Energy Strategies for India under Perspective Energy Scenario

V. A. Kulkarni[#1], P. K. Katti[#2]

[#1]Padmashree Dr. D Y. Patil, Institute of Engg. & Technology, Pune, India

[#2]Dr. Babasaheb Ambedkar Technological University (BATU), Lonere, India

[1]vjykulkarni58@yahoo.com; [2]pk_katti2003@yahoo.com

Abstract- **Energy Supply – demand gap is increasing in almost all parts of the world. With depleting energy resources, the energy scarcity has become a global problem. Global supply-demand gap during the year 2010 was 11.35% as against 5.32% in 2001. Industrialisation and increased use of energy may result in energy crisis and thus needs to be addressed with priority. With seemingly poor growth rate of 5.6% of fuel resources it does not match the power requirement. For India, the energy scenario is not different. The demand has grown by 54% in the last five years and the average gap is 9.1% with net capacity addition of just 6.5%. This paper highlights the global and Indian energy scenario along with the need for energy studies in the wake of energy import situation. Further, the required energy policies and strategies to be implemented to tackle the energy challenges under the Indian scenario have been discussed.**

Keywords- Energy Scenario; Energy Challenges; Energy Strategies

I. INTRODUCTION

Energy is the basic necessity of human beings. With globally increased quality of life and advancements in technologies, the requirement of energy is increasing every year. As regards to global energy, there is record growth in all aspects like, energy consumption increased to 5.6% in 2010, oil to 3.1%, oil production to 2.2%, crude runs to 2.4%, natural gas consumption to 7.4%, coal consumption to 7.6% and increased imports in major countries. But proved reserves of oil from 1990 to 2010 was 1003.2 to 1383.2 thousand million barrels, at an annual rate of increase of 3.6%. This is superseded by the consumption which is 5.2% [1].

India is home for 17% of the world's population. The requirement of its energy is unquenchable for many years. India is facing significant challenges in achieving reduction in power generation while also meeting the predicted growth in demand and supply. More efficient use of electricity in India would be greatly helped by adequate policies, regulations and standards encouraging the use of more efficient appliances and systems. This should be supplemented by a combination of various energy strategies. Various aspects of necessity for energy studies, energy scenario, energy strategies, policies and regulations have been discussed in the following sections.

II. NEED FOR ENERGY STUDIES

Demand for energy is rising rapidly with growing population, industrialisation and changed life style. Energy is needed for all the energy sectors like transport, industries, domestic and commercial. This results in increase in per capita consumption [2]. Non renewable energy sources like Coal and other fossil fuels are fast depleting. Today, 85% of primary energy comes from non renewable, and fossil sources (coal, oil, etc.) are diminishing leading to exhaust of resources. In the last two hundred years, 60% of all resources have been consumed [3]. It is estimated that the world will need to produce far more energy in 2030 than it does today. World energy demand may expand by 36% between 2008 and 2030 an average rate of increase of 1.2% per year. In America, with power accounting for 40% of CO_2 emissions, the U.S. faces challenges in producing clean electricity [4].

Globally, the gap between the supply and demand is rapidly increasing which may pose challenge to the world. It is required that generation should match the demand at generation side, efficient transmission in transmission network and at distribution side by reducing the demand using efficient use and effective management of energy. This necessitates the need for the extensive study to be made for saving of energy at all the sectors and stages of energy. In any case, reliable and affordable energy is expected from the end user.

III. ENERGY SCENARIO

Energy scenario deals with the energy expected to be consistent with the possible futures. It explains the past event present status and future trends. Hence it helps in planning and execution of energy projects.

A. Global

Oil is the leading fuel having 33.6% share of global consumption. But because of increase in its volatile price, it is losing the market. Table I shows the share and growth rate of the fuels. Global energy consumption growth rate is 5.6% in 2010, the highest rate in 1973[1]. Energy demand is increasing at an annual average rate of 1.6% from 2004 and expected to reach more than 50% till 2030. But at the current rate of production, global coal reserves are estimated to last for almost another 150 years.[4], [5], [6].

Energy demand is increasing at an annual average rate of 1.6% from 2004 and expected to reach more than 50% till 2030. But at the current rate of production, global coal reserves are estimated to last for almost another 150 years[4], [5], [6]. Competition for fossil fuel resources is a source of international tension, and potentially a matter of conflict. Average world per capita energy consumption is 2782kWh. Table II shows nation wise per capita consumption in the years 2006 and 2010. Majority of nations show consistently the increasing trend in supply - demand gap [7, 8].

