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Potential of green energy resources for sustainable development of renewable energy technologies for Bihar

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Abstract
Now a days, the public/private and government sectors are giving more emphasis on the development of non-conventional energies in which biomass and solar energy are very progressive. Solar energy are available in the nature in a huge quantity. We have only to develop our method and techniques to extract the useful energy from it. In the similar way the waste materials are available in the huge quantity from which we have to abstract the biomass energy from it. Thus, we must also make effort towards the development of new techniques for the extraction of energy like biomass and solar. The solar energy is tremendous all over the world. If we can make ourselves so efficient to abstract the total solar energy and convert it to useful power then there is no need to depend upon another sources of energy. The resources of thermal energy are coal and nuclear fuel which are not much more sufficient on the earth. Day by day they are decreasing and a day may come when it will be totally vanished and at that time we will have to depend upon another sources of energy. This case is also similar with the hydel energy. The resources of water are decreasing day by day. The rivers are losing their water and the growth rate of rivers and dams are very less. So in this case the growth rate of hydel energy cannot be enhanced. But in case of Biomass and solar the resource is huge and it cannot be vanished. We must have only the skill and techniques to abstract from it. If we can develop ourselves in such a way that we can abstract the total biomass and solar energy to useful power in that case we would not have to depend upon other sources of energy. Only these two will be sufficient to supply the demand of power all over the world.

Keywords: renewable energy, sustainable development, probability, Markov analysis

Introduction

Energy is the life for man and machine both. We rely on the energy stored in food to keep us alive and on the energy locked within fuels to drive our machines and industries. The law of conservation of energy says that energy is always conserved – it can be neither created nor destroyed. When objects gain or lose energy, the energy simply transfers from place to place or changes into a different form. It consists in many different forms including electricity, sound, heat and light.

Background

Bihar State Electricity Board was constituted under section 5 of the Electricity Supply Act, 1948 vide Bihar Government's Notification No. 2884 - A/AI-121/57 dated 25th March, 1958 with effect from 1st April, 1958. The Board was given the responsibility of promoting coordinated development of Generation, Transmission and Distribution of Electricity in the State in an efficient and economic manner. The bifurcation of state in 2000 resulted in major power stations going to Jharkhand, leaving only two old thermal generating stations in present Bihar. Consequently, the state is lagging much behind other states in the country in terms of power availability and needs to purchase 90 percent of its power requirements from central utilities. At the end of 2009, BSEB had 2.96 million consumers and overall sales were at 5325 gigawatt hours (GWh), of which 33 percent were to domestic, 27 percent to industrial and 15 percent to irrigation. Sales growth was around 10 percent in the years 2006 to 2009.

Power Supply Position

The per capita power consumption in the state is around 100 units against an all India average of 717 units. No new generating unit has come up in the state in the last 25 years. The power supply position in Bihar is very poor and the deficit in relation to peak demand is ever increasing. The total installed capacity including hydel is about 600 MW, against the peak demand of 3000 MW. The deficit, which was around 17 percent in 2006-07, increased to 31 percent in 2007-08 and to 40 percent in 2009-10. In 2010-11, the deficit is estimated to be around 45 percent.

Bihar‘s current installed generation capacity is only 584.6 MW, including renewable resources owned by the Bihar State Hydroelectric Power Corporation. The state has access to a total of 1846 MW, including capacity allocated from central stations. This has led to severe rationing of power to meet consumer requirements. While some of the deficit can be attributed to legacy issues arising from the creation of Jharkhand, there has been no major addition to generation capacity.

BSEB’s thermal generating stations at Barauni and Muzaffarpur have undergone major renovation and modernization. Rapid augmentation of generation capacity is a prime priority for the state government, which intends to set up joint ventures (3 X 660 MW at Nabinagar), expand existing plants, catalyze Independent Power Producer (IPPs) projects at Banka (4 x 660 MW), Pirpainty (2000 MW) and

Kahalgaon (2 x 660 MW) and seek allocations from central sector plants to ensure that the state is not required endure the 66 percent peak deficit in 2012, as forecast by the Central Electricity Authority.
The state has to depend entirely on the central sector to meet its power requirements. As per the meter readings, the state government gets 1746-1791 MW power from the central sector. It gets around 40 percent share from each of Talcher STPS and Kahalgaon STPS-I. However, from Kahalgaon STPS-II, it gets only around 7 percent. The overall share of Bihar from central power stations is around 26 percent.

Present Status of Rural Electrification

As far as energy is concerned, Bihar is one of the most backward states of India. It has the lowest per capita consumer expenditure as well as it has more than 1.21 crore families living below the proverty line. The population of Bihar is more than 10 crore at presest. The hard truth is there are more than 2.5 crore people in rural Bihar, which is about 25% of the population, who have got used to live in the dark. Even after 64 years of Independence, the 18000 odd villages of Bihar have not received the benefits of electrification. As against a total of 39015 inhabited villages of Bihar, where about 90% of the state's population lives, electrification has taken place in just 20959 villages only. The remaining 18056 villages still deprived of electricity.

