

ELECTRICITY SUPPLY-DEMAND PROJECTIONS

MODEL FOR INDIA

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ABSTRACT

Growth of Power sector plays a major role in the economic development of the country as it facilitates development across various sectors of the economy. Since Independence the Power Sector in India has grown considerably. Over the years the installed capacity of Power Plants (Utilities) has increased to about 3,02,088 MW as on 31.3.2016 from a 2,38,200 MW in 2012 which was meager 1713 MW in 1950. Similarly, the electricity generation increased from about 5.1 TWh in 1950 to 1071TWh in 2012 to 1107 TWh(including imports) in the year 2016-17. The per capita consumption of electricity in the country has also increased from 15 kWh in 1950 to about 914.41KWh in 2012-13 to 1,100 kWh in the year 2016-17. This consumption is just 1/3rd of the world’s average. To compete with the world’s standard, we need to analyze our previous growth rates, present situation and based on those analyses we need to project the demand. In this paper LEAP software has been used to analyze the future demand projections using various scenarios.

Key words: LEAP, electricity demand and supply projections, electricity demand and supply scenarios.

I. INTRODUCTION

Electricity is one of the key parameter whose present and future status needs to be analyzed as it is having a major share in total energy generation across the country. Share of electricity generation in total energy generation in 2012 is 54%.Elctricity consumption in the year 2012 was 877.1TWh and in the year 2017 was 1124.9TWh which shows a growth of 28% over the years and is expected to double in the year 2022. Keeping in view the ever increasing demand of electricity, projections are given using various scenarios in LEAP software.

II. DATA ANALYSIS

India’s present electricity demand status (2012-2017) is shown in Table 1 and its graphical representation is shown in Fig.1:

Table 1:Sectorwise electricity Demand 2012-2017(In TWh)²

Branches	2012	2013	2014	2015	2016	2017
Industry	336.6	354.2	372.8	392.3	412.9	434.6
Telecom	13.9	14.6	15.4	16.2	17.2	17.9
Buildings	239.1	252	265.6	279.9	295.1	311.1
Agriculture	135.9	138.8	141.7	144.7	147.7	150.8
Cooking	72.8	78.4	84.4	90.8	97.7	105.1
Transport	78.7	83.5	88.5	93.8	99.4	105.4
Total	877.1	921.5	968.4	1017.7	1070	1124.9

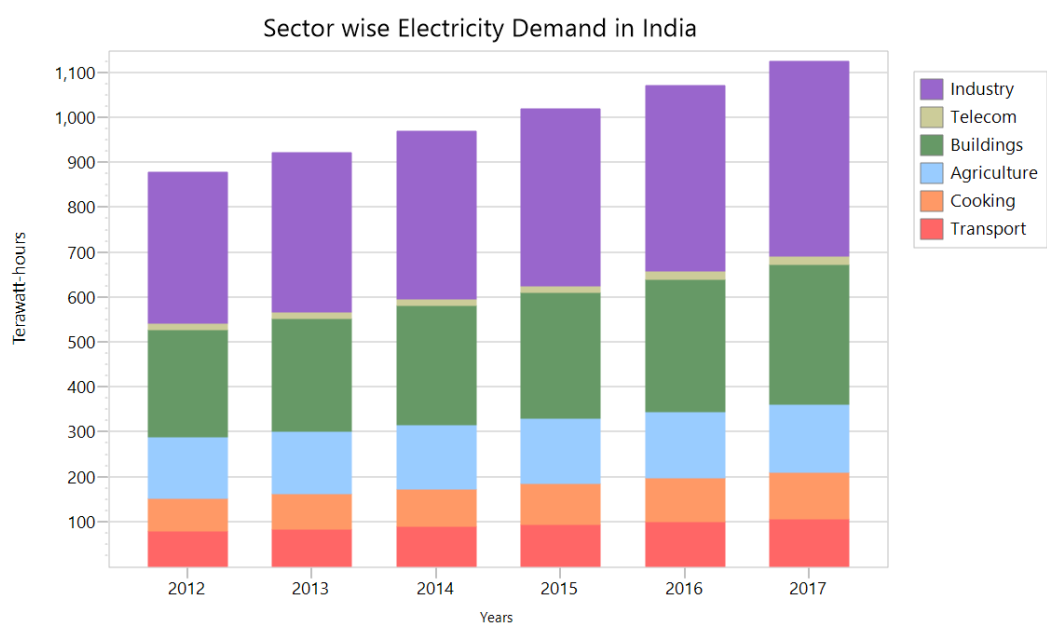


Fig1: India’s present electricity demand status (TWh)

The data shows that in the year 2012 the demand of energy in the industrial sector was 38.38%,in Telecom sector it was 1.58%,in Building sector 27.26%,in the Agriculture sector 15.49%,in Cooking sector 8.3% ,in Transport sector 8.97%. In the year 2017, the corresponding demand in the in the Industrial sector was 38.63%,in Telecom sector it was 1.59%,in Building sector 27.66%,in the Agriculture sector 13.4%,in Cooking sector 9.37% ,in Transport sector 9.36%.This shows the marginal positive growth rate in all the sectors expect Agriculture.

