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Balancing Energy Consumption and Sustainability: An Indian Perspective

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Abstract: ***There is glaring gap in per capita energy consumed in our nation as compared to developed nations our energy consumptions is 1/10th of developed nations. There is gap also in urban vs. rural western –eastern northern southern and in north-eastern in our country itself. The places where the large fossil and renewable energies are available are not able to consume it which is hindrance in their economy development and living standard and monetary growth. This results in per capita income of these areas being very low. The condition need to improve for betterment of living conditions. India mostly consumes and rely on coal, large scale import of oil and gas, country is also burdened monetarily on coal and large scale import of oil and gas, It is difficult to cope with financial burden of import also environment is paying the price for large scale energy production, transformation, transportation and use. It is clear that to try to achieve the level of energy consumption compared to developed nations is unessential but to improve quality of life of all citizens of our country the per capita energy consumption need to increase. We need to find balance between the energy consumption and extraction of the fossil fuel and also try to find new sources of energy, which will lead to improve in quality of life. It is high time that we make shift towards renewable and replenish able form of energy. This strategic change needs paradigm shift in our development approach i.e. from non-responsible growth to a climate friendly moderate development. Serious environment related problems (Global warming, acid rain and ozone layer depletion) are mostly related to energy form and source which is used it is in our national and interest for world at large that we minimize energy usage without sacrifice of the energy requirement for a decent quality of life. A time bound implementation of program is essential to move to renewable energy dominant decentralized system from the existing non replenish able and exhaustive energy system dependent on fossil fuel centralized system***

Keywords: energy, fossil, renewable energies, climate, global warming, ozone depletion

Objective

- To study energy scenario keeping in view Indian scenario
- Search for the way forward for sustainability and energy security in future

1. Introduction

We have studied the available literature in the current energy scenario especially for Indian context. The available literature is huge and it will consume time to study the whole of the literature. We have tried to produce the gist of the available literature and tried to explain in simple terms with the help of diagrams and figures the energy scenario.

There is relationship between the development of nation and the per capita income, The developed nation naturally will have greater use of energy as maximum population will work, they will invest in luxury item, the transportation will be higher, continuous power supply will be required. Similar is the case with the developed State and the state which are still developing like Bihar, Jharkhand, Rajasthan, MP etc. the energy consumption will be lower in these states as compared to the developed states like Maharashtra, Gujarat, Goa etc. Similar conclusion can also be drawn for the rural part of India and Urban part of India. There are data substantiating this fact of the co relation between energy consumption and life style upliftment.

We in India and world at large are consuming and fully dependent in fossil fuel and Bio Mass.

There are inherent disadvantages of using this fuel in large quantity. The most concern area is that the energy are depleting very fast, the price is increasing, the sustenance with this rate of use will be huge problem in future for India and for world.

The least said about the carbon index is enough for the glaring issues we are facing the major of them are global warming, dangerous gases emission like Carbon Dioxide (CO2) Methane (CH4), and Nitrous dioxide (N2O) also in recent years in state like Delhi, Haryana, Punjab etc. the acid

Although now we have started to find the alternatives for the depleting fossil fuels. In forms of solar energy, wind energy, geothermal energy etc.

We have presented resources of the country region wise. The energy used by different sectors is discussed. The supply and demand side problems of energy are covered and possible strategies for energy security and sustainenance is discussed followed by conclusion of article.

Energy is essential for every activity of life. There is a strong positive correlation between energy use and quality of life. There is a strong positive correlation between energy use and the quality of life. At global level, per capita income of a country is directly proportional to the per capita energy consumption. Similar trend is also observed in states of India as well (fig 1)