TABLE I GLOBAL TYPE OF FUEL –SHARE AND GROWTH

Sl. No.	Type of Fuel	Global Share (%)	Growth Rate (%)
1.	Oil	33.6	3.1
2.	Coal	29.6	7.6
3.	Hydro	18.5	5.3
4.	Nuclear	7.0	2.0
5.	Natural gas	3.00	7.4
6.	Renewable	1.8	15.5
7.	Other	7.1	1.5

TABLE.II NATIONWISE PER CAPITA CONSUMPTION

Sl. No.	Nation	Per Capita Consumption (kWh)	
		year 2006	*year 2010*
1.	Brazil	2078	2200
2.	China	2041	2631
3.	U K	6226	6325
4.	Russia	6122	6134
5.	Israel	6711	6822
6.	Japan	8252	8320
7.	U S	13574	13651
8.	Canada	16724	16822
9.	Iceland	31328	51259
10.	India	597	813

Table.III and Fig.1 show the increasing global supply-demand gap for last ten years. Presently, the gap in supply and demand is 11.35% at global level.

TABLE III GLOBAL SUPPLY- DEMAND GAP

Sl. No.	Year	% of Gap
1	2001	5.32
2	2002	5.95
3	2003	6.8
4	2004	7.2
5	2005	7.91
6	2006	8.53
7	2007	9.27
8	2008	9.98
9	2009	10.9
10	2010	11.35

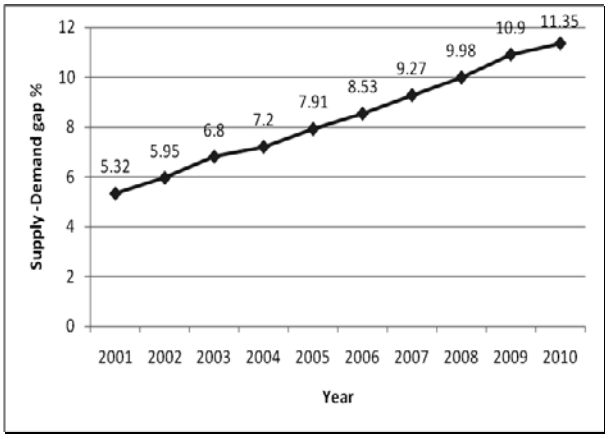

Fig. 1 Global supply-demand gap

B. India

India is a typical, developing energy-importing country. Because of its rapid energy demand growth, which surpassed its growth in domestic energy production, its energy imports are growing fast. Thus the supply-demand gap shows consistently increasing trend. Indian power system installed generating capacity in 2011 was 1, 86,654.62 MW. The total power generation capacity addition planned for the XIth and XIIth five year plan (2007-2017) is around 1,50,000 MW of which approximately 10% (i.e. 15,000 MW) has been aimed as the share of renewables such as wind, solar, biomass and small hydro. India is a tropical country and has abundant solar insolation for almost 300 days of the year. Since the seasonal variation is marginal solar energy can be harnessed economically throughout the year. Table IV and Fig. 2 show total installed capacity of India from 2007 indicating the increase in the yearly capacity addition and and average of 6.5% for five years and Table V and Fig. 3 indicate the share of various types generation mix of India[9],[10],[11],[12]. Similarly, Table VI and Fig. 4 indicate the energy demand, supply and gap for the country.

TABLE IV INSTALLED CAPACITY – INDIA

Sl. No	Year	Installed Capacity(MW)	Increase in %
1.	2007	132329	-
2.	2008	143061	7.5
3.	2009	147965	3.3
4.	2010	159398	7.1
5.	2011	173626	8.2

The demand has exceeded the available system capacity every year. Average gap is 9.1%. There is consistent increase in the demand from 481269 MU in 2007 to 880000MU in 2011 amounting to 54.7% increase in five years.

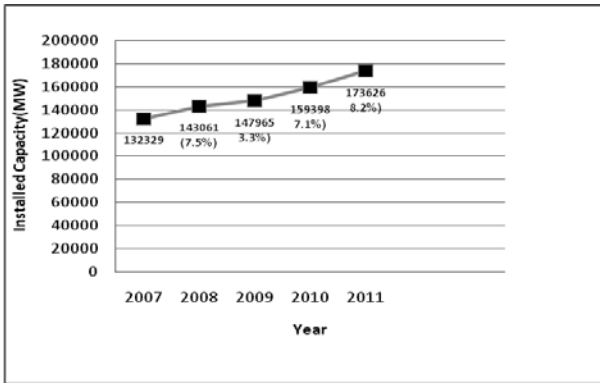

Fig. 2 India installed capacity year wise

TABLE V INDIA-SHARE OF GENERATION MIX

Sl.No	Type of Generation	Power(MW)	%
1.	Thermal(coal))	93918	54
2.	Hydro	37567	22
3.	Renewable energy	18455	10
4.	Gas	17706	10
5.	Nuclear	4780	3
6.	Diesel	1200	1
Total		**173626**	**100**