III. ABOUT LEAP³

LEAP Stands for **Long Range Energy Alternative Planning**. Salient features of LEAP are:
 It predicts the intensity of Energy demand and supply situation in various areas under various sectors.
 2. **Forecasting** is done using various Energy **Scenarios**.

IV. WORKING PRINCIPLE OF LEAP

LEAP works on Markel Model, the details of which is as shown in Fig.2⁷

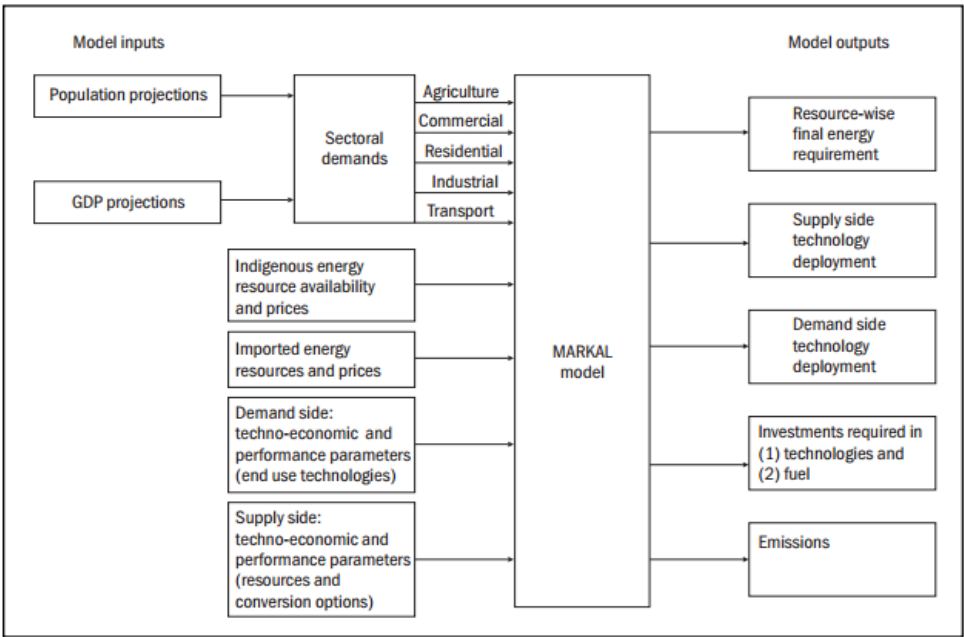


Fig.2: LEAP structure

Comparison of LEAP with other Energy Models:

- 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.
- LEAP is notable for the degree of methodological choices it provides to users.

V. 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

VI. ELECTRICITY DEMAND PROJECTIONS USING VARIOUS LEAP SCENARIOS:

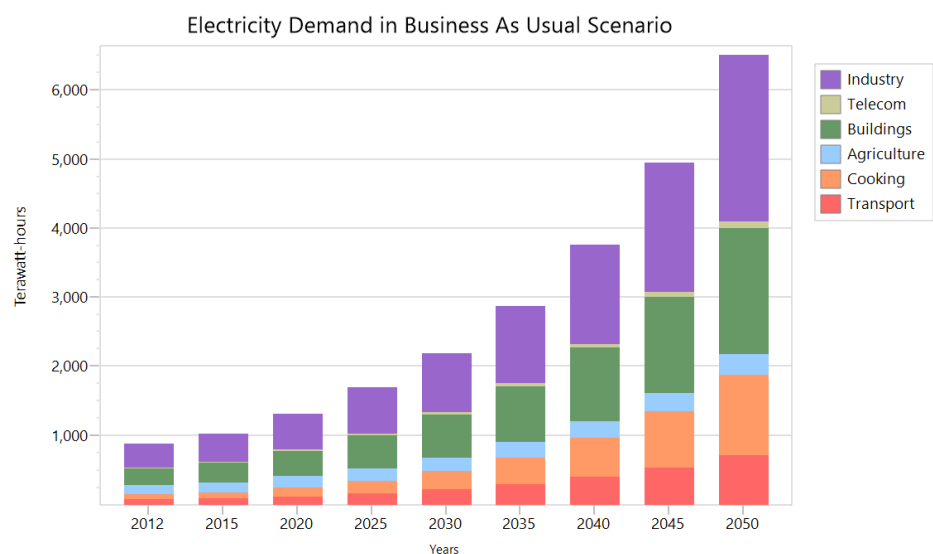


Fig.3: BAU Scenario

Business as Usual Scenario (BAU) is based on the existing trends in the energy sector. This scenario assumes that the global dynamics of change continue without great surprises or much change in energy sources and consumption patterns other than those that might be expected as a result of the change dynamics and trends already in place. Here it is clear that the total electricity Demand in year 2012 was 877.1TWh and it is expected to be 2190TWh and 6509TWh in 2030 and 2050 respectively