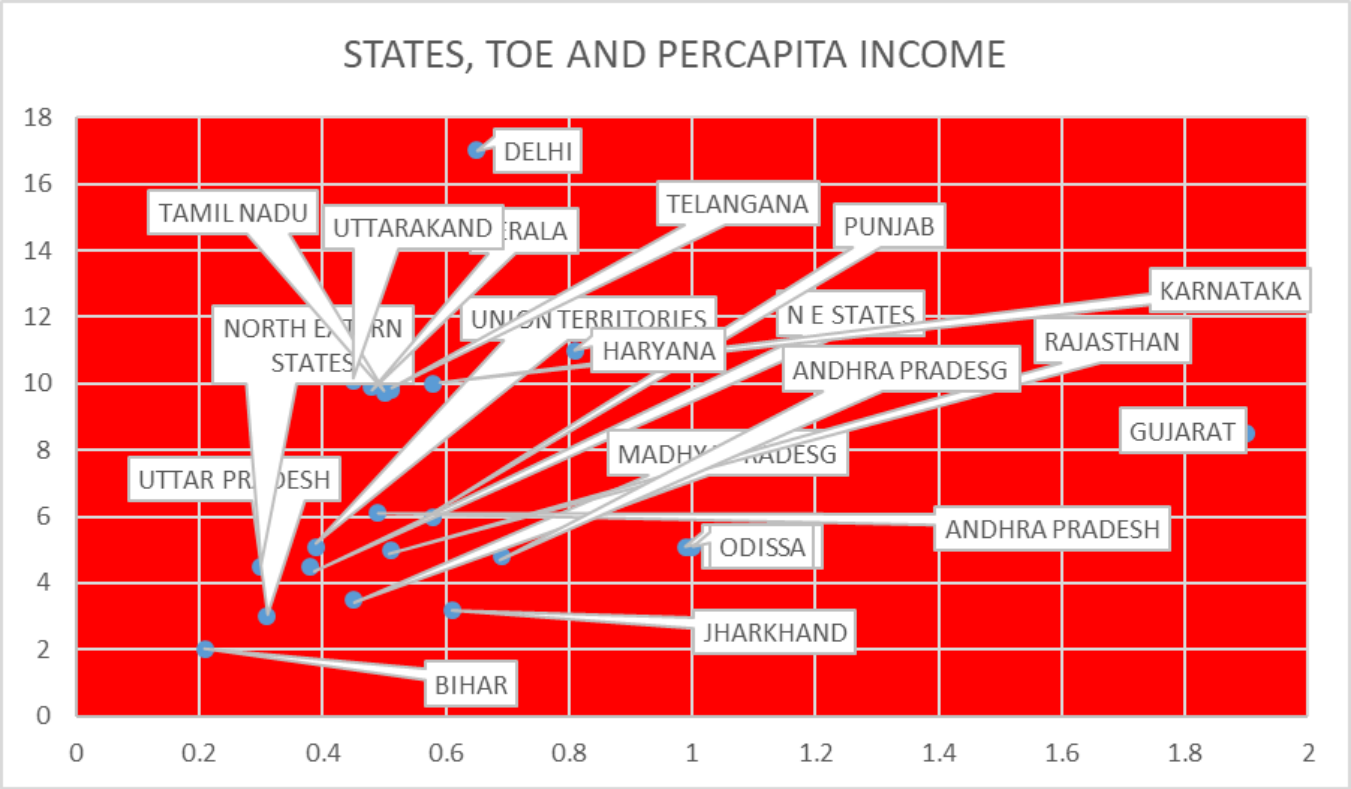

Figure 1: Graphical representation of TOE and Thousand USD per capita in states
Source TEEDDY (year book 2018-2019)

Energy classification is done in different ways for proper understanding and study. We are mentioning some of the ways in which energies are classified and further studied.

Commercial and Noncommercial Form
Commercial energy are energies which are can be utilized in industries and can be purchased and sold in like commodity and used by the consumers the sources for this type of energies includes coal, gas, electricity and in some cases biomass.

Noncommercial energy includes mostly Biomass which generally do not carry price tag and available abundantly like the woods used for cooking in the rural areas. The accurate and noncommercial energy data use is not available. In 2000 India's energy mix was 55% commercial and 45% noncommercial (TEEDDY 2010)

Primary Secondary and Tertiary
Considering the stage of transformation energy can also be classified as primary (Coal crude oil natural gas water geothermal wind solar heat biomass etc.)

Secondary (steam chilled water petrol diesel biogas hydroelectricity solar electricity etc.) and tertiary type (electricity).

Primary energy sources are those that are present prior to any human induced modification. Higher energy sources are obtained from the transformation of lower sources. Primary energy sources are those that present prior to any human induced modification. Higher form of energy is clean, offer ease of operation and controllable which make them expensive. A number of political economical social technological and ecological factors play crucial role in ensuring access to use of right quantity and quality of energy by the common people

Renewable and Non-Renewable Energy
The energy which are classified according to the replenishment or limited availability. Renewable energy is obtained from sources that are essentially inexhaustible. Examples of renewable resources include wind power solar power renewable resources include wind power solar power geothermal energy tidal power and hydroelectric power Non –renewable energy is the conventional fossil fuels such as coal oil gas which are likely to deplete with time.

Energy Sources in India
Energy resources of India have all the possible sources of energy. These include all forms of non renewable and renewable energy sources. The energy resources availability is not uniform across the country Table 2 indicates the energy sources in major locations of the country.

Table 1: Sources of Energy Statewise (Teddy 2010)

