Gujarat, Karnataka, Kerala, Punjab, Uttarakhand, Uttar Pradesh, and West Bengal are implementing this Scheme.

Solar PV Power by Defence Establishments

The Scheme envisages setting up 300 MW of grid-connected solar PV power projects by Defence Establishments under the Ministry of

Defence and Para Military Forces with Viability Gap Funding. The Schemes aim at utilizing land/rooftop available with the defence establishments and also boost domestic manufacturing in the country. The projects would be set up under developer and EPC mode selected through competitive bidding, during the period 2014–19. Out of the above, 150 MW has been allocated to Ordnance Factory Board under the Ministry of Defence.

1,000 MW of Solar PV Power by CPSUs

The above Scheme aims to motivate CPSUs to procure equipment from domestic manufacturers and participate in various Central/State Government Schemes, from time to time, during the period from 2014–15 to 2016–17, for sale of solar power to the State Utilities/ Discoms at competitive tariffs. The MNRE has already allocated 924.50 MW capacity to various CPSUs and Central Government Organizations. Balance capacities are being allocated by the Ministry based on the requests received.

3,000 MW solar PV Power : With Unallocated Conventional Power

NTPC is implementing the Scheme and will purchase the solar power from the selected solar PV plants at a quoted tariff determined through bidding and Thermal Power at tariff as determined by the *Central Electricity Regulatory Commission* (*CERC*) from time to time from the respective thermal power plant from which power was allocated. The bundling of the power would be on 2:1 basis (2 MW of solar power with 1 MW of thermal power), and selling of the bundled power to willing State Utilities under 25 years Power Purchase Agreements at a weighted average tariff. These projects are at various stages of tendering.

2,000 MW Solar PV Power Projects with VGF

The Scheme envisages setting up 2,000 MW of solar PV projects by Solar Power Developers (SPDs) on 'Build, Own, Operate' basis. A VGF shall be given to the selected SPDs based on his bid, with upper limit of ₹1 crore/MW for projects under open category and ₹1.31 crore/MW for projects under DCR category. The levelized tariff for the term of the PPA will be ₹5.79 per kWh, with first year tariff as ₹5.43 per kWh escalated annually @ ₹ 0.05 per kWh for next 20 years and thereafter at a tariff of ₹6.43 per kWh up to end of the term. The projects are under tendering process.

5,000 MW solar PV Power Projects through VGF

The Scheme is same as the earlier one with capacity enhanced to 5,000 MW. The entire capacity shall be implemented in four tranches of 1,250 MW each. The tariff for the first tranche shall be the same as the earlier Scheme. For the balance capacity, the tariff shall be reduced @ ₹ 0.10 per kWh in each subsequent tranches. The projects are under tendering process.

Grid connected Solar Rooftops

The scheme has targeted 4,200 MW solar rooftops through 30 per cent financial incentives for selected categories and some achievements based incentives for government buildings including PSUs and other government organizations. ₹ 5,000 crore have been allocated by the Government. So far, 27 States have notified regulations for the net-metering and connectivity. About 300 MW rooftop capacity have been installed so far.

New Initiatives:
5,000 MW Solar PV power by CPSUs

The Scheme is envisaged to be implemented as Phase-2 of the earlier Scheme with enhanced solar capacity of 5,000 MW with VGF. The tariff payable to the Project Developers would be fixed at ₹4.50 per kWh or as may be specified by the MNRE based on market conditions, for the entire PPA period of 25 years. The projects would be selected through bidding process. The project would be developed by either developer mode or EPC mode or both, as decided by the MNRE. The Scheme is under approval stage.

Solar Parks and Ultra Mega Power Projects

Keeping in view the success of the solar power park, another 20,000 MW solar parks are being considered for approval. This will make a total 40,000 MW solar parks in the country and probably the largest solar power in the world.The Scheme is envisaged to be implemented as Phase-2 of the earlier Scheme keeping the solar capacity of 20,000 MW.

Solar Power Projects by Defence Establishments

Another 500 MW scheme is under approval.

Support to Existing Manufacturers of Solar Cells and Modules

The Scheme envisages providing Production Subsidy to the existing solar manufacturers for manufacturing of 6,375 MW of solar cells and 15,775 MW of solar modules in the country for supply to project developers for setting up the solar power projects under any Scheme.The Scheme is under approval.

Small Grid-Connected Solar PV Power Projects (1 to 5 MW)

The Scheme envisages setting up 10,000 MW of solar capacity in the country. The Scheme is under approval.

The Way Forward

The solar capacity has grown with a CAGR of 46 per cent since the last five years, taking solar capacity from 1,023 MW in 2011–12 MW to 6,763 MW in 2015–16. India stands among the top six countries in terms of solar capacity, and with the present trend, India may move up in global solar capacity position.

India, with its vast solar-power potential, would be a leading source of electricity ahead of fossil based

Physical Progress (Achievements) As on 31.05.2016

Ministry of New & Renewable Energy			
Programme/ Scheme wise Physical Progress in 2016-17 (& during the month of May, 2016)			
Sector	FY- 2016-17		Cumulative Achievements
	Target	Achievement	(as on 31.05.2016)
I. GRID-INTERACTIVE POWER (CAPACITIES IN MW)			
Wind Power	4000.00	106.40	26932.30
Solar Power	12000.00	559.78	7568.64
Small Hydro Power	250.00	1.80	4280.25
BioPower (Biomass & Gasification and Bagasse Cogeneration)	400.00	0.00	4831.33
Waste to Power	10.00	0.00	115.08
Total	**16660.00**	**670.98**	**43727.60**
II. OFF-GRID/ CAPTIVE POWER (CAPACITIES IN $MW_{EQ)}$			
Waste to Energy	15.00	0.00	160.16
Biomass(non-bagasse) Cogeneration	60.00	0.00	651.91
Biomass Gasifiers -Rural	2.00	0.00	18.15
-Industrial	8.00	0.00	164.24
Aero-Genrators/Hybrid systems	0.30	0.00	2.69
SPV Systems	100.00	2.07	325.40
Water mills/micro hydel	1.00	0.00	18.71
Total	**186.30**	**2.07**	**1341.26**
III. OTHER RENEWABLE ENERGY SYSTEMS			
Family Biogas Plants (in Lakhs)	1.10	0.00	48.55

power, which is fast depleting. Growth in competition and scale has led to significant decline in solar tariff, which are very competitive as compared with the conventional power. The latest round of reverse bidding saw the lowest bid dropping to ₹ 4.34 per kWh for a project in Rajasthan.

The conducive policies initiated by the Government of India have helped in bringing about competitive rates through bidding process. The Tariff Policy has been amended to increase the solar power consumption and mentioned that "within the percentage so made applicable, to start with, the SERCs shall also reserve a minimum percentage for purchase of solar energy from the date of notification of this policy which shall be such that it reaches 8 per cent of total consumption of energy, excluding hydropower, by March 2022 or as notified by the Central Government from time to time". The Tariff Policy would mandate the States to buy solar power.

The Government is also coming up with schemes for providing production incentives to encourage growth in manufacturing in solar cells and solar modules. This will help in increase in domestic manufacturing of solar cells and solar modules at competitive rates as the imported solar equipments. Other new initiatives are also being considered.

At the state level too, many state governments are actively promoting the development of solar power through a supportive policy and regulatory framework.

Achievement of 100 GW of solar power will lead to abatement of 170.482 million tonnes of CO_2 over its life cycle. With an enhanced target of 100,000 MW, upto 1 million jobs will be created. More employment and investment opportunities will enhance income. Higher solar power targets will augment power generation in India improving energy security and energy access. Solar manufacturing will also pick up after visibility on this investment opportunity to support these targets. Power generation through solar will offset conventional power generation, reducing the need to import coal and gas and lead to foreign reserve savings. Revenue to the Government through taxes and duty, etc., from plants in power generation and manufacturing will also increase and solar projects will provide a productive use of abundant wastelands.

