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Article

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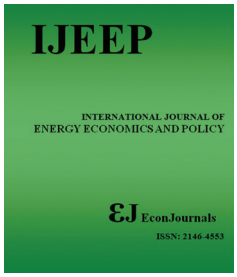

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Access to Modern Energy Services and Human Development in India: Has Government Policies Paid Off?

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ABSTRACT

In this paper we investigate the relationship between access to modern energy services and human development in India over a decade. We estimate an index of human development, multidimensional energy poverty index, and confidence index. Empirical result shows that energy poverty is quite widespread in most of the states in spite of the progress made in reducing the same during the study period. States with higher level of human development are having lower level of energy poverty implying a strong negative correlation between energy poverty and human development. Further, the strength of negative relationship between energy poverty and human development has strengthened during the study period. Among the components of human development, energy poverty has highest impact on GSDP percapita index followed by education index and life expectancy index. The study also finds that confidence index has positive relationship with human development index, whereas negative relationship with energy poverty.

Keywords: Energy Poverty, Human Development Index, Capability, Multidimensional Energy Poverty Index, Confidence Index
JEL Classifications: O13, O15

1. INTRODUCTION

On 29th April, 2018, the Prime Minister of India tweeted: "I am delighted that every single village of India now has access to electricity." Even though this declaration does not essentially mean that all households in Indian villages are electrified, it reflects the pulse in Indian energy sector and a sense of urgency for ensuring access to energy services. Modern energy services like electricity and LPG have become necessities of life and hence access to reliable and affordable energy services has significant impact on various walks of life (Nussbaumer et al., 2012 and González-Eguino, 2015). For example, with electricity at home and better lighting facilities, children can comfortably study in the night which is expected to increase the educational attainment of children especially from rural areas (Sagar, 2005 and Ray et al., 2016). And household members can use modern electronic gadgets like television, radio and mobile phone with educational effects like increase in the awareness about various social and political developments in the society (Kanagawa and Nakata, 2008 and Lenz et al., 2017). Hospitals in general and primary health centres in rural areas in particular can provide effective and reliable services only with the availability of electricity to use medical appliances with huge social implications (Sovacool, 2013 and Lenz et al., 2017).

Access to reliable and affordable electricity also leads to creation of job opportunities, income generation and improvement in the productivity of enterprises of all sorts (Sovacool, 2012; Szakonyi and Urpelainen, 2015). From the view point of gender and security of women, an adequately illuminated street or way lane will be far safer for women than it is otherwise (Khandker et al., 2012; Urpelainen, 2016). Further, having LPG to cook will ease women of a lot of household strain and make cooking easier which will certainly protect women from chronic health problems (Andadari et al., 2014; Sadath and Acharya, 2017). Finally, from the view point of developed countries in the north,

availability of energy resources in an adequate and affordable manner to heat home is vital for the sustenance of life during winter (Santamouris et al., 2014, Lacroix and Chaton, 2015; Teller-Elsberg et al., 2016). In short, the availability of modern and clean energy services has been recognized as a crucial catalyst in the transformation of life of the people for the better with productive employment opportunities, education, health care, etc (Birol, 2007, Srivastava et al., 2012, Sovacool, 2012 and Spagnoletti and O'callaghan, 2013).

2. ACCESS TO ENERGY SERVİCES AND OVERALL DEVELOPMENT

Better education and health, employment opportunities, safety and dignity in the society, etc are generally described by what is known as development which relies, among other things, on access to modern energy services (Khandker et al., 2012, 2013). The concept of development has received various interpretations. According to Sen (2000), development has to be seen in a broader sense as a process of expanding real freedom of the people so that they can live a life they value. Arrangements for public facilities like education, health care and infrastructure development for the expansion of energy access are important determinants of the freedom and development. As per Sen's approach, society must strive to enhance the capabilities of individuals as it is a prerequisite for achieving entitlements defined as command over what is required to lead a life with dignity. Fundamental challenges faced by society like poverty and inequality can only be addressed with the enhancement of the entitlements of the people (Cook, 2011). Accordingly, access to modern energy services like electricity and LPG is a question of development as it serves to expand the freedom and capabilities of people, as outlined in the beginning of this section, leading to improvement in the entitlements of the people (Day et al., 2016).

Further, access to affordable and modern energy resources has to be considered as an economic instrument capable of enhancing the capabilities and thereby the entitlements of the people (Sadath and Acharya, 2017). For example, 2.8 million people die prematurely every year due to the pollution caused by the use of bio-fuels for cooking and therefore, universal access to clean cooking can lower the premature death by 1.8 million per year in 2030 (IEA, 2017). Further, United States, for instance, the largest energy consumer in the world is also one of the countries with high human development achievements (HDI is 0.924 in 2017). Extant literature also shows plenty of evidences about the enabling influence of energy access on the socio-economic progress of the people (see, for e.g., Pachauri et al., 2004; Sovacool, 2013; Lacroix and Chaton, 2015; Szakonyi and Urpelainen, 2015 and Thomas and Urpelainen, 2018). Thus, it is a fact that access to modern and affordable energy services is indispensable to improve the standard of living and enhance human development (Martinez and Ebenhack, 2008). It is this realization that led United Nations (UN) to identify "affordable and clean energy for all" by 2030 as one of the sustainable development goals (SDGs) along with zero poverty and hunger, good health, quality education, etc (IEA, 2017).

In this paper, therefore, we examine the link between access to modern energy services and human development in India and evaluate the effectiveness of government sponsored policies and programmes to expand energy access from the view point of human development in India.