Energy source	Key location	Remark
Coal	Jharkhand, Odisha, Chhattisgarh, West Bengal, Andhra Pradesh, Madhya Pradesh, Maharashtra	Jharkhand, Odisha and Chhattisgarh constitute 69% of total reserve as on 1 April 2010
Oil	Onshore: Assam, Nagaland, Gujarat, Rajasthan Offshore: Andhra Pradesh, Tamil Nadu, Bombay High	94% of onshore production from the four states in 2009-10.
Gas	Assam, Nagaland, Gujarat, Andhra Pradesh, Tamil Nadu, Rajasthan, Tripura	89% of gas production from Assam, Nagaland, Gujarat, Andhra Pradesh, Tamil Nadu
Hydro electricity	All the regions of India	76% identified capacity in North-eastern and Northern region
Electricity (Hydro and Thermal)	All the regions of India	Thermal power plants are concentrated in coal rich states
Uranium and Thorium	Uranium in Jharkhand and Rajasthan Thorium in coastal Odisha, Kerala, Andhra Pradesh and Tamil Nadu	
Wind energy	Karnataka, Gujarat, Tamil Nadu, Rajasthan, Maharashtra, Kerala, Madhya Pradesh, Andhra Pradesh, Odisha, West Bengal	77% of gross potential in Karnataka, Gujarat, Tamil Nadu, Rajasthan and Maharashtra
Biomass energy	All the regions of India	
Solar Energy	All the regions of India	More prominent in Rajasthan desert because of cheap land availability
Geothermal Energy	Chhattisgarh, Jammu and Kashmir, Madhya Pradesh	
Biogas energy	All the regions of India	

Status of Renewable Energy

The renewable energy will play pivotal role in energy ecosystem; it is also essential factor in the energy security studies. Our country has large potential for renewable energy exploitation. Target for production till the year 2022 is presented in Table 3.1.

Table 2: Renewable energy target and actual utilization (Wikipedia)

Renewable energy	Target for 2022	Actual
Wind power	60.00 GW	38.12 GW
Solar Power	100.00 GW	36.05 GW
Biomass	10.00*	10.14 GW
Small Hydro Power		4.739 GW
Waste –To – Power	- included in target for Biomass	1.68 GW

The technology for production utilization distribution is not developed as per requirement for the efficient use. This constrains us in large scale implementation; the cost of production is still very high. The policies of government are improving and the changes are visible however we have to go a long way in implementation in large scale use of renewable energy. Government is proactive in resolving these constraints and we have increased our renewable energy utilization many folds in last ten years as 36.9 BU mentioned in table 3

Table 3: Source: Installed Grid Interactive Renewable Power Capacity in India as of 30 September 2020 (Excluding Large Hydropower)

Year	Conventional sources Billion Unit	Renewable sources Billion Unit	Conventional plus renewable sources Billion Unit
2003-2004	558.3	3.4	561.7
2004-2005	587.4	4.5	591.9
2005-2006	617.5	6.6	624.2
2006-2007	662.4	9.9	672.4
2007-2008	704.5	25.2	729.7
2008-2009	723.8	27.9	751.7
2009-2010	771.6	36.9	805.4
2010-2011	811.1	39.2	850.4
2011-2012	876.9	51.2	928.1
2012-2013	912.0	57.4	969.5
2013-2014	967.2	53.1	1020.2
2014-2015	1048.7	61.7	1110.4
2015-2016	1107.8	65.8	1173.6
2016-2017	1160.1	81.5	1241.7
2017-2018	1206.3	101.8	1308.1
2018-2019	1249.3	126.8	1376.1
2019-2020 up to Dec 2019	950.4	103.7	1054.1

Source Wikipedia

Table 4: Indicating energy requirement available and shortage

Year	Energy requirement	Energy available	Energy shortage	Energy shortage percentage
	Mu	Mu	Mu	%
2003-2004	559264	519398	39866	7.1
2004-2005	591373	548115	43258	7.3
2005-2006	631554	578819	52735	8.4
2006-2007	690587	624495	66092	9.6
2007-2008	737052	664660	72392	9.8
2008-2009	777039	691038	86001	11.1
2009-2010	830594	746644	83950	10.1
2010-2011	861591	788355	73236	8.5
2011-2012	937199	857886	79313	8.5
2012-2013	995557	908652	86905	8.7
2013-2014	1002257	959829	42428	4.2
2014-2015	1068923	1030785	38138	3.6
2015-2016	1114408	1090850	23558	2.1
2016-2017	1142929	1135334	7595	0.7
2017-2018	1213326	1204697	8629	0.7
2018-2019	1274564	1267209	7355	0.6
2019-2020 up to Dec 2019	980944	975719	5225	0.5

Source: wikipaedia

Power Generation Position

As per Wikipedia The total electricity generation including generation from renewable sources in the country during year 2019-20 (up to December 2019) was 1054.075 BU as against the generation of 1048.068 BU which is mentioned in table (4) during the corresponding period last year, showing a growth of 0.6 percent. The electricity generation from conventional sources in the country increased from 420.6 Billion unit (BU) during 1997-98 to 950.397 BU during the year 2019-20 (up to December 2019). The electricity generation from renewable sources increased from 3.4 billion unit BU during 2003 - 04 to 103.7 BU during the year 2019-20 (up to December 2019). The growth in availability of electricity during the current year has surpassed the requirement of electricity. During the year 2019 – 20 (up to December 2019).

Energy Use

TEEDDY 2018-19 has mentioned the energy used in various sectors over the years. This publication has shown the changes which are being used as percentage from the year 2011-12 to 2017-18. We can infer from the graph that percentage use in agriculture and residential and commercial are almost same however the industrial and transportation sectors have taken larger portion of energy consumed which is mostly dependent on fossil fuels. The publication has also mentioned the bifurcation of sectors which are mentioned in the coming passages of articles.

