A Review on "Influence of Extreme Temperature on Electricity Demand in Madhya Pradesh" (India)

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Abstract: **The climate is defined as 'thegeneral or average weather conditions of a certain region, including temperature, rainfall, and wind'. The earth's climate is most affected by latitude, the tilt of the Earth's axis, the movements of the Earth's wind belts, and thedifference in temperatures of land and sea, and topography. Human activity, especially relating to actions relating to the depletion of the ozone layer, is also an important factor. Urban centers heavily depend upon electricity for their existence, with increase in temperature electricity demand for space cooling also increases. Climate Change induced temperature rise also affect electrical generation at power plants. Due to excessive cooling demand many cities in India has tooverdraw the electrical power from the grid, while the other not so important has to bear the power cuts due to increased demand by others.Urban areas are continuously growing larger creating huge demand of electricity for their smooth functioning; Rapid urbanization and improved lifestyle also adds further increase in the electrical demand of the city. This study attempts to improve upon an existing forecasting model indicating a quadratic Relationship between temperature and peak electricity demand whereby peak electricity loadincreases exponentially with increasing temperature based on previous analysis.**

Keywords: **Climate Change, Global Warming, Heat Island Effect, Electricity demand, influence of weather conditions.**

1 INTRODUCTION

It is generally agreed that climate is one of the key factors influencing the energy consumption (Colombo et al., 1999; Hekkenberg et al., 2009). Amongst various climatic factors, which may affect the energy consumption, temperature is the most dominant one (Yan, 1998). Cline (1992) provided the earliest study on the impacts of climate change in his seminal book The Economics of Global Warming. Akbari et al. (1992) reported that the peak cooling electricity load in some U.S. cities would increase by 0.5% to 3% with an ambient temperature increase of 0.6±C. Deschenes and Greenstone (2007) provided the first panel-data based approach for estimating the impacts of climate change on residential electricity demand.

In an indication of growing appetite for electricity in India, the country's per capita electricity consumption has reached 1010 kilowatt-hour (kWh) in 2014-15, compared with 957 kWh in 2013-14 and 914.41 kWh in 2012-13, according to the Central Electricity Authority (CEA), India's apex power sector planning body."The per capita electricity consumption reached 1010 kWh some time back."

India's per capita power consumption is among the lowest in the world. Around 280 million people in the country do not have access to electricity. In comparison, China has a per capita consumption of 4,000kWh, with developed nations averaging around 15,000kWh per capita. Interestingly, while the peak shortage in the country was at 2.3% in May, many believe that the demand still looks artificially suppressed as state electricity boards (SEBs) are not buying power. SEBs have been unwilling to procure electricity because of their weak financials due to low tariffs, slow progress in reducing losses, higher power purchase costs and crippling debt. India has an installed power generation capacity of 272,503MW.

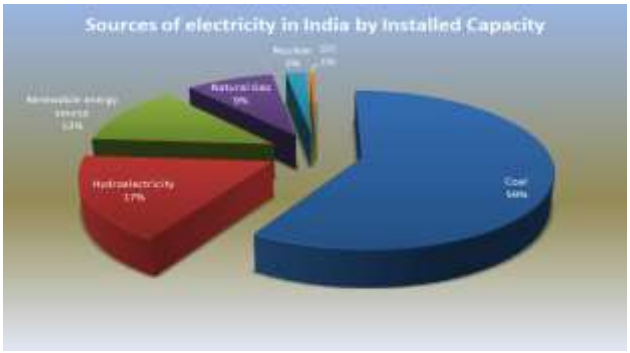

Fig 1 various sources of electricity in India

In developing countries, there is a powerful positive correlation among wealth and energy especially electricity utilization. Though, the method of electricity production and consumption may generate air pollution and greenhouse gas which results global warming (Leeand Chiu [2], Ferguson [7]). Earlier studies mostly apply time-series or cross-sectional datasets to examine the appropriate topic of energy (Wolde- Rufael, [8,9]). Investigators have also started to utilize panel data to investigate the issues on energy (Lee and Lee [10]).

Economic derivatives, such as future and alternative agreement on electricity, are usually engaged with this objective [11]. As electricity has become the basic need for survival in India. Unfortunately India has been in deficit regarding electricity. Only 16% of rural population has grid-connected electricity, compared with 85% of the urban population [12]. To overcome these problems an appropriate analysis of the link between electricity consumption and climatic variables, particularly air temperature, must be undertaken.

2. OBJECTIVE OF STUDY

The basic aim of the study is to carry-out a methodology for assessment of electricity demand on the basis of various factors like temperature and different other environmental parameters. The objective of this study is to give only a quick and approximate overview of the impact, therefore a less precise, less costly and less time-consuming method might be sufficient and appropriate.

DATA AND METHODS

HOU Yi-Ling et. al. (2014) gives the methods i.e. Monthly CDD and HDD are calculated based on the following formula:

$$\mathrm{CDD} = \sum_{i=1}^{M} (T_i - T_{\mathrm{base}}) \quad (\text{for } T_i \geqslant T_{\mathrm{base}})$$

$$\mathrm{HDD} = \sum_{i=1}^{M} (T_{\mathrm{base}} - T_i) \quad (\text{for } T_i \leqslant T_{\mathrm{base}})$$

Where M is the number of days in a month, Ti is the daily mean temperature of day i and Tbase is the base temperature which will be determined later.

