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Research paper

Energy Audit with Innovative Technology Management for Resourcing the Clean Energy and Sustainability in India

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Abstract

Energy is an essential input to the overall development of the economy. It provides light and fuel to millions of households, industry, agriculture, commerce all service sectors and so on. Since energy is a critical component, development of conventional and non-conventional forms of energy for meeting the growing demand of the society at reasonable price and quality is the responsibility of the government. Energy Audit is an important and vital tool in the management of energy both at industry and nation level. It is required for improvising the efficient management practices in energy production, utilization and distribution with better technology and to thereby conserve for future growth and development. With the growing importance for industrial sectors in the country's development and increasing energy consumptions, it has become essential and necessity to opt for more optimization methods in the consumption of energy. A saving of 15 to 30% can be done by optimal usage of energy at home. Energy conservation and safety is the topmost priority in today's world to have a consistent growth, increase in production and to protect our environment. Energy audit and its management is instrumental to cope with the variation in the cost of energy, to identify the appropriate mixes of energy, to improvise the energy conservative equipment and technologies. Along with innovative technology for energy consumptions we also require innovative methods in the management of energy audit to help the country with efficient energy management system, reduce cost and save energy for future requirements. To study and understand the need for Energy audit with innovative technology management in India. To analyze its importance for resourcing clean energy and sustainability in India.

1. Introduction

The term 'Energy Audit' is an analysis on the energy flows of a system and to optimize the energy input into the system without negatively affecting the output. In industrial and commercial sectors an energy audit is the basic step done to identify the opportunities to reduce the consumption levels and its cost. As per Indian Energy Conservation Act 2001 it is "verification, monitoring and analysis and use of energy including submission of technical report containing recommendations for energy efficiency with cost benefit analysis and an action plan to reduce energy consumption." The objective of an energy audit is accomplished by identification of optimization areas for energy conservation with formulation of measures with marginal investment or no investment. Also, to identify areas which require efficient equipment and upgradation of existing equipment.

The energy manager identifies all the energy inputs and its usage in the system with more information and attempts to propose various course of action along with its consequences. Energy audit helps in optimization of energy resources, controls pollution and improves maintenance and operating activities of the system. **Eric Hirst and Marilyn Brown (1990)**, identifies the structural and market barriers in US for efficient and effective energy management. Uncertain and distorted fuel prices, government policies, codes and standards and infrastructure limitations as structural barriers. Attitudes, investments, information gap as behavioral barriers. **Ediger and Huvaz (2006)** observed a linear relationship between GDP and primary energy consumption in Turkey during 1980-2000. If the future pattern continues with the past trends than any decrease in the rate of energy consumption would affect the economic growth for the forecasted period. **David Mcdougall (2013)**, mentions the Government data on energy from industries contributing 30% of Greenhouse gases. Also, stresses the need for industries to reduce consumption of energy to maintain competitiveness in plant facility at a time of global uncertainty and environmental concerns. **Rakesh Dubbudu (2016),** has identified the electrification of villages as the reason behind increase in the per capita electricity consumption in India. He had also pointed India's per capita electricity consumption being lowest among BRICS nations and 1/3rd the world average. **Ripudaman Malhotra (2016)**, discusses about the global energy consumption and its increase by 17.4% from 2006 to 2014. He also stresses about the climate concern due to CO_2 emissions from Non-renewable sources and the IPCC reports on anthropogenic emissions of Green House Gases causing catastrophic damage. This indicates a need for a counter production sources with CO_2 free energy. **Rijul Dhingra, Abhinav Jain, Abhishek Pandey, and Srishti Mahajan (2014),** indicated the highest conversion process required for Hydro and the least one for Biomass. Also, the autonomy of power generation for wind, solar and biomass compared to Nuclear and Hydro where the former depends on fuel from other countries and the latter depending on the river flow from more than one country.

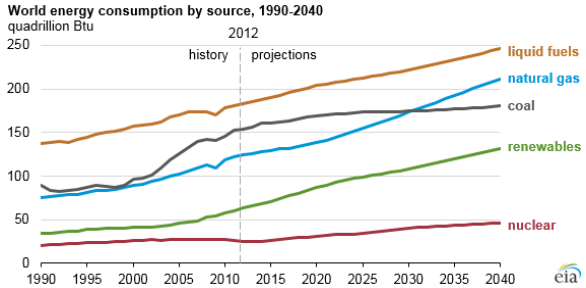
2. Methodology

Energy audit is an effective tool in defining and pursuing comprehensive energy management programmes. It has positive approach aiming at continuous improvement in energy utilization in contrast to financial audit which stresses to maintain regularity. Energy audit provides answer to the question – what to do, where to start, at what cost and for what benefits?
The paper does a non-empirical study on the need for energy audit with innovative technology management in India by analyzing the production - consumption patterns, energy efficiency in the country and by analyzing the global pattern.