3. SUMMARY OF MAJOR INİTİATİVES TO EXPAND ENERGY ACCESS AND MOTİVATİON FOR THE STUDY

3.1. Summary

The prime motivation for this paper is certain remarkable developments witnessed in Indian energy scenario since 2000 as a result of various initiatives of the government. For example, India's energy consumption has almost doubled since 2000 with half a billion people gaining access to electricity and almost doubling of electrification rate with about 75% of it fuelled by coal (IEA, 2015 and 2017). Quite in consonance with ground reality, IEA (2015) had further noted that if a well managed expansion of energy supply can be achieved; its benefits can be reaped by 1.25 billion people of India in the form of improved quality of life.

Government of India has adopted a variety of policies and programmes since 2000 to expand energy access in India especially in rural areas. For example, the electricity sector has witnessed a series of reforms and policies like Electricity Act, 2003, National Electricity Policy, 2005; rural electrification programmes like "Rajiv Gandhi Grameen Vidyutikaran Yojana" (RGGVY) in 2005, "Deendayal Upadhyaya Gram Jyoti Yojana" in 2015 and "24x7 power for all" in 2017. All these programmes and policies were aimed at removing the traditional bottlenecks in the electricity sector and infuse fresh energy to the sector so as to expand the reach of efficient and reliable electricity. As part of reform measures undertaken in the backdrop of Electricity Act, 2003, government also acknowledged the importance of the role private sector can play in the energy sector as it requires huge investment to develop infrastructure.

On the cooking side, government of India has introduced certain important initiatives like direct transfer of subsidy on LPG cylinders to the bank account of the beneficiary, which is termed as one of the world's largest cash transfer programme (IEA, 2015), increase in the quota of subsidized LPG cylinders from 9 to 12 annually and "Pradhan Mantri Ujjwala Yojana" which aims to provide access to LPG to 50 million families living below poverty line by 2019. As a result, the share of people in India depending on bio-fuels for cooking has declined from 66 % in 2011 to 59 % in 2015 and further proactive policies of the government is expected to provide means for clean cooking to about 300 million households by 2030 (IEA, 2017). Obviously, these measures are expected to incentivize the use of clean cooking and generate positive socio-economic dividends.

3.2. Motivation

As IEA (2015) remarked, India is in the middle of a rapid socio-economic transformation with rapid economic growth, potential of demographic dividend with almost 60 percent of population

below the age of 30 and raising urbanization. However, Indian policy makers face the twin challenges of meeting the growing energy requirements to fuel this transformation and at the same time, ensuring that the fruits of this transformation and growth are shared fairly among all sections of the society. This paper, therefore, examines the extent of energy access in Indian states and whether India's achievements in the energy sector since the turn of the century has really resulted in the improvement in the standard of living of the people.

This paper contributes to the literature in the following ways. Although vast literature exists on the extent, nature and determinants of energy poverty (for eg, Sagar, 2005; Pereira et al., 2011; Barnes et al., 2011, Sadath and Acharya, 2017, etc.), analysis of impact of access to modern energy resources on human development is limited. And most of the existing studies on the human development impact of having access to modern energy resources are top-down macroeconomic studies, like Niu et al. (2013), which cannot reveal as well as characterize the subtle nuances in the link between energy access and human development. Moreover, Indian studies like Kanagawa and Nagata (2008) and Ray et al. (2016) are based on single sates like Assam and West Bengal respectively, whose findings cannot be generalized to the rest of the country as geography, culture and tradition in terms of use of energy resources are very crucial determinants of the behaviour of people. Additionally, as Alkon et al. (2016) pointed out, energy access is subject to policies of the state governments which will vary from state to state and region to region.

Other studies like van de Walle et al. (2013) and Ahmad et al. (2014) are limited in scope as they have examined single energy service like electricity or impact of electrification on limited indicators of human development such as education and health. Finally, unlike Ouedraogo (2013) who focused on the price of oil as most of the electricity in the study area is produced with oil, bulk of the electricity in India is produced with coal than oil. For example, according to statistic furnished on the website of Ministry of Power, Government of India as on 16 April, 2018, 65.5 % of total power generated is by thermal power, out of which, 57% is coal-fired and just 0.3% is generated with oil. Hence, there is a case for an India specific study. Since we have used a multi-dimensional energy poverty index (MEPI) to measure energy poverty or energy access, this paper cover more energy services than previously studied. Also, being a study across states, region specific dynamics can also be captured by this study. In short, this paper, to the best of our knowledge, is the first attempt to assess the relationship between energy access and human development on pan-Indian basis.

Empirical results show that energy poverty is quite widespread in India and at the same time various policies of the government have resulted in reduction in energy poverty. Energy poverty and human development have negative relation, indicating access to modern energy services is necessary for the human development. The relationship is positive between human development and confidence of people, whereas negative between energy poverty and confidence of people. It shows that there is a crucial role for the government institutions in improving human development.

4. ACCESS TO ENERGY AND HUMAN DEVELOPMENT

The role of modern energy services in the promotion of human development is well established in the literature (Gaye, 2007). For instance, Srivastava et al. (2012), while detailing the fundamental issues in ensuring energy access in India, even proposed that the energy access goal be translated into a more sensitive objective of creating an enabling environment that empowers each human being. In the same vein, Day et al. (2016) observed that the idea of energy poverty in the global south is much comprehensive than it is in the global north to include how access to energy services is connected to socio-economic development, well-being and quality of life. Summarizing the findings of the existing literature on the developmental effects of electrification, Jimenez (2017) reveals that, in general, access to the electricity leads to better education outcomes and thereby better human capital formation with related long term benefits like increase in labour productivity and household income.