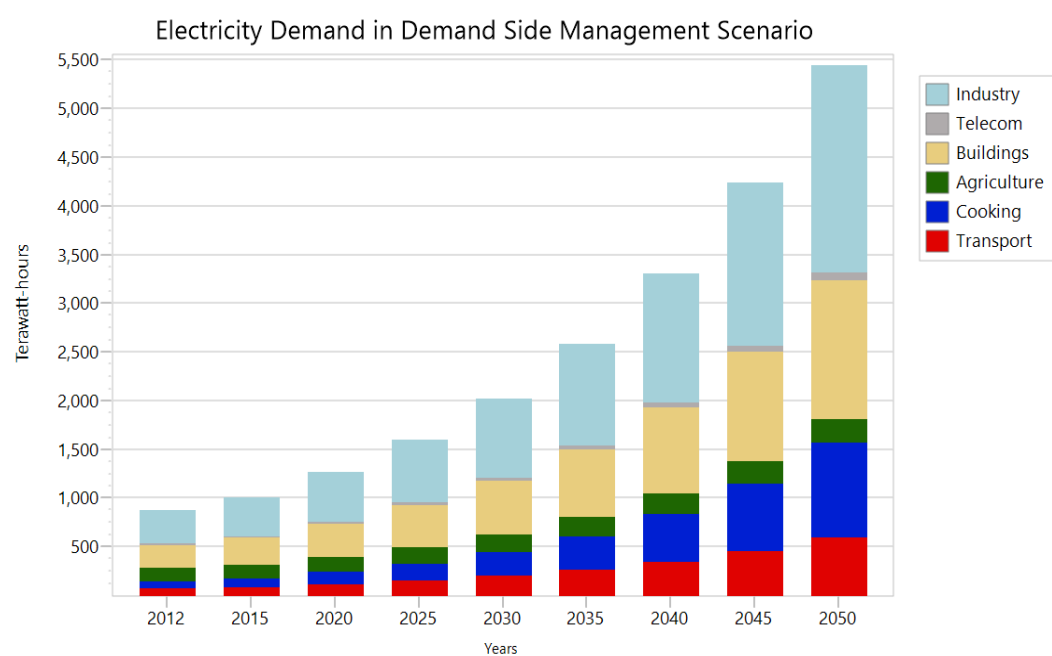


Fig.4 Demand Side Management Scenario

Demand Side Management Scenario includes the combine effect of efficient Lighting, efficient Refrigeration, reduction in T&D losses and also the effect of plant load factor. Fig 4 indicates that the total electricity Demand in the year 2012 is 877.1TWh, in 2030 it will be 2018.3TWh and in 2050 it will be 5445.5TWh whereas in BAU scenario in 2030 it will be 2190TWh and in 2050 it will be 6509TWh. This shows the reduction in the electricity demand of 7.8% in 2030 and 16.33% in 2050 as compared to BAU scenario.

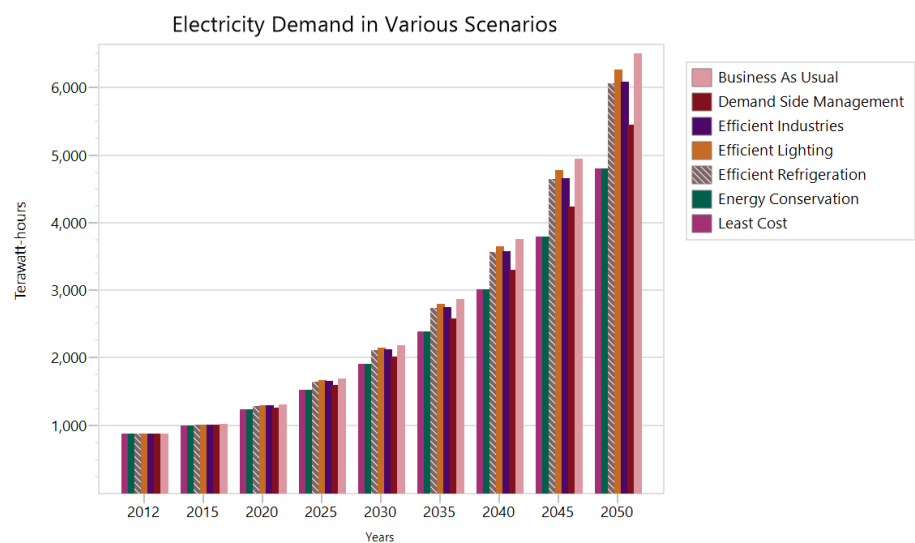


Fig.5: Electricity Demand In Various Scenario

Fig. 5 shows the electricity demand projections for various scenarios. The % growth of electricity demand in BAU scenario in 2030 will be 149.7% and in 2050 it will be 642%, in DSM it will be 130% and 521% respectively, in EI it will be 141.8% and 521% respectively, in EL it will be 145% and 641%respectively, in ER it will be 141% and 592% respectively and in EC it will be 117% and 447% .

