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Maharashtra State's Electricity Supply - Demand Forecasting for 2030 and 2050 using LEAP

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Abstract:

Electricity is one of the essential facilitator for achieving socio-economic development of the state and so the country. Amongst various modes adopted for meeting the ever increasing demand of electricity to achieve the targeted growth rate, Generation (supply) capacity enhancement is the most essential component. The economic growth leads to growth in demand of power. However, in view of the limited available fuel resources for generation, to meet this demand the capacity addition has to be planned very optimally Keeping in view the status of Maharashtra state as per as electricity consumption is concerned, it becomes essential to forecast the electricity requirement of the state and to meet that forecasted demand, what must be the installed capacity and the rate of electricity generation . In this paper LEAP software has been utilized for electricity requirement (Demand) and electricity generation(Supply) projections using various scenarios for Maharashtra state in 2030 and 2050 .

Key Words: LEAP, electricity demand and supply projections, electricity demand and supply scenarios

I. INTRODUCTION

Maharashtra, situated in the western part of India, is the second largest state in India in terms of population and geographical area (3.08lakh sq.km.).As per Census 2011 the state has a population of 11.24crore which is 9.3percent of total population of India . Being highly urbanized (45.2% people residing in urban areas) and also the most Industrialized state , Maharashtra ranks 5th in the country with Human Development Index(HDI) of 0.572 whereas HDI of India is 0.467.Per capita electricity consumption of Maharashtra state in 2012 is 1054.1KWh and that of India is 914.41KWh . Thus the percentage increase in per capita consumption of Maharashtra state is 15.27%.

A. Historical Trends :

Installed capacity of Maharashtra state in 2010-11 was 18853MW and in 2015-16 it was 32332MW which shows a percentage increase of 14.3% per year. The details are shown in Table 1 and Fig.1. The RE growth in the state has been more than 15% in the last five years. The current installed capacity of RE in the state is about 6.9 GW(2015-16) . Out of this wind capacity has the highest share i.e. over 60% . Objective of Govt. of Maharashtra is to achieve at least 14. 4 GW of RE by year 2020.

Table 1: Installed Capacity of Maharashtra State

Installed Capacity in MW						
Type of plant	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Thermal	9665	10366	13946	17206	18436	19216
Renewable	3408	4198	4789	6172	6717	6978
Hydro	3066	3066	3066	3066	3066	3066
Natural Gas	2714	2740	3072	3112	3072	3072
Total in State	18853	20370	24873	29556	31291	32332

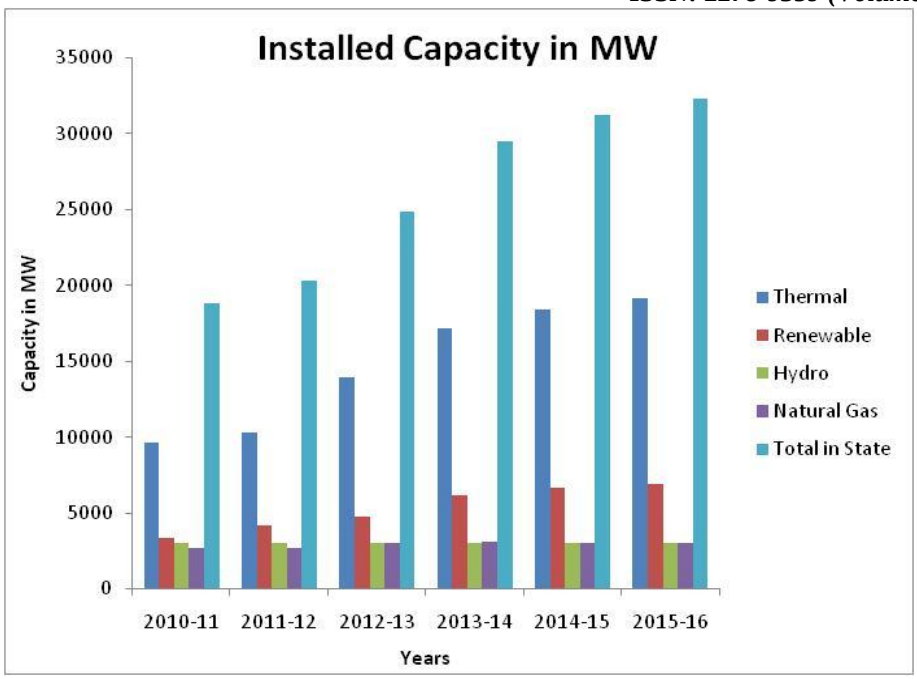

Fig 1: Installed capacity (MW) of Maharashtra State 2011-2016

Electricity Supply –Demand scenario of Maharashtra state as per NITI Aayog report is as shown in Fig 2. Electricity generation in the year 2011-12 was 106.874TWh and it was 126.738TWh in the year 2014-15 showing a percentage increase of 3.71per year. Electricity Consumption in the year 2011-12 was 101.812TWh and it was 113.639TWh in the year 2014-15 showing a percentage increase of 2.32per year.

