

Development in the Field Of Technology for Cooperative Problem Solving Utilizing Non-Conventional Energy Resources in India & Future Trend

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Abstract: Cooperative problem solving is the key to effective and efficient energy management. Energy is the reward of nature to people. Meeting massive demand of power is a major issue and a concern. Hence, the concept of cooperative problem solving can be effectively applied by bringing various public and private sector together to mitigate the problems. The main focus of this paper is the application of cooperative problem solving technique to provide an efficient solution to rising demand for power. It shall apply qualitative and quantitative computational approach. This paper illustrates on various sources of renewable energies available in India and developments in technology for utilizing this resource. It also focuses on present energy demand and future need for energy by evaluating India's energy demand with the growing technology development in the renewable energy sector.

Keywords: Co-operative Problem Solving, Non-conventional energy, Renewable Energy.

1. Introduction

However, the common source of world's energy has been obtained from traditional sources of fossil fuels such as coal, oil, and natural gases. The sources of energy obtained from conservative source of fuel that are readily available are nevertheless limited but it could be exhausted in the coming future. Renewable energy sources are constantly restocked by natural processes for example, solar energy, wind energy, bio-energy, hydropower and bio-fuels are developed continuously. A renewable energy system converts the energy into a structure that can be used such as heat or electricity.

In case of conventional energy, the sources of energy that are being utilized are coal, petroleum, natural gas and water power. These sources of energy are exhaustible except water. These sources of energy when used cause pollution, as they give out smoke, carbon-dioxide and dust. Whereas in case of non-conventional energy the resources which are yet in the procedure of development over the past few years. They are inexhaustible. These sources of energy are pollution free and less costly due to local use and easy to maintain. [1][2][10]

2. India's Energy Scenario

With the increase in India's population need for energy has also amplified significantly. The requirement of energy has been rapidly growing in India to congregate the necessities of economic growth and various development objectives.

Past says the commercial energy consumption in different sector has been increasing day by day. If we will consider industrial sector, it was 36.9 MTOE in the year 1980/81 but it increases to 137.98 in the year 2010/11. In Transport sector, it was 17.4 MTOE in the year 1980/81 but it increases to 55.34. In Residential and commercial, it was 5.6 MTOE in the year 1980/81 but it increases to 43.43. In Other energy sector, it was 1.9 MTOE in the year 1980/81 but it increases to 30.25. In Non-energy sector, it was 5.3 MTOE in the year 1980/81 but it

increases to 26.15. In Agriculture sector, it was 1.6 MTOE in the year 1980/81 but it increases to 23.14.

Fig. 1, Fig. 2 illustrates projections of India's energy scenario. The Government of India's (GoI) planning commission expected in future there will be significant requirement for coal and oil over the coming 6 years. Fig. 1 shows outcrop of India's power need in its Integrated Energy Policy (IEP) report published in August 2011. In the present scenario contribution of Nuclear Energy is prominent by using a indigenous technology, but the nuclear industry's progress has been protected by India's refutation to precursor the Nuclear Non-Proliferation Treaty, cutting the country off from collaboration and support in civil nuclear technology. The figure predicted from below mentioned figure foresees coal to be more demand in India for future power generation.

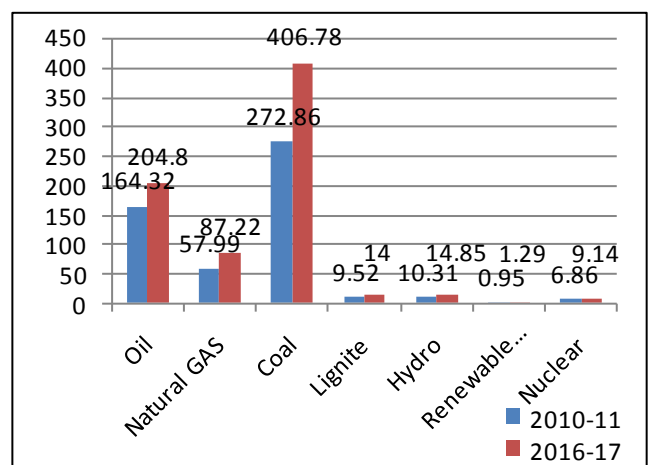


Figure 1: Energy required from different sources (*NB: MTOE-million tones oil equivalent)

The Growth of India is determined by development of economic system of the country. This as a result directs India for meeting the growing need for electricity. The Electric Power Survey 17 projects to hit the highest point of demand by

9% during the period of the XI Plan (2011-12) against actual achievement of 5.3%. In 2009, CRISIL research anticipated that approximately \$160 billion would be expected to invest in the power sector by 2014.