The study by Pasternak (2000) showed significant association between percapita electricity use and Human Development Index (HDI) until a threshold annual percapita consumption of 4000 KW/h, beyond which the increase in the consumption of electricity appears to have no impact on HDI. Comparable evidences are reported by Martinez and Ebenhack (2008) from a panel of 120 countries where they observed that the relationship between energy consumption and human development can be characterized by what is called a saturation phenomenon in the sense that human development in energy poor countries is heavily contingent upon access to energy resources and the relationship between human development and access to energy eventually declines and therefore, little improvement in the welfare of the people can be achieved with increase in the energy accessibility in the industrialized rich countries (saturated region). Similar evidences of non-linear positive relationship between energy consumption and various indicators of quality of life like life expectancy, infant mortality rate, etc from 21 industrialized countries are reported by Mazur (2011). Wu et al. (2012), Lambert et al. (2014) and González-Eguino (2015) also noted that the relationship between energy consumption and human development is not linear implying that at low level of development, increase in energy access and consumption will have profound positive impact on the human development.

Analysis of Ouedraogo (2013) from a panel of 15 developing countries shows that access to modern energy resources has important positive impact on HDI. Comparable evidences are reported by Kanagawa and Nagata (2008) and Ahmad et al. (2014) from India where significant positive relationship between access to electricity and wellbeing of the people measured by education attainment and health is observed. Grogan and Sadananad (2013) provide evidences of economic empowerment of women in the electrified households in Nicaragua as women from electrified households have greater wok propensities than women from un-electrified households. For household chores like cooking and lighting, it is easier in an electrified house and therefore, women will have greater incentive to work outside home and earn money.

Obviously, economic empowerment of women will have direct positive impact on the human development aspects of a family such as education and health care of children. Identical results are provided by van de Walle et al. (2013) from electrified households in India where electrification of households has resulted in the increase in girls schooling and labour market participation of women.

Ray et al. (2016), in addition to positive impact of energy access on health and education, also found that it has opened up multiple economic opportunities especially for women in West Bengal state in India. Welfare gains like improvement in income, increase in children's school attendance and increase in number of years of schooling and financial empowerment of women are reported by Zahnd and Kimber (2009), Khandker, et al. (2012 and 2013) from Nepal, Bangladesh, Vietnam and India respectively after electrification of households. van Gevelt (2014) found evidences of improvement in the overall quality of life after massive rural electrification in South Korea with notable improvements in areas such as sanitary conditions which has helped to reduce the incidence of communicable diseases. Pasten and Santamarina (2012) also found global evidence of strong relationship between quality of life measured by variables like infant mortality rate, mean years of schooling, etc and per-capita energy consumed. In an interesting study Parikh et al. (2012) has noted shift in the aspirations of slum dwellers to higher order involving education, health and employment once they are provided with energy services.

Empirical results from a study of fifty countries by Niu et al. (2013) and Fang and Yang (2016) indicate that it will take time to realize the positive fruits of electrification on human development. Insights of Lenz et al. (2017) from Rwanda reveal that expansion of electricity access under Rwandan Electricity Access Role-Out Program (EARP) has resulted in an increase in the time spent for studies by children, improvement in the quality of household air, health and remarkable improvement in the service delivery of primary health centres after electrification. Thus, two things are evident from available literature. First, access to modern energy services has profound impact on the indices of human development across the globe. It is against this background, International Energy Association (IEA, 2017) observed that "energy access is the "golden thread" that weaves together economic growth, human development and environmental sustainability and access to energy services is critical for advancing human development, furthering social inclusion of the poorest and most vulnerable in society and to meeting many of the SDGs." Second, the dynamics between access to energy services and human development may vary from region to region depending upon the various determinants like tradition and culture. This paper, therefore, explores the link between them from India in a deep and fundamental manner based on data from all states in India so that effectiveness of government intervention in the energy sector with the aim of the promotion of well being of the people can be evaluated.

5. DATA AND METHODOLOGY

5.1. Data

Study collects data from different sources namely, Census of India, India Human Development Survey (IHDS) database, and Central Statistical Organisation (CSO). We use 2001 and 2011 census data to measure educational attainment and the data for the same is collected from the official website of the Census of India. Further, life expectancy at birth is collected from the Sample Registration System (SRS) life tables pertaining to the period 2004-2008 and 2011-2015. Gross State Domestic Product (GSDP) is collected from the CSO in constant 2004-2005 prices for the year 2004-2005 and 2011-2012. Using population data for the corresponding period, we calculate the percapita GSDP. We use decadal annual average growth rate in population and educational attainment to estimate these values for the year 2004-2005. Data for estimating energy poverty is collected from the IHDS survey conducted in 2004-2005 and 2011-2012.

5.2. Methodology

Objective of the study is to measure the relationship between energy poverty and human development. For this purpose, we calculate a human development ındex (HDI) and a multidimensional energy poverty ındex (MEPI) at the state level. Further, human development is also influenced by various factors like employment opportunities, education, health services etc which are largely influenced by the government. Therefore, we construct a Confidence Index (CI) representing the confidence of people in government at different levels and government services pertaining to health and education.