Further, there are growing concerns about the viability of the newly bid projects. With project auctions becoming increasingly competitive, margins are coming under pressure and leading players to take increasingly more risks. Increased domestic manufacturing of solar cells and modules capacity may take care of the risk and help in capacity addition programme of the Government of India. ❑

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NORTH EAST DIARY

KENDRIYA VIDYALAYA, CRPF, GUWAHATI WINS YOUTH PARLIAMENT CONTEST

Kendriya Vidyalaya, CRPF, Amerigog, Guwahati won the 28th National Youth Parliament Competition for 2015-16 organised by the Ministry of Parliamentary Affairs. Ministry of Parliamentary Affairs has been organizing National Youth Parliament Competition from 1966 for schools, colleges and Universities for familiarizing the students with the practices and procedures of Parliament, techniques of discussion and debate and development of leadership qualities, spirit of self-discipline and tolerance of diverse opinions. ❑

SUBSIDY INCENTIVES IN NORTHEAST FOR EMPLOYMENT GENERATING UNITS

Ministry of Development of North-Eastern Region (DoNER) will offer subsidy incentives in Northeast for industrial and other units generating employment. As a policy, the Ministry will encourage such entrepreneurship and business establishments which generate employment for the youth in the region. For this purpose, the assistance to North Eastern Development Finance Corporation (NEDFI) would incorporate a component of higher interest subsidy for such units which give more employment. DoNER Ministry is coordinating with Union Ministry of Finance in this regard.

The action plan for the year to come includes Venture capital funds as another incentive for those undertaking "Startup" initiatives in the North-Eastern region. This will be an added attractive feature for youth from all over India who wish to avail the benefit of Prime Minister's "Startup India, Standup India" programme by setting up an establishment in Northeast.

North Eastern Space Applications Centre (NESAC) will also carry out satellite based survey for planning and monitoring of projects in the region, to expedite the projects and also avoid discrepancies. In a similar initiative, all the 8 States of Northeast region have agreed to cooperate in carrying out geo-tagging by giving GPS details of various ongoing schemes in the respective States.

DoNER Ministry will also take up waste management project under North East Rural Livelihood Project (NERLP) and North Eastern Region Community Resource Management Project (NERCORMP). In this case, the Ministry would study the other tried models of waste management including the Tamil Nadu model under the Capacity Building &. Technical Assistance (CB&TA) scheme. ❑

A Renewable Energy Future for India

Chandra Bhushan

Central to the vision of a decentralized and distributed electricity future is the increased role for small-scale electricity generators who may be households, businesses, and mini-grids. These millions of small generators would meet their own energy requirements and feed excess energy into the grid and draw on the grid when needed. The role of grid, therefore, would change from being the main supplier of electricity to one of a platform where surplus electricity between millions of generators and consumers would be traded and transported

Today, in India, we face both an environment crisis and a development crisis. On one hand, we are still struggling with the problems of inequality, poverty and improving the human development indicators. On the other, environmental pollution and ecological destruction is now a runaway problem. Both these crises are also interacting and reinforcing each other. This is best reflected in our energy sector.

India suffers from chronic energy poverty. Officially, about 300 million people have no access to electricity. But if we consider the fact that about three-fourth of the rural households connected to the grid have erratic and less than six hours of electricity supply, then about 700 million people in the country can be termed as electricity poor. Similarly, about 700 million Indians use biomass such as dung, agricultural waste and firewood as their primary energy resource for cooking. These fuels cause indoor pollution and increase the burden of diseases of the women folks. The estimated economic burden of using traditional fuels, including health cost and lost economic opportunities due to poor education of girlchild, is estimated to be Rs 30,000 crore. About two-thirds of Indians, therefore, are still deprived of modern energy services.

India is largely dependent on coal to meet its energy needs. Coal meets more than 50 per cent of the current commercial energy needs and generates more than 70 per cent electricity. We are the third largest producer of coal in the world after China and USA. But the energy from coal comes at a huge environmental and health cost.

It is estimated that of the entire industrial sector, 60 per cent of particulate matter (PM) emissions, 45-50 per cent of SO_2 emissions, 30 per cent of NOx emissions and more than 80 per cent of mercury emissions comes from coal-based power plants. Coal based power plants also account for about 70 per cent of the total freshwater withdrawal by the industrial sector and close to half of our total greenhouse gas emissions. On top of this, most of the coal mining areas have been declared as critically polluted areas as well. In fact, there exists a fatal overlap of coal reserves, dense forests, tribal population, high poverty and backwardness. Mining coal, therefore, leads to a huge conflict between the local communities on one hand and destruction of dense forests and wildlife which may be extremely difficult or impossible to regenerate.

The challenge before India is how to meet its energy requirements without compromising the ecology

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of the country. In addition, we have to be mindful of the looming danger of climate change. Climate change is already impacting the water and agriculture sector of the country. We cannot afford to let global temperature rise exceed 2 degrees centigrade from the pre industrial era. Even 2 degrees would devastate many vulnerable communities and ecosystems. India therefore, must work with other countries to reduce greenhouse gas emissions and control the rising temperature. In such a situation, we ourselves cannot have a fossil fuel dominant energy future.

So, how do we move ahead?

Converging Energy and Environmental Security:

In the last few years, five trends have become quite clear. The first is India's dependence on imported fossil fuel is increasing at an alarming rate. We now import close to 40 per cent of commercial energy and this is only going to go up in the near future. This trend has huge implications for energy security of the country.

The second trend is the reducing costs of renewable energy, especially solar and wind power. In the last five years, the cost of solar energy has come down by two-third. In fact, in a city like Delhi where the distribution companies (DISCOMS) charge about Rs. 8 per unit from commercial establishments, solar PV can supply electricity at Rs. 5.0 per unit during daytime. Though 24 x 7 solar power is still expensive because of the storage costs, there are large number of applications and areas where solar power is competitive or even cheaper than coal power. Wind power has already achieved grid parity across the country.

The third trend is the use of electricity for practically all applications. Apart from lighting, cooling and heating, electricity is now being used widely and efficiently for cooking as well. Electric transportation, including cars and buses, are increasingly becoming a reality. Most industrial applications that currently rely directly on fossil fuels for heating, cooling, transportation, etc. can also shift to electricity. A world where most household, commercial, transport and industrial activity is performed by electricity is becoming a reality.

The fourth trend is the urgency of reducing greenhouse gas emissions. Last year in Paris, a new climate agreement was signed to keep the global temperature rise between 1.5 to 2^0C degrees. About 160 countries have submitted their action plan to mitigate climate change. India has committed to have 40 per cent of its electricity capacity from non-fossil fuel sources. Most countries have given some or other renewable target. So, there is a clear global signal to upscale renewable energy to mitigate climate change.

The fifth trend is the increasing global recognition to supply clean energy to all. Last year, all countries agreed to a set of Sustainable Development Goals (SDGs), which includes goals to provide basic energy services to all. The Government of India has also committed to provide affordable 24 x 7 electricity to all households by 2019.

These five converging trends demand that we develop an energy strategy that is based on electricity as a prime mover and this electricity is generated from renewable energy resources. This would mean we come out with a new integrated energy policy that charts a roadmap for a renewable electricity future. Our current energy policy of 2006 is primarily focused on developing fossil fuel resources for electricity and direct use of oil and gas for transport, industrial usage and cooking.

But just moving to renewable electricity won't be sufficient. We need a renewable electricity future that is affordable and accessible to all.

The Future:

The idea of electricity access in India has been centralized generation and grid-based distribution. This idea has failed to give adequate electricity supply to two-thirds of our people even after seven decades of independence. In our renewable energy policy also, the idea of centralized generation and grid-based distribution dominates. For instance, Ministry of New and Renewable Energy wants to setup Ultra-mega solar power plants of more than 4000 MW each. State governments are setting up solar parks to install large solar power plants. Will this ensure energy access to all? Is mammoth DISCOMS, centralized grid and large renewable based power plants, compatible with a renewable electricity future?

It is important to understand that a 24 X 7 renewable electricity generation is not going to be cheap. The cost of generating and storing intermittent electricity is an expensive proposition. On top of this, if we have expensive transmission and distribution, which will be the case with centralized grid and big DISCOMS, the cost of 24 x 7 renewables will not be affordable to a large number of population. Our DISCOMS are in the red and we have a leaking grid (the T&D loss in the country is in excess of 20 per cent). The idea that we can sustain big DISCOMS with large share of renewable electricity in our electricity mix needs a serious reexamination.

I believe that the renewable electricity future is a decentralised and distributed one. The fact is renewable energy is decentralized—sunlight falls everywhere and wind blows everywhere. Demand for electricity too is decentralized, and most renewable technologies are modular. This makes renewable electricity most suitable for decentralized generation and consumption.