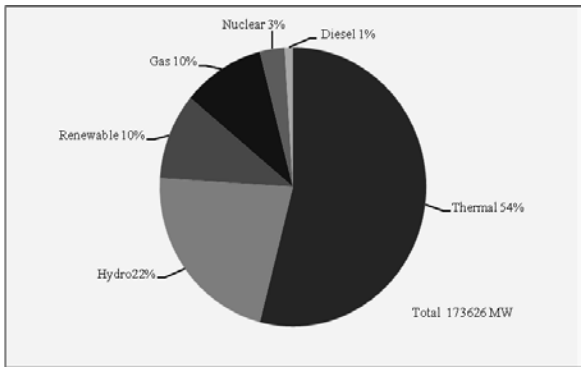

Fig. 3 India – share of power generation mix.

TABLE VI INIDIA SUPPLY-DEMAND GAP

Sl. No	Year	Demand (MU)	Supply (MU)	Gap% (Deficit)
1.	2007	481269	442985	8.0
2.	2008	514886	459077	10.8
3.	2009	549257	495821	9.7
4.	2010	861591	788355	8.5
5.	2011	880000	804320	8.6

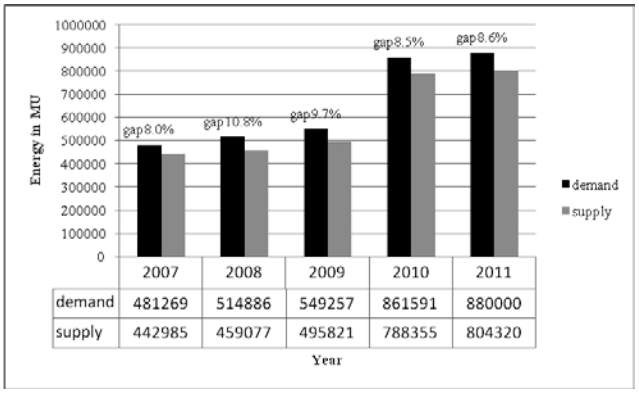

Fig. 4 India supply- demand gap

Status of peak power has been shown in Table.VII and Fig. 5. The demand for peak power has increased from 100715MW in 2007 to 119437 MW in 2011 with increase of 84.3% and average deficit of 13.04%.

TABLE VII INDIA PEAK SUPPLY-DEMAND GAP

Sl. No	Year	Demand (MW)	Supply (MW)	Gap% (Deficit)
1.	2007	100715	86818	13.8
2.	2008	108866	90793	16.6
3.	2009	109809	96785	11.9
4.	2010	119166	104009	12.7
5.	2011	119437	107286	10.2

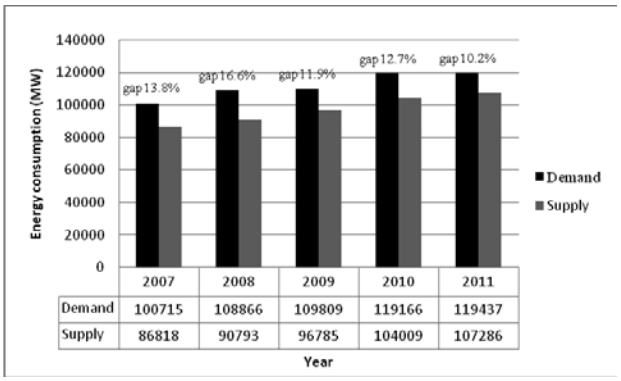

Fig. 5 India- peak supply-demand gap

From the data, it may be noted that an average supply-demand gap is 9.1% and the peak gap is 13.04% on the deficit side whereas the capacity addition is only 6.5% indicating that there is no substantial increase in the capacity resulting in mismatch in supply and demand. Table.VIII shows the anticipated power supply position for the year 2012 [11], [13].