From table 2 , if saving in energy is the criteria then EC is the best scenario which gives the saving of 285.6TWh and if per capita electricity consumption is the criteria then BAU can be considered as the best scenarios according to its projections the value of per capita consumption of electricity in 2030 will be 1447.45TWh.

Table 2: Comparative analysis of Various Electricity Demand Side Scenario for the year 2030

TYPE	BAU	EFF.RERI	EFF.IND	EFF.LIGHT	EC	DSM	LEAST COST
Total Electricity Demand(TWh)	2190.6	2113.9	2121.6	2148	1905	2018.3	1905.4
Saving in Electricity	*****	76.7	69	42.6	285.6	172.3	285.2
GHG Emissions(Billion MT of CO2 Equivalent	6.6	6.5	6.6	6.4	4.9	6	4.8
Per Capita Electricity Consumption (KWh)	1447.45	1397	1402	1420	1259	1333	1259

Table 3 shows that 1712.1TWh of energy is saved in EC scenario which makes it highly lucrative as far as energy saving is the main objective. For per capita energy consumption criteria, BAU is the best scenario as according to its projections the value of per capita consumption of electricity in 2050 will be 3376TWh. Per capita consumption values in 2030 and 2050 though seem to be attractive in BAU scenarios; still it is far below expectations. To compete will the world standard we need at least three times the BAU value in 2030.

Table 3: Comparative analysis of Various Electricity Demand Side Scenario for the year 2050

TYPE	BAU	EFF.RERI	EFF.IND	EFF.LIGHT	EC	DSM	LEAST COST
Total Electricity Demand(TWh)	6509	6066.7	6084.4	6262.1	4796.9	5445.5	4796.9
Saving in Electricity	*****	442.3	424.6	246.9	1712.1	1063.5	1712.1
GHG Emissions (Billion MT of CO2 Equivalent	15.8	15.2	13.4	14.5	7.8	12	7.8
Per Capita Electricity Consumption (KWh)	3376	3147	3155	3248	2488	2824	2488

VII. ELECTRICITY SUPPLY PROJECTIONS USING VARIOUS LEAP SCENARIOS

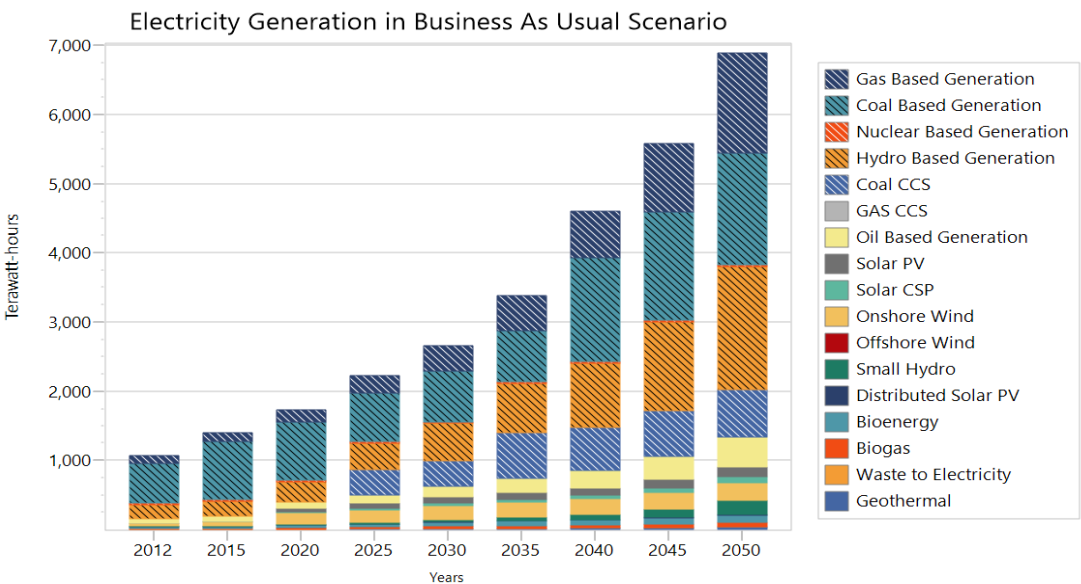


Fig. 6: Electricity generation in BAU Scenario

Fig 6 shows the electricity generation in BAU scenario in 2012 is 1071TWh it will be 2649.7 TWh in 2030 and it will be 6889.1TWh in 2050.