Central to the vision of a decentralized and distributed electricity future is the increased role for small-scale electricity generators who may be households, businesses, and mini-grids. These millions of small generators would meet their own energy requirements and feed excess energy into the grid and draw on the grid when needed. The role of grid, therefore, would change from being the main supplier of electricity to one of a platform where surplus electricity between millions of generators and consumers would be traded and transported. In this energy future, there is no role of big DISCOMS. Instead, we will have mini-DISCOMS that would meet the electricity needs of small communities in cities and villages. These mini-DISCOMS would feed excess power to the grid and buy power from other mini-DISCOMS when in deficit. Grid, therefore, would be used to meet a small percentage of total electricity demand. There will be a role for large power plants based on other non-fossil technologies, but this role would be to supplement decentralized generation, which would also reduce over a period of time.

This is not a utopian future. Germany, the leader in renewable energy, has most of its solar PV installed on rooftops. About 1.5 million households in Germany have installed more than 30,000 MW worth of solar PV panels on their rooftops. They are either feeding it to the local grids or consuming it domestically.

What Germany has done, we have to do it at a much grander scale and in a much more decentralized fashion. Also, we will have to dovetail renewable electricity with superefficient appliances and use them in energy efficient buildings. It doesn't make any sense to use expensive renewable energy in inefficient appliances and buildings. We now have superefficient appliances that consume one-fourth electricity than the appliances currently available in the market. The renewable electricity world, therefore, has to be a world of Kilowatts and Watts and not Megawatts and Giga-watts. This is the only way we can keep the renewable electricity affordable and accessible to all.

If operationalised, this model will revolutionise the way power is produced and consumed in India. Millions of households would produce and consume their own electricity. Thousands of renewable energy based mini-grids would promote millions of small businesses and social entrepreneurs to create local jobs and build local economies. Living standards in villages will improve which in turn, will ensure women empowerment, better health and education. There cannot be a better development agenda for the country.

In the end, this might be the only way we can avoid large fossil fuel plants. This might be the only route through which we can end the political interference with the electricity sector. If there is no DISCOM, there cannot be a promise of free electricity to the electorates. In one stroke, we can make renewable electricity the main source of energy, solve the challenges related to energy poverty, address climate change, build local economies and move towards a secure energy future for India. This, I think, is the way ahead. Lets develop a blueprint to achieve this future. ❑

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FOSSILISED FUEL

UNCONVENTIONAL

Shale Gas in India: Challenges and Prospects

Anil Kumar Jain, Rajnath Ram

While many challenges to shale gas exploitation, viz., the nature of hydraulic fluids, threat of seismic activity, contamination of water, methane emissions, etc., can be addressed by greater transparency in the operations of this industry, these threats are not unique to shale gas exploitation

India is the third largest consumer of energy in the world after China and USA (Source: BP Statistical Review, 2016), but it is not endowed with abundant energy resources. High reliance on imported energy imperils fiscal stability given volatile energy prices, and also impinges adversely on energy security. Meeting the energy needs of achieving 8 per cent-9 per cent economic growth as also meeting the energy requirements of the population at affordable prices, therefore, presents a major challenge. It calls for a sustained effort at increasing energy efficiency to contain the growth in demand for energy while increasing domestic production as much as possible, to keep import dependence at a reasonable level.

The scope for containing the growth of demand for energy depends upon our ability to reduce the energy intensity of GDP taking account of both the need for energy as an input into production, and in direct final consumption in lighting/heating/cooling and transport. Energy intensity has special relevance in petroleum sector, as our import dependence is likely to rise from 73 per cent in 2011-12 to more than 80 per cent by the end of the 12th Plan (2016-17). This is accentuated by the fact that the use of petroleum products in several areas cannot be substituted by other fuels. Enhancing fuel efficiency of vehicles is vital for India, especially in Heavy Duty Vehicles (HDVs).

As India maintains its rate of economic growth, primary energy consumption is unlikely to abate. In the year 2015, the growth in the primary energy consumption in India over the previous year was 5.2 per cent, whereas China, US, Russia and Japan registered growth rates of 1.2 per cent,1.9 per cent, 3.3 per cent, and 1.2 per cent, respectively. In petroleum, India registered nearly 11 per cent growth rate in 2015, a historic high. It is expected that, as has been the trend the world over, the share of gas is likely to rise given increased availability and trade of gas and its environment friendly nature. As per International Energy Agency (IEA), if the industry abides by the 'golden rules' proposed by it, the share of gas in the global energy mix could rise from the present levels of 23 per cent to 25 per cent in 2035 overtaking coal (24 per cent), to become the

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second largest primary energy source after oil (27 per cent). This has even prompted IEA to suggest in a publication in 2012 that the world is entering a golden age of gas. The share of unconventional gas in natural gas could rise from 14 per cent in 2010 to 32 per cent by 2035. Consequently, the emergence of unconventional sources of gas, particularly shale gas, holds special relevance for India. Policy Planners are committed to evolving a conducive policy for harnessing modern technology in tapping this source of energy to augment domestic energy supply.

Global Trends in Unconventional Gas Sources

Unconventional gas sources are the ones which exist in such reservoirs, that their production requires greater effort than the other kinds of sources. They also require specialized technology, depending on the nature of their presence in the specific situation. Traditionally, the following sources of gas have been categorized as un-conventional ones:

- Coal bed methane (CBM)
- Coal mine methane (CMM)
- Shale gas
- Tight gas

While the global gas demand is likely to go up by 50 per cent between 2010 and 2035, one-third of the above in the year 2035 is likely to come from unconventional sources. Internationally, unconventional gas has not played an important role in meeting the energy demand until some years back. The rapid rise in production of gas from shale in the US has led to renewed interest in unconventional gas sources globally. From virtually nil production in the year 2000 in US, shale gas production had reached a level of 23 per cent in 2010 and is expected to comprise nearly half of total natural gas supply in 2035. This is likely to be supplemented by other unconventional gas sources, mainly coal bed methane and tight gas with all the unconventional gas sources to comprise 70 per cent of total natural gas supply in US in the year 2035. The emergence of this new source of gas has already led to US becoming a net exporter of gas against being an importer. Barring shale gas, India has been familiar with all other sources of unconventional gas.

Throughout the world, different types of sedimentary rocks contain natural gas deposits, for example sandstones, limestones and shales. Sandstone rocks often have high permeability, which means that the tiny pores within the rock are well connected and gas can flow easily through the rock. In contrast, shale rocks where gas is trapped as a continuous accumulation throughout a large area usually have very low permeability, making gas production more complex and costly. The shale gas boom in recent years has been due to modern advancement in technology in hydraulic fracturing (fracking) to create extensive artificial fractures around well bores. Shale exists in sedimentary basins and typically forms about 80 per cent of what a well will drill through. As a result, the main organic rich shales have already been identified in most regions of the world. Often, enough is known about the geological history to infer which shales are likely to contain gas or oil or a mixture of both. However, the potential zone within shale sequence, the amounts of gas present and what proportion of it can be recovered technically and economically, cannot be known until a number of wells have been drilled and tested. The amount of condensate present in the gas can also vary considerably with important implications of economic production, as condensates command a high price in energy markets.

Three factors have come together in recent years to make shale gas production economically viable:

- Technological advances in horizontal drilling;
- Hydraulic fracturing; and
- Increase in natural gas prices in the global market.

Horizontal drilling and hydraulic fracturing have dramatically improved daily production rates in USA and also increased the total ultimate recovery potential of individual wells to as high as 54 per cent. Figure 1 provides the projected potential development of shale gas in the year 2035 in major countries.