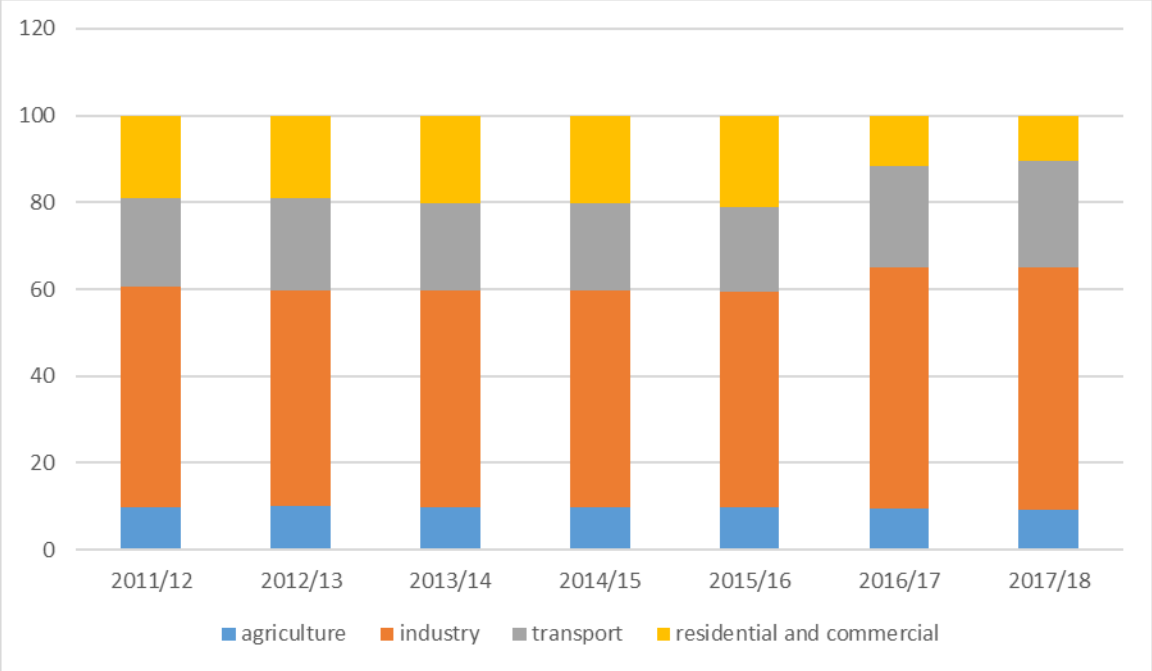

Figure 2: Power Utilization by Various Sectors Over the Years
Source (TEEDDY 2018-2019)

Agriculture Sector

Integration of policies and strategies in the agriculture, water and energy sectors progressing from a sectorial to a holistic approach is required, this approach will be beneficial in enabling sustainable use of resources. It will also address the long term sustainability of food, water and energy security this is mentioned in (TEDDY 2018-19)

Industry accounted for 56 % of the total energy consumption in 2017 t0 18 of the total electricity consumption. In the year 2018-19 industry accounted for the largest share (41.48%) (IEA 2019). The electricity consumption in the industry sector has increased at a much faster pace compared to other sectors between 2008-09 and 2017 to 2018 (CAGR of 8.39 %). The consumption of electricity in the industrial sector registered an increase from 347 671 GWh in 2011-12 2468 25 in 2017-18. Highest share 41.48 percent followed by domestic (24.20%) Agriculture (18.08%) and commercial sectors (8.51 percent), (MoSPI 2019). Different processes within the industrial sector consume different amount of energy however there has been a transition towards reduction of energy – efficient techniques in production processes. Say for example the cement industry in India is one of the most energy efficient in the world, with relatively large production units using latest technologies. (TEDDY 2018-2019)

Transport

As per (MoSPI 2019), in 2017 to 2018, the transport sector accounted for 9.44 percent of the total final energy consumption, it was the second largest energy consuming sector in the country (after the industry sector). The transport sector accounted for more than 70 percent of total diesel sales in India in 2017 to 18, and the third largest user of natural gas with a share of 16.25 percent in 2017 to 18 (MospI 2019). Over the period of 2013 to 2018, Diesel and electricity consumption by the railways grew at CAGR of 0.6 percent and 3.7 percent. (TEEDDY 2018-2019)