3. Results and Discussion

Global Energy Scenario

Fossil fuels like petroleum, natural gas and coal account for three quarters of world energy. As per EIA projection liquid fuel mostly petroleum based is the largest energy source but future oil prices may bring the share of liquid fuel energy consumption from 33% to 30% in 2040. Coal is world's slowest growing energy source and China, US and India account for major consumption of more than 70% in the world. Projection of Coal consumption in India shows rise and leads US coal consumption in 2030.(Fig 1)



Source: U.S. Energy Information Administration, International Energy Outlook 2016

Fig. 1: World energy consumption by source, 1990-2040.

Due to the concern of fossil fuel slow growth rate compared to non-fossil fuels, emissions and Green House Gases causing environmental concerns and increasing oil price the non-fossil renewable energy sources and nuclear power have become fastest growing energy sources over the projection period with average of 2.6% and 2.3% per year respectively during the projection period.
According, to reports from Pew Charitable Trust, 2010: China leads the G-20 members in investment in clean energy technology with $ 34.6 billion compared to India with $ 2.3 billion and ranks 10th position. This indicates the global growth in renewable sources of energy to avoid environmental concerns and supplement more energy requirements.

Energy Efficiency in India

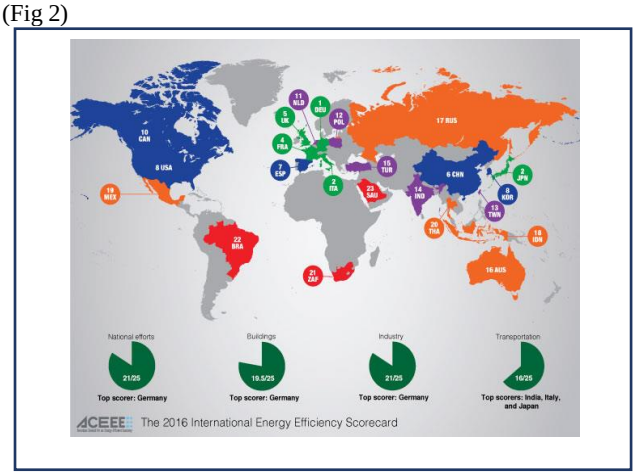
Energy Audit is happening in Industry, State and Country level but the question arises if these audits are
innovatively managed to support the ultimate purpose of conserving the energy for future demands.
The main objective of these energy audits with innovative management therefore becomes:

- Availability of energy to everyone in the country and to millions of people who still lacks a basic energy service.
- Meeting the growing demand of Industries and other commercials.
- Providing a clean source of energy keeping in mind the environmental concerns and emissions from certain energy sources.

Keeping in mind these objectives we need to know few facts related to India:

Fact 1: Need to Improvise Energy Efficiency in Building and Industrial Sectors

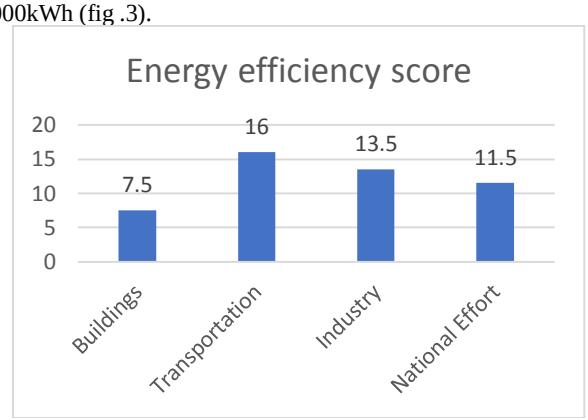
As per ACEEE, India is 14th in the energy efficiency score card with a total of 48.5 points and ranked 15th in national efforts on energy efficiency and has better energy efficiency management in transportation. 65% of passenger's trip are with public transport. (Fig 2)



Source: ACEE 2016 International Energy Efficiency Scorecard.

Fig. 2: The international efficiency score card

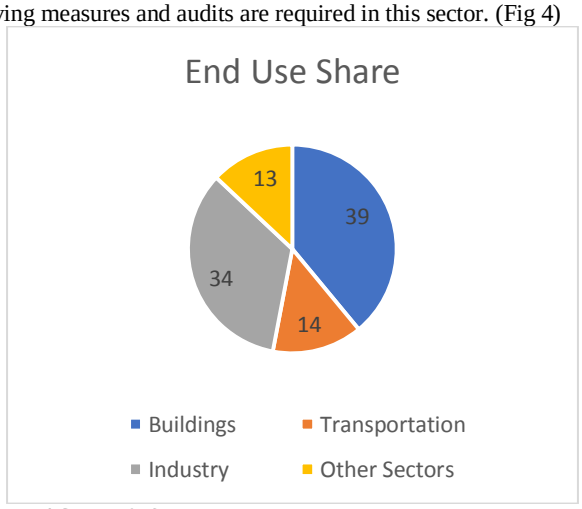
The per capita electricity consumption in India has grown up by 46% from 2008-09 to 2015-16 with an average increase of 6% every year. The per capita consumption in 2014-15 has crossed 1000kWh (fig .3).



