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An Analysis Of Energy Demand And Peak Deficit In India With The Contribution Of Small Hydropower Plants

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Abstract - **Small hydro power (SHP) is a renewable, financially attractive and environmental friendly source of energy. SHP has operational flexibility for reliability of power system. SHP plants are found to be the best alternative for meeting the peak demand as peak deficit in India was around 4.5% in 2013-14. The present study is aimed at evaluating the various factors affecting the losses in small hydropower system resulting in reduced generation due to which targeted peak demand is not met. An analysis of generation growth of energy, energy demand and deficit and peak demand and deficit is carried out.**

Keyword s - Renewable energy, Small hydro power plants, peak demand, peak deficit, energy losses.

1. INTRODUCTION

Small hydropower (SHP) is considered the most significant renewable source of the world's electricity supply and there is still a large unexploited potential available in many areas. Continued exploitation of this resource is likely as a response to the world's demand for energy [1]. SHP has operational flexibility such as quick starting, stopping and load variations thus help in improving reliability of power system. SHP plants are the best alternative for meeting the peak demand [2]. The total electricity generation in India **includes appreciable contribution from renewable** energy sources (RES). In 2013-14, peak deficit of electricity in India was 4.5% where as during the year 2014-15, up to September it was 4.7%. It is anticipated that power supply position for peak shortage for the year 2014-15 can be 2.0% [3, 4, and 5].

2. ENERGY SCENARIO

The total installed energy capacity of India as on 22 October, 2014 was **254049 MW,** out of which 176779 MW (69.6%) from thermal (coal, gas, oil), 40799 MW (16.1%) from hydro, 4700 MW (1.9%) from nuclear and 31692 MW (12.5%) from renewable energy sources as shown in Fig. 1. Renewable energy sources (RES) include wind energy, small hydro power (SHP), biomass gasifier (BG), biomass power (BP), urban & industrial (U & I) and waste power [3].

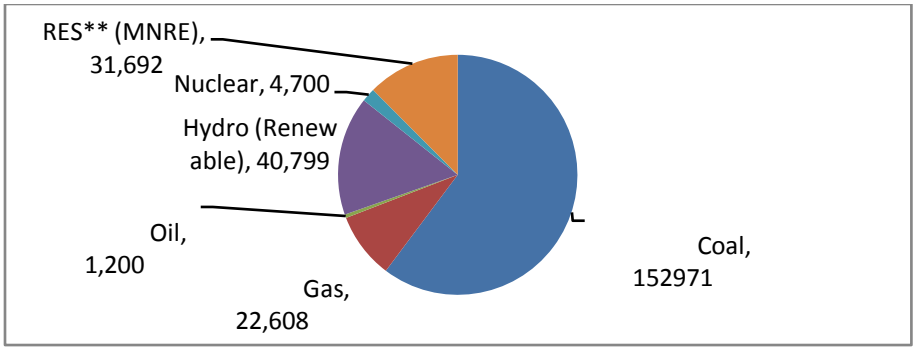


Figure 1: The total installed energy capacity in **MW**

The electricity generation target for the year 2014-2015 was fixed as 1023 Billion Units (BU) with growth of around 5.77% over actual generation of 967.150 for the previous year (2013-2014). The generation during April-September, 2014 was found 531.835 BU as compared to 482.025 BU generated during April-September, 2013, representing a growth of about 10.33% as shown in Table1 which also shows electricity generation growth from 2009 to September 2014 [5].

Table 1: Actual achievement and growth in electricity generation from 2009 to Sep 2014

Year	Target (BU)	Achievement (BU)	% of target	% growth
2009-10	789.511	771.551	97.73	6.6
2010-11	830.757	811.143	97.64	5.56
2011-12	855.00	876.887	102.56	8.11
2012-13	930.00	912.056	98.07	4.01
2013-14	975.000	967.150	99.19	6.04
2014-15 (Upto Sept, 2014)	508.461	531.835	104.60	10.33

The power supply requirement, availability and surplus/deficit in the country are shown in Table 2. It also shows the peak demand and deficit for the period 2009 to September 2014 [5]. An anticipated power supply position during 2014-15 in India shows that, there would be energy shortage of 5.1% and peak shortage of 2.0%. The annual energy requirement, availability peak demand and peak availability in the country are given in the Table 3[4].

Table 2: The power supply position in the country during 2009 to sep. 2014

Year	Energy				Peak			
	Requirement	Availability	Surplus/Deficts(-)		Peak Demand	Peak Met	Sirplus/Deficts(-)	
	(MU)	(MU)	(MU)	(%)	(MW)	(MW)	(MW)	(%)
2009-10	8,30,594	7,46,644	-83,950	-10.1	1,19,166	1,04,009	-15,157	-12.7
2010-11	8,61,591	7,88,355	-73,236	-8.5	1,22,287	1,10,256	-12,031	-9.8
2011-12	9,37,199	8,57,886	-79,313	-8.5	1,30,006	1,16,191	-13,815	-10.6
2012-13	9,95,557	9,08,652	-86,905	-8.7	1,35,453	1,23,294	-12,159	-9.0
2013-14	10,02,257	9,59,829	-42,428	-4.2	1,35,918	1,29,815	-6,103	-4.5
2014-15	5,52,633	5,30,350	-22,283	-4.0	1,48,166	1,41,160	-7,006	-4.7