A piecewise linear fitting method is used to detect the breakpoint of the temperature series (Tome and Miranda, 2004). This methodology uses a least squares approach to compute the best continuous set of straight lines that fit a given time series, subject to a number of constraints on the minimum distance between breakpoints and on the minimum trend change at each breakpoint. In that paper, the breakpoint has been regard as the base temperature.
Muhammad Ali et. al.(2013) gives another methods for the same i.e. The series of electricity demand shows seasonal effect, that can be examined with the monthly seasonal variation index (MSVI) and can be defined as;

$$\mathrm{MSVI}_{ij} = \frac{\mathrm{MEC}_{ij}}{\mathrm{MAE}_j}$$

Where MSVIij is the index value for month i in year j, MECij is the monthly electricity consumption for month i in year j, and MAEj is the monthly average electricity load for year j [6]. Figure 2 illustrate the average, maximum, and minimum MSVI values for each month of the year. Here the average values confirm the relative behavior of electricity consumption between different months while the variation between the highest and lowest amount shows the actual deviation from this mean behavior.
Delson Chikobvuet. al.(2013) gives another methods based on *Piecewise modellinear regression* The piecewise linear regression model used formodelling the influence of temperature on electricitydemand is given in equation

$$ADED = \alpha_0 + \alpha_1 \max(0, t_h - ADT) + \alpha_2 \max(0, ADT - t_c) + \varepsilon_t$$

Where ADED is average daily electricity demand and ADT average daily temperature which separate summer and winter sensitive period (hot and cold temperature) from the weather neutral period respectively. The parameters to be estimated are α_0,α_1 and α_2 and ε_t is the error term.

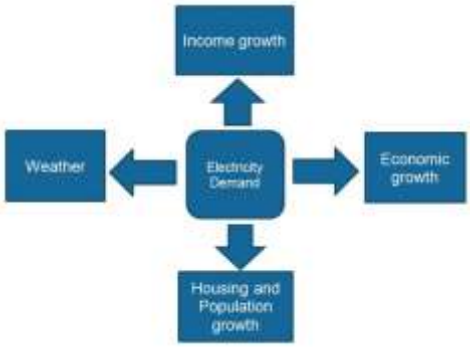

Fig 2 Drivers of electricity demands

4. Literature Review based on previous study

RajatSoniet. al. (2015) reported that, it is clear that the electricity demand, in absence of a high demand for other activities and electrical appliances, depends on the temperature change. Moreover, it increases with increase in temperature during summer months and increases with decrease in temperature during winter months. Thus, for establishing the relationship between temperature change and electricity consumption, definition of comfort limits and calculation of heating and cooling hours during the day may prove to be useful. With the availability of hourly temperature data it is possible to calculate the number of hours when cooling or heating would be required.

DelsonChikobvu et.al.(2013) The paper discusses the modelling of the influenceof temperature on average daily electricity demandin South Africa using a piecewise linear regressionmodel and the generalized extreme value theoryapproach for the period - 2000 to 2010. Empiricalresults show that electricity demand in South Africais highly sensitive to cold temperatures. Extremelow average daily temperatures of the order of8.20C are very rare in South Africa. They onlyoccur about 8 times in a year and result in hugeincreases in electricity demand.

In many developing countries like Nepal and Bangladesh, the rural household energy consumption constitutes over 70 percent to the national energy use (ADB, 1998; Koopmans,2005). The use of energy varies between rural and urban population, between high andlowincome groups with in a country. Energy use variations not only subsists in rural and urban regions, but also varied in lower and higher earner groups, between national and international levels (Pachuari 2004).

According to UNDP and World Bank estimates on investigations in 15 LCDs, household energy consumption accounts for 30-95% compared with 25-30% in developed countries. Ouedraogo (2006) for Africa, Rao& Reddy (2007) and Pachuari (2004) for India states thatthe inertia of the household energy preferences and consumption pattern are due to some factors such as economic condition household size, sex, age distribution of the household members, age of holdings, nature of the occupations, low living standard, education attainment of the principal wage earner and of the family members and high frequency of cooking certain meals.

Preeti Malhotra, H Rehman, Preety Bhanadri, Ronnie Khanna, RituUpreti (2000) "rural energy data sources and estimation in India" they have explained that mainly in rural areas fuelwood is used for cooking meals. Petroleum and kerosene are less use than two percent of the total energy consumption in the rural areas. In rural India kerosene is mainly used in lighting. According to 50thround of NSS (NSSO 1996) around 26 percent of therural households usedkerosene primarily for lighting. Only two percent of rural household use kerosene primarily for cooking fuel. In term of extension of grid electricity to the rural areas, the rural electrification programme, which is the largest rural energy programme today, claims to have electrified more than 85 percent of the 58000 villages in the country (CEA 1996).

According to Shweta Singh and UshaBajpai, access to energy is energy is an important prerequisite for a nation development in India where 70 percent live in rural areas (Census2001). So they have suggested that renewable energy and to use these is an efficient form forthe benefit of the people. There are 105293 villages yet to be electrified (MOP, 2008) lack of electricity is one of the main hurdles in the development of rural India.

CONCLUSION

This present work focuses on – the importance of climate change in electricity demands and mainly its importance in the modern context; government policies on rural electrification and the benefits of electricity. One of the main objectives of the present work is to analyses the determinants of changing in demand pattern of electricity in rural and urban areas. To identify the number of methods for analysis. This study will give description analysis how change in consumption pattern of electricity due to increasing in climate factors like temperature.

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