House hold energy

During 2017 to 2018 the estimated energy consumption in residential sector stood at 1130.244 TwH. This sector accounted for 24.20 percent of the total power consumption in the country. There has been a rise in the residential consumption of electricity along with the growth in total number of consumers of electricity. Between 2015 to 2016 and 2016 to 2017 residential consumers grew at a rate of approximately 42.27 percent, whereas the growth in total consumers of electricity was only 6.68 percent. (CEA various issues). There has been decline in the growth of per capita electricity consumption in the same time period. During 2017 to 18 the residential sector consumed 87 percent and 95 percent of the total LPG and Kerosene in the country, respectively, across all consumer categories. Between 2018 and 2019 there has been 18 percent growth in residential consumers with access to LPG across urban and ruler areas. Between 2017 and 2019, the no. of beneficiaries of Pradhan Mantri Ujjwala Yojana in terms of access to residential LPG connection and LPG stoves have more than doubled. The primary sources for cooking for residential households have been coke, coal, charcoal, Fire wood and chips, LPG, Dung Cake and kerosene. There is decline in the use of firewood and chips and increase in LPG as cooking fuels. (TEEDDY 2018-2019)

Buildings

Commercial Buildings account for about 9 percent of the total energy consumed in India (MoSPI 2019). Out of the total electricity consumed in the building sector, the residential sector accounts for about 75 percent. Electricity consumption projected for next 10 years and 20 years for the commercial buildings sector is about 134 BU and 227 BU respectively. The share of space cooling in peak electricity load is projected to rise sharply in many countries, with the biggest increase occurring in hot countries such as India, where the share is expected to rise from 10 percent in 2016 to 45 percent in 2050. (TEEDDY 2018-2019)

In pie chart mentioned in fig below we (TEEDDY 2018-2019) has mentioned further sectoral use in commercial and residential sectors in industry HVAC requires major consumption whereas in the residential fans followed by lighting utilize major energies these can be taken care by solar energy if properly utilized.

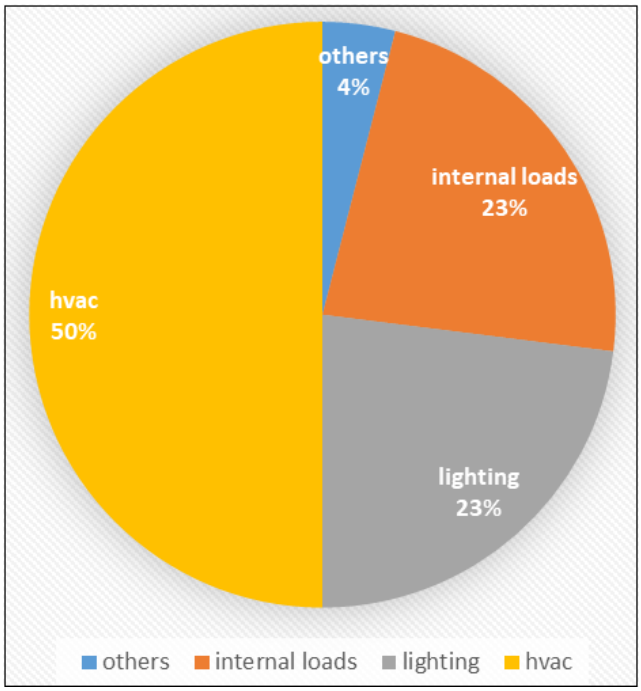

Figure 3: Commercial energy consumption by use (TEEDDY 2018-2019)

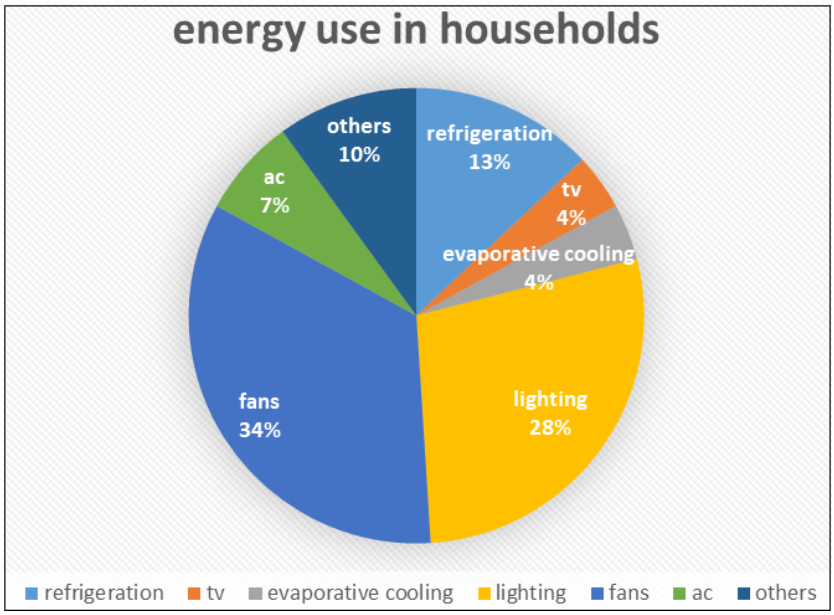

Figure 4: Energy use in households (TEEDDY 2018-2019)

