A Study for Building Segmented Energy Infrastructure and it's Financing Propositions to the Indian Cities

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***Abstract*— Today in India there is needs of around 150.000 MW of electric power to meet its current energy needs, but so far we are able to produce only about 90,000 MW (two thirds of its current need). Additional finances are also difficult to manage and infrastructure is often not available to make electric power reach to the remote areas. Heavy rostering in city areas has been a perpetual feature in some states. Many of the dwellers of small cities have come to depend on what is called an inverter and its associated battery based storage system to cope up with the frequent power outages. Looking from another perspective, these systems only lack the solar panels to become completely self contained power systems. Thus addition of solar panels to these will be only an incremental cost. By encouraging this approach several problems can be solved all the same time. First of all this additional investment will be from the users themselves. Next the power generated will be environmentally friendly and the regular power supply and the grid may need to be used sparingly. These storage based systems may become parts of Smart Grids of the future as they may be further evolved to feed power into the grid. Evaluation of the performance of these systems has been studied through simulation and the economics of the system has been investigated under various conditions for typical users. The proposed system has been compared with the early telecom systems in India that were based on land lines and could not be expanded fast enough. Later the privatized and decentralized wireless based approach provided the desirable solutions.**

***Keywords*— Energy, Renewable Energy, Solar Energy, Wind Energy, Bio-fuel, Bio-mass**

I. INTRODUCTION

Energy is the measure of the development of any nation. Booming economic growth, rapid industrialization and high standard of living of the global population demand more and more energy in different forms. Since the quantity of available energy from conventional resources is deleting day by day, development of newer or renewable energy technologies and improvement of conventional technologies become necessary to meet the energy demand in the future. While the quest for sustainable energy technologies persists to cater the need for energy, selective task group of research and development community across the globe review continually current energy consumption methodologies from energy conservation point of view and advocate for a good understanding of the mechanisms involved in every step of energy transformations from the primary thermal or mechanical energy to the end – use forms of energy like electricity for both the improvements and innovations of the technology. The world is undergoing a period of global climate change. Growing demand for energy despite limited fossil fuel reserves and growing environmental concerns due to increase emissions of carbon dioxide and methane, well-known green house gases, is undoubtedly the major challenge of the 21st century. It is of international importance that technological solutions can be brought to bear to solve these problems as well as providing alternative sources of power and energy.

To achieve a sustainable development, the origin and the use of energy have to be addressed, and advanced energy technologies for both fossil and renewable energy carriers have to be developed. The continuous rise of the petrol price and natural catastrophes in the past years, have made the public aware and increasingly sensitive to energy issues and their global warming impact. The Kyoto protocol is a ray of hope for mankind with new issues and challenges for scientists and engineers to increase their efforts in research on safe, efficient and sustainable systems. Therefore, we people have to develop and test the technical and economical availability of innovative energy technologies. There is need to think globally but act locally. The

adoption of new energy sources, energy carriers and better energy management will not only affect the energy market but also will have social economic and environmental impacts.

New energy technologies and in particular heating and cooling technologies are decentralized and will create markets and employment essentially at a local level and, therefore, will induce a modification of individual behaviour. From an economic viewpoint, new energy technologies are capital intensive sources energy and the present period is particularly interesting for the development of such technologies and systems due to relatively low cost of money and high cost of energy.

An estimation of energy demand of various sectors and techno economic and environmental assessment of alternatives are carried out. Non commercial energy constitutes 84%, met mainly by sources like firewood, agricultural residues, charcoal and cow dung, while commercial energy's share is 16%, met mainly by electricity, oil etc.[1]. The largest single user of bio-energy is the domestic sector, followed by industries. Increased shortage of wood fuels has forced many users to shift to substantial use of agricultural residues. Bio-energy users are faced with limited options of accessible and affordable fuels. Energy resources; renewable and non-renewable, energy demand (sector wise), environmental, data aggregation, data analysis (energy scenarios, techno economic analysis) and integrated plan are the various modules being incorporated in the Integrated Regional Energy Plan (IREP).

The energy scenarios module along with energy demand, transformation, techno-economic and environment module are used (in integrated module) to perform an integrated energy-environment planning exercise for a region (village / blocks/ / district / state). Environmental database is used automatically calculate environmental impacts of energy scenarios. Scenario analyses aids in creating a picture of the current energy situation and estimated future changes based on expected or likely plans and growth patterns. Base case or business-as-usual is based on present population growth, industrialization, agricultural energy requirement.