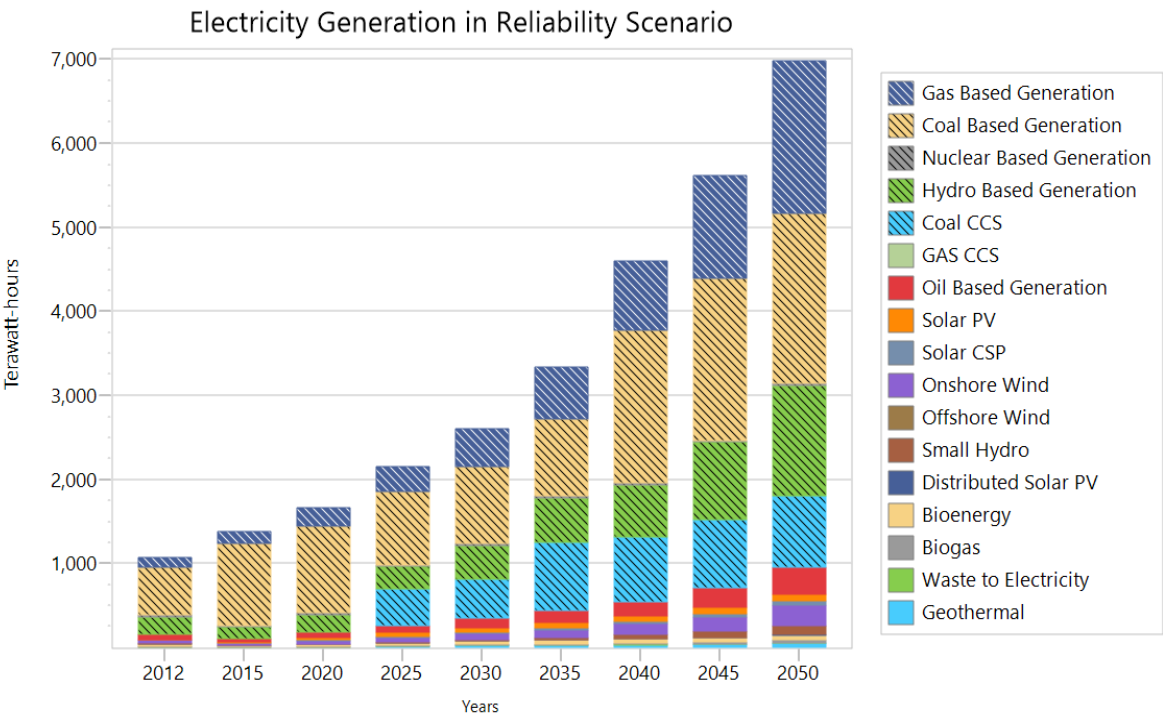


Fig. 7: Electricity generation in Reliability Scenario

In case of reliability scenario, generation is based on merit order. As shown in fig 7, expected generation as per Reliability scenario in 2030 will be 2596.4TWh and will be 6982TWh in 2050 which shows a percentage reduction of 2% in 2030 and 1.34% increase in 2050 as compared to BAU scenario.