Way Ahead for Energy Use

India's dependence on imported fossil fuels rising continuously due to the limited domestic petroleum resources. India ranked as the fourth-largest petroleum consumer in the world following China, the United States, and Russia. The country's energy demand continues to climb as a result of its dynamic economic growth and modernization. India's consumption of petroleum products increased by 5.3% to previous year which is more than 200 MMT is causing a significant expenditure on oil import. Keeping in view the growing demand of fossil fuel and rapidly growing motor vehicle fleet in India, Govt. of India set a target to reduce 10% reduction on import by 2022. (BEE WEBSITE LINK PROGRAMME TRANSPORT Bureau of Energy Efficiency | A statutory body under Ministry of Power, Government of India (beeindia.gov.in))

Efficient ways of converting energies

The energy conversion can be done by many processes, some of the processes are efficient and some of the processes generate more waste than other processes. One of the process is of electricity generation in thermal power stations. A thermal power station normally transforms around 38 percent of the input of primary energy into electricity. By using combined cycle the efficiency can be improved up to 45.46 percent (Schwarz 1983). In hot countries like India by reducing the inlet air temperature through absorption chiller the combined cycle power plant efficiency can be improved. Further improvement in thermal efficiency of conventional power plants is restricted by the constraint of material and physical property of working fluid. In warm climates about 45 per cent of primary energy is dumped into atmosphere at condenser and cooling tower of a utility at a temperature of around 300 degree Celsius. This waste of heat is practically useless (and sometimes harmful) for any industrial and domestic use with the sole exception of horticulture and fish farming in cold climates. In terms of national energy economy this waste heat amount can be dramatic. By using the co generation technology in urban areas the wasted heat can be utilized for district cooling (through vapor absorption technology) and process energy in industries. Panda H conference paper January 2011 publication research gate.in)

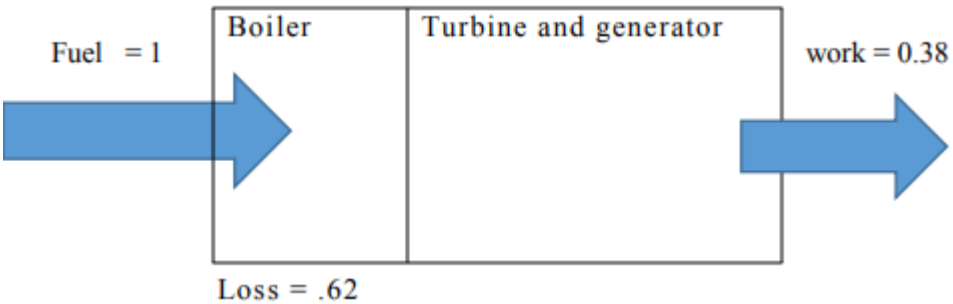

Figure 5: Conventional Coal Fired Thermal Power Plants

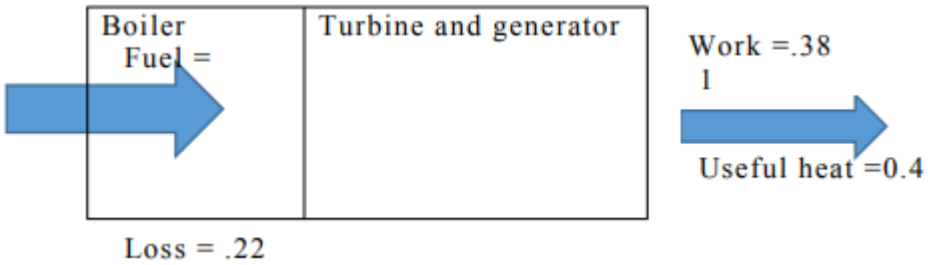

Figure 6: Energy Savings from Cogeneration

Factors of rise in demand and strategy for reducing primary energy consumption

There are six major factors which influence the aggregate demand for commercial energy. These include a) process efficiency b) economic growth c) how advanced is technology d) population growth d) energy price.

If we will substitute for biomass with other sources, the efficiency of the process and prices often have negative impact on the growth of energy demands. Biomass still accounts for about one third energy demand in India We have to think about the strategy for substituting the Biomass with other forms of energy which are cheap energy efficient and technologically advanced. This strategy will reduce primary commercial energy consumption. There are three strategies to reduce primary commercial energy consumption specially the fossil fuels (Figures 6).

They are

- The demand is to be rationalized and wastage in energy use to be reduced
- Switch to renewable and other environmentally friendly source of energy
- Design, develop and technically advancement in the process of energy generation, utilization and conversion