India today needs to have around 150,000 MW of power to meet its current energy needs, but it is able to provide only about two thirds of it. Additional finances are difficult to arrange and the infrastructure is often not available to make power energy, reach to the remote areas. Heavy roistering in city areas has been a perpetual feature in some states. Many of the dwellers of small cities have come to depend on what is called an ‘inverter’ and its associated battery based storage system to cope up with the frequent power outages. While looking from another perspective, these systems only lack the solar panels to become completely self contained power systems.

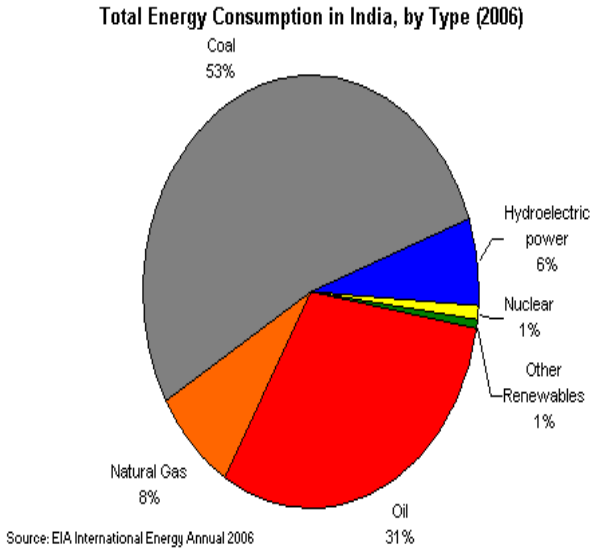

Figure 1: Energy Comparison in India

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that were based on land lines and could not be expanded fast enough. Later the privatized and decentralized wireless based approach provided the desirable solution.

II. At A Glance Renewable Energy Sources in India

A. Solar Energy

Solar power as a clean renewable resource with zero emission has got tremendous potential of energy which can be harnessed using a variety of devices. With recent developments, solar energy systems are easily available for industrial and domestic use with the added advantage of minimum maintenance. Solar energy could be made financially viable with government tax incentives and rebates.

An exclusive solar generation system of capacity of 250 to KWh units per month would cost around Rs. 5 Lacs, with present pricing and taxes. Most of the developed countries are switching over to solar energy as one of the prime renewable energy source. The current architectural designs make provision for photovoltaic cells and necessary circuitry while making building plans [2].

B. Wind Energy

Wind power is one of the most efficient alternative energy sources. There has been good deal of development in wind turbine technology over the last decade with many new companies joining the fray. Wind turbines have become larger, efficiencies and availabilities have improved and wind farm concept has become popular. It could be combined with solar, especially for a total self-sustainability project.

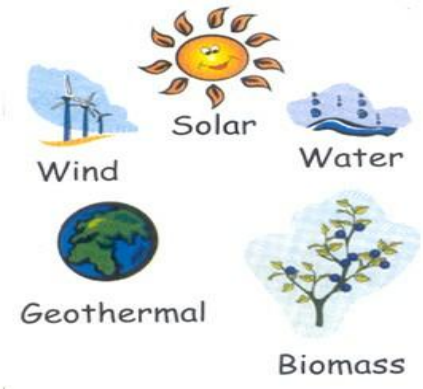


Figure 2: Renewable Sources

The economics of wind energy is already strong, despite the relative immaturity of the industry. The downward trend in wind energy costs is predicted to continue. As the world market in wind turbines continues to boom, wind turbine prices will continue to fall. India now ranks as a wind superpower having a net potential of about 45,000 MW only from 13 identified states. This may be harnessed around to 65,000 MW taking account all states.

C. Hydro Electric Power

India has a huge hydro power potential, out of which around 20 % has been realized so far. New hydro projects are facing serious resistance from environmentalists. Resettlement of the displaced people with their lands becomes major issue. But small hydro units can be installed with major canals already existing in India by creating water check dams at appropriate intervals that may enhance the capacity and power can be distributed to villages.

D. Biomass Energy

Biomass Energy can play a major role in reducing India's reliance on fossil fuels by making use of thermo-chemical conversion technologies. In addition, the increased utilization of biomass-based fuels will be instrumental in safeguarding the environment, creating new job opportunities, sustainable development and health improvements in rural areas. Biomass energy could also aid in modernizing the agricultural economy.