5.2.1. Human development ındex (HDI)

The study calculates HDI at the state level using life expectancy at birth, education and GSDP percapita. We try to replicate the HDI of the United Nations Development Programme (UNDP) as far as possible, but need to adapt it considering the availability of data. Life expectancy at birth data is available at the state level and the same is used in the calculation of HDI. In the UNDP HDI measure, education has two components; mean years of schooling and expected years of schooling. Due to data non-availability on gross enrolment and dropout rates at different age groups at the state level, we modify this measure. Our education index consists of mean years of schooling of the population in the age-group of 7-24 and in the age group of 25 and above. We hope the mean years of schooling of the population in the age group of 7 to 24 should be close to the expected years of schooling of UNDP HDI, whereas the mean years of schooling of the population in the age group of 25 and above is same as in the UNDP HDI measure. Finally, using GSDP and state population, we calculate the GSDP percapita and use the same in the index calculation.

Following UNDP HDI calculation methodology, we use similar goalposts in our HDI calculation. For example, in life expectancy index calculation, we use 20 years as minimum and observed maximum among the states as goalposts. Regarding education index, for the mean years of schooling of the population in the age group of 7-24, we use 0 as minimum and 18 years as maximum as in the case of expected years of schooling of UNDP HDI measure. In the case of mean years of schooling of the population in the age group of 25 and above, we use 0 as minimum and 15 years as maximum. Finally, for GSDP percapita, we follow the UNDP

HDI measure. We arrive at a rough measure[1] of 100 PPP$ in Indian rupee and is used as minimum, whereas observed maximum is used as goalposts.

We use the following formula to calculate the dimension index:

$$\frac{\text{Actual} - \text{Minimum}}{\text{Maximum} - \text{Minimum}}$$

We apply the above equation to life expectancy at birth and GSDP percapita individually. In the case of education, there are two components namely, mean and expected years of schooling. We apply the above formula to both components and a simple average of the two indices is taken as the composite education index. Finally, geometric mean of the three dimension indices gives us the composite HDI at the state level.

<H3>5.2.2. Multidimensional energy poverty ındex (MEPI)

Energy poverty being multidimensional in nature, we use the multidimensional approach to measure energy poverty. We follow Sadath and Acharya (2017) in measuring MEPI using the IHDS database. We measure energy poverty using three dimensions viz. lighting, cooking and use of bio fuels. Access to electricity is a single measure under lighting. Cooking has two sub-dimensions; first, access to Liquefied Petroleum Gas (LPG) and second, whether the house has a stove with chimney. Under the use of bio fuels, there are five dimensions representing the use of bio fuels viz. Kerosene, Coal/Charcoal, Dung Cake, Corp Residue, and Firewood. Each dimension is coded as 1 for the presence of energy poverty and 0 for the absence. Therefore, energy poverty index value closer to 1 represents higher poverty and vice versa. All three dimensions of energy poverty have equal weight and sub-dimensions within a dimension also have equal weight.

To test the strength of relationship of MEPI influencing human development as measured by human development index, we use linear regression model. As human development depends on many qualitative and quantitative factors, we consider the confidence of people in government institutions as a major factor. Therefore, we build a multidimensional confidence index using four factors namely, confidence of the people in state government, panchayat and services provided by educational and medical institutions. We select these four dimensions based on the logic that state government plays a major role in providing basic facilities to the public in India. Even the central government schemes are implemented through the state governments. Panchayats are the grass-root level local self-governance system in India which has direct relationship with the people at the village level. Infrastructure facilities and livelihood of the people are closely intertwined with these two governance institutions. As education and life expectancy are the two main components of HDI, we include confidence of the people in education and medical institutions. Using household level survey data, if a household has confidence in the state government, it is coded as 1, otherwise 0. In the same manner, confidence in panchayats, educational and medical institutions are coded. The overall index is constructed with an equal weight of 25 percent each. For example, if a household has confidence in state government but not in the panchayat and has confidence in educational institutions but not in medical institutions, the index will be calculated as [(0.25*1) + (0.25*0) + (0.25*1) + (0.25*0)] = 0.5. The confidence index value ranges from 0 to 1; higher index value represents people having higher confidence in the institutions and vice-versa. We estimate a cross-sectional regression with MEPI as dependent variable and HDI and confidence index as independent variables to test the nature and strength of relationship. Regression equation is specified as follows:

$$HDI=\alpha_0+\beta_1 MEPI+\beta_2 CI+\varepsilon \quad (2)$$

where, HDI represents human development index, MEPI represents multidimensional energy poverty index and *CI* represents the confidence index. All variables are measured at the state level. We expect MEPI to have negative relationship with the HDI, whereas confidence index to have positive relationship with HDI. It is based on the reasoning that lower level of energy poverty and higher level of confidence in government institutions are conducive for higher level of human development.

6. EMPİRİCAL RESULTS

Empirical result of the study is presented in this section.

Figures 1 and 2 presents the comparison between energy poverty and components of the education index namely, mean and expected years of schooling for the year 2004-2005 and 2011-2012 respectively. Both mean and expected years of schooling have increased for all states during the study period. However, improvement in energy poverty is not uniform during the same period. A comparison between energy poverty and components of educations shows that the states with low energy poverty have higher level of education. Southern states like Kerala, Tamil Nadu and a few smaller states have lower levels of energy poverty and higher education level.

Figures 3 and 4 shows the comparison between energy poverty and GSDP percapita for 2004-2005 and 211-12 respectively. States with low energy poverty have higher level of GSDP percapita.

States like Bihar, Odisha, Uttar Pradesh, and Madhya Pradesh have very low level of percapita income and very high level of energy poverty. However, energy poverty level of some of the higher income states like Gujarath, Haryana, and Maharashtra are higher than the states like Kerala which has comparatively lower level of income.