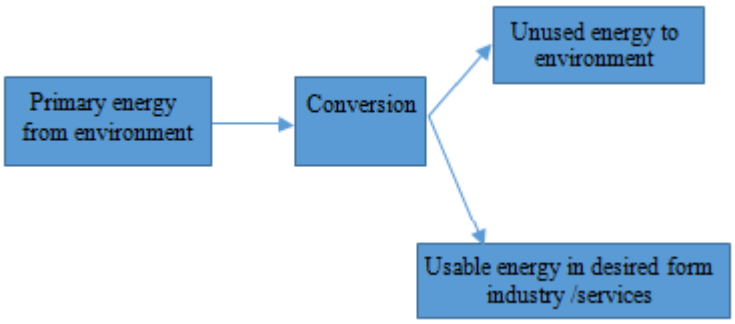

Figure 7: Energy Flows in an Industrial/Service Operation

The process efficiency and the substitution of conventional form or energy to renewable form of energy is the way forward. The end use of energy requirement depends on the operating practice and standards of living. There are some unwanted practices in developed areas such as overheating and over cooling in living areas increases energy consumption, this does not lead higher quality of living. People with facilities for acquiring benefits that money can buy developed countries cannot leave the pumpous lifestyle. The growth in standard of living combined with population rise will demand far more primary energy consumption in future. We have option in renewable energies but their high unit cost does not make them economically viable. Considering the slow pace of renewable energy technology development distorted price of commercial energy and overall complacency it is not expected to be a viable alternative in the near future. So ultimately improvement of process efficiency and adoption of various energy management techniques for energy conservation can be the immediate option. There is requirement of investment in research and development, sensitizing people and investment in infrastructure.

Transport Sector Fuel Efficiency

Transport sector is major contributor in the environmental problems like green house effect, global warming the emission of particulate matter. It is high time that we must improve the process efficiency in the transportation sector.

BEE is planning on the Development of fuel efficiency norms for Vehicles that could moderate the rising demand of fuel. Some of the strategies devised by BEE mentioned in its 2020 edition of fuel efficiency publication is mentioned below:-

Fuel Economy Norms for Heavy Duty Vehicles:

In August 2017 the Government of India finalized fuel efficiency norms for commercial vehicles (CVs) with a gross vehicle weight (GVW) of 12 tonnes or greater. Manufacturers must demonstrate compliance with the rule by evaluating vehicles over the constant speed fuel consumption (CSFC) test procedure. In the CSFC protocol, trucks are driven at constant speed on a test track at 40 and 60 kilometers per hour (kph), and buses are run at 50 kph. Recently Ministry of Road Transport and Highways has revised the safe axle weight limits, subsequently the norms for HDVs is under review to meet the revised GVW range. . (BEE WEBSITE LINK PROGRAMME TRANSPORT Bureau of Energy Efficiency | A statutory body under Ministry of Power, Government of India (beeindia.gov.in))

Corporate Average Fuel Economy Norms for Passenger Cars:

The Government of India, Ministry of Power, issued average fuel consumption standards for cars on 23rdApril 2015. This standard is applicable for the motor vehicle using petrol or diesel or liquefied petroleum gas or compressed natural gas, which carry passengers and their luggage and comprising not more than nine seats including driver's seat, and of Gross Vehicle Weight not exceeding 3, 500 kilograms tested.

The fuel consumption standards is effective from 2017-18 onwards, and a second set of standards would come into force from 2022-23. The standards relate the Corporate Average Fuel Consumption (in liters/100 km) to the Corporate Average Curb Weight of all the cars sold by a manufacturer in a fiscal year.

According to the first standard, the average weight of all cars is guided to be 1037 kg in 2016-17, and the Average Fuel Consumption Standard would have to be less than 5.49 km/100 liters for this average weight. The second standard assumes car average weight of 1145 kg in 2022 and requires the average fuel consumption to be less than 4.77 l/100km at this average weight.

It may be noted that the standards apply to the Corporate Average Fuel Consumption i. e. the average of the standard fuel consumption of all vehicles sold by the manufacturers in the fiscal year, and not to the fuel consumption of an individual model. The fuel consumption is measured under standard conditions at the nationally accredited labs over the national driving cycle.

It is expected that these standards would lead to a reduction of 22.97 million tons of fuel consumption by 2025.

Fuel Economy Norms for Light & Commercial Vehicles:
In addition to norms for CVs greater than 12 tons, the development of fuel efficiency standards for CVs between 3.5 and 12 tons has been completed. The norms for this lighter segment of CVs is centered on CSFC testing. The norms has been finalized and notified by Ministry of Power on 16th July 2019 in the Gazette of India.

Fuel Efficiency Standards/Star Labeling for Agricultural Tractors:

The tractors are different than other types of vehicles & preferably used as a machine for various processes like cultivation, traction etc. Development of Fuel Economy norms for Agricultural tractors is also under process and likely to be finalized soon. It will be preferably "Star Labelling programmed for Tractors".

Other initiatives in Fuel Efficiency in Transport Sector:
There is huge scope of fuel saving by on-road vehicles also. Tyres as an important component of vehicle has been identified for potential saving of the fuels. Approximately, 2/3rd market of tyres is replacement by customers. Keeping this in mind, Standard and Labelling programme for vehicular tyres has been initiated also.

The vehicle fuel efficiency is being tested prior to the launch of a model. Presently the test procedure which are in place, are costly and consumes much time & energy. So, it is required to develop a tool which can assess the fuel efficiency of a vehicle without performing any physical test. BEE has initiated the development of a computer-based simulation tool (like VECTO in EU) as per Indian specific conditions.