TABLE VIII INDIA- ANTICIPATED SUPPLY FOR THE YEAR 2012

Sl.No.	Particulars	Energy (MU)	Peak Power (MW)
1.	Requirement	933741	136193
2.	Available	837374	118676
3.	Shortage	96367	17517
4.	Percentage	10.3%	12.9%

IV. POLICIES AND REGULATIONS

A. Need

The Energy Scenario presents a radical departure from current system of energy use. It postulates the fastest possible deployment of energy efficiency and sustainable energy options. It may not be able to deliver on the current context comprehensively. Instead, an adapted political and economic environment must be established to allow these developments to happen in the economic marketplace. This will require detailed analysis of possible instruments and current best practices at regional level. Therefore, scenarios supported by policies and regulations serve the purpose of generating clear concepts of the energy. It is accomplished by two major players [8].

- *Public bodies:* creation of the correct framework and investment in projects and infrastructure and formulation of guidelines.
- *End users:* Operating and adoption of best practices for efficient energy use.

By setting and maintaining the policy frameworks, energy related issues can be addressed. Governments are the critical participants in the development and popularising the energy technologies to the nation. The objective of policies and regulations is to reduce the supply-demand gap, streamline the efficient use of energy by incentivising and ensuring reliability. Such framework should be a top priority of energy diplomacy.

Following are five fundamental elements of framework:

- *Robust and scientifically sound technology*: This will enable the optimization of the present resources and the development of a full range of new energy sources. Joint ventures and partnerships foster the sharing of technology and best practices.
- *Increased energy efficiency:* This is the cheapest and most abundant form of new energy. Energy conservation and efficiency must be part of energy policy and should incorporate a wide range of behaviours and standards.
- *Responsible development:* The production and use of energy must serve as a platform for broader economic growth and social well-being. Economic benefits of energy flow to all stakeholders, including the poor and the vulnerable should be ensured.
- *Open markets:* Transparency and the free flow of energy trade and investment can occur only on a level playing field. Removing market barriers can significantly increase production and moderate the price volatility we face today.

- *Sound policies:* To encourage investment across the entire energy portfolio, sound and consistent policies must be enacted. These policies should promote stable, predictable fiscal and regulatory regimes, protect the sanctity of contracts and strengthen the rule of law.

B. Global Perspective

Some countries like Brazil, Canada, Colombia, U.S., China, India, Australia, New Zealand, and South Africa have implemented subsidies, soft loans or tax exemptions as policy measure.

1) Europe:

The European Union Member States have agreed on renewable energy targets, increasing the share of primary energy from 6 percent in 1995 to 12 per cent by 2010, and increasing the proportion of electricity generated from renewable sources from 14 percent in 1997 to 22 per cent in 2010. The Latin American and Caribbean Initiative, signed in May 2002 in São Paulo, included a target of 10 percent renewable energy by 2010. Germany passed Renewable Energy Sources Act in 2000 to establish a framework for doubling the market share of renewable energy sources by 2010 [14]. The UK government's 2010 'Green Deal' Proposal aims to energy-efficiency measures. The goal is to establish a framework to enable private firms to offer consumers energy efficiency improvements to their homes, community spaces, and businesses at no upfront cost, and recoup payments through a charge in instalments on the energy bill [15].

2) U.S.A :

The Energy Policy Act of 2005 (EPact) serves as the first comprehensive national energy legislation. It has influence on energy efficiency; renewable energy development; the type of fuels used in the vehicles of the future and regulations of energy related matters. U.S. Department of Energy (DOE) on 20 June 2011 recognized the publication of ISO 150001/50001, a new global energy efficiency and energy management standard which will help organizations worldwide save money in their buildings and industrial facilities. U.S. Secretary of Energy Steven Chu on 11 February 2011 detailed President Barrack Obama's $29.5 billion Fiscal Year 2012 budget request for the Department of Energy under Industrial Technology Program (ITP) [16].

3) China:

Energy Conservation Law was passed in 1997. Standards and regulation of buildings were implemented in 2005. State council has given more importance to energy efficiency measures by incentivizing. Medium and long time objectives have been formed to achieve till 2020, reduction of use of coal to around 60%, control the dependence on imported oil to less than 60% and ensure renewable energy generation and utilisation [17].

4) Australia:

Out of total oil demand, 70% is met by the country's own production and 30% is imported. The breakdown of energy demand shows that 40% is covered by coal, 55% by oil and gas and remaining 5% by other alternative resources. The policy of the government is aimed at reducing the rate of growth of Australian dependency on imported oil [18].

5) Russia:

In the year 2000 the Russian government approved the main provisions of the Russian energy strategy to 2020, and in 2003 the new Russian energy strategy was confirmed by the government. The Energy Strategy document outlines several main priorities: an increase in energy efficiency, reducing impact on the environment, sustainable development, energy development and technological development, as well as improved effectiveness and competitiveness. Energy framework consists of special, targeted, specific law on energy efficiency and federal law on the support of renewable energy sources.