According to the US Energy Information Administration (EIA), Report, June 2013, the estimated world shale gas resources is 7576 trillion cubic feet (tcf) comprising of 48 countries across the world (as per updates in September, 2015 by EIA). In Table-1 (EIA Report, 2013 and update Sep, 2015) China leads

Figure 1: Unconventional Gas Producers in 2035 (as per golden rule case of IEA)

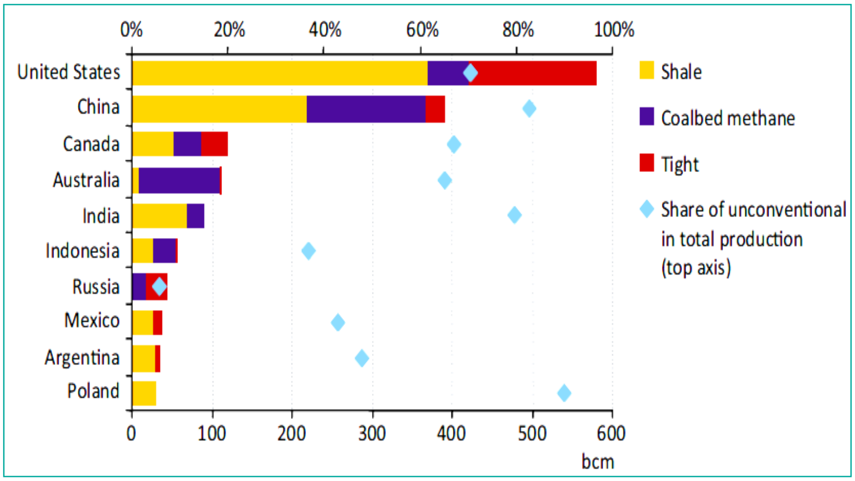

Table 1: Leading Countries with Technically Recoverable Shale Gas Resources

Rank	Country	Technically recoverable Shale gas (trillion cubic feet)
1	China	1,115
2	Argentina	802
3	Algeria	707
4	U.S.A	623
5	Canada	573
6	Mexico	545
7	Australia	429
8	South Africa	390
9	Russia	285
10	Brazil	245
11	India	96
	World Total	**7576**

the world in technically recoverable shale gas. US which was 2nd in order after China in terms of technically recoverable gas until last year, has now slipped to 4th position.

Chinese investments in joint ventures represent 20 per cent of total foreign investment in U.S. shale plays. This has provided China with valuable expertise that can be applied to its own domestic production, helping to lower well development costs. In 2012, to encourage the exploration of shale gas, the Chinese government established a four-year, $1.80 per million British thermal units (MMBtu) subsidy program for any Chinese company reaching commercial production of shale gas. In mid-2015, these subsidies were extended to 2020, but at a lower rate.

Major Challenges in Shale Gas Exploitation: Global Experience

Exploitation of shale gas poses a bigger challenge than other sources of gas. They are different from conventional gas sources, also because being completely onland, shale gas exploitation leaves greater footprints. Even technologically, producing this source is very challenging. Due to the tightness of the reservoirs, these require hydraulic fracturing horizontally to cover a large part of the reservoir and sometimes require multi-stage fracturing and frequent stimulation. The typical flow rates of a shale gas well is very high in the first 1-2 years, and then tapers to a much slow rate extended over many years. This requires drilling of a large number of wells leading to greater interface with the communities, environment and effort.

The various phases of the shale gas development, life cycle and their associated issues have been organized for assessment as follows:

- Drill Pad construction and Operation;
- Hydraulic Fracturing and Flowback Water Management;
- Groundwater Contamination;
- Blowouts and House Explosions;
- Water consumption and Supply;
- Spill Management and Surface Water Protection;
- Atmospheric Emissions; and
- Health Effects.

The biggest apprehension in exploitation of shale gas is the hydraulic fracturing job wherein large amounts of water mixed with fracturing fluids/proppants is injected at high pressure into the reservoirs. The horizontal drilling within the shale gas bearing zones has to be enabled to receive gas trapped in the horizontal shales. The use of sand/ceramic with high pressure water helps to fracture the shales and the resultant deposits of sand in the fractures keeps the pores open for the gas to leak into the horizontal wells. A mixture of chemical is also used to give such properties to the fluid that are needed for fracturing. It is these sands and fractures which are apprehended from the point of view of contamination of aquifers which support life. If these fractures were to take place along a fault, they could result in shallower levels being affected, with resultant mixing of chemicals. Even the fear of gas escaping thorough these fractures and contaminating the ground water has been a cause of concern.

Apart from the main concern of water contamination, there are other multiple challenges while exploring and producing shale gas. A large amount of water, from few thousands to 20 thousand cubic metres per well is required for hydraulic fracturing. Local environmental challenges and issue of water availability and water disposal after fracturing jobs pose serious threats to the environment. Shale requires a vast land cover in comparison to conventional oil and gas, which is also a challenge especially for countries like India which have a heavy pressure on land. While one well in a conventional field may drain hydrocarbons from an area of 10 sq. km and may require a 100 – 500 sq. km licensing area, those of shale may require many times over, as has been seen with Marcellus shale in US which covers over 25000 sq. km. Multi-stage fracturing (10-20 stages) may require from 1000 to 4000 tonnes per well of proppants. Such high injection in the wells has also been feared with earthquake risks. This has led to country concerns in approving shale exploitation, and as per one Report, has resulted in natural gas production in Germany to fall by about 6 per cent in the past year. Controversy over shale gas and hydraulic fracturing is blocking conventional gas production as well. For more than 3 years, the ongoing discussion on shale gas has prevented projects from being approved that require the use of hydraulic fracturing even for conventional gas production

In the light of the above, every country which embarks on shale gas exploitation regime must plan an adequate regulatory regime and environmental standards to safeguard against any long term damage to the environment. Water being a scarce resource in India, particularly calls for strengthening of the local institutions in undertaking baseline studies, monitoring of water quality and water balance.

Shale Gas Resource in India

Having understood that shale rocks, which are the original source rock, have now also become a reservoir or a producing formation, it naturally follows that in every hydrocarbon producing country, there is every likelihood of shales holding hydrocarbons in varying degrees. It is interesting to note, that shales even in non-producing basins could be holding hydrocarbons, opening up a potential in not only the 7 producing sedimentary basins, but in all the 26 basins. It has already been mentioned earlier that the task before exploration and production companies is basically to visualize/learn geological properties of shales to be able to produce oil/gas from them.

India, too, has a long experience of exploring and producing oil and gas from on-land sources, and the presence in-depth of shale rocks is largely known more in the 7 producing basins, basically due to the vast exploration already done in these basins. There are no firm estimates of Shale oil/gas in the country. Several agencies have provided different estimates as per Table-2.

Table-2: Estimates of Shale Gas for Indian sedimentary basins

1	M/s Schlumberger	300 to 2100 TCF
2	Energy Information Administration (EIA), USA (4 baisns-Cambay Onland, Damodar, Krishna Godavari Onland & Cauvery Onland),)	584 TCF
3	ONGC 6 basins	187.5 TCF
4	Central Mine Planning and Design Institute (CMPDIL) 6 sub basins	45 TCF
5	United States Geological Survey (USGS) in 3 basins	6.1 TCF

The US Geological Survey (USGS) has released a lower estimate of 6.1 tcf in 3 basins. As per published report of EIA, June 2013, the risked shale gas in-place is 584 tcf and the technically recoverable shale gas is about 96 tcf (Cambay, Krishna-Godavari, Cauvery, Damodar Valley, Upper Assam, Pranhita-Godawari, Rajasthan and Vindhyan basins). The vast difference in the estimates of the two US agencies has confused Indian administrators and is yet to be resolved. It may, however, be borne in mind that the two reports cannot be compared as USGS reports undiscovered gas resources, while US EIA reports total recoverable resources. The latter differs from undiscovered, by proven reserves and discovered, but, undeveloped resources. It may also be added that as in the case of unconventional gas, there is no real discovery process but merely an appraisal process, as a result, the difference between undiscovered, and discovered but not developed is blurred.

In India, the national oil companies had undertaken a large scale of on land exploration during the last several decades, which has now been supplemented both by them and private companies after the launch of the Production Sharing Contracts (PSC) regime. It is believed that they have drilled several thousand wells, particularly in Cambay, KG and Cauvery basins. These wells had yielded a wealth of data regarding the extent, depth and nature of shale formations in the different sedimentary basins. However, in most other on-land basins, the details of the shale deposits are yet to be fully ascertained. Even the cores of the wells may not have been preserved properly for an analysis of kerogen content. It is also well-known that under the New Exploration Licensing Regime (NELP) and pre-NELP contracts, a large number of on-land wells have been drilled whose data is available with Directorate General of Hydrocarbons (DGH) for unhindered usage in promotion of the nation's acreage. This data has to be suitably scrutinized and a full picture developed on the prospectivity of shale gas in the country. We are also aware that the EPINET, the corporate data repository of ONGC (and similar one of Oil India Ltd.) has already hosted a large amount of data on their respective networks. The above data banks need to be networked with active involvement of the NOCs for the shale gas exploitation programme to be implemented on fast track basis.

The big issue of diversity of shale and key is finding the correct fracturing technique. Shale gas reservoirs are referred to as statistical plays, as many wells are needed to understand the play and assess the recoverable resource. Moreover, as unconventional gas has a higher cost of production per unit (due to lower overall recovery rate of less than 35-40 per cent and high cost of well, some of the wells in US have recovery rates varying from 8 per cent to 19 per cent), the economic size of reserves is also an exercise of both technology and pricing. However, a challenge still remains as to how to assess shale deposits especially for the purpose of carving out of blocks for bidding programme.