The tool will be helpful to reduce the cost and time for testing of vehicles. Similarly during energy conversion and transmission a number of energy efficient technologies can be used for better efficiency. . (BEE WEBSITE LINK PROGRAMME TRANSPORT Bureau of Energy Efficiency | A statutory body under Ministry of Power, Government of India (beeindia.gov.in)

Possible Policy Measures
Organizationally energy sector is divided into a number of ministries and departments. These include Ministry of coal, Ministry of power, Ministry of petroleum and Natural Gas, Ministry of new and Renewable energy and the department of atomic energy. At the state level respective department and ministries undertake the job. Regulatory role is undertaken by Central Electricity Regulatory commission (CERC), Petroleum and Natural Gas Regulatory Board and atomic energy regulatory Board (AERB) and state electricity regulatory commissions (ERC). Integration of energy related initiatives in the country are undertake by Nation development council and planning commission. Figure 7 indicates the organization of the energy sector in the country

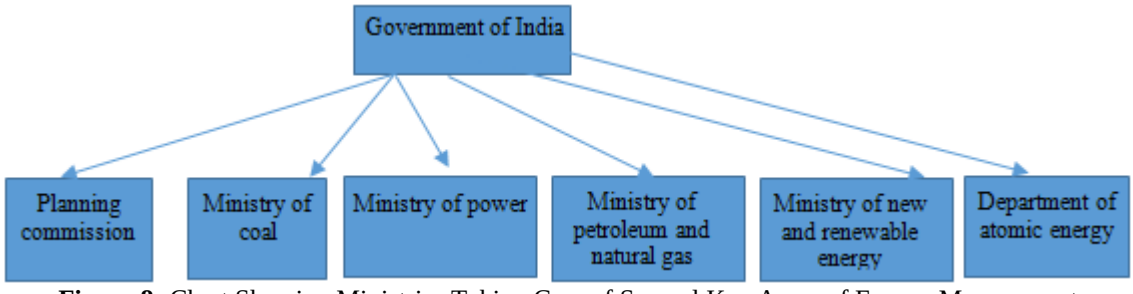

Figure 8: Chart Showing Ministries Taking Care of Several Key Areas of Energy Management

Key drivers of change affect energy sector in India.

- These are fast economic growth
- Privatization
- Increasing household income and
- Fast depleting biomass resources,
- Limited domestic reserve of oil and gas and

- Adverse impact on the environment of the rapidly developing urban and rural areas.

There is a need to undertake energy conservation and energy productivity enhancement. Unfortunately challenges still facing us are:

- Poor pricing policy, weak institution and ineffective incentives to stimulate energy efficiency
- Lack of information Vicious cycle of poverty Energy saving devices require higher initial cost and since poor people do not have savings for investment capital they are forced to use inefficient equipment and pay many times more for a unit of delivered services
- Lack of access to the best available fuel efficient design and production process
- Lack of encouragement for public transport in place of private transport.

Reform in the electric sector leading to privatizing some of the sectors in power distribution. There are still challenges of reduction in transmission and distribution loss, investment in infrastructure to enhance reliability and availability of distribution infrastructure to enhance reliability and availability of distribution infrastructure and meeting the expectation of agriculture and rural consumers. The regulatory system has not been effective to address the above issues similarly, Privatization in coal and petroleum sector have benefitted the private and big players more than the state.

Subsidizing will also not solve the issue instead the energy price, incentive may be given for the use and developing efficient processes and products. There is a need to identify such processes products and technologies and disseminate this information to the consumer and energy creators, we may think of financial incentives and penalties.

2. Conclusion

Energy scenario to improve in India has still miles to go as compared to developed countries. The country has very low per capital energy consumption in comparison to developed countries. India is primarily dependent on low quality indigenous coal and imported oil and gas. There is significant improvement in the renewable energy potential and actual achievement to Bridge the gap the country has to overcome the constraints of technology financial resource crunch, policies and institutions.

Continued dependence on fossil fuel will worsen the environment conditions like global warming, acid rain and ozone layer depletion. The country is moving towards energy security in big leaps. The sustainable energy and economy growth for long period goal. India needs to think in terms of moving away from perishable towards renewal energy sources. The efficiency enhancement will not serve the purpose, the steps towards replacing/reducing source. In long run this can be effectively achieved by changing the products like promoting electrical vehicles and hybrid vehicles, utilizing solar energies and other replenish able sources of energies (with technology policies and pressures) which will help towards reducing waste and pollution.

To implement this requirement, covering several large-scale social and technological transitions are mentioned below;

- Shift away from era of fossil fuels towards an era of energy efficiency and renewable energy.
- Move from an era of capital and material intensive technologies to an era of capital and material intensive technologies to an era of new technologies that rely on inputs with low environmental costs
- Shift towards ecologically oriented productions technologies (design with nature)
- Move towards honest economies in which policies do not subsidize the use of raw materials or the generation of waste
- Move to more national approaches to solving environment problem

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