Table 3: Anticipated power supply position during 2014-15

Particulars	Peak Energy (MU)	Peak Power (MW)
Requirement	1,048,672	147,815
Availability	995,157	144,788
Surplus(+)/ Shortage (-)	-53,515	-3,027
Surplus(+)/ Shortage(-) %	-5.1	-2.0

3. SMALL HYDRO POWER

Small hydropower is a renewable and environmental friendly source of energy. Ministry of New and Renewable Energy (MNRE) has been established in India with the responsibility of developing SHP projects up to 25 MW plant capacities [6]. Estimated potential of SHP projects in India is about 20,000 MW. SHP has got special importance due to their relatively low administrative and executive costs, and a short construction time compared to large power

plants. SHP Programme is one of the thrust areas of power generation from renewable with the MNRE. It has been recognized that SHP projects can play a critical role in improving the overall energy scenario of the country as shown in Fig. 2. Upto September 2014 the grid interactive renewable energy generation was 32780 MW as shown in Fig. 2. The contribution of SHP in renewable energy generation is presently 11% [7].

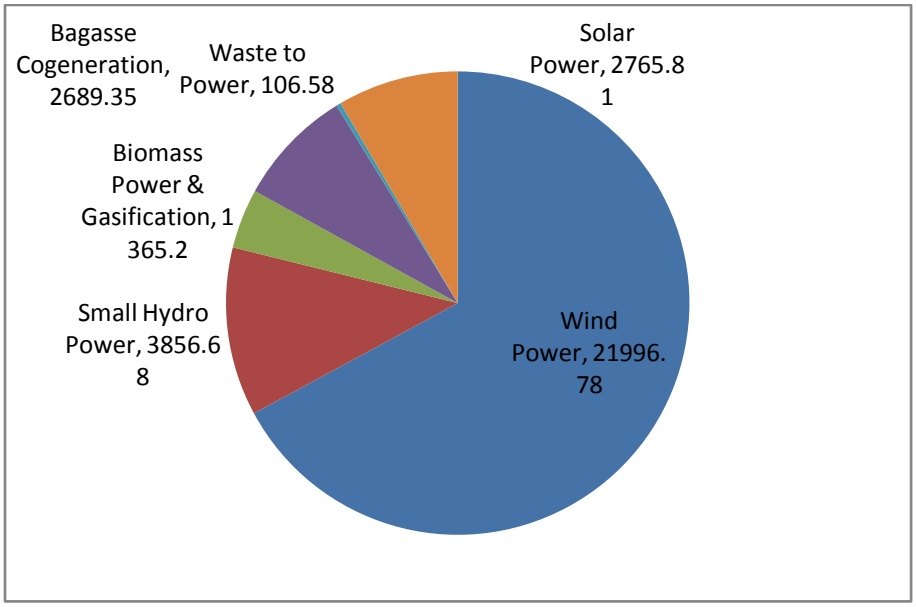


Figure 2: Renewable energy achievement as on September 2014 in MW

The energy demand is increasing significantly day by day. These demands vary season to season. For example, the highest peaks are usually found during summer. Since hydroelectric generators can be started or stopped almost instantly, hydropower is more responsive than most other energy sources for meeting peak demands. Energy generated by hydroelectric system is faster than that of any other energy source. The operation of electricity generation sources gives priority to meet peak demands, maintain the system voltage levels, and quickly restore power supply. In reservoir based hydropower stations, water can be stored overnight in a reservoir until needed during the day, and then released through turbines to generate power to help supply the peak load demand and decrease the deficit at peak [8]. Table 4 gives the peak shortage and energy shortage during the year 2013-14 and up to October 2014 along with percentage improvement in achievement [9].

Table 4: Peak shortage and energy shortage

Parameter	Achievement 2013-14	Achievement April-October 2014	Improvement
Peak Shortage (%)	6.3	4.7	25.4
Energy Deficit (%)	5	4.0	20.0

4. ENERGY LOSSES IN SMALL HYDROPOWER PLANT

The components of small hydropower plants are mainly categorised as civil, mechanical and electrical components. The loss of energy in hydro power system is mainly occur in the areas listed below:

1. Civil structures: due to improper design, construction and eroding of material in civil structure, energy loss may occur. This may also cause insufficient supply of water to generate the energy upto its full capacity. The civil works where such loss may occur are listed below:
    - Diversion structure
    - Head regulator
    - Power channel
    - Desilting tank

- Forebay
- Penstock
- Tail Race

2. Mechanical works: Mainly losses are occurred in turbine and flow controlling works as listed below:
    - Main inlet valve
    - Bye pass valve
    - Pressure reducing valve
    - Cooling water
    - Turbine and its auxiliaries
    - Gear box (if available)
    - Governor
3. Electrical: the mainly losses are occurred in the generator and other auxiliaries as listed below:
    - Hydro generator
    - Excitation system
    - Generator transformer
    - Station transformer
    - Bus bar system
    - Circuit breakers and Isolators etc.