It may be noted that all the nations in the world have some policies, laws, acts or regulations for energy related subject. Although the nature and type of the policies may differ, the objective is the formulations to save the energy in one way or another.

C. Indian Perspective

India was among the first few countries in the world to provide for the protection and improvement of the environment in the national constitution, and it has taken several steps in designing policies and legislation to overcome environmental problems. With regard to climate change, India has undertaken numerous response measures that are contributing to the objectives of the United Nations Framework Convention on Climate Change (UNFCCC). The strategies/measures include an emphasis on energy conservation, promotion of renewable energy sources, abatement of air pollution, afforestation, wasteland development, and fuel substitution policies [19].

India's energy sector is administered and managed through a complex multi-ministerial structure that involves the Union Ministry of Power (MoP), the Ministry of Coal, the Ministry of Petroleum and Natural Gas (MPNG), the Ministry for New and Renewable Energy (MNRE), the Department of Atomic Energy (DAE), the Planning Commission, State Government Power Ministries and other government bodies and agencies such as the Bureau of Energy Efficiency (BEE) [20,21, 22].

Following are some initiatives:

1) Policy under the Five-Year Plan:

The Eleventh Plan (2007-12) includes some specific objectives relevant to climate change, including increasing forest cover by 5%, reducing energy intensity by 20% by 2016-17.

2) Energy Conservation:

The Energy Conservation Act-2001 (ECA2001) and Electricity Act-2003 (EA2003) are the most important multi-sectoral legislation in India with respect to energy related issues. They are intended to regulate energy consumption. They specify energy consumption standards for equipment and appliances and prescribe energy consumption norms and standards for consumers, energy conservation codes for efficient use of energy in commercial buildings, industries and other establishments. They also establish a compliance mechanism for energy consumption norms and standards through energy audits by accredited auditors.

Under ECA2001, Bureau of Energy Efficiency (BEE) was established in 2002 to provide a regulatory body at the sectoral level. BEE is an autonomous body that is working under Ministry of Power (MOP). The primary objectives of BEE are to improve the energy efficiency and reduce the energy intensity of the Indian economy through various

regulatory and promotional instruments. In this regard, it is required to develop policy and strategies with a focus on self-regulation and market principles for all sectors of the economy. Further, BEE is empowered to establish a compliance mechanism to measure, monitor and verify energy efficiency in individual sectors. The legal provisions of the Energy Conservation Act of 2001, the Electricity Act of 2003, and a range of national electricity, tariff, and integrated energy policies provide much of the legislative and policy framework for the power sector in the country, along with the Action Plan for Energy Efficiency.

The EA 2003 has progressive framework for the development of the electricity sector in the country. Its main objectives are promoting competition, protecting the interests of consumers, supplying electricity to all areas, rationalizing electricity tariffs, and ensuring transparent policies regarding subsidies. It also requires State Electricity Regulatory Commissions to specify a percentage of electricity that the electricity distribution companies must procure from renewable sources. Several Commissions have already operationalised this mandate and also notified preferential prices for electricity from renewable energy.

3) The National Electricity Policy and the Tariff Policy:

They have been notified under the provisions of the Electricity Act, by the Ministry of Power in 2005. The objective is development of the power system based on optimal utilization of resources such as coal, natural gas, hydropower and renewable sources of energy. It aims at achieving the following objectives [22]:

a. access to electricity – to be made available for all households in next five years.

b. availability of power - demand to be fully met by 2012. Energy and peaking shortages to be overcome and adequate spinning reserve to be available.

c. supply of reliable and quality power of specified standards in an efficient manner and at reasonable rates.

d. per capita availability of electricity to be increased to over 1000 units by 2012.

e. achieving minimum lifeline consumption of 1 unit per household per day as a merit by year 2012.

f. financial turnaround and commercial viability of electricity sector.

g. protection of consumers' interests

The policy seeks to address the following issues:

a. rural electrification.

b. generation

c. transmission

d. distribution

e. recovery of cost of services and targeted subsidies

f. technology development with research and development (R&D)

g. competition aimed at consumer benefits

h. financing power sector programmes including private sector participation

i. energy conservation

j. environmental issues

k. training and human resource development

l. cogeneration and non-conventional energy sources

m. protection of consumer interests and quality standards

V. ENERGY STRATEGIES FOR INDIA

Indian federal governance structure is such that each of India's states and union territories (UTs) has significant constitutional rights in the power sector. Most states and UTs have established a state-level ministry or department for electricity, and some also have ministries or departments for energy and their own policies under the central government framework [19]. Energy for sustainable development will depend on the more widespread, efficient use of existing technologies and innovative use. The energy strategies can be classified having their components as below [3]:

- short-term strategy
- medium-term strategy
- long-term strategy

Indian Government has accorded very high priority to the target of 'Electricity for all by 2012'. Following are some strategies:

A. Non Conventional and Renewable Energy

Develop and expand installed capacity base through non-conventional sources of electricity generation. There is a separate Ministry in the Government of India to exclusively focus on this important area of power generation. Ministry of New and Renewable Energy (MNRE) has set a target of achieving at least 25,000 MW capacities through various non-conventional sources, by the year 2012. The Ministry of Power (MOP) has been supporting various renewable energy programs for the promotion of biogas plants, solar thermal systems, photovoltaic devices, biomass gasifiers, etc. Integrated Rural Energy Program (IREP) are being implemented for several years for the popularising the energy initiatives. From 2009 for three years, about 2,000 megawatts of renewable-electricity capacity has been added in India every year, bringing the total installed renewable capacity to over 11,000MW. Of this, a little over 7,000 megawatts is based on wind power. India now has the fourth largest installed wind capacity in the world.

B. Distribution Sector Reform

MOP has launched two main programs aimed at improving distribution network.

1) Rajiv Gandhi Grameen Vidyutikaran Yojana, (RGGVY):

The project is meant for the rural electrification considered as an important instrument to bring about growth, about 62,000 villages have been electrified and about sixty lakhs (6 million) below poverty line (BPL) households have been given free electricity connections under this scheme.

2) Accelerated Power Development and Reform Programme (APDRP):

It is being implemented through the X^{th} Plan (2002-07) aiming at comprehensive reform of electricity distribution in urban/industrial centres. Revamping, augmenting and modernizing the distribution network and system for

improved reliability of power supply, reducing technical and commercial losses, and improving financial health of distribution utilities are the main objectives of the scheme.

C. National Grid

The energy potential in the country is concentrated in certain pockets. Coal reserves are located in a few states and similarly huge hydro-electric potential is located in a few states. This poses a challenge to embark upon massive inter-regional transmission capacity.

D. Augmentation of National Grid

Intra-regional expansion of transmission capacity is linked to generation projects. Inter-regional connectivity has been planned with hybrid systems, consisting of HVDC, Ultra High Voltage AC (765 KV) & Extra High Voltage AC (400 KV) lines. Present Inter-regional transfer capacity is 9,500 MW, being enhanced to 17,000 MW by 2007 and 37,000 MW by 2012.

E. Supply Side

On the supply side, the mismatch between demand and supply is so large that India can ill-afford to choose one option in preference to the other. For several years, in fact may be for next few decades, India would need to exploit all possible options to create reasonably large capacity base on the energy side. It needs to expand manifold the coal production, extract through all possible means, the oil and gas reserves, wherever possible, resort to import of coal, acquire coal and gas reserves abroad, will need to continue substantial dependence on import of oil, and exploit fully the large hydro electric potential which is of the order of over 1,50,000 MW. Only about 32,000 MW i.e. about 20% of the hydroelectric potential has been exploited so far. Increase in the capacity base of power generation through dependence on the coal reserves of the country, which are of the order of 200 billion tones is inevitable. Nuclear programme has proved to be effective and successful. After initial teething problems in mid eighties, from early nineties, the nuclear power plants have demonstrated to be utilized at substantially high level of availability and efficiency and this is one of the important options that India is pursuing. Gratifyingly, a number of companies in India have discovered huge gas reserves, both on the Western, and more particularly, toward the Eastern coast. Besides, a number of LNG terminals have also been developed and are being developed so that the use of gas could be supplemented through import of Liquefied Natural Gas. India is one of the very few countries which has been successful in employing wind turbine technology and today of the total capacity of 1,25,000 MW in the country about 5% is constituted by the various non-conventional sources of generation, wind being the largest contributor. The National Hydro Energy Policy has resulted in the accelerated addition of hydropower in India, which is now over 35,000 megawatts.

F. Distribution Side

Distribution system is an important component of power system. There is substantial scope for energy studies and saving as there are many energy consuming components at distribution side (end user). On the basis of random sampling studies conducted on various segments of energy consumption, it has been established that over 20% of energy is wasted because of in-efficient consumption. Implementation of energy conservation measures, energy audit (EA) and energy management (EM) certainly improves the system condition. As per EA2003, annual EA is mandatory for an HT consumer. But this has not been successful as EAs are not carried out in true sense. EA reports are submitted to the authorities for the official purpose. Similarly, pilferage (leakage) and efficient metering are the issues to be addressed [13].