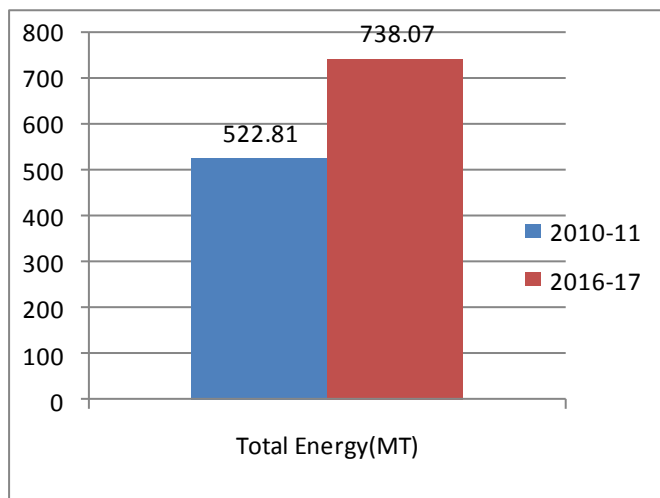


Figure 2: Energy required from different sources (*NB: MT-Million Tons)

Spike in demand of power majorly from the agricultural sector and industrial sector has been forcing the state governments to increase power cut in the summer months. For example the state of Orissa has been always a power deficit .In order to meet the requirement of power demand it has been mandated an one-to-two-hour-per-day power cut in order to meet the power requirement of the steel and other industry and manufacturing industry; the power cut hour per day may also increase depending on meeting demand for supply of power. Arrangements are being made by the Government of Orissa (GoO) towards increasing capacity for which power management schemes are being searched to minimize the charge and to maximize the trust of power supply to customers. An array of initiatives has been carried out in order to increase the additional capacity of power generation by inviting both public & private parties such as IPPs and group captive generation. It is speculated that even with this initiative the demand of power is expected to exceed supply well into the XII Plan period. With the large-scale progress taking place in the power sector and the related disputes, significance of complete project supervision organization is prevailing to ensure that projects are accomplished in a meticulous and timely approach.[6][7][8]

3. Renewable Energy Scenario

The non conventional sources of energy that has been identified by MNRE) Ministry of New and Renewable Energy) are hydro projects, biogases cogeneration, biomass power generated from urban and industrial waste, wind & solar energy. There has been noticeable growth in renewable energy sources since the 10th Five Year Plan (2002-2007) during this period non conventional grid capacity in India has been increased by a factor of five and during the year 2010 non conventional energy has contributed about 4% of total energy generation mix .As per MNRE data the cumulative renewable energy power (REP) installed capacity has achieved more than 18GW till end of 2010 this installed capacity represents 10% of the overall installed capacity .

During the year 2010 installed wind power accounted a major share among various sources of non-conventional energy which is about 13GW (70%) where as contribution from small hydro power projects is 16%. The remaining portion of power is dominated by grid-connected cogeneration from biogases is 8% and power generated from biomass is 5%. The contribution of energy from solar power and waste –to-energy combined together accounts 0.5%.During 11th Five Year Plan (2007-2012) the Government of India had a plan to increase the contribution of renewable energy power to 5% and to increase the cumulative installed capacity to go beyond 25GW during this five year plan. [7][8][12]

As per the records from MNRE ,during the year 2011 installed capacity of wind power has contributed a majorly with over 13GW (70%),where as small hydro power contribution is 20% and rest power is generated from Biomass and solar energy.[6]