Comparison between energy poverty and life expectancy at birth is shown in Figures 5 and 6 for the year 2004-2005 and 2011-2012 respectively. Kerala is the only state to have life expectancy at birth of more than 70 years in 2004-2005 closely followed by Himachal Pradesh and Jammu and Kashmir. States like Madhya Pradesh and Uttar Pradesh have shown substantially lower level

1 Using India's PPP$ percapita for the corresponding year in the HDI report, we calculate a measure of exchange rate between Indian rupee and PPP$. Further, we use this exchange rate to calculate the rupee equivalent of 100 PPP$.

Figure 1: State-Wise energy poverty, mean and expected years of schooling in 2004-2005

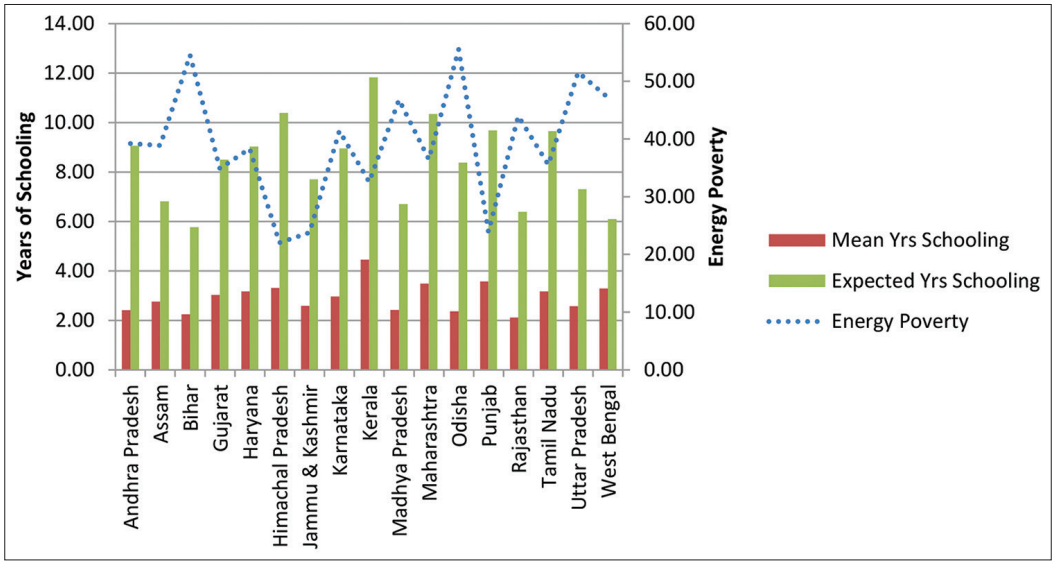
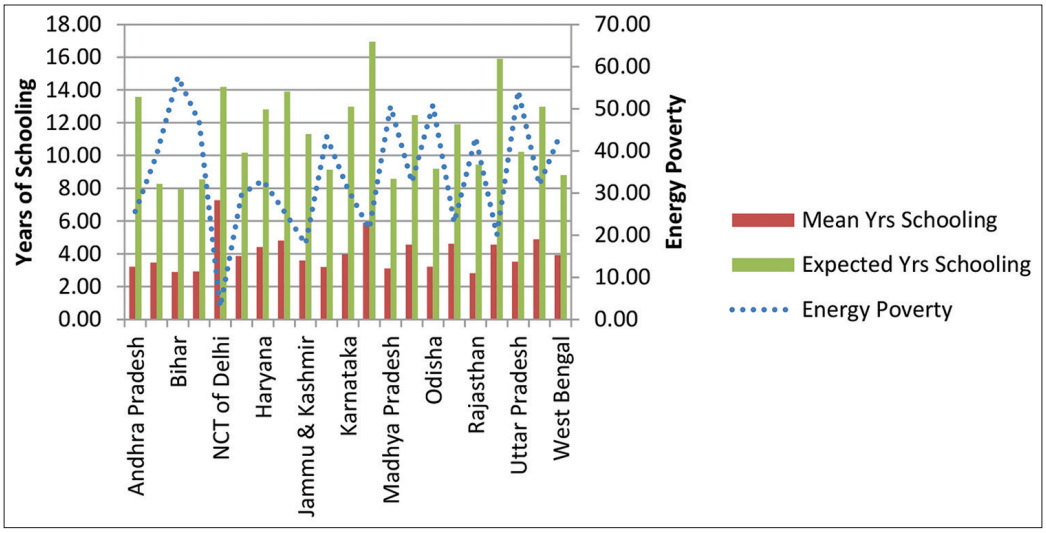


Figure 2: State-wise energy poverty, mean and expected years of schooling in 2011-2012



Source: NCT of Delhi being national capital shows lowest energy poverty level.