Mitigating Shale Gas Challenges

Shale Gas exploitation raises a large number of challenges which are specific to this resource due to specialized technological interventions, viz., hydraulic fracturing. These challenges begin from resource assessment, regulatory and environmental framework, availability of open land, water availability, seismic as well as encouraging shale gas regime. These also need to be seen in the light of the fact, that while shale gas success has been reported in the US, the landscape being vastly different in our country, the US practices cannot be directly replicated. However, we already have a successful policy of exploiting an unconventional gas resource, viz., CBM, which provides us enough experience in this area.

The starting point of addressing the shale gas challenge is interpreting the statutory framework and the existing policy for exploration of oil and gas, to find its applicability of the regime on shale gas. It may be noted that under the Oil Field Regulation and Development Act, 1948 and Petroleum and Natural Gas Rules, 1959, the definition of natural gas includes all 'naturally' occurring gas. It was due to this statutory interpretation that coal bed methane, which is a naturally occurring gas, came in the domain of MoPNG and not Ministry of Coal. Even when offering oil and gas blocks under NELP, it was perhaps acknowledged that CBM would also get covered under the NELP PSC. As a separate regime was being proposed for CBM, the production sharing contracts of NELP specifically excluded coal bed methane out of the PSC. In 2013, the Government allowed public sector oil companies to explore and produce shale gas from their blocks under the nomination regime -the blocks which were given to companies such as ONGC and OIL before the launch of the NELP. However, in the case of competitively awarded NELP blocks, the contractors have to abide by the exploration related contractual provisions, particularly those related to exploration phases. If the blocks have moved out of exploration phase, then they cannot initiate exploration of shale gas. In the recently approved Hydrocarbons Exploration Licensing Policy (HELP), a unified exploration license will be granted which will allow exploration of hydrocarbons, which is a significant improvement over the earlier regime.

The second major challenge relates to availability of land and water. It is well known in US, private land owners, State Governments and the Federal Government have full ownership of minerals vested in respective lands. The situation being different in India, while on the one hand it is easy for the Union Government to authorize shale gas exploitation by grant of a license at its level, the disincentive to the occupier of the land becomes a stumbling block. The encouragement given by the land owners in USA to oil and gas companies in shale gas operations due to monetary incentives reaped by the land owners gave a big push to this programme. Nevertheless, the vast population cover and agricultural pursuit in the Indian condition will pose a challenge to shale gas exploitation. The same will be true for availability and supply of water. In this regard, a way forward would be as adopted in the Sichuan Basin of China, where they took up that region first, which was rich and closer to water resources. On the issue of water contamination and injection of hydraulic fluids as well as any other area of environment, a significant distinction needs to be appreciated between India and the West.

> **...the vast population cover and agricultural pursuit in the Indian condition will pose a challenge to shale gas exploitation. The same will be true for availability and supply of water. ...On the issue of water contamination and injection of hydraulic fluids as well as any other area of environment, a significant distinction needs to be appreciated between India and the West.**

In the US, federal laws are aimed at environment protection, and they allow states to promulgate additional regulations. Most oil and gas specific Acts/regulations are left to States with regulatory bodies being responsible for licensing and enforcing regulations specific to oil and gas production as well as environmental loss. E&P regulation primarily encompasses well fencing, standard procedures in well construction, hydraulic fracturing, waste handling and well blocking as well as chemicals and water spills. These regulations along with federal environment regulations provide a comprehensive statutory and regulatory framework. Along with the above, industry bodies like the American Petroleum Institute (API) have also developed shale specific operating standards. Therefore, in India, while developing a framework of regulation and statutes in environmental area is a challenge, but due to the existing framework in other parts of the world, it would not be difficult to develop a similar one suited to our needs. The 'Golden Rules' which have been discussed in a dedicated publication by IEA exhaustively cover the recommendations which are necessary in the area of shale gas exploitation.

While many challenges to shale gas exploitation, viz., the nature of hydraulic fluids, threat of seismic activity, contamination of water, methane emissions, etc., can be addressed by greater transparency in the operations of this industry, these threats are not unique to shale gas exploitation. Even in CBM exploitation where a lot of water activity takes place at a shallow depth (which is more risk prone than shale gas), a decade long experience in India has not been negative. One recommendation which will go down well for India is that the Government itself needs access to scientific and credible knowledge base before widely spreading shale gas development. Australia in 2011 established an Expert Scientific Committee federally funded with $150 million over four years to address CBM related environmental and other issues.

In conclusion, India needs to pay special attention to the environmental safeguard issues of the shale gas programme. Due to heightened public activism, strong judicial supervision and scarce land/water issues, shale gas exploration will be subjected to close scrutiny. While the Indian environmental laws at the national level are also on the lines of US federal laws – prescribing specifications for discharge of air, water etc. from industrial uses, in the case of Shale Gas, even processes will have to be prescribed. In the West, a robust industry standards compliance is also an accepted form of conducting business. Unfortunately, the confidence levels in India are not too high, and compliances are more rule/regulation driven. Further, as it may not be possible for the states to promulgate regulations due to the complex nature of shale gas industry, the Central Government may need to issue these regulations. However, the concerns being local – land and water issues, the state machinery alone will be able to enforce the regulations. Prior to regulations, it will be essential to develop baseline water data, both the stock as well as the characteristics, at the local level. Hence, a lot of capability building in the manpower resources at the State/ district level may be required to assure the local communities of their health and well- being. Shale gas exploration, hence, will not only have contractual, fiscal and technical challenges, but also those related to environment and capacity building. In view of stagnant oil and gas production and rising import dependency in India, it will be well worth the effort to address the above challenges to exploit our shale gas prospects.

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YE-84/2016

Energy Efficiency: Need of the Hour

Saurabh Kumar, Darpan Mago

We're indeed living in a golden age, when the first major push to innovative ways for energy usage have come up. Interestingly, saving a unit of electricity comes out to be way cheaper than producing it in the first place. This way, we are able to cater to the growing demand by not simply increasing the electrical production but majorly saving electrical units through effective appliance efficiency

Since the early 2000s, India has witnessed a tremendous growth. The nation has taken great strides towards expanding its industrial sector. In due course, the number of households have increased and so have the modern amenities. To keep up with India's pace of development, meeting the increasing energy demand becomes central. This mission of uninterrupted power supply throughout the country is an arduous task and there are significant challenges involved to be countered in a short span. While the non-renewable sources of energy production are an added burden to the environment and may soon become obsolete, the renewable sources of energy are still deterred by a relatively high cost factor.

To overcome this challenge, the Government has taken up initiatives to think out of the box and come up with innovative solutions. While the government works to enhance the electrical production, energy efficiency has been seen as a sustainable way out. Energy efficiency means to be able to deliver the same amount of services or more through reduced energy input. Efficiency in energy can be brought by using appliances which consume less energy over the traditional ones or adopting new technologies. The miracles of energy efficiency have been brought forward in public sphere in a simplistic manner, which effectively counter the roadblocks of awareness and affordability. We're indeed living in a golden age, when the first major push to innovative ways for energy usage have come up. Interestingly, saving a unit of electricity comes out to be way cheaper than producing it in the first place. This way, we are able to cater to the growing demand by not simply increasing the electrical production, but majorly saving electrical units through effective appliance efficiency. Laying our focus on this premise, the country's premier organisation, Energy Efficiency Services Limited (EESL), has been designated the task of carrying out pan-India energy efficiency projects and increaseing the count of saved units to light up the remaining dark corners of India. EESL along with BEE in India holds the responsibility to blossom the energy efficiency market in the country. Taking the journey forward with respect to significant governmental push in EE arena, today, EESL is running successful energy efficiency schemes like UJALA (Unnat Jyoti by Affordable LEDs for All), Street Light National Programme (SLNP), energy efficient fan distribution programme, efficient buildings programme along with AgDSM, the agricultural pump distribution

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scheme. All these initiatives are catering to their specific domains to reduce the energy consumption and add to energy savings.