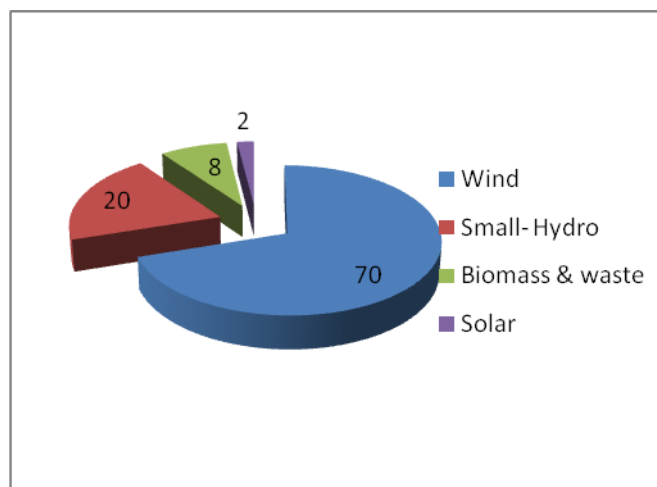


Figure 3: Contribution from various Renewable Energy Sources

The potential of various renewable energy technologies in India are estimated by IREDA as on 31/05/2014 and are listed in Table 1 and Table 2.

Table 1: Growing Consumption Of Various Non-Conventional Energy Systems In The Country (2014-15)

SECTOR	TARGET	
	2013-14	2014-15
I.GRID –Interactive Power (Capacities In KW)		
Solar Power	11X 10 ⁵	11X 10 ⁵
Waste to power	20000	20000
Biogases Cogeneration	300000	300000
Small Hydro Power	300000	250000
Biomass Power & Gasification	105000	100000
Wind Power	25 X10 ⁵	20 X10 ⁵
Total	4325000	3770.00
II. OFF-GRID/Captive Power (Capacities In KW)		
Biomass	80000	80000
Bio-gas based energy system	2000 (500no.)	4000 (500no.)
Biomass Gasifies.	1000	800
1. Rural	9000	8000
2.Industrial		

Table 2: Achievements Of Various Non-Conventional Energy Systems In The Country (2014-15)

Sector	Achievements during the Month of May		Cumulative Achievements	
	2013-14	2014-15	as on 31.05.13	as on 31.05.14
I.GRID –Interactive Power (Capacities In KW)				
Solar Power	73000	-	1.76*10 ⁶	2.64 *10 ⁶
Waste to power	-	-	96080	106580
Biogases Cogeneration	-	-	2337430	2648350
Small Hydro Power	24000	-	3671250	3803650
Biomass Power & Gasification	-	-	126480	1365200
Wind Power	114300	53050	191.3*10 ³	212.62 *10 ³
Total	211.30	53.05	28446.05	31833.01
II. OFF-GRID/Captive Power (Capacities In KW)				
Biomass	2800	-	473950	531820
Bio-gas based energy system	-	-	10650 (213no.)	13210 (2643no.)
Biomass Gasifies.	-	-	16790	17480
1. Rural	-	-	142080	147200
2.Industrial	-	-		

Source: Own compilation Database.

4. Renewable Energy Source

4.1 Solar Energy

This source of renewable energy is available abundantly but main drawback is utilization of solar energy has been minimal amount .With proper utilization of this source of energy it would have been the major source for supply of energy irrespective of the facts that one day all other sources of renewable energy may get fatigued.

In Order to use solar energy practically we use photovoltaic solar cells for producing solar energy, it converts solar energy directly to electricity. In order to meet the building demand for power ,photovoltaic cell have been readily used in India for supplying power to water pumps that is used for water supply and it covers street lights in rural area, community TV sets, medical refrigerators .This indicates small power loads can be utilized by setting up solar power plants. The amount of solar energy received in India is between 5 to 7 kWh/m² for 300 to 330 days in a year. This energy is plenty to put up 20 MW solar power plant per square kilometer land area .The two different methods of utilizing solar energy is by solar thermal route and solar electric (solar photovoltaic) routes. In case of solar thermal route heat of sun is used to produce hot air or water, for different purpose (Ex-cooking etc). It also uses sun's heat to generate electricity (Ex- lighting home, running motors, electric appliances etc).