Figure 3: State-wise energy poverty and percapita ıncome in 2004-2005

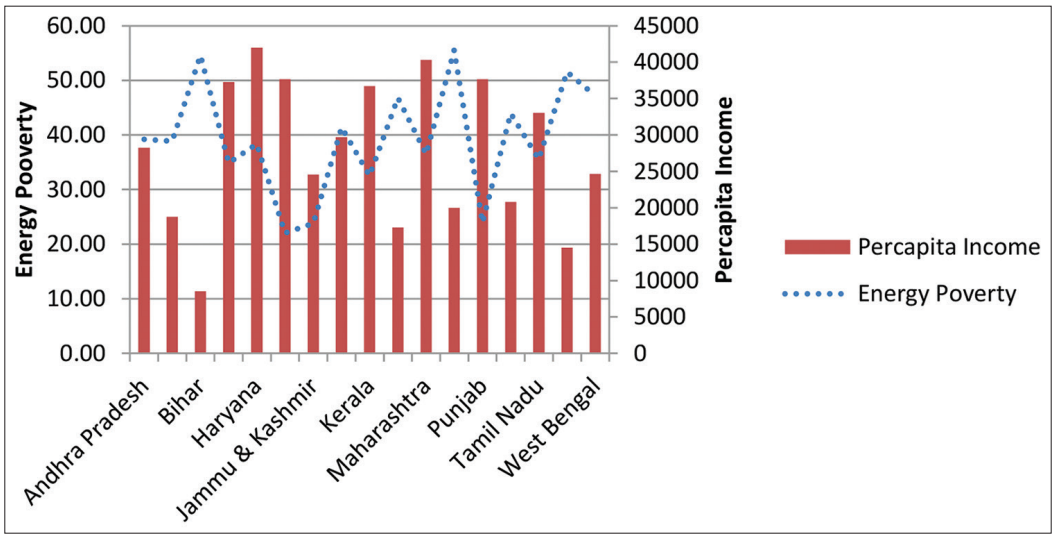


Figure 4: State-wise energy poverty and percapita ıncome in 2011-2012

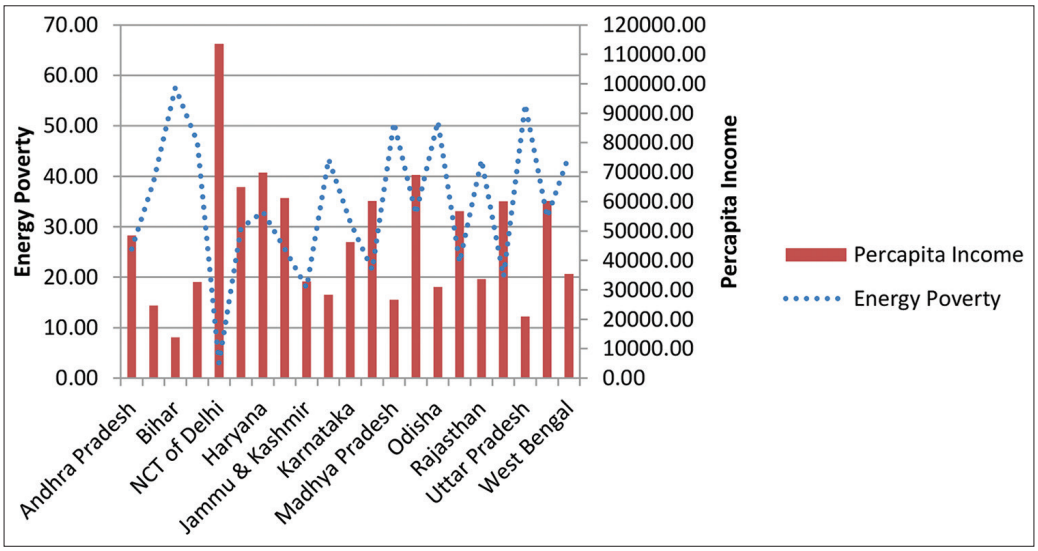


Figure 5: State-wise energy poverty and life expectancy at birth in 2004-2005

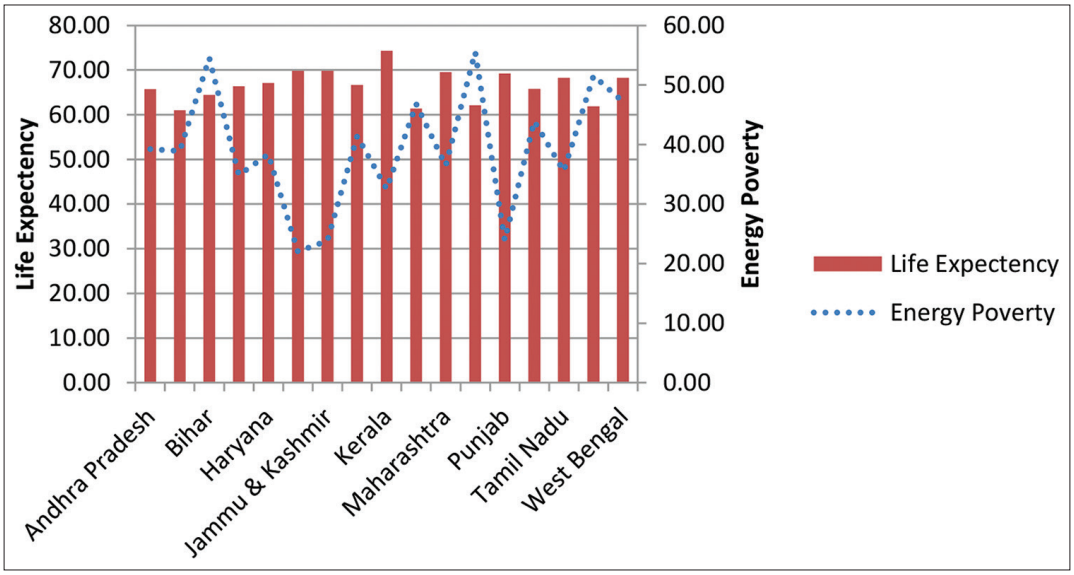
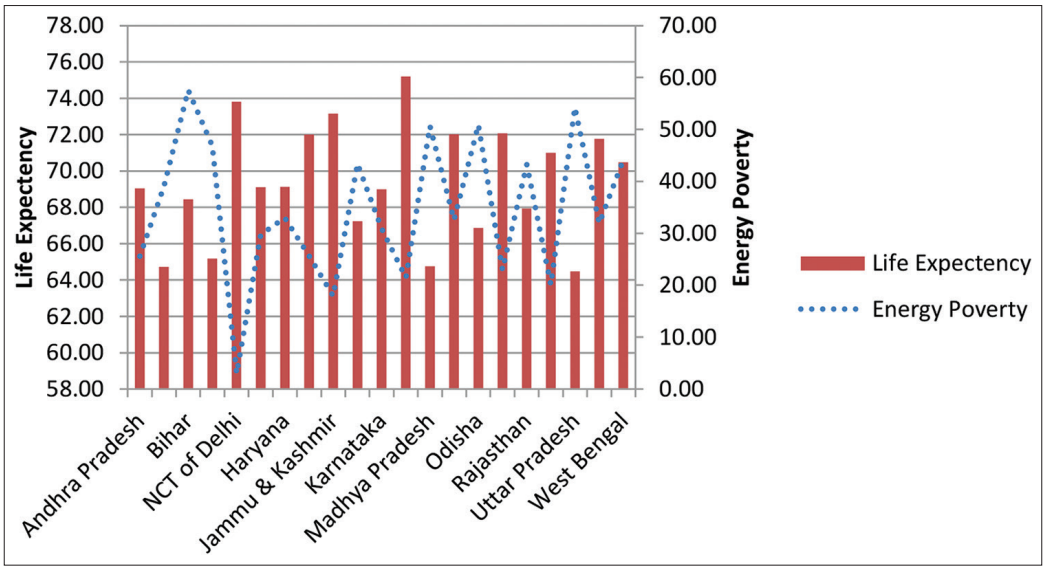