G. Fuel Pricing

Energy price does not reflect true cost to society. Energy prices are undervalued and energy wastages are not taken seriously. Pricing practices in India like many other developing countries are influenced by political, social and economic compulsions at the state and central level. The Indian energy sector offers many examples of cross subsidies e.g., diesel, LPG and kerosene being subsidised by petrol, petroleum products for industrial usage and industrial, and commercial consumers of electricity subsidising the agricultural and domestic consumers. Regulations are to be implemented in coal, oil and gas sectors for purchase, pricing etc [1].

H. Regional Exchanges

As short term strategy, efforts were made for optimal utilization of the available electricity in the country by enhancing inter-regional/ inter-state exchanges. The total inter-state and inter-regional exchange during the year 2010-11 was 52269 MU which was 33% more than the previous year. This helped in mitigating the shortages in various constituent States/ systems [11].

I. Capacity Addition

As long term strategy, it is planned to install generation plants of 82000MW during XIIth five-year plan (2012-17). As seen from Table.VIII, the shortage of 17517MW for the year 2012 will be met under this plan [18].

National Action Plan on Climate Change (NAPCC)

NAPCC comprises of national missions to facilitate the use of energy alternatives and energy efficiency. Following are the missions under NAPCC [19]:

1) National Solar Mission :

a. Target of production of 20 GW of grid - connected solar power, 2 GW of off grid solar applications, 20 million of solar water collectors, and 20 million solar lighting systems are to be deployed by the year 2022. Generating 1000 MW of solar power per year to be connected to the national grid and contribute at least 10% of India's power from harnessing the solar energy.

b. Strengthen India's manufacturing capability for PV modules and reach 4 GW to 5 GW by 2020. In addition, a major R&D programme should be launched to improve the efficiency of existing applications, reducing the costs for the balance of system (costs for required equipment in addition to the PV module) and addressing such issues as the variability in daily insulation and land requirement for solar energy.

2) National Mission for Enhanced Energy Efficiency:

It is based on initiatives to enhance energy efficiency, in addition to already existing programmes. A market based mechanism is introduced to enhance energy efficiency in large industries and facilities, through certification of energy savings. These saving could be traded. Energy intensive industries have been designated like paper, textile industries. Use of energy efficient appliances and equipment are encouraged in these industries. Mission involves the

mechanisms to be created that would help demand side management (DSM) programmes in all sectors by capturing future energy savings.

J. Rural Electrification Policy (REP)

It was established in 2006 under provisions in the EA 2003. It sets out ambitious proposals to provide reliable electricity at reasonable rates to all households by 2012. Nearly 80000 villages are to be electrified. Rural electrification is primarily the responsibility of each state and UT government. This is supported by central government policy funding, provided through various financing schemes administered by the Rural Electrification Corporation under the Ministry of Power. Akshay Prakash Yojana, a scheme in Maharashtra State prevents use of agricultural pumps during peak hours leading to load management and ensuring power quality [20].

K. Awareness Programs

Training, talks, seminars, discussions and such programs are supported by state and Central Governments. These are held in rural/urban areas, educational institutions and industries. State Government owned, 'Energy Development Agencies (EDA)' are the nodal organisations to organise such programs with the support from the public institutions.

VI. CONCLUSIONS

Indian energy sector is complex in nature having vast area, with many challenges and tremendous scope for the studies. In the present condition, India's supply should meet the alarmingly increasing demand and reduce the dependency on imports. Reduction in the supply-demand gap is possible by following methods:

- by national policies and regulation frameworks
- initiatives to be taken in energy sectors and organisations coming under them
- individual and group efforts

The Government reforms and acts have opened up many avenues to improve the condition. EA2003, ECA 2001various plans and missions have allowed private participation by throwing competition between public sector and private undertakings. Hence the technical and administrative environment has improved bringing about improvement in overall system efficiency. However, the issues like EA, pilferage and metering need to be successfully solved and addressed efficiently. Various energy consuming sectors including industry have taken up the issue of energy conservation as an important matter in their establishments. Many effective energy saving programs being implemented resulting in earning of the revenue at organisation level and avoiding the increase in generation capacity at national level. Awareness, training and educational programs have generated the attitude among the society to save the energy from personal to group, locality town and city levels. Providing electricity access for poor rural villages also requires immediate attention. Continuing and expanding programmes to develop decentralised solar systems with storage, and other types of decentralised renewable supply options, could enable the achievement of this important goal. Renewable energy sources like solar and wind are good options with a large technical potential, and must be included in the strategy. In spite of many measures to popularise these technologies the degree of penetration is low. A much more ambitious approach is needed in this direction.