The hydropower generating machines are designed for certain efficiencies at full load and part loads. The turbine efficiency can be upto 94%, generator efficiency upto 98% and gear box efficiency upto 99%. Different manufacturers provide efficiencies differently for their equipment. In india more losses also occur in Transmission and Distribution (T&D) lines. Aggregate Technical and Commercial (AT&C) losses are shown in Table 5 [10]. Technical losses are ageing of transformers, Overloading of transformers, feeders and conductors etc. Whereas commercial losses Low metering efficiency, non reading of meters, Faulty meter reading, inefficient billing and Faulty bill distribution.

Table 5: Loss in energy

Year wise projection		**% improvement**
2013-14 (Provisional)	2014-15 (Projected)	
23.70	22.17	6.5

To control the losses, proper operation and monitoring mechanism is required so forced outages, low generation and load shedding etc. could be minimized to reduce the deficit of electricity for meeting the peak demand or energy demand. Some of majors are suggested below:

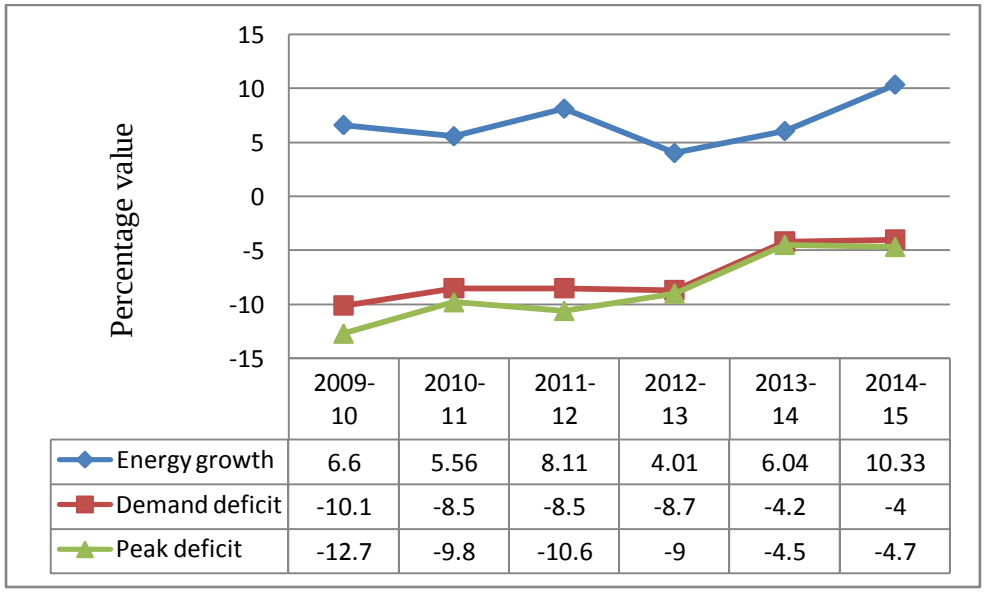
- Checking of water passage properly during monsoon and after monsoon season.
- Ensuring proper availability of discharge
- Proper cooling oil in transformer
- Cooling supply of turbine and transformer.
- Pressure, temperature and vibration in turbine and generator
- Proper scheduling and planning of maintenance of plant
- Replacement of equipment as and when required
- Availability of spare equipment for faster replacement
- Periodically training of the plant operation staff
- Operation and maintenance manual of every equipment should be followed.

For technical and commercial losses reduction, a proper network design with specification of equipment and parameter can be derived. Data collection regarding existing loads, operating conditions, forecasting of expected loads can give the output for proper operation. Technology options including integration of features for modernization of system, evaluation of various alternatives for least cost optimal solution should be adopted. To

overcome the energy deficit and peak shortage, it is imperative to have a consistent energy policy, together with relentless pursuit of energy efficiency and conservation.

5. CONCLUSIONS

Energy is vital for development thus the reliable availability of energy need to be ensured for the country like India moving towards a higher growth. Small hydropower is found to be the most important renewable source having benefits such as their quick generation, low installation cost and higher useful life. In total installation of energy in India16.1% is produced by large hydro plants where as renewable including small hydro power plants contribute about 11%.. In this study, it has been found that the energy growth is increasing every year where as demand deficit and peak deficit is giving downward trend as seen from Fig. 3. The energy and peak demand can be reduced by proper inspection of equipments and scheduling for maintenance of hydropower stations. On other side the T&D and AT&C losses can also be reduced to some extent. Such losses can be minimized by proper design network, efficient equipments with their modernization and least maintenance solutions.



	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Energy growth	6.6	5.56	8.11	4.01	6.04	10.33
Demand deficit	-10.1	-8.5	-8.5	-8.7	-4.2	-4
Peak deficit	-12.7	-9.8	-10.6	-9	-4.5	-4.7

Figure 3: Analysis of energy growth, demand deficit and peak deficit from 2009 to Sep. 2014

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