A large amount of energy is expended in the cultivation and processing of crops like sugarcane, food grains, vegetables and fruits which can be recovered by utilizing energy-rich residues for energy production. The integration of biomass-fuelled gasifies and coal-fired energy generation would be advantageous in terms of improved flexibility in response to fluctuations in biomass availability with lower investment costs. Waste to energy plants offer two important benefits of environmentally sound waste management and disposal, as well as the generation of clean electric power. Waste-to-energy facilities produce clean, renewable energy through thermo chemical, biochemical and physicochemical methods. Moreover, waste-to-energy plants are highly

efficient in harnessing the untapped sources of energy from a variety of wastes.

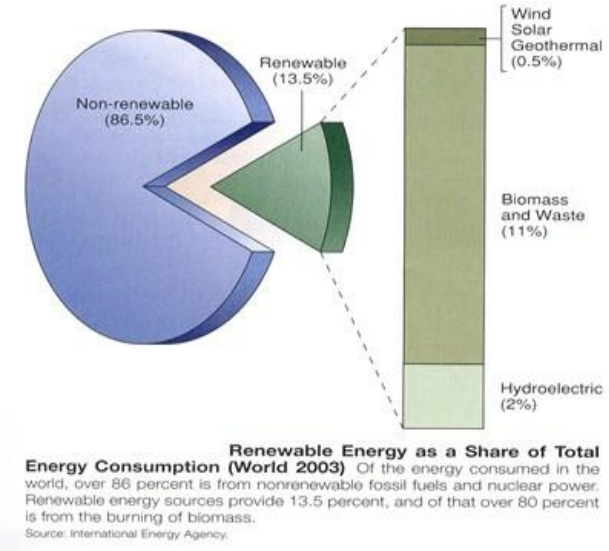


Figure 3: Comparative Details of Renewable Sources

III. At a glance Non renewable energy sources in India

A. Oil

According to *Oil & Gas Journal (OGJ)*, India had 5.6 billion barrels of proven oil reserves as of January 2009, the second-largest amount in the Asia-Pacific region after China. India's crude oil reserves tend to be light and sweet, with specific gravity varying from 38° API in the offshore Mumbai High field to 32° API at other onshore basins. India produced roughly 880,000 bbl/d of total oil in 2008, of which approx. 650,000 bbl/d was crude oil, with the rest of production resulting from other liquids and refinery gain. India has over 3,600 operating oil wells, according to *OGJ* [3].
Although oil production in India has slightly trended upwards in recent years, it has failed to keep pace with demand and is expected by the EIA to decline slightly in 2009 as shown in Fig.5.

India's oil consumption has continued to be robust in recent years. In 2007, India consumed approximately 2.8 million bbl/d, making it the fifth largest consumer of oil in the world. Demand grew to nearly 3 million bbl/d in 2008. EIA anticipates consumption growth rates flattening in 2009 largely due to slowing economic growth rates and the recent global financial crisis [1,4], which leads to import demand of oil from other country as shown in Fig. 6.