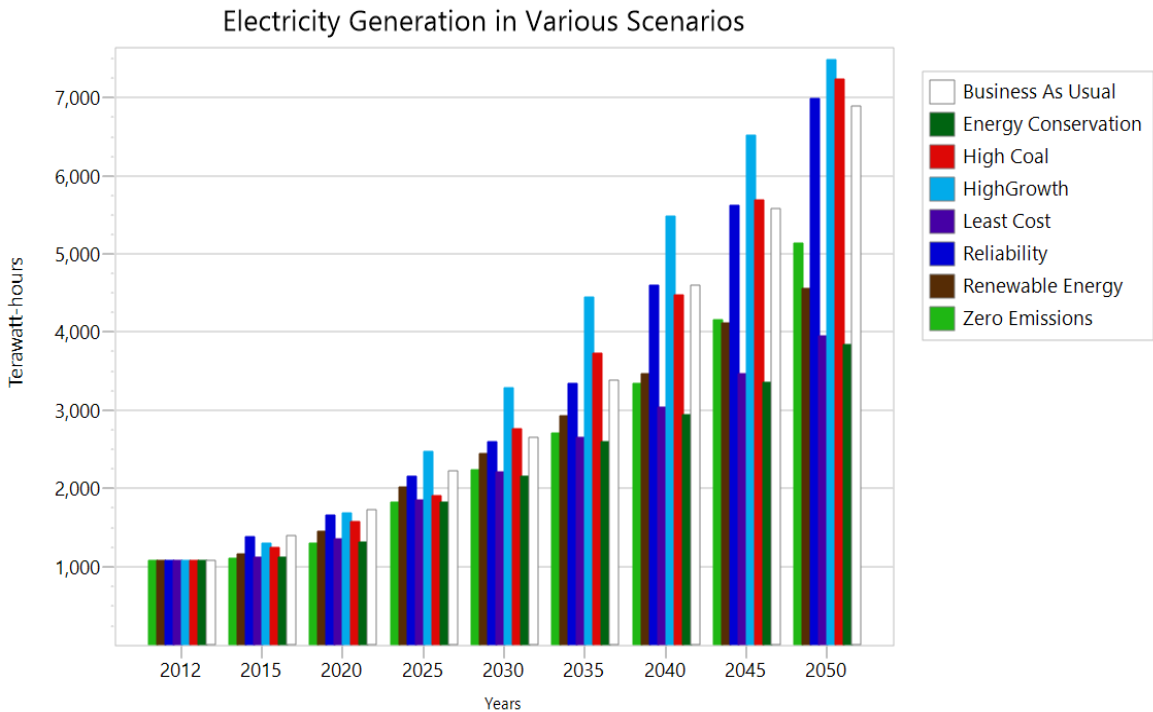


Fig. 8: Electricity generation in various Scenarios

As per fig. 8, percentage increase of electricity generation in 2030 and in 2050 as per BAU scenario is 147% and 543% respectively, it will be 100.9% and 258% in EC scenario respectively ,it will 158% and 576% in high growth scenario respectively, it will be 142% and 551% in reliability scenario respectively ,it will be 128.6% and 325% and 109% and 380% respectively.

Comparison of various Electricity Generation (Supply) side Scenarios:

Table 4 Comparison of Electricity Generation Projections in 2030 for Various Scenarios

TYPE	BAU	EC	High Coal	LC	Reliability	RE	ZES
Electricity Generation (TWh)	2649.6	2152	2768.1	2212	2596.4	2448.6	2243.1
Saving in Electricity Generation	*****	497.6	-118.5	437.6	53.2	201	406.5
GHG Emissions (Billion MT of CO2 Equivalent)	6.6	4.9	7.2	4.9	7.1	5.7	3.7

Table 5 Comparison of Electricity Generation Projections in 2050 for Various Scenarios

TYPE	BAU	EC	High Coal	LC	Reliability	RE	ZES
Electricity Generation(TWh)	6889.1	3842.9	7242.2	3950.1	6982	4561.6	5142.9
Saving in Electricity Generation	*****	3046.2	-353.1	2939	-92.9	2327.5	1746.2
GHG Emissions (Billion MT of CO2 Equivalent)	15.8	7.8	17.2	****	16.9	10.8	4.5

Table 4 and 5 it is clear that if saving in electricity generation is the criteria then Energy conservation scenario is the best option and if minimum emission is the criteria then Zero Emission scenario is the best option.

Suggested Electricity Supply – Demand Model for India

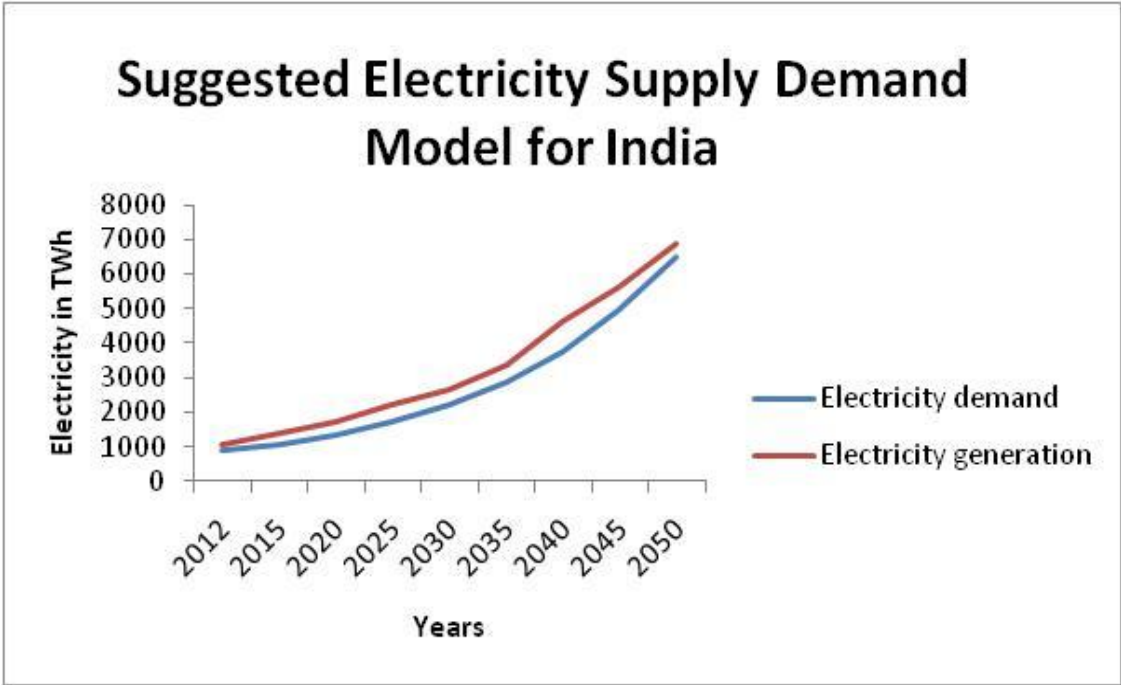


Fig 9: Suggested Electricity Supply Demand Model for India

Salient features of suggested Electricity Supply- Demand Model for India are:

- [1.] The model for electricity demand is based on Energy conservation, Least cost and Demand side management scenario.
- [2.] The model for electricity generation is based on minimum GHG emission, Least cost ,Renewable energy and Energy conservation scenario. Maximum availability of the resources is also one of the influencing factors.