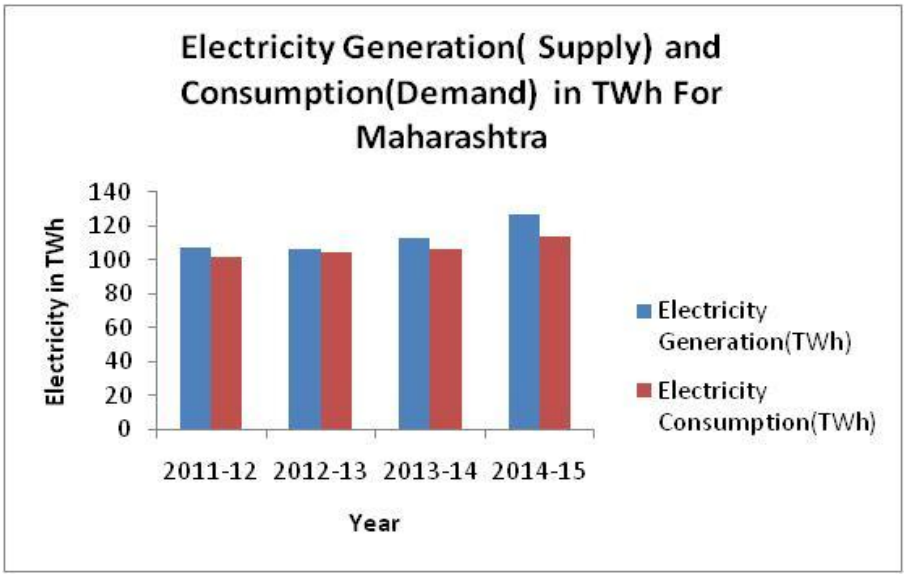

Fig 2: Electricity Supply Demand in (TWh) of Maharashtra State 2011-2015

B. Future Projections:

As per Fig 2, it is clear that the gap between electricity generation and consumption is increasing i.e. Generation is more than the demand but looking at the state's progress scenario of population growth, standard of living , industrialization and technological enhancement , demand of electricity is bound to increase. To keep the pace with the ever increasing demand proper planning is required for generation options.

II. LEAP

LEAP(Long range alternative planning)software which works on Markel's Model is used for giving the future predictions using various scenarios for supply as well as demand options.

LEAP's focus is on transparency of results, ease-of-use, data flexibility, adaptability to different scales, powerful data & scenario management and policy-friendly reporting. No other energy modeling tools have such powerful scenario & data management and reporting capabilities.

A. LEAP Scenarios:

Scenarios are the options given for future energy projections on Supply and Demand side .

- The projections under each Scenario take into account the overall availability of resources and the likely growth in the demand for energy in the economy.
- Generation and evaluation of scenarios can be done by comparing them on the basis of Energy requirement, Social cost and benefit, and their environmental impact.

The Electricity Supply Demand projections have been given under **Twelve scenarios:**

1 Business as Usual Scenario (BAU)
2. Efficient Lighting Scenario (EI)
3. Efficient Refrigeration Scenario (ER)
4. Efficient Industries Scenario (EI)
5. Energy Conservation Scenario (EC)
6. Demand Side Management Scenario (DSM)
7. Least Cost Scenario (LC)
8. High growth Scenario (HG)
9. High Coal Scenario (HC)
10. Renewable Energy Scenario (RES)
11. Zero Emission Scenarios (ZES)
12. Reliability Scenario

III. PROJECTIONS USING LEAP

A. Demand Side Projections:

Fig 3 shows the expected electricity demand in 2030 will be 311.5TWh and in 2050 it will be 1196.9TWh as per BAU scenario which shows the approximate increase of 14.21% every year.