Source: ACEEE 2016

Fig. 3: The bars show ACEEE scores for energy efficiency

Therefore, due to higher percentage of usage share in the building (both residential and commercial) and industrial sector more saving measures and audits are required in this sector. (Fig 4)

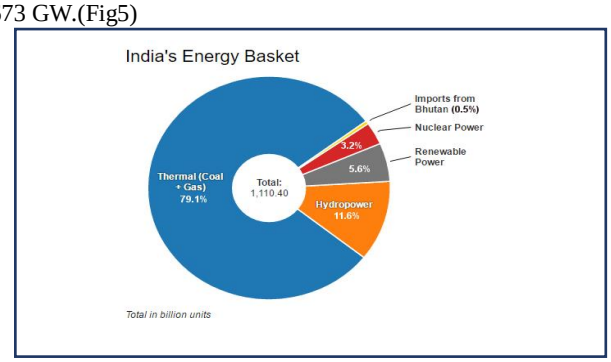


Source: ACEEE 2016

Fig. 4: The pie chart shows 2013 end-use energy shares of buildings, industry, transportation and other sectors

Fact 2: To Increase the Capacity of Renewable and Clean Energy Sources

In India, renewable energy generation has been growing faster and contributes to 61.8 billion units than Nuclear power generation with 36.1 billion units. The Global renewable energy capacity is 673 GW.(Fig5)



Source: IndiaSpend "Cheaper Renewable Energy Soars Past Nuclear Power in India", 2016

Fig. 5: India's energy basket

India's Position in Renewable Energy

- Renewable Energy Wind: India stands 5th in RE Wind with 22.6 GW with Global wind at 370 GW. (As on Dec 2014: Global Wind Energy Council)
- Renewable Energy Solar: India stands 11th in RE Solar with 3.3 GW with Global solar with 177 GW. (As on Jan 2014, IEA PVPS)

India is lowest in its operational efficiency of thermal plants. India can show betterment in its efficiency by more Government spending and investment in energy efficiency.

Fact 3: Investments and Support by Government for Energy Efficiency in Msmes and Smes

Financial constraints seem to be a major barrier in the Industrial energy efficiency.

- There is a need for funds in Energy efficiency projects due to lesser internal investments by top management and limited borrowing capacity by SMEs.
- Access to information and energy efficiency technologies. Knowledge on Project developmental and execution process and preparation of reports on developmental and transaction costs for bankers by SMEs.
- Support from bankers and encouragement in financing projects on energy efficiency. Risk management, sharing and perceptions between bankers and industries.
- Need for Centre for excellence and best practices on cost cutting and energy saving technologies.

These financial barriers are more predominant in small and medium industries than large industries.

Fact 4: to Network Demand, Supply and Distribution Cost

Knowledge on availability of energy sources, its production cost and advantages & disadvantages, consumption pattern and distribution cost is essential to form a proper network of the energy sources to balance the demand and supply chain and to conserve for the future. Power sector has become the major energy consumer and impacts the economic development.

Table 1: The State Wise Allocated Power Capacity as of November 2015 Shows That

Region	Total Capacity (in MW) (includes Thermal, Nuclear and Renewable)	% of total
Western Region	100,137.54	36.39%
Southern Region	65,685.90	23.81%
Northern Region	73,203.42	26.53%
North Eastern Region	3,513.08	1.27%
Eastern Region	33,320.53	12.08%
Islands	51.15	0.02%
Total	282,023.39	100.00%

Source: "Executive summary of month of November 2015", Central Electricity Authority, Ministry of Power, Government of India.

Despite additional power generation, the country still faces shortage of 3.6 % of demand in the year 2015. The Indian rural mass still heavily depends on traditional biomass which needs to be addressed. As per 2011 census, 80% of the rural population and houses use biomass like wood and residues for cooking in comparison to 22% of urban households.

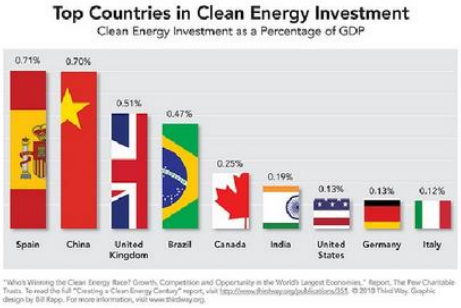
This indicates a need for more alternative source of energy for production of power and more networking on the demand and supply chain pattern considering the distribution cost factor.