[3.] Generation (supply) is very close to demand which indicates more supply sources need to be harnessed to meet any unexpected demand projections. Maximum focus should be given to renewable sources to satisfy” GHG Emission free India “concept.

[4.] The expected GDP growth rate is considered as 6.8 and population growth rate is 1.22 for construction of model and year 2012 is considered as the base year.

Energy basket for Electricity demand and supply (generation) are shown in fig. 10 and fig. 11.

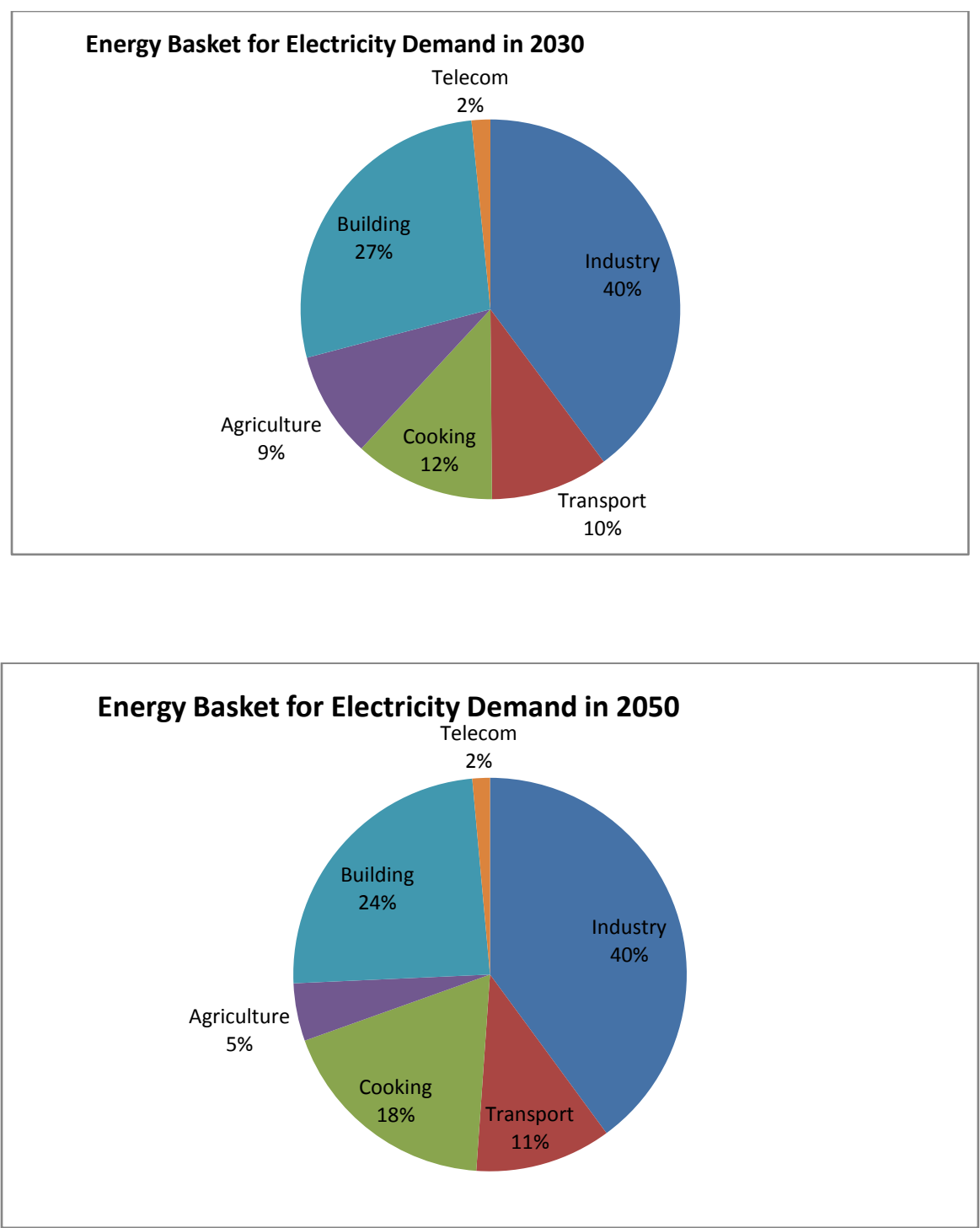


Fig.10: Energy basket for Electricity demand based on the suggested model for the year 2030 and 2050