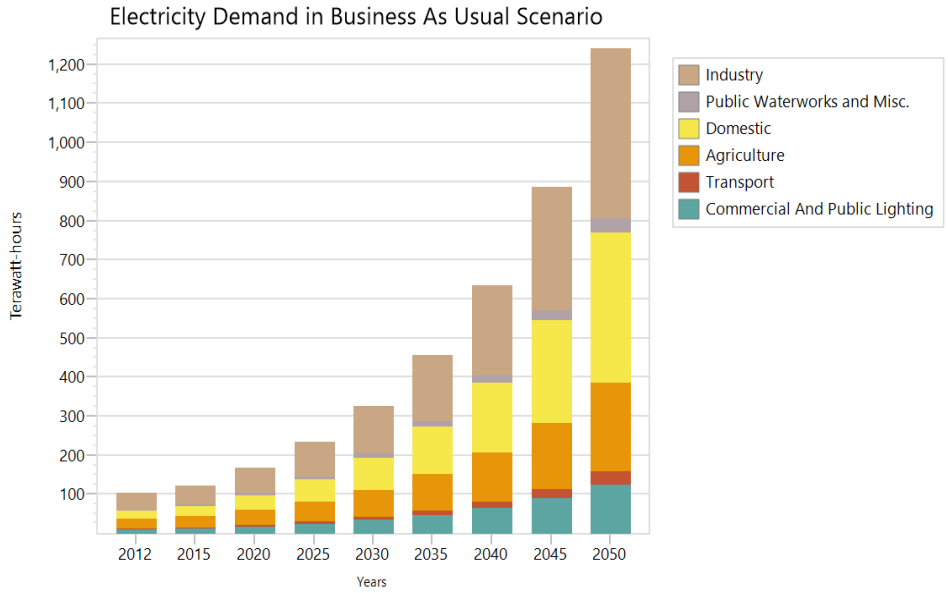

Fig 3: Electricity Demand (TWh) in BAU Scenario of Maharashtra State

Fig 4 shows the expected electricity demand for various scenarios. Here Energy Conservation scenario shows the minimum demand of 243.9TWh in 2030 and 713.8TWh in 2050 followed by Demand Side Management scenario showing expected demand of 256.6TWh in 2030 and 792.9TWh in 2050.

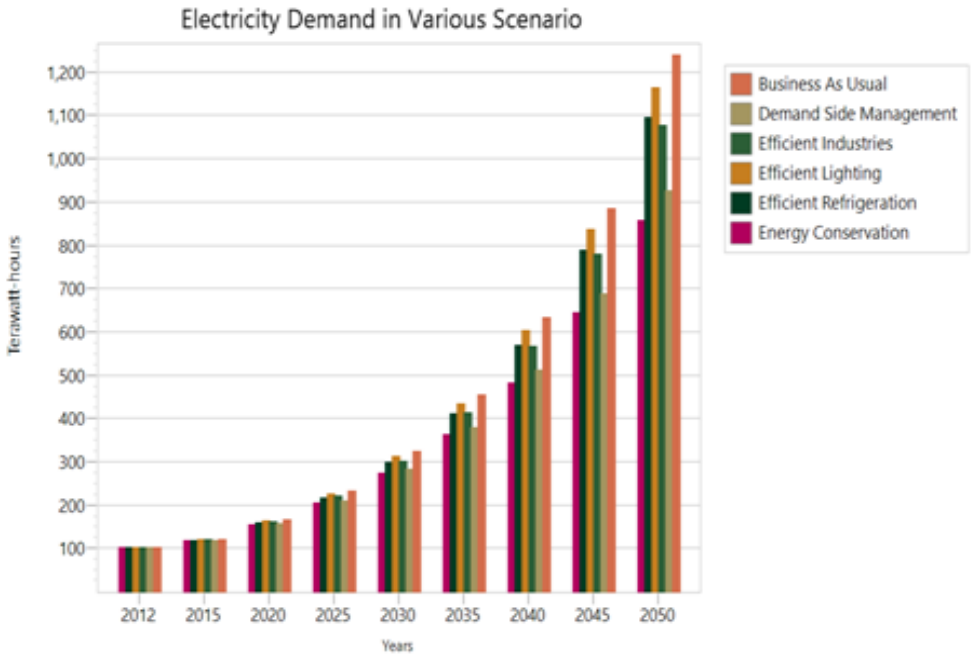

Fig 4: Electricity Consumption (Demand) (TWh) of Maharashtra State in various scenarios

B. Supply sideProjections:

As shown in Fig 5, it is found that as per BAU scenario ,electricity generation requirement in 2030 will be 374.5TWh whereas in 2050 it will be 1360.9TWh which shows a percentage rise of 13.17% every year.