Yearwise forecast of power potential for different sources of energy in Bihar

We propose to estimate year-wise power potential from different sources of energy namely thermal, hydel, Bio and solar energy for development of Bihar. We are to calculate future optimal values of different sources of energy with the help of Markov analysis.
The present proportion of various types of energy available for Bihar is based on the table for power capacity in Bihar as on 31 Dec. 2010. The table has been shown in chapter 3. The installed capacity of Bihar on 31 Dec. 2010 was 1855.23 MW, comprising 1661.7 MW (90%) thermal, 129.43 MW (7%) hydropower and only 64.10 MW (3%) came from renewable energy sources.

Assumptions

Let A, B, C and D denote different sources of energy, thermal, hydel, Bio and solar energy, respectively. The present proportion of different energy as on 31 Dec. 2010 can be expressed by the matrix:
[A B C D] = [.9 .07 .02 .01]

The transition matrix T for the year 2010-11 can be formed on the basis of the following assumption

1. 70% chance that proportion of thermal energy will not change next year and 10% chance that it will be transformed to hydel, Bio and Solar energy, respectively.
2. 88% chance that proportion of Bio energy may remain same next year, a 10% chance it will be transformed into thermal and 10% chance that it will be transformed into hydel and solar energy, respectively.
3. 50% chance that proportion of hydel energy may remain same next year, 10% chance that it will be transformed into thermal and 20% chance that it will be transformed into Bio and solar energy, respectively.
4. 70% chance that proportion of solar energy may remain same next year and 10% chance that it will be transformed into thermal, hydel and Bio energy, respectively.

Calculation

Based on the above assumptions, we form a transition matrix for different sources of energy. The probability of various sources of energy has been shown in the transition matrix T.

$$T = \begin{array}{c} \\ A \\ B \\ C \\ D \end{array} \begin{array}{c} \begin{array}{cccc} A & B & C & D \end{array} \\ \begin{pmatrix} .7 & .1 & .1 & .1 \\ .1 & .5 & .2 & .2 \\ .1 & .01 & .88 & .01 \\ .1 & .1 & .1 & .7 \end{pmatrix} \end{array}$$

Using Markov analysis, we calculate the probability of power potential for different sources of energy after one year i.e. for the year 2011-12. Which may be expressed as:

1. [A B C D] = [.9 .07 .02 .01] x T
= [.64 .1262 .1226 .1112]

Thus the optimal values of thermal, hydel, Bio and Solar energy for the year 2011-12 will be 64%, 12.62%, 12.26% and 11.12%, respectively.

2. The probability of power potential for different sources of energy after two years i.e. for the year 2012-13 may be expressed as:

[A B C D] = [.64 .1262 .1226 .1112] x T
= [.4840 .1394 .2082 .1683]

Thus the optimal values of thermal, hydel, Bio and solar energy for the year 2012-13 will be 48.40%, 13.94%, 20.82% and 16.83%, respectively.

3. The probability of power potential for different sources of energy after three years i.e. for the year 2012-14 may be expressed as:

[A B C D] = [.4840 .1394 .2082 .1683] x T
= [.3904 .1370 .2764 .1962]

Thus the optimal values of thermal, hydel, Bio and solar energy for the year 2013-14 will be 39.04%, 13.7%, 27.64% and 19.62%, respectively.

4. The probability of power potential for different sources of energy after four years i.e. for the year 2014-15 may be expressed as:

[A B C D] = [.3904 .1370 .2764 .1962] x T
= [.3342 .1299 .3293 .2066]

Thus the optimal values of thermal, hydel, Bio and solar energy for the year 2014-15 will be 33.42%, 12.99%, 32.93% and 20.66%, respectively.

5. The probability of power potential for different sources of energy after five years i.e. for the year 2015-16 may be expressed as:

[A B C D] = [.3342 .1299 .3293 .2066] x T
= [.3005 .1223 .3699 .2073]

Thus the optimal values of thermal, hydel, Bio and solar energy for the year 2015-16 will be 30.05%, 12.23%, 36.99% and 20.73%, respectively.

6. The probability of power potential for different sources of energy after six years i.e. for the year 2016-17 may be expressed as:

[A B C D] = [.3005 .1223 .3699 .2073] x T
= [.2803 .1156 .4008 .2033]

Thus the optimal values of thermal, hydel, Bio and solar energy for the year 2016-17 will be 28.03%, 40.08% and 20.33%, respectively.

7. The probability of power potential for different sources of energy after seven years i.e. for the year 2017-18 may be expressed as:

[A B C D] = [.2803 .1156 .4008 .2033] x T
= [.2682 .1102 .4242 .1975]

Thus the optimal values of thermal, hydel, Bio and solar energy for the year 2017-18 will be 26.82%, 11.02%, 42.42% and 19.75%, respectively.

8. The probability of power potential for different sources of energy after eight years i.e. for the year 2018-19 may be expressed as:

[A B C D] = [.2682 .1102 .4242 .1975] x T
= [.2609 .1059 .4419 .1914]

Thus the optimal values of thermal, hydel, Bio and solar energy for the year 2018-19 will be 26.09%, 10.59%, 44.19% and 19.14%, respectively.