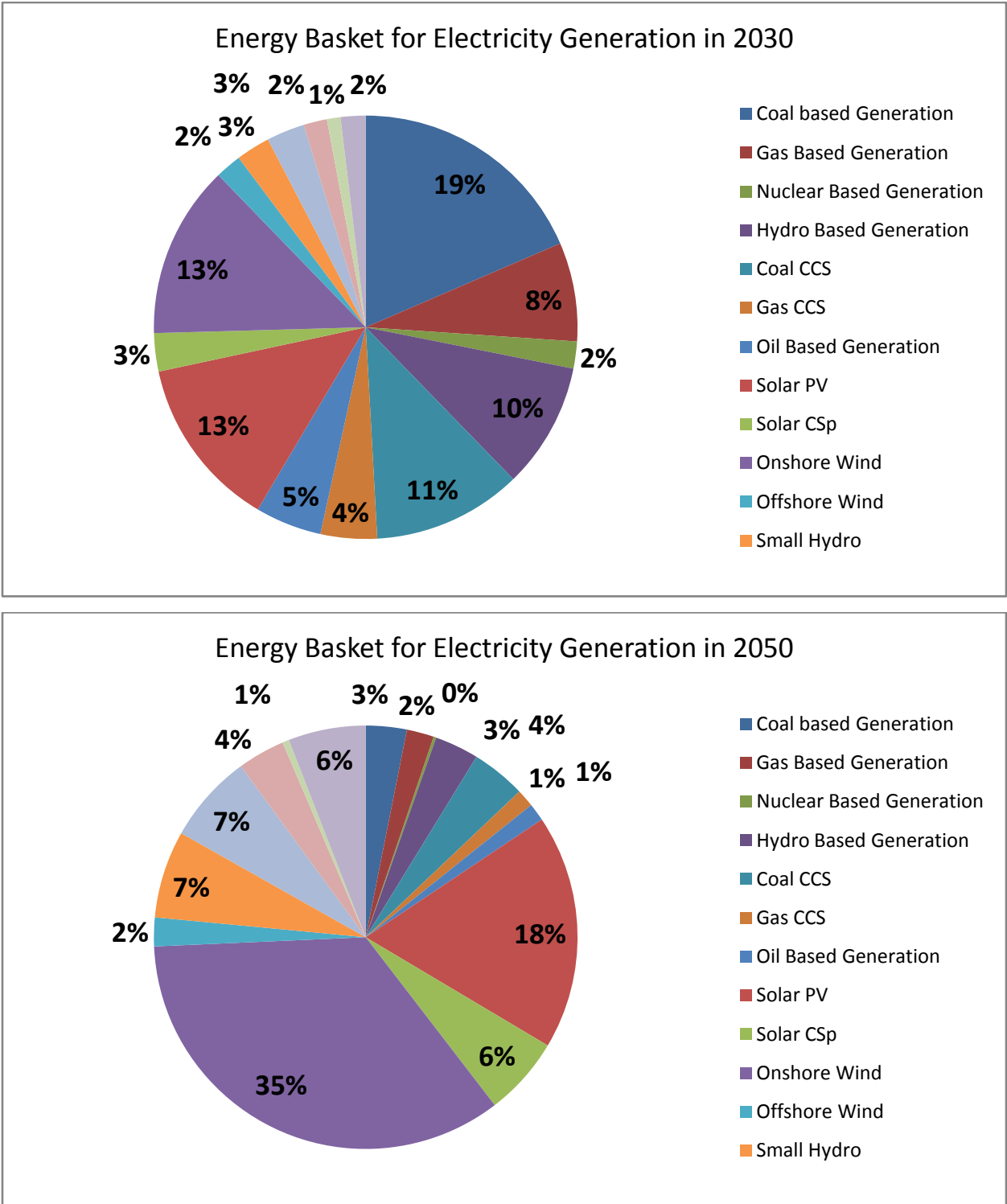


Fig.11: Energy basket for Electricity generation based on the suggested model for the year 2030 and 2050

VIII. RESULTS AND DISCUSSIONS

1. In 2012, Electricity supply is 1071.1TWh,in 2030 it is 2649.7TWh and in 2050 it is 6889.1TWh which shows the rise of 87.7 % and 153.1% respectively.
2. As far as Electricity Demand is concerned, in 2012 it is 877.1TWh, in 2030 it is 2190.6TWh and in 2050 it is 6509TWh which shows the rise of 72.97% and 148.2% respectively.
3. Increasing 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.

REFERENCES:

1. NitiAayog<http://niti.gov.in/documents/reports>
2. TEDDY 2012-13 <https://books.google.co.in/books?isbn=8179935205>
3. LEAP<https://www.energycommunity.org/default.asp?action=introduction>
4. Planning Commission <http://planningcommission.nic.in/plans/planrel/11thf.htm>
5. CEA <http://www.cea.nic.in/>
6. India Vision 2020http://www.teindia.nic.in/files/reports/ccr/pl_vsn2020.pdf
7. National Energy Map for India: Technology Vision 2030 <http://bookstore.teri.res.in/docs/books/PSA%20Report-Summary.pd>
8. Planning Commission of India, Integrated Energy Policy: Report of the Expert Committee, Government of India, 2006