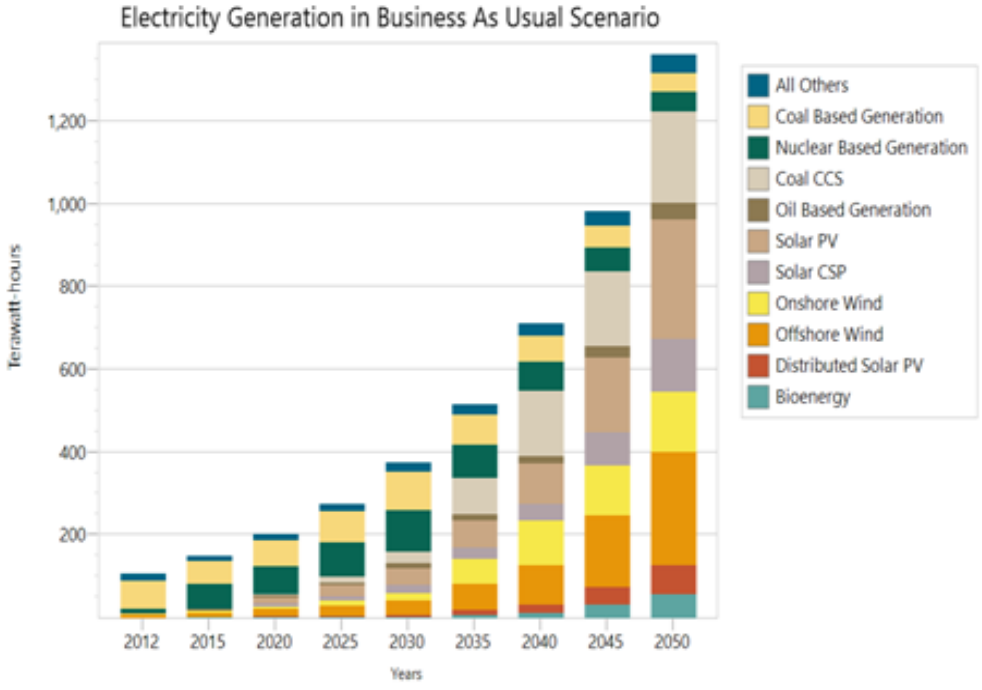

Fig 5: Electricity Generation(TWh) of Maharashtra state in BAU scenario

As per Fig 6, it can be observed that electricity requirement in the year 2030 will be 432.6TWh and 2060 TWh in the year 2050 in High Coal Scenario. Coal based generation is highest in Maharashtra state and still Govt. is giving the permission for erection of new coal based plants ,only condition being it should be based on super critical technology. So high coal scenario justifies the case of maximum requirements to be fulfilled by coal based generation.

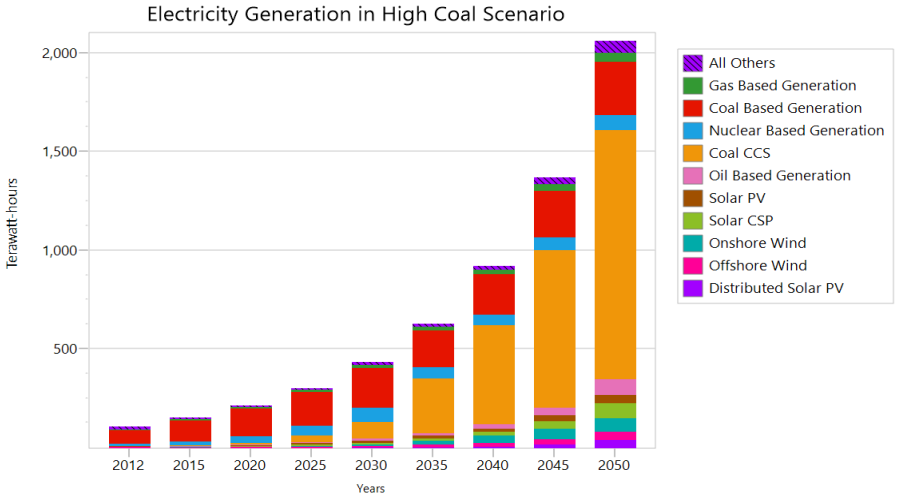

Fig 6: Electricity Generation(TWh) of Maharashtra state in High Coal scenario

Fig 7 shows the details of electricity generation (supply) in various scenarios. Minimum electricity requirement in 2030 will be 249.9TWh according to High RE scenario whereas it will be 942.1TWh in 2050 as per Energy Conservation Scenario.