The Magical Light of UJALA

The fundamental achievement of one of the government's first energy efficiency pan-India programme is reflected by UJALA or the LED bulb programme. This simple act of change of one light bulb to LED at South Block Prime Minister's office heralded a movement in the entire country for considering the same change. Lighting is the first basic source of electrical consumption in Indian households and the best way to bring drastic energy savings was to target this domain. Indian houses, workplaces and market areas were a hotbed of incandescent bulb usage. The main reasons behind LED lights being uncommon were high pricing and lack of public awareness. This traditional means of lighting wasn't only inefficient, but insufficient lighting level from each bulb led people to use more bulbs per spot. The increasing number of inefficient bulbs was only adding to soaring electrical consumption of the nation. Now, if a first significant energy savings impact was to be exhibited, it was only possible by changing all incandescent bulbs in the entire country with energy efficient LEDs. This problem was an opportunity in disguise and led to the birth of the world's largest and most extensive LED distribution programme, UJALA (Unnat Jyoti by Affordable Lighting for All). In this initiative, the nodal organisation, EESL, undertook the task of setting up phase-wise LED distribution centers across the nation to provide people with affordable LED bulbs on either upfront basis or through on-bill financing. After procuring massive quantity of LEDs from indigenous manufacturers, these were sold to public through an extensive chain of distribution kiosks. Due to bulk LED bulb procurement by EESL, a healthy competition rose among the manufacturers and brought down the prices of LED bulbs in India from a range of about Rs. 300 - Rs.400 to a range of Rs. 75 - Rs. 95 per LED bulb. EESL transformed the market for energy efficient lighting in India in about one year. The latest price at which EESL procures the LED bulbs is about Rs. 55 and then sells it to the grid connected consumers in India after adding the taxes and overhead expenses. The dominant bottleneck hindering adoption was pricing and now it stood crushed. The earlier costly LED bulbs were now available at an extremely cheaper price due to this massive government intervention.

Currently, UJALA scheme is running in stages and aims to cover all the states in India. More than 10 crore LEDs stand distributed under the UJALA scheme, which is resulting in more than 3.5 crore kWh energy savings per day. This way, we have avoided a peak demand of about 2,665 MW in India and are leading to a reduction in carbon footprint of about 29,536 tonnes per day. Not only this, as per state specific surveys, we have overshot our commitment of energy savings by about 32 per cent per bulb than what was initially promised. Social surveying strongly suggests public contentment with the scheme and people openly express their happiness after witnessing reduction in their electricity bills. Easy replacement through a unique number in electricity bill gives more power and independence to the consumer. By March 31, 2017, it is expected that the target of distributing about 20 crore LED bulbs all across the country would be reached.

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Lighting the Way through SLNP

Another prominent and successful initiative of the government, run by EESL, to counter energy inefficiency is the Street Lighting National Programme (SLNP). Street lights in India were recognised as the second most potential group that will result in significant energy savings. In India, use of inefficient sodium vapour lights and traditional tube lights to illuminate the streets is still prevalent. The conventional lighting is not only a burden on current energy production, but the insufficient lighting levels and bad colour rendering indices have become a public problem. It has been theoretically stated that if illuminated street light structures are visible from the sky, it is nothing more than additional wasted light that spans to unnecessary areas and pollutes the night sky. Here, the concept of 'dark sky initiative' was imbibed and research was carried out to come up with street lights which consume less energy, illuminate only the pathways, reduce light trespass and have improved colour rendering index. A way forward was planned and EESL began replacing the conventional street lights with new energy efficient ones at its own cost ,i.e., without any investment from Urban Local Bodies (ULBs). The new lights being put in place consume way less energy, have drastic colour rendering index and illuminate only their focused area. Now, in place of the lighting structures being visible from the sky, only the well-lit pathways were prominent in an aerial view of the well lit region. The street light contracts that EESL enters into with ULBs or municipalities is typically of a 7-year duration, wherein EESL not only guarantees a minimum energy saving (usually of 50 per cent), but also provides free replacements and maintenance of lights at no additional costs to the municipality. In this scheme, the investment is recovered through the long term energy savings resulted by the new street lights.

More than 7,63,000 energy inefficient street lights have already been replaced with LED lights across the nation and continuous work is going on to change more. The overall annual energy savings estimated from the completed cities is about 10,11,81,263 kWh. Interestingly, every completed project in the state was under a strict timeline. The lowest time taken for completing a ULB was one month and that the highest recorded was only 11 months. While it was also noted that maximum projects were wrapped up in 4-5 month time frame. Not only this, but switching to energy efficient street lights has majorly impacted the environment of the region by reducing the carbon footprints. The combined reduction of CO_2 emissions taken from completed ULBs of different states is about 230 tonnes per day.

Energy Efficiency in Agriculture

After tapping the lighting sector, significant potential for energy savings was recognized in the most unimagined area of agriculture. Government, in its big push to the energy efficiency space, successfully demonstrated that there is a scope of energy efficiency in India's expansive agricultural sector. India's agricultural sector uses about 18 per cent of the total national electricity consumption. As per the Central Electricity Authority (CEA), there are about 20.27 million pump sets installed in the agricultural sector. Here, it was observed that a vicious circle of unreliable power supply and usage of sub-standard pump sets in response were continually burdening the electrical grid.

As electricity supply is not constant in the rural regions, the farmers frequently have to spend money on pump repairs. This lead them to react by adopting rugged, locally manufactured pumps, which are highly inefficient but pose a better option than purchasing a new pump set each time. While the electricity tariff remains subsidized or free in the agricultural sector, the need for farmers to use energy efficient pumps gets further reduced. Thus, this challenge of high energy demand due to organised use of inefficient agricultural pumps further burdens the supply and continues to damage the equipments (pumps). In the only move, which can pull everyone out of this entrapment, EESL introduced the mega-initiative of Agricultural Demand Side Management (AgDSM) to provide farmers with energy efficient pump sets. Here, EESL enters into an understanding with the farmers and DISCOMs to provide them with free BEE star labled pump set and later recover its investment through received energy savings. The move initiates the change at a point where it all begins and is needed the most.

Under AgDSM, about 4,423 pump sets have already been replaced in Andhra Pradesh and Karnataka combined. The AgDSM initiative has resulted in estimated savings of about 229.7 lakh kWh of electricity per annum. It is observed that the energy efficient BEE star labeled pumps provided to the farmers have the potential to improve the efficiency by 25-37 per cent when compared to old energy inefficient pumps. In the above regions of Andhra Pradesh and Karnataka, it was noted that well designed and targeted DSM programmes have proven to set examples and can be replicated at a large scale. This opportunity not only reduces the costs of Government and the farmers, but also holds the potential of transforming into a big business opportunity, where investments can be recovered through monetary energy savings. The above mentioned successful projects of AgDSM have reinforced the thought that investment in agricultural pump sets efficiency can payback in a short time duration. Notably, this programme is reducing the electrical consumption along with minimising the subsidy burden of the Government.

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Building Blocks of Smart Infrastructure:

In recent times, it has been recognized that efficient buildings are the future of sustainable development. The way to sustainable future lies in having smart infrastructure, that consumes less energy and yet works better than the existing setup. It has been estimated that on an average, a building wastes about 30 per cent of energy and if nothing was ever done to improve its efficiency, there is a lot of room to bring about a big change. EESL is also working on programmes to devise ways to secure the 30 per cent general energy loss in buildings. EESL's buildings programme has successfully been completed at NITI Ayog, Shram Shakti Bhawan, India Habitat Center, UPSC building, IP Bhawan along with others in the capital. Currently, work is being carried out in more than 18 buildings to make them more energy efficient. It was observed that on an average, EESL has successfully received energy savings of about 19 per cent in its completed buildings projects. Here, a relatively new technology of BMS or Building Management System was installed in government to keep track of the savings and equipment performance. BMS is a software with easy user interface helping the building administrator manage the savings.

Fan the Savings Through NEEFP

Moving on from light sector, efforts are being made to cater to the fans market. Fans in the Indian market are sold at an annual growth rate of 6 per cent. With the demand increasing day by day, EESL has also started its efficient fans programme based on the patterns of UJALA scheme. Under

NEEFP, EESL aims to replace over 35 crore inefficient fans by BEE 5 star labled energy efficient fans by 2018. Currently, the scheme has been implemented in the state of Andhra Pradesh and Uttar Pradesh. Preliminary discussions with the Government of Rajasthan and Government of Bihar are underway. EESL plans to expand the operations of the scheme throughout India.