With all these discussion in conclusion, the authors feel that concerted efforts are needed for India to tackle the problem of ever increasing demand for the energy.

REFERENCES

[1] *BP statistical review of world energy*, June2011 www. bp.com/statistical review.

[2] S.Rao and B B Parulekar, *Energy Technology*, Khanna Pub., Delhi, India,2007, pp.20.

[3] *Energy scenario*, Bureau of energy efficiency (BEE), Government of India, www.bee_india_nic.in.

[4] International Energy Agency(IEA), "*World Energy Outlook 2009.*"

[5] World energy council 2011"*Global energy scenarios to 2050 and beyond*"

[6] World energy council 2007"*Survey of energy resources", by 2050*.

[7] World bank data – www. data.worldbank.org.

[8] *WWF the energy report 100% renewable energy*, WWF Internationalpub. 2011.

[9] V .A. Kulkarni and P.K.Katti "Efficient utilization of energy in industry – energy management perspective," *IEEE International Conference on 'Power Systems Technology (POWERCON2010) China, 24- 28 Oct 2010* Page – 259.

[10] V .A. Kulkarni and P.K.Katti 'Improvement of Energy Efficiency In Industries By Facility Based Energy Management,' *IEEE Int. Conf on* Energy, Automation and Signals(ICEAS2011), Bubaneshwar India, 28 to 30 Dec2011.

[11] Central Electricity Authority(CEA), Ministry of Power, Govt. of India, June2011 *"Growth of electricity sector in India from 1947-2011"*.

[12] Central Electricity Authority (CEA), Ministry of Power, Govt. of India, Jan2011 *"Power scenario at a glance"*.

[13] R V Shahi ' energy markets and technologies in India ' Keynote Address in Global Energy Dialogue at Hanover (Germany) on 25 April 2006.

[14] United Nations Development Programme, 2004. *"World Energy Assessment: Overview 2004 Update"*.

[15] World energy council (WEC) , www. worldenergy.org. "*WEC Survey 2011, Energy-Industry Executive"*.

[16] *IEEE* www.electripedia.us "*Electricity and energy policy"*.

[17] Research Centre for Sustainable Development, Chinese Academy of Social Sciences, China, "Uunderstanding China's energy policy economic growth and energy use, fuel diversity, energy/carbon intensity, and international cooperation", background paper,

[18] *Kerry P. McHugh, "Australia's energy policy", Volume 6, Issue 8, August 1981, pp. 803–807*.

[19] *Bharat H. Desai, "Strengthening Legal and Policy Frameworks for Addressing Climate Change in Asia: India", Center for International Legal Studies, SIS Jawaharlal Nehru University New Delhi, India.*

[20] Uwe Remme, Nathalie Tru deau, Dagmar Graczyk and Peter Taylor "Technology development prospects for the Indian power sector", information paper, International energy Agency(IEA), February 2011 pp41.

[21] Ram Ganesh Yadav, Anjan Roy, S A Khaparde and P Pentayya, " India's fast growing power sector", IEEE Power &Energy magazine July/Aug2005 pp39.

[22] National electricity policy – The gazette of India, Ministry of power, Govt. of India, 12 Feb. 2005.

Vijaykumar Annaji Kulkarni received his degree in Electrical Engineering (B.E.) from University Vishveshwaraiah College of Engineering, Bangalore, India in 1982 and Master of Engineering (M.E.) in Electrical Power Systems from Govt. College of Engg. Pune, India in 1994.

He is working as faculty member in Padmashree Dr. D.Y.Patil Institute of Engg .& Tech. Pune, India. He is member of IEEE and The Institution of Engineers (India). He has published many technical research papers at national and international level. He has organised many

technical events like summer schools, seminars. His areas of interest are energy conservation, management, DSM and application of energy technology for rural areas and industries.

Pradeep. K. Katti was born in 1961. He graduated from Mysore University's degree in Electrical Engineering (Power) from BIET-Davanagere in 1985. He obtained M.E (Control System) from Govt. College of Engineering of Pune University in 1991. He obtained Ph. D in Energy system from VNIT-Nagpur –India in 2007.

He has wide teaching experience, and presently working with Dr. Babasaheb Ambedkar Technological University as professor and Head in the Dept. of Electrical Engineering. He has guided projects at U.G. & P.G. and PhD research level. He has several Publications to his credit at international and national level through conferences, journal, magazines et