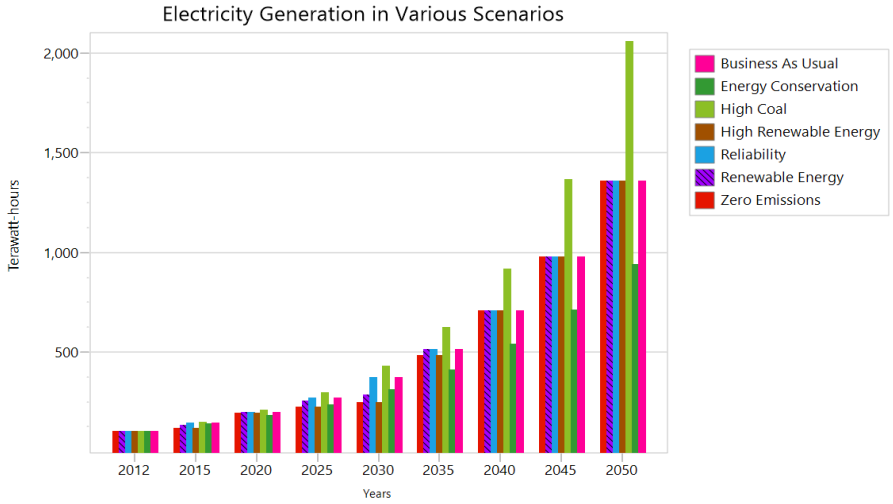

Fig 7: Electricity Generation(TWh) of Maharashtra state in various scenarios

Fig 8 shows the installed capacity of various types of plants for BAU scenarios. In the year 2030 it will be 106.9GW and in the year 2050 it will be 385.4GW which shows the percentage increase of 13 % every year.

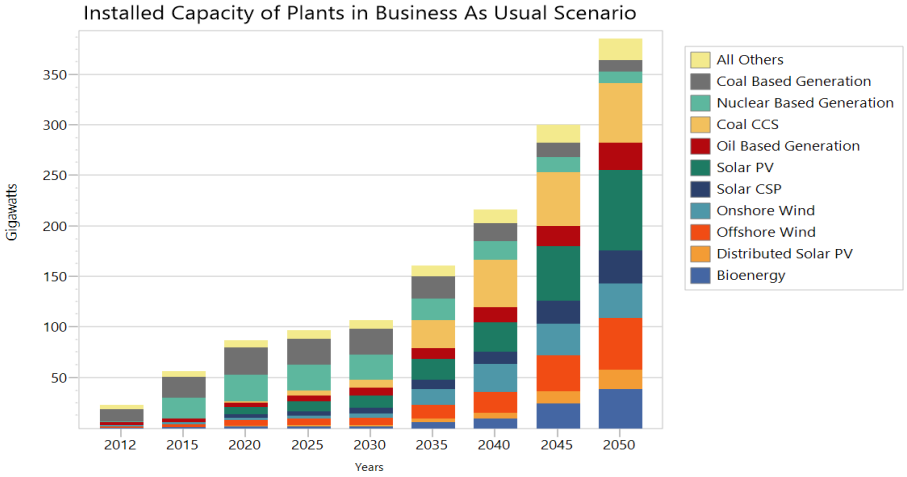

Fig 8: Installed capacity of plants (GW) of Maharashtra state in BAU scenarios

Fig 8 shows the installed capacity of various types of plants for various scenarios. The requirement of installed capacity will be 47.1GW in the year 2030 as per High Renewable Energy Scenario where as it will be 220.2 in the year 2050 as per Energy Conservation Scenario.