There are many remote places where co-operative problem solving technique has been implemented for supply of power by setting up solar power plant. For instances, there is a village named Indra Nagar under district Thonk in state of Rajasthan where collaborative effort had been by Minda NexGenTech Ltd and the local sarpanch Ms Chhavi Rajawat for building up a solar power plant of capacity 240Watt that led to a renovation

in the village. The main objective of this project was to solve power problem and empower villagers through generating income sources. [2][3][4]

4.2 Wind Energy

Other than different sources of energy available Wind energy is one of the most widely utilized alternate sources of energy. Electricity generated from wind energy has an important contribution towards meeting the demand of power in our country .Between the different renewable energy sources; an important contribution is done by wind energy to the installed capacity of power generation. It seems wind energy is emerging as a convenient option. The principle of power generation by using wind energy is done by running a wind mill .The running of wind mill produces mechanical energy to produce electricity by driving a generator. The mechanical energy produced by running a wind mill can be used for various activities. The wind speed available in India is in low range .Due to low wind speed in India efforts is being made to develop low cost wind mill to match the low wind speed. Wind mills are used for irrigation of small and marginal farm. In India there are areas which is suitable for setting up wind power projects ,such as coastal region of Saurashtra, western Rajasthan, Tamil Nadu, Karnataka and some parts of central India [5].As per wind survey by CWET there are, one in Uttar Pradesh and one wind potential stations in Andaman Nicobar, two in West Bengal, seven in Orissa, seven in Madhya Pradesh, eight in Rajasthan, eight in Lakshadweep, sixteen in Kerala, twenty six in Karnataka, twenty seven in Maharashtra, thirty in Andhra Pradesh, thirty six in Gujarat and thirty nine in Tamil Nadu. Seven stations have shown wind power density more than 500 Watts/ m² out of 208 suitable stations. The investment cost for installation of wind energy equipment is less as compared to other conventional energy equipment.

The Government of India has few benefits for investing in this sector which is attracting private investors such as retail investors, IPP and captive power producers. A few industrial application of wind energy are listed as(1)Utility interconnected wind turbines produces current which is synchronous by means of the network and are used for captive consumption this in turn reduces the value of bills consumed for domestic purpose and the surplus power is sale to electricity board .(2)The energy generated by Wind turbines can be used for powering remote areas (off the grid) generate DC current which charges the battery.(3)A 3-phase AC current is generated from wind turbine which used for remote water pumping. Wind turbines appropriate for housing or rural community range from 500 Watts to 50 kilowatts.

In present scenario development of technology in the field of wind turbine is very prominent. The present government of India has provided various schemes that encourages big private parties as well public sector to invest in wind power project such as accelerated depreciation benefit has been restored to 80% under section 32 of IT act. This help in co-operatively solving power scarcity problem. [4][13][15]

4.3 Biomass

This form of non –conventional resource are produced from the carbonaceous despoil of various human and natural actions. The resultant from different supply, which also includes by-products from wood including the by-products from timber business, farming crops, different stuff from the tree-plant,

wastage products from domestics etc. This form of renewable energy source helps in reducing carbon dioxide in environment and liberates it while used as a fuel. This form of renewable source can also be used for generation of electricity by means of the same machinery used for burning of fossil fuels required for generation of power. Biomass is an imperative basis of energy generation. After deployment of Biomass, it is also considered to be an important source of energy after other non-renewable energy like coal, oil and various non-conventional energy resources.

The energy produced from Biomass can be utilized for cooking, mechanical functioning and for generation of power. The future of Biomass as an alternate source of energy is highly significant. In India program are being implemented for optimizing the utilization of Biomass resources for production of energy and to build Biomass power generation system efficiently. [3][5][11]

4.4 Biogas Energy

This type of renewable energy is produced through anaerobic fermentation of various biological products such as cow-dung, human waste and from different type of biological excretes. The fuel produced from this source of energy does not cause pollution of atmosphere. The energy produced from this process can be utilized for cooking purpose and for illumination. The major benefit of Biogas is that we can use by-products as manure for agriculture. The method for generation of Biogas is bit complicated a digester is built in which slurry that is mixture of dung with water is fermented, an inlet reservoir is built to mix the feed and letting it in to the digester. The gas produced is collected in dome and an outlet reservoir is built to exit the spent slurry. The gas produced is distributed through pipelines for cooking purpose or for lighting.