Figure 6: State-wise energy poverty and life expectancy at birth in 2011-2012



of life expectancy at birth in comparison with states with higher life expectancy at birth.

States with higher energy poverty scores and lower improvement in the reduction of energy poverty have lower level of life expectancy at birth and did not make rapid strides in the latter as well. Overall, it shows that the states with higher level of energy poverty have lower level of performance in different components of HDI. It clearly shows that eradicating energy poverty is very crucial to achieve progress in human development.

Table 1 presents results relating to HDI and MEPI at the state level for the year 2004-05. The states are grouped under three categories as high, medium and low human development. The classification is based on dividing the states more or less into equal number across three categories as per the HDI. Last column presents the difference between HDI rank and MEPI rank, a negative value indicates that a state ranked better by HDI, whereas a positive value indicates that the state is ranked better by the MEPI. Under the high human development category, the result is on expected line with Kerala leading the pack followed by the richer and smaller states. For example, Maharashtra which includes the financial capital of India, Mumbai, is better ranked compared to the rest of the states. Whereas, rest of the states in this category are relatively smaller states and have rich agriculture base.

Under the medium human development category, all south Indian states find place along with Gujarat, West Bengal and Jammu and Kashmir. Finally, under the low human development group, we find states from central, western and eastern parts of India. For those who are familiar with the spatial development of India, the results furnished in Table 1 are on the expected lines. Comparison of HDI with MEPI shows that states with higher values of HDI are associated with lower values of MEPI indicating a higher level of overall development. However, to make a clear comparison of the difference in the ranking of states based HDI and MEPI, we present the HDI rank minus the MEPI rank. States with better HDI rank have slightly poor rank in MEPI as indicated by negative values of HDI minus MEPI rank. However, as we move to low human development category, the difference is positive indicating a better rank in MEPI compared to HDI. This result seems to reaffirm the saturation phenomenon thesis in the literature which states that role of energy consumption in the promotion of HDI is critical only until a threshold level of income and as country or region grows beyond the threshold level, the importance of energy consumption in the human development saturates (Martinez and Ebenhack (2008) and Mazur (2011)).

To further shed light on the relationship between different components of HDI and MEPI, we present the correlation matrix for the year 2004-05 in Table 2. As expected, there is a positive correlation among different components of HDI; HDI has higher correlation with GSDP percapita index followed by education index and life expectancy index. There is a negative correlation between different components of HDI and MEPI. GSDP percapita and education indices have slightly stronger negative correlation

Table 1: HDI and MEPI of states- 2004-2005

HDI rank	State	HDI	MEPI	HDI rank-MEPI rank
High human development				
1	Kerala	0.574	32.539	–3
2	Maharashtra	0.543	36.475	–5
3	Himachal Pradesh	0.530	22.021	2
4	Punjab	0.523	23.925	1
5	Haryana	0.520	38.333	–3
Medium human development				
6	Tamil Nadu	0.490	35.532	0
7	Gujarat	0.487	34.860	2
8	Karnataka	0.456	41.404	–3
9	Andhra Pradesh	0.439	39.206	–1
10	Jammu & Kashmir	0.416	23.804	8
11	West Bengal	0.402	47.189	–3
Low human development				
12	Odisha	0.371	55.499	–5
13	Rajasthan	0.358	43.932	1
14	Assam	0.347	38.872	5
15	Madhya Pradesh	0.333	46.794	2
16	Uttar Pradesh	0.322	51.542	1
17	Bihar	0.253	54.534	1

Table 2: Correlation matrix of the components of HDI and MEPI- 2004-2005

	Life expectancy ındex	GSDP percapita ındex	Education ındex	HDI	MEPI	Confidence ındex
Life Expectancy Index	1					
GSDP percapita ındex	0.708	1				
Education ındex	0.750	0.838	1			
HDI	0.793	0.974	0.927	1		
MEPI	–0.685	–0.705	–0.623	–0.730	1	
Confidence ındex	0.202	0.551	0.527	0.571	–0.272	1

with MEPI in comparison with the life expectancy index. However, the difference is very small. Finally, confidence index has positive relationship with different components of HDI and negative relationship with MEPI. It shows that government institutions good in delivering the services to the citizens help in improving human development and reducing energy poverty. The strength of relationship of confidence index is stronger in case of GSDP percapita and education index in comparison with its relationship with life expectancy and MEPI.