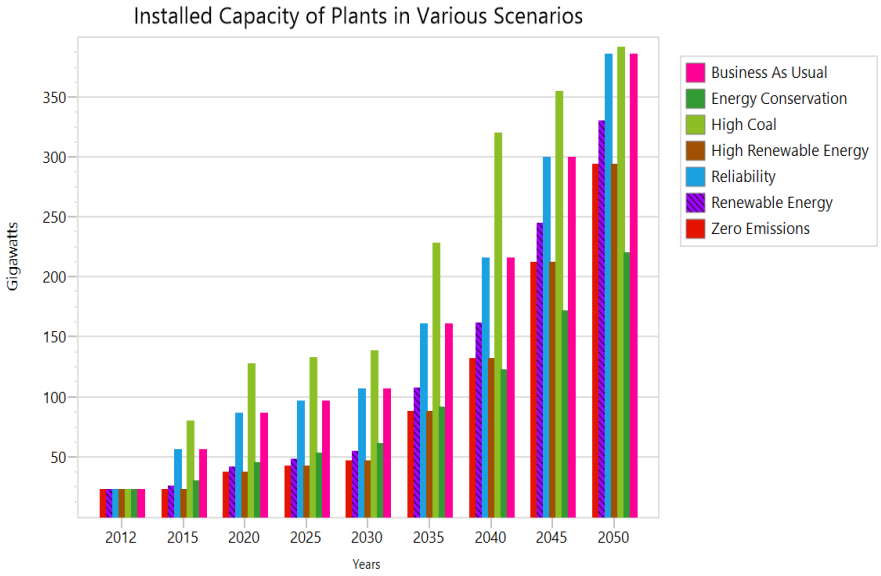

Fig9: Installed capacity of plants (GW)for Maharashtra state in various scenarios

Table 1 shows the highest saving in Electricity Demand can be achieved in Energy Conservation scenario i.e.51.9TWh where as lowest can be achieved in Efficient Lighting scenario in the year 2030. This shows that Energy Conservation scenario is the best as per as Electricity Demand predictions are concerned. Per capita electricity consumption will be highest in BAU scenario i.e. 1676KWh

Table 1: Comparision of Electricity Demand Projections in Maharashtra in 2030 in Various Scenarios

Type	BAU	DSM	EI	EL	ER	EC
Total Electricity Demand(TWh)	325.9	283.8	302.4	314.5	299.2	274
Saving in Electricity Demand(TWh)		42.1	23.5	15.4	26.7	51.9
Per Capita Electricity consumption(per KWh)	1676	1460	1555	1617	1539	1409

Table 2 shows the highest saving in Electricity Demand can be achieved in Energy Conservation scenario i.e.382TWh where as lowest can be achieved in Efficient Lighting scenario i.e 75.7TWh in the year 2050. This shows that Energy Conservation scenario is the best as per as Electricity Demand predictions are concerned. Per capita electricity consumption will be highest in BAU scenario . Per capita electricity consumption will be highest in BAU scenario i.e 3535KWh .

Table 2: Comparision of Electricity Demand Projections in Maharashtra in 2050 in Various Scenarios

Type	BAU	DSM	EI	EL	ER	EC
Total Electricity Demand(TWh)	1241.1	927.8	1077.8	1165.4	1076.4	859.1
Saving in Electricity Demand(TWh)		313.3	163.3	75.7	164.7	382
Per Capita Electricity consumption(per KWh)	3535	2642	6600	3319	3065	2447

Lowest GHG emissions can be obtain in Zero Emission scenario i.e 1054 MMT of CO_2., in the year 2030 and it will further reduce to 147.3 MMT of CO_2, in the year 2050, as shown in table 3

Table3:GHG Emissions for Various Scenarios in Maharashtra for 2030 And 2050 (In Million Metric Tonne of CO_2)Z

Scenarios	2030	2050
BAU	2142.5	5109.9
EC	1848.2	4012.8

High Coal	2637.2	8058.5
High Renewable Energy	1945	4837.1
Reliability	2286.5	5285.6
Renewable Energy	1967.4	5008.9
Zero Emissions	1054.1	147.3

IV. CONCLUSION

1. Growing population, increasing standard of living and Technology enhancement points towards substantial growth in demand. To fulfill the unprojected demand, emphasis should to given on the use of clean energy as conventional sources are dying very fast and also are responsible for GHG emissions.
2. From above discussion it is clear that for meeting the electricity requirement of Maharashtra State it is very essential to focus on energy conservation scenario as it shows the least energy requirement and at the same time reduces the GHG emissions moving towards "Clean Maharashtra and Power to All"
3. The most suitable energy source is Solar energy, so more importance must be given to use Solar power which is the best form of clean energy and in result will reduce GHG emissions.

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