There are many cases where Biogas has been successfully generated by biogas plants. In the year 2001 community biogas plant was setup in five village groups consisting of 28 villages in Tumkur district of Karnataka. The aim of this project is to produce bioelectricity for electrification of villages and for cooking stoves. This project is collaborative effort by Government, representative of gram panchayat along with private parties for co-operatively solving the issue of power. [5][6]

4.5 Ocean Energy

The two different types of energy caused from ocean are thermal energy and mechanical energy. The sun's heat provides thermal energy where as mechanical energy is generated from tides and waves. The thermal energy and mechanical energy generated from ocean can be used for various activities one of the major activity is electricity generation. Closed-cycle, open cycle, and hybrid are the three types of electricity conversion systems. In the process of closed cycle system ocean's surface water evaporates to form a working fluid. This working fluid expands and turns a turbine as result of which generator is activated to produce electricity. In case of Open-cycle system sea water is boiled by working at low pressure. This process results in formation of steam which is utilized for driving the generator. There also exists a hybrid system which is a mixture of both closed-cycle and open-cycle system. The functionality of ocean mechanical energy is somewhat different from ocean thermal energy. Although major activity of ocean is caused due

to influence of sun but tidal activity is mainly under the influence of gravitational pull of moon and waves are driven by wind. In order to utilize the tidal energy for generation of electricity, water is forced through turbines from dam for creating kinetic energy which activates a generator. [4][6]

4.6 Geo-Thermal Energy

This form of energy lies deep-rooted within the earth. It is considered that earth has a molten core. It is observed in few locations that steam and hot water comes apparently to the surface of earth. Generation of power by utilizing geothermal energy can be done by two methods. In one of these methods heat energy is transmitted to a running fluid that activates the power cycle. This can be only useful at places where new volcanic activity occurs. During the volcanic activity fresh molten interior mass of earth comes out to the surface with very high temperature, such as between 450 to 550 C. Coil of pipes rooted so that carriage of water through them can be raised. As a result hot geothermal water or steam generated is utilized to drive the turbine directly. In the current situation electricity can be generated by the steam ejected from ground and the boiling water coming out is rejected as it contains 30% dissolved salts and minerals and this could result in corrosion of the turbine. [3][4]

4.7 Hydrogen Energy

Hydrogen energy has been able to grab global notice as a spotless and proficient energy carrier with a futuristic view to substitute non-renewable source. There has been noteworthy improvement progress presented by a number of countries which also includes India. The progress of hydrogen as power source can be considered as an alternative to fossil. With continuing diminution of fossil fuel reserves along with release of carbon dioxide in the atmosphere have been the reason behind global alteration effort towards a hydrogen-based economy. Hydrogen is considered to have a very high energy content and the only by-product generated is water - when burnt and is therefore, environment friendly. In present scenario hydrogen is available readily as now day's hydrogen is available as a derivative from quite a few chemical processes, industries or plants.

The potential energy of falling water is transformed to mechanical energy by water wheels, powered starting of industrial revolution. Wherever adequate head, or change in altitude could be set up, rivers and streams were dammed and mills were built. Water under pressure flows through a turbine causing it to spin. The Turbine is connected to a generator, which produces electricity. [5][15]

4.8 Small Hydropower

The concept of small hydro power most likely is very old and it is considered as one of the most dependable source of renewable energy among all other sources. Small Hydro Power is a consistent, established and proven technology. It is pollution free and does not require building of large dams or damage to nature.

The major benefit of this resource is that it can be utilized nearly all over in India where there is a running stream or channel and is mainly atmosphere caring approach, which are usually meet in the progress of large hydro power development. Small hydro technology is mature enough. In the financial year 2013-14 about 24MW capacity has been installed in India and

the cumulative capacity installed till 31.05.2014 is 3803.65 MW. [9][14]

5. Cost of Renewable Energy Technology System.

Place The capital and generation cost of Renewable Energy Technology systems in India (such as: SHP, Wind power, biomass/Cogeneration, Biomass/Gasification, S.P.V) is given below (Table 3). [8]