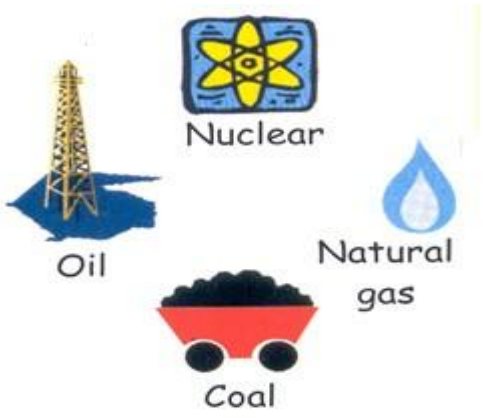


Figure 4: Non Renewable Sources

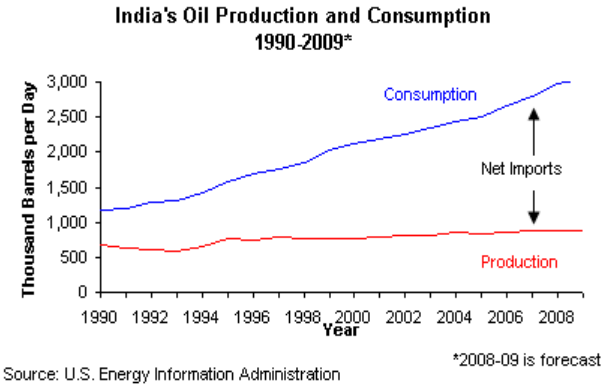


Figure 5: Oil Production and Consumption

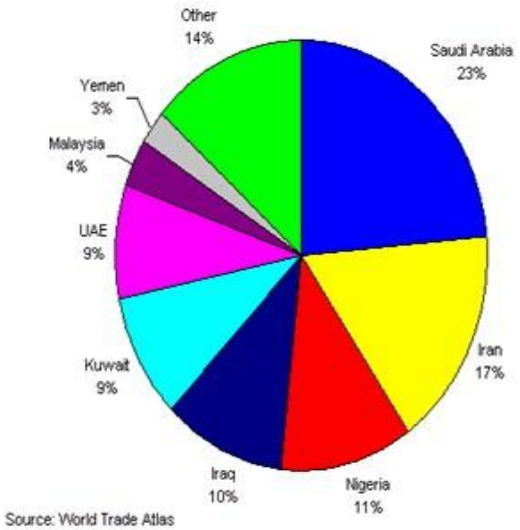
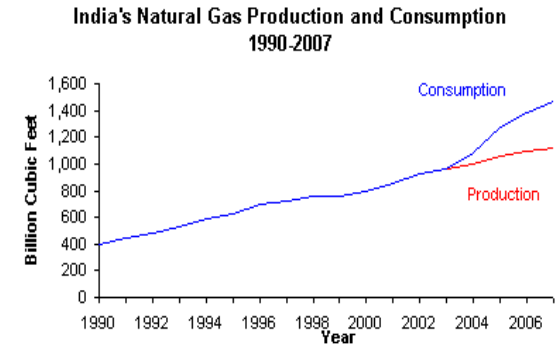


Figure 6: Crude Oil Imports by Source, 2007

B. Natural Gas

Although India's natural gas production has consistently increased, demand has already exceeded supply and the country has been a net importer of natural gas since 2004. India's net imports reached an estimated 353 Bcf in 2007. India imports natural gas via liquefied natural gas (LNG). In 2007, India consumed roughly 1.5 Tcf of natural gas, approximately 100 Bcf more than in 2006, according to EIA estimates. Natural gas demand is expected to grow considerably, largely driven by demand in the power sector. The power and fertilizer sectors account for nearly three-quarters of natural gas consumption in India as shown in Fig. 7. By 2030, EIA expects Asian demand for natural gas to more than double, and India is expected to be responsible for a sizeable part of that growth. Natural gas is expected to be an increasingly important component of energy consumption as the country pursues energy resource diversification and overall energy security [5].



Source: U.S. Energy Information Administration

Figure 7: Natural Gas Production and Consumption

C. Electricity

In 2006, India had 144 gigawatts (GW) of installed electric capacity and generated 703 billion kilowatt hours. Nearly all power in India is generated with conventional thermal sources, which produced over 80 percent of electricity in 2006 [6]. Hydroelectricity has been a consistent source of power in India, accounting for nearly 16 percent of power generated in 2006. Finally, nuclear energy produced roughly 2 percent of electricity during the same year, while geothermal and other renewable sources accounted for as little as 1 percent.

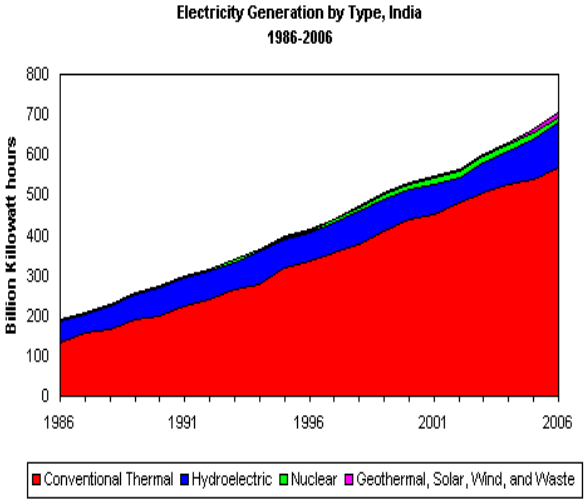


Figure 8: Electric Power Generation in India

According to Oil and Gas Journal (*OGJ*), India had 38 trillion cubic feet (Tcf) of proven natural gas reserves as of January 2009. The EIA estimates that India produced approximately 1.1 Tcf of natural gas in 2007, up only slightly from 2006 production levels. The bulk of India's natural gas production comes from the western offshore regions, especially the Mumbai High Complex. The onshore fields in Assam, Andhra Pradesh, and Gujarat states are also significant sources of natural gas [1,6,7]. The Bay of Bengal has also become an important source of natural gas for the country.