Way Forward:

Taking forward from success of various schemes of EESL, it is required by us to constantly work to recognise the usage of energy inefficient equipment and replace them with energy efficient products through exemplary and innovative financial models. ❑

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Easing the Process of "Getting Electricity" Connection

Ministry of Power has undertaken several reform measures to ease the process of 'Getting Electricity' over the last two years. The Government has made it mandatory to provide electricity connection within fifteen days to the consumers in normal conditions. A simplified procedure for getting electricity connection has been adopted after detailed discussions with Delhi and Maharashtra Discoms and other concerned agencies. DERC has made the necessary changes to allow LT connection up to 150 KVA and had also rationalized the tariff for the same in 2015. The Ministry has also stipulated time for each step required for providing the connection. Within three days of online form submission for electricity connection, the field inspection of the site will be done, which will lead to the process of estimate preparation, load sanction and intimation for fee deposit to be completed in next four days. After this, installation work including meter and flow of electricity will be done in eight days, thus completing the whole process in 15 days.

While applying for connection, consumers in Delhi and Mumbai will be required to provide self certification for type of consumer along with ID proof and premises ownership. An amendment to CEA notification has been made to waive off electrical approval for 11 KV installation carried out by Discoms and allowing self certification by Discom engineers in such cases. It has been agreed by the Discoms that reliability of power supply will be improved progressively each year till international benchmarks are achieved. An amendment in CEA notification for allowing installation of transformers up to 500 KVA on double pole structure has also been made. Apart from these initiatives, a simplified online mechanism for Right of Way (RoW) approval process for electrical works is also under process. These measures will drastically reduce the time taken for getting an electricity connection and will benefit citizens and industry alike.

Power for All by 2019: No Longer A Distant Dream

Anupama Airy

Thanks to the ongoing pace of reforms in the power, coal and renewable energy sector, a country where perpetual fuel shortages marred generation plans of power companies, today boasts of coal and power surpluses

With a number of path-breaking reforms initiated by this government in the country's power sector, the much talked about "Power For All" plan in India is no longer a distant dream, but a reality of the near future.

These reforms have got the world talking and the government is confident of providing its people round the clock 24x7 power at affordable rates within the next three years i.e. by 2019.

So what exactly are these reforms/ flagship programs in the power sector that promise to turnaround the once most criticised and ailing sector of the Indian economy?

To begin with, the most comprehensive reform measure that has ever been initiated in this country is the UDAY scheme or Ujwal DISCOM Assurance Yojana for operational and financial turnaround of the state distribution companies or commonly known as the DISCOMs.

DISCOMs are the backbone of India's power sector and for any initiative or reform program to succeed, the first and foremost task is to operate upon these financially bleeding institutions and make them healthy.

Fully aware of the fact that power is a concurrent subject and reforms cannot be forced upon any state, the scheme UDAY was launched with a hope that it will see active participation from the states.

With the outstanding debt of Discoms mounting from Rs 2.4 lakh crore in 2011-12 to about Rs 4.3 lakh crore in 2014-15, and interest rates up to 14-15 per cent, these DISCOMS– were clearly the weakest links in the entire power value chain.

Repeated power outages in some states was creating operational issues for companies, thereby affecting industrial and manufacturing activity in that state and unreliable power was leading to investors moving out. Therefore, to get this mission of 24x7 affordable and environment friendly 'Power for All' working on ground, the government's decision to focus upon the turnaround of these state power distribution companies was essential and much needed.

Acknowledging the significance of the UDAY scheme, the States realized that not only was UDAY their perfect survival plan, but it was indeed the only plan that could save them from drowning in their own debt while gradually transforming them from the weakest to the strongest link in the chain.

The author is an Independent Journalist and Energy Expert. She has worked with leading mainline financial and national daily for 23 years. She is also the Founder and Editor of EnergyInfraPost.com and DefenceAviationPost. com.

By joining UDAY, the states were giving a new lease of life to their DISCOMs, as a financially and operationally healthy DISCOM would be in a position to supply more power.

Higher demand for power would mean higher PLF of Generating units and therefore, lesser cost per unit of electricity, which in turn would mean lesser cost per unit of electricity to the consumers. A steady and affordable supply of power will ultimately provide momentum to the industrial and manufacturing activity in states and create a healthy investment climate.

Launched in November 2015, UDAY provides the ailing Discoms with a clear roadmap and opportunity to become profitable in the next 3 years.

UDAY has been designed through extensive stakeholder consultations and has been a game changer for States. Under UDAY, every DISCOM is expected to eliminate losses by 2019-20, with potential savings of over Rs. 180,000 crore every year, starting 2019.

And so, despite the scheme being an optional one, as many as 20 States and Union Territories have given their consent to join, out of which, 13 States, viz, Rajasthan, Uttar Pradesh, Chhattisgarh, Jharkhand, Punjab, Bihar, Haryana, Gujarat, Uttarakhand, Karnataka, Goa, Jammu & Kashmir and Andhra Pradesh have already signed MoU's with the Central Government. UDAY bonds worth about Rs. 1 lakh crore were issued within three weeks.

In 2015-16, bonds worth Rs 99,541 crore were floated by the participating States to clear 50 per cent of the outstanding debt of States and outstanding CPSU dues in Jharkhand and Jammu & Kashmir. Further, DISCOM bonds worth Rs 11,524 crore were floated. In the year 2016-17, bonds worth Rs. 48,391 crore have been floated by Rajasthan, Uttar Pradesh and Punjab.

Under UDAY, the turnaround of DISCOMs is being made possible through:

(i) Improving operational efficiencies of DISCOMs;

(ii) Reduction in the cost of power;

(iii) Reduction in interest cost of DISCOMs through States taking over 75 per cent of the DISCOM debt, as on 30th September, 2015 over two years, and the rest being re-priced through bonds and loans at lower interest rates, and;

(iv) Enforcing financial discipline on DISCOMs through alignment with State finances.

13 states and union territories have already signed agreements to join UDAY and benefit from this scheme. UDAY will put DISCOM reforms on an accelerated path and is considered to be a significant step in making the vision of 24X7 Power for All a reality.

Demand Side interventions in UDAY such as usage of energy-efficient LED bulbs, agricultural pumps, fans & air-conditioners and efficient industrial equipment through PAT (Perform, Achieve, Trade) would help states in reducing peak load, flatten load curve and thus help in reducing energy consumption.

Demand Side interventions in UDAY such as usage of energy-efficient LED bulbs, agricultural pumps, fans & air-conditioners and efficient industrial equipment through PAT (Perform, Achieve, Trade) would help states in reducing peak load, flatten load curve and thus help in reducing energy consumption. Improvement in operation efficiency would enable the DISCOMs to borrow at cheaper rates in future, for their infrastructure development and improvement of existing infrastructure.

The ultimate benefit of signing the UDAY MoU's would go to the people of respective states. Reduced levels of transmission and AT&C losses would mean lesser cost per unit of electricity to consumers.

The 24x7 Power For All Plan:

As on date, in partnership with all the States/UTs, 24x7 documents have been finalized except Uttar Pradesh, out of which, 28 States have already signed the documents.

Implementation of the plan envisaged in the document is under progress, which is being jointly monitored by the State and the Central Government. Successful implementation of these plans will ensure reliable and affordable power round the clock to all the consumers.

The plans aim to provide each household access to electricity, 24x7 reliable power supply and adequate supply to agricultural consumers as per state policy by 2019.

The plans for each State/UT envisions reduction of AT&C losses by increasing the collection efficiency and effective metering so as to achieve financially viable 24x7 Power Supply.

It also emphasises on the development of transmission and sub transmission network, which plays a vital role in providing round the clock power supply.

"Connecting the Unconnected" or electrifying thousands of villages in remote areas, where power was still a dream, is seen as another big reform initiative of this government. In his address to nation on the Independence Day, the Prime Minister had announced a plan to electrify the 18,452 villages of India within 1000 days i.e. by 01st May, 2018 and on August 15, 2015 pledged to provide electric poles, electric wires and electricity to 18,500 villages within the next 1000 days.

The Ministry of Power decided to take this project on a mission mode and announced a strategy for electrification of villages almost a year ahead of the deadline . As part of the strategy, the implementation schedule was reduced to 12 months and the entire village electrification programme was divided in 12 stage milestones with defined timelines for monitoring.

Today, 8,681 villages have already been electrified as on July 7th, 2016 and out of remaining 9,771 villages, 479 are uninhabited, 6,241 villages are to be electrified through grid, 2,727 villages are to be electrified through off- grid where grid solutions are out of reach due to geographical barriers and 324 villages are to be electrified by State governments.