Table 3: Capital and Generation Cost

Capital and Generation Cost of RET Systems. Sl. No.	Sources	Capital Cost (Rs. lakhs/ MW)	Cost of Generation (Rs.Lakhs/ kWh)
1.	SHP	300 – 600	100 – 250
2.	Wind Energy	400 – 450	225 – 275
3.	Bio mass/ Cogeneration Energy	250	175 – 200
4.	Biomass/ Gasification Energy	250 – 300	175 – 200
5.	S.P.V.	2000 – 2500	900 – 1200

non conventional sources of energy that has been identified by MNRE) Ministry of New and Renewable Energy) are hydro projects, biogases cogeneration, biomass power generated from urban and industrial waste, wind & solar energy. There has been noticeable growth in renewable energy sources since the 10th Five Year Plan (2002-2007) during this period non conventional grid capacity in India has been increased by a factor of five and during the year 2010 non conventional energy has contributed about 4% of total energy generation mix .As per MNRE data the cumulative renewable energy power (REP) installed capacity has achieved more than 18GW till end of 2010 this installed capacity represents 10% of the overall installed capacity .

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6. Future Energy Scenario

India being a developing country there is always a growing need for energy or power in each and every sphere. With rise in

industrialization and increase in population meeting the everyday need for power has become a major issue. It has been estimated that in order to congregate the requirement of power for emerging economy and for betterment of life ,main utilization of power is projected to be 412MTOE(million tones oil equivalent) and 554 MTOE in the end years of the Tenth and Eleventh Plans, respectively (Planning Commission 1999).It is projected burning up of gas in India is anticipated to amplify at an average annual rate of 5.1%, thereby attaining 2.8 trillion cubic feet by 2025 ,where as contribution of electric power sector is projected to be 71% by 2025. Around 315MT of coal is expected to be consumed over the predicted period. The usage of coal for production of power in India is anticipated to rise by 2.2% annually during the period 2002–25, thus involving an extra 59000 MW of coal-fired capacity. The requirement of oil in India is anticipated to rise by 3.5% annually during the above mentioned period. It is reasonably evident that coal shall remain as a major source of energy in prospect. However, imports of petroleum and gas shall remain as a vital source of energy, resulting in an outsized energy import bill. It is therefore very critical to focus on developing various non-conventional energy resources implementing more proficient technology.

7. Global Commercial Energy Consumption

Fossil fuels will continue to supply much of the increment that will take place in the commercial energy use worldwide throughout the projection period. Coal gives approximately 30% of global main energy requirement, produces around 41% of the total world's power and is utilized for production of 70% of the world's steel during 2012and it is anticipated to rise further to 38% in 2030.Natural gas consumption will amplify by 1.9% per year on average over the projection period, from about 100 trillion cubic feet in 2004 to 163 trillion cubic feet in 2030. The utilization of hydroelectricity and other grid friendly renewable energy sources is anticipated to inflate during the above mentioned period .It shall be same for natural gas also. Worldwide electricity generation in 2030 is anticipated to total 30,364 billion kWh. World's total installed nuclear capacity is expected to rise from 368 GW in 2004 to 481 GW in 2030 and the electricity generation from the slants is predicted to boost from 2619 billion kWh to 3619 billion kWh.

8. Advantages of Renewable Energy Technology

In order to meet the growing demand for energy in today's scenario the best option is use of renewable energy, as they have the following advantage:-

The availability of Renewable energy resources in is substantial quantity to all developing nations.

Quite a lot of renewable selections are economically and cost-effectively ready for accomplishment planned towards firm applications, such as in distant place.

The power plants do not have any fuel cost which are based on renewable energy. So the running cost is negligible.

There is low energy density in renewable resources and more or less they do not cause pollution to the environment nor do they create ecological balance problem.

Renewable energy helps to preserve foreign exchange and create local employment. Short conception phase and small investment

To resolve the power issue various incentive schemes co-operative problem solving is done by both State/ Union Govt. encouragement, these schemes have made more attention-grabbing for private sector contribution and public sector.

9. Conclusion

There exists huge potential for generation of electricity to be derived from non-conventional energy sources. With increase in demand for power continuous effort is being made by Government of India to utilize this prospective. Co-operative problem solving technique is being implemented by government by collectively bring different parties such as private, public, captive power producers and IPPs to solve the issue related to supply of power.

The growing demand for power supply has become a major issue of concern. This is a rising social issue and to solve it co-operative effort is required in order to utilize the unexploited prospective in an efficient manner and fulfill the energy demand. Specific plan of action is required to be made for encouraging private and public parties to set up research and development units to utilize the potential of renewable resources such as biomass, hydropower, solar and wind.

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