Fact 5: Innovative Policies by State and Central Government on Energy Efficiency and Clean Energy Activities Depending on the Consumption Pattern of Regions

The production capacity in each region should consider the demand and consumption pattern of the area or region. The consumption patterns differ by regions.

Table 2: Region Wise Consumption in India

Region	Consumption
Union Territories	High
Puducherry, Goa, Punjab, Gujarat, Haryana and Delhi	Above National Average
Bihar	Lowest
North eastern states	Below National Average
West Bengal, Madhya Pradesh, Kerala, Uttar Pradesh & Jharkhand	Below National Average



Source: Third Way

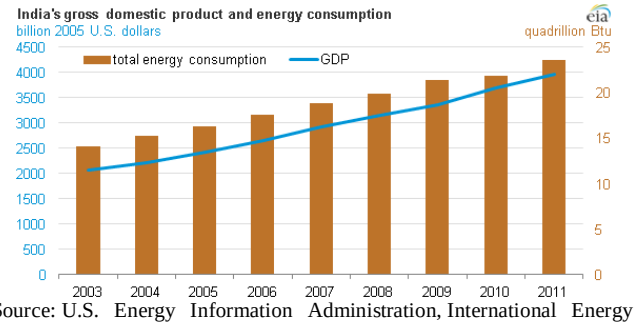
Fig. 6: Clean energy investment as a percentage of GDP

More energy efficiency investments and priorities should be given by Government in the regions with higher consumption.

Fact 6: Correlation between GDP and Energy Consumption

We need to understand the relationship between GDP and the electricity consumption. Most of the developed countries show a strong correlation between GDP and per capita electricity consumption except for few countries like Bhutan (Fig 7). The average Indian growth rate is 6.27% from 1980 -2014 and it is 7.3% in the third quarter of 2016.

The per capita consumption has reached 1075 kWh in 2015-16. Assuming the past pattern and the growing GDP rate in India we need more energy sources to meet the future demands.



Source: U.S. Energy Information Administration, International Energy Statistics, and Oxford Economics.

Fig. 7: Per-capita electricity consumption vs. per-capita GDP, southeast asian countries with outliers deleted

Thus, we need an "Innovative model for our energy audit in India" with priorities on essential areas at National, Regional, Industrial and household level. We need renewable energy with more R & D and Investments to cater the future needs and non-renewable energy with more technological advancements for conservation and environmental friendly. The above two energy supply routes should be monitored and audited innovatively by prioritizing the investments to meet the fast-growing energy demand (Fig 8).

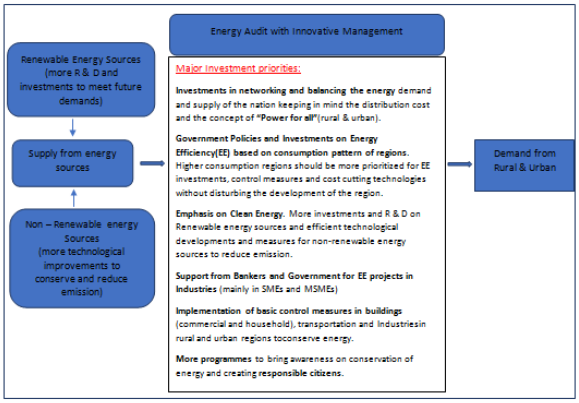


Fig. 8: Innovative model for our energy audit in India

4. Conclusion

Energy is the future for the economic growth and to improve the quality of life. More innovative management of energy audit has become essential to address future demands and projections in India.

Networking of Power Sector: Power sector will be the dominant consumer of energy. Wealth creates electricity and to sustain the wealth in future electricity and other sources of energy are important. Networking of the power plants with proper distribution as per consumption patterns in regions could provide electricity to many people who are without basic power in the Nation.[13]

Conservation of non- renewable resources to reduce import cost, environmental emissions and to meet future demands: Coal, petroleum and natural gas are going to be dominant sources of energy in future but the future demands can be met by conserving and managing efficiently these sources with more technological developments and innovative energy audits. As the oil prices are fluctuating reduction in oil and natural gas in consumption sectors could help the economic growth as the consumption of these could higher the import bills and would impact growth. More usage of them also creates environmental concerns.[14]

More investment and R & D in renewable sources of energy: R & D and investments in more renewable energy sources could meet future demands and help in clean energy. Thus, we need an energy audit with innovative technology management to conserve and reduce the higher consumption cost of non-renewable sources of energy and supplement that energy need with more of renewable sources of energy with better investments. This could bring an efficient energy management, sustainability and growth in India.

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