IV. Financing and Creating Infrastructure of Energy

Most important thing for any developed or developing country is electricity and source of water. In present scenario of development nothing is possible to proceed further without electricity. For example; if someone has a mobile, computer, TV, vehicle, internet connection etc., and power fails then, in our opinion, nothing can run.

Thus an essential and honest attempt required to design a system, which can provide better solutions, would be key steps [8] as mentioned below:

i). Planning, ii). Modeling, iii). Simulating, iv).Controlling, v). Tariff policy, vi). Analysis through software designing, vii). System

designing, and Mathematical processes, and viii). Obtaining final results.

Likewise, in the energy sources, the solution lies with following elements:

i). Animal, ii). Biomass, iii). Coal, iv). Oil, v). Natural gas, vi). Nuclear, vii). Hydrogen and viii). Renewable energy.

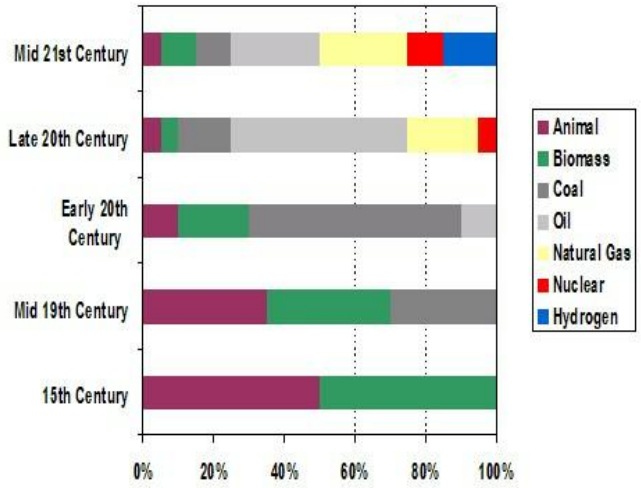


Figure 9: Comparison of Energy Uses in various Periods

As per the earlier data available, we were using resources as under:

a) In 15th century, we used 50% animal and 50% biomass,
b) Mid 19th century, we used 33.33% animal, 33.33% biomass and 33.33% coal.
c) Early 20th century we used 10% animal, 15% biomass, 65% coal, and 10% oil.
d) Late 20th century we used 5% animal, 5% biomass, 15% coal, 3% nuclear, 17% natural gas, and 55% oil.
e) Mid 21st century we used 5% animal, 7% biomass, 7% coal, 7% nuclear, 9% hydrogen, 35% oil and 35% natural gas.
f) Now in 21st century, we are using 2% renewable energy, 5% animal, 5% biomass, 7% coal, 7% nuclear, 9% hydrogen, 35% oil, and 35% natural gas.

It is fact that a human cannot live without energy similarly World cannot stand on the earth without energy. It is therefore very important factor for any country to have sustainable energy resource. In India, since we are generating only 90,000 MW of energy against our required demand of 1, 44, 543MW of energy, thus there is deficit of 55,543MW of energy, which means we are suffering under crisis of energy.

- In the year 2012, we had requirement of 2, 00,000MW energy and
- In coming year 2020 we would require 4, 00,000MW energy [9].

Thus our main motive is to focus for the sustainable development of India which is possible only when we should balance / exploit our following key resources:

i). Population, ii). Environment, iii). Pollution, iv). Infrastructure, v). Economic growth, vi). Transportation, vii). Industry, viii). Resources, ix). Financial and x).PPP.

The dream of former President of India, Dr. A.P.J. Abdul Kalam was to fill the gap between rural area and town area up to 2020 and create Energy Freedom in India by 2030. This dream can be only achieved when we all join hands to create possible Plan, Model, Design, Simulate, Control, Implement them to obtain a complete solution of Energy.

V. Conclusion

From the above study, it is concluded that in India there is deficit of about 55,000 MW electric power in India against the current requirement of 1, 50, 000 MW. Thus there is need by scientific community not only think but develop advanced energy technologies to contribute in improving the existing ones. Even if renewable energies and new energy carriers, such as; hydrogen etc., are promising solutions. Even today, our society still relies on fossil fuels as primary energy and for many other applications. Thus we have to take following steps to augment our energy resource at village and town level by exploiting:

a) Use of Solar Energy
b) Use of Wind energy and Wind form
c) Developing Check dam for small Hydro-generation

d) Enhance Bio-mass and Bio-gas
e) Privatization in Energy Sector

Thus by re-enforcing collaboration between the various sectors and promoting an exchange of knowledge and experience between countries that we will be able to meet the challenge of 21st Century Energy crisis not in India, but globally.

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