9. The probability of power potential for different sources of energy after nine years i.e. for the year 2019-20 may be expressed as:

[A B C D] = [.2609 .1059 .4419 .1914] x T
= [.2566 .1026 .4553 .1857]

Thus the optimal values of thermal, hydel, Bio and solar energy for the year 2019-20 will be 25.66%, 10.26%, 45.53% and 18.57%, respectively.

10. The probability of power potential for different sources of energy after ten years i.e. for the year 2020-21 may be expressed as:

[A B C D] = [.2566 .1026 .4553 .1857] x T
= [.2540 .1000 .4654 .1807]

Thus the optimal values of thermal, hydel, Bio and solar energy for the year 2020-21 will be 25.4%, 10%, 46.54% and 18.07%, respectively.

Results

Table 1: The optimal values of different sources of energy (in percent) for Bihar

Year/energy	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**
Thermal	64	48.4	39.04	33.42	30.05	28.03	26.82	26.09	25.66	25.4
Hydel	12.62	13.94	13.7	12.99	12.23	11.56	11.02	10.59	10.26	10.0
Bio	12.26	20.82	27.64	32.93	36.99	40.08	42.42	44.19	45.53	46.54
Solar	11.12	16.83	19.62	20.66	20.73	20.33	19.75	19.14	18.57	18.07
Total	100	100	100	100	100	100	100	100	100	100

Analysis

As the result shows that in 2011-12 the thermal energy shows 64% whereas the hydel energy is 12.62%, biomass energy 12.26% and solar energy 11.12%. As we move from 2011-12 to 2012-13 the thermal energy reduces from 64% to 48.4%, whereas hydel energy increases from 12.62% to 13.94%. It is found that there is heavy increase in biomass energy from 12.26% to 20.82% and in the similar way for the solar energy it increases from 11.12% to 16.83%. It shows that the non-conventional energies such as hydel, biomass and solar energy are increasing rapidly whereas the thermal energy is declining.

In the similar way if we further go after 2012-13 i.e. for 2013-14, 2014-15, 2015-16, 2016-17, 2017-18, 2018-19, 2019-20 and 2020-21 the average trend of the thermal energy is declining. It shows that the public/private and government sectors are trying to develop non-conventional sources of energy. In 2020-21, the thermal energy has decreased from 64%to 25.4% which is less than half of 2011-12. As from the table it is seen that in the case of hydel energy it is also decreasing but the rate of declination is not high. It is only 12.62% to 10.0% from 2011-12 to 2020-21. But in the case of biomass energy it is increasing tremendously and it has been increased from 12.26% in 2011-12 to 46.54% in 2020-21. If we see the case of solar energy it was 11.12% in 2011-12 which has increased to 18.07% in 2020-21.

From the above it is clear that in the case of thermal energy and hydel energy there is a decline in their production whereas there is a tremendous increase in the growth rate of biomass and solar energy

Conclusion & Suggestions

As we have concluded that the biomass energy and solar energy will be the most important energies, which will have the major contribution towards fulfillment of ever increasing demand in Bihar. As per the result, it is observed that in future the solar energy and biomass energy have increasing trend and its growth rate is very high. As the growth rate of biomass energy and solar energy will be more the conventional energy such as thermal energy requirement will be less. In this situation we will not have to be fully depending upon other conventional energies.

In the above situation we must go in the search of different techniques and method by which the maximum solar and biomass energy will be converted to power to overcome the shortage of power. These two energies are such that their resources in nature are available in huge amount and they cannot be exhausted in future. We must develop our skill to extract the power from these sources of energy. Thus we should develop the new and modern technology by which the maximum power can be extracted from it in the public and private sectors. It is also suggested that such type of energies must also be popularized in the rural areas as well as urban areas. The cost of power obtained from the biomass and solar energy will be cheaper and pollution free also. Ultimately, it will be beneficial to the whole society.

On the basis of results and analysis obtained in the previous chapters, we have proposed the following suggestions for sustainable development of Bihar.

1. Govt. of Bihar may create specific database of different biomass sources including agriculture residues, urban and municipal wastes and bagasse from sugar mills in the state. It will also help to locate areas which can be potentially used to generate power from biomass sources.
2. There is a huge potential for development of solar power project in the waste land area. It is suggested to create proper database for all solar applications in the state.
3. Support may be extended for promotion of biomass based power generation in small scale decentralized mode. Family type biogas plants should be installed in villages. Special schemes for SPV water pumping to be promoted for farmers. Solar applications such as roof top PV, Biomass-solar system, solar water heaters and solar cookers should be promoted to the grass root level

in rural areas.

4. The grant of suitable financial incentives may be considered for investment in renewable energy. This will encourage the manufacturers to set up their units in the state.
5. Electrification of remote villages without grid power may be undertaken using renewable energy technology, especially biomass and solar energy technology.
6. R&D may be encouraged and supported so that the efficiency of devices could be improved and cost brought down.
7. For successful implementation of renewable based power project, there should be a training provision for entrepreneurs.

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