In order to expedite the progress further, a close monitoring is being done through Gram Vidyut Abhiyanta (GVA) and various actions are also being taken on regular basis like reviewing the progress on monthly basis during the RPM meeting, sharing lists of villages which are at the stage of under energisation with the state Discom, and identifying the villages where milestone progress has been delayed. The village electrification programme is being implemented under **the Deen Dayal Upadhyay Gram Jyoti Yojana (or DDUGJY).**

The story of reforms initiated by the government would be incomplete if one did not touch upon the success of energy efficiency measures under the government's **UJALA or 'Unnat Jyoti by Affordable LEDs for All' programm**e. As energy saved is energy generated, the unassuming strides made by this government through energy efficiency measures are beyond anybody's imagination.

The state-owned Energy Efficiency Services Ltd (EESL) that two years ago used to distribute around 6 lakh LED bulbs a year is today distributing over Rs 8 lakh bulbs a day—a record of sorts by any standards. The UJALA or 'Unnat Jyoti by Affordable LEDs for All' programme of the government being led by EESL, involves replacement of incandescent lamps/CFL bulbs with LED bulbs to save energy and reduce the bills of customers.

It is pertinent to note here that even the 24x7 documents entails a plan for increasing generation through renewables and energy efficiency measures which suggests replacement of Incandescent lamps/ CFL bulbs with LED bulbs under UJALA programme.

Under the UJALA Programme, EESL has already sold and distributed over 12 crore LED bulbs and through UJALA, India is headed for the top slot in the global LED market, which will replace 77 crore bulbs with energy efficient LED bulbs by 2019. Over 9 crore LED bulbs were distributed in 2015-16, about 150 times higher than 6 lakh in 2013-14.

Under its street lighting programme, EESL is replacing conventional street lights with LEDs as part of an innovative plan of "pay as you save". For instance, in the street light LED projects, the cost of replacing conventional street lights with LED lights is being recovered over a period of time by way of consequent reduction in energy and maintenance costs of the municipalities.

After spreading the word in India, the "pay as you save" model of Energy Efficient Services Limited is being looked at by developed countries like the US and Canada. Besides, EESL is also in talks with neighbouring countries like Nepal, Sri Lanka, Bhutan and Maldives to expand its UJALA programme.

Another innovative scheme of this government has been the distribution of SIM enabled mobile phone connected smart energy efficient agricultural pumps to farmers and replacing the age old agricultural pumps. These smart agri pumps give Indian farmers the advantage to sit in the comfort of their homes and operate pumps through mobile phones. Distribution of energy efficient fans, tube lights and Air conditioners are some other initiatives by EESL.

From announcing UDAY (Ujwal DISCOM Assurance Yojana) to boosting domestic coal supply, to ramping up the country's ailing transmission networks offering subsidized gas to plants, introducing UJALA programme to replace incandescent lamps/CFL bulbs with LED bulbs to save energy and reduce electricity bills, several initiatives have been introduced in these two years.

Domestic coal supply has improved and international coal prices have fallen over the last two years. Thermal power, which accounts for approx 70 per cent of the country's power generation, rose around 5 per cent to 943 billion units in 2015-16.

The country's thermal power capacity has shot up more than 11 per cent to 2,10,675 MW by March 2016.

According to the government's targets, the country's transmission lines network will be expanded to a further 3,64,900 cKm by March 2017. The addition of 2,49,400 MVA transformation capacity during 2012-16, has been the highest ever in the country's history.

The focus imparted by this government on renewable power generation is another noteworthy initiative of the government that has been recognised globally. On its way to become the World's Clean Energy Capital, India is currently running the world's largest renewable energy expansion programme with a target to increase overall renewable capacity by more than 5 times from 32,000 MW in 2014 to 1,75,000 MW in 2022.

Alongside, by taking a leadership role in the International Solar Alliance of 121 countries and organising RE-Invest 2015, the world's largest renewable financing meet, the government has already laid the foundations for massive growth in this sector. During a recent visit, the group president of the World Bank, Jim Yong Kim congratulated the government for its reform initiatives and announced over $1 billion support for India's solar power projects.

Thanks to the ongoing pace of reforms in the power, coal and renewable energy sector, a country where perpetual fuel shortages marred generation plans of power companies, today boasts of coal and power surpluses.

In this story on scarcity to surpluses, power shortages are clearly a talk of the past. Record capacity addition of around one-fifth of current conventional power capacity and solar power capacity addition of 157 per cent in the last two years led to a boost in power generation.

Today, not a single power plant faces shortage of coal as opposed to the impending power crisis in 2014 when two-thirds of major power plants had critical coal stocks of less than 7 days. Working on war footing, our government completely eliminated coal shortage in the country.

In line with achieving the target of doubling coal production to 100 crore tonnes by 2020, the last two years witnessed the highest ever growth in coal production of 7.4 crore tonnes.

For a common man, all these initiatives and reforms are brilliantly presented and simplistically displayed, but behind each new and innovative idea is a team working round the clock, tirelessly, meticulously and whole heartedly to help our country attain its full potential and its countrymen receive 24x7 maximum benefits. ❑

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YOJANA WEB- EXCLUSIVES

Yojana publishes articles on various topics in its 'Web-Exclusives' column for the benefit of its readers on the website of Yojana : www.yojana.gov.in. Announcements about the articles under the Web-Exclusives section are carried in the Yojana magazine of the month.

We are carrying the following articles under the Web-Exclusives section of Yojana for August 2016.

- Goods and Service Tax-The 'flawless' paradigm and thereafter — By Debdulal Thakur
- Bio fuels as promising substitutes for high carbon energy sources — By Mayanglambam Ojit Kumar Singh
- Energy at Threshold-Imminent Role of Infrastructure as Energy Carriers — By Megha Jain

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India Skills-New Initiatives Launched

President Shri Pranab Mukherjee inaugurated the first edition of "India Skills Competition" on the occasion of World Youth Skills Day i.e. 15th July 2016, which is also the first anniversary of Skills India Initiative.

Ministry of Skill Development and Entrepreneurship (MSDE) also announced the launch of five major initiatives - Pradhan Mantri Kaushal Vikas Yojana 2.0, India International Skill Centres, India Skills Online and a Labour Management Information System (LMIS).

The 2.0 version of the Pradhan Mantri Kaushal Vikas Yojana (PMKVY), has an outlay of ₹12,000 crore to train a total of 1 crore youths over the next 4 years (April 2016 to March 2020). Last year's edition of the scheme saw training of close to 20 lakh youth in 2015-16, while the overall achievement of the Ministry stood at 1.04 crore trainings across ministries.

50 India International Skill Centers were also announced that are slated to be opened by the end of this year. In the initial phase, 15 centres have been launched by the President, across the following eight sectors: Domestic Workers, Healthcare, Retail, Security, Capital Goods, Automotive, Construction and Tourism and Hospitality. These will be set up through National Skill Development Corporation (NSDC) and will be implementing the Pradhan Mantri Kaushal Vikas Yojana (PMKVY) and Pravasi Kaushal Vikas Yojana (PKVY) to the youth seeking global mobility for jobs. The Ministry of External Affairs (MEA) will provide support for Pre-Departure Orientation Training, which includes language and soft skills training modules. The first 15 will be the following States: Uttar Pradesh (6), Kerala (2) and one each in Jharkhand, Bihar, Andhra Pradesh/Telangana, West Bengal, Maharashtra, Punjab and Rajasthan.

A single window platform to aggregate supply and demand trends in the Indian skill development ecosystem, referred to as the National Labour Market Information System (LMIS) - www.lmis.gov.in was also launched. LMIS is an integrated set of institutional arrangements, procedures, mechanisms and data systems designed to produce labour market information as per global standards and best practices. Another initiative of the Ministry leveraging technology to reach millions of skill seekers - India Skills Online (www.indiaskillsonline.com), an online platform for learning skills of choice, was also launched. With the introduction of Online Skill-learning environment, the whole nation potentially becomes a classroom. India Skills resolves to bridge the digital divide by providing basic digital literacy opportunities to all skill-seekers, thus enabling them to become more aware, and better suited for the work environment of the day.

India Skills is a national competition steered by Ministry of Skill Development & Entrepreneurship (MSDE) and National Skill Development Corporation (NSDC) to select the best talent who will lead India's participation at the biennial World Skills International Competition scheduled at Abu Dhabi in 2017.

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