HDI and MEPI of the states for the year 2011-2012 are presented in Table 3. There are more number of states in 2011-2012 compared to 2004-2005 due to the availability of data for some states and also creation of new states by carving out of the existing states. Majority of the states have recorded improvement in the HDI value. However, Assam, Punjab, Odisha and West Bengal have recorded a marginal decline in HDI values. With regard to MEPI as well, majority of the states have shown improvement in 2011-12 over 2004-05. However, Assam, Bihar, Uttar Pradesh and Himachal Pradesh have shown deterioration in the energy poverty. Observations made as per the 2004-05 results in Table 2 on the relative position of states as per HDI and difference in the ranking based on HDI and MEPI holds good in the context of 2011-2012 as well.

Table 3: HDI and MEPI of States-2011-2012

HDI rank	State	HDI	MEPI	HDI rank-MEPI rank
High human development				
1	NCT of Delhi	0.723	2.984	0
2	Kerala	0.598	21.436	-2
3	Tamil Nadu	0.560	20.073	0
4	Maharashtra	0.557	32.549	-7
5	Himachal Pradesh	0.552	25.645	-2
6	Haryana	0.551	32.982	-6
7	Uttarakhand	0.540	31.909	-3
Medium human development				
8	Punjab	0.517	22.967	3
9	Gujarat	0.503	29.728	1
10	Andhra Pradesh	0.481	25.587	4
11	Karnataka	0.475	30.907	2
12	Jammu & Kashmir	0.416	17.907	10
13	West Bengal	0.400	44.124	-3
Low human development				
14	Rajasthan	0.380	43.237	0
15	Odisha	0.369	50.865	-4
16	Chhattisgarh	0.361	46.821	-1
17	Jharkhand	0.358	43.400	2
18	Madhya Pradesh	0.338	50.634	0
19	Assam	0.330	38.989	6
20	Uttar Pradesh	0.327	54.237	0
21	Bihar	0.269	57.563	0

Table 4 presents the correlation among components of HDI, MEPI, and confidence index for the year 2011-2012. The correlation between different components of HDI and composite HDI with MEPI remains negative and the strength of relationship has increased in 2011-2012 in comparison with 2004-2005. The relationship between confidence index and various components of HDI has remained positive; however, the strength of relationship has decreased in comparison with 2004-2005. The relationship between confidence index and MEPI is very close to zero in 2011-2012.

To test the relationship between HDI and MEPI, we estimate a cross-sectional regression with HDI as dependent variable and MEPI and confidence index as independent variables for 2004-05 and 2011-12. Confidence index is used as a proxy for the role played by the state in providing basic facilities for improving the human development.

Results in Table 5 shows that there is a negative relationship running from MEPI to HDI. One percent reduction in MEPI leads to a 0.564 percent improvement in HDI in 2004-2005, whereas it leads to an increase of 0.729 percent in 2011-2012. The confidence index has positive relationship with HDI and the strength of relationship has increased from 2004-2005 to 2011-2012. R squared of the regression also has increased from 0.68 to 0.85. It shows that reducing energy poverty and improving the governance as reflected in the confidence of the people lead to improvement in the HDI.

Table 4: Correlation matrix of the components of HDI and MEPI- 2011-2012

	5.322 pt	GSDP percapita ındex	Education ındex	HDI	MEPI	Confidence Index
Life expectancy ındex	1					
GSDP percapita ındex	0.796	1				
Education ındex	0.682	0.812	1			
HDI	0.788	0.924	0.965	1		
MEPI	–0.790	–0.829	–0.815	–0.871	1	
Confidence ındex	0.107	0.348	0.198	0.271	0.040	1

Table 5: Regression result of HDI, MEPI and confidence ındex relationship

Year	Variable	Coefficients	Std. Error	t Stat	P-value	R Square	F
2004-2005	Intercept	0.167	0.212	0.785	0.445	0.68	15.01*
	MEPI	–0.564	0.142	–3.960	0		
	Confidence Index	0.571	0.223	2.566	0.022		
2011-2012	Intercept	0.159	0.164	0.967	0.346	0.85	52.09*
	MEPI	–0.729	0.075	–9.758	0		
	Confidence Index	0.640	0.189	3.377	0		

İndicates significance at 5% level of significance

The empirical results in general suggest that access to modern energy services is critical to the human development in India as elsewhere and various programmes and policies of the government during study period to expand access to the energy services appear to have generated positive impacts on the socio-economic fronts. Finally, findings of this paper are consistent with evidences in the literature from India (Kanagawa and Nagata, 2008; van de Walle et al., 2013; Ahmad et al., 2014; and Ray et al., 2016). Also, the results justify the theoretical underpinning of the paper, following Amartya Sens's approach to the development; access to the modern energy services, with the support of public action represented in this paper by the confidence of the people in the government, improves the agency of individuals and hence expands their socio-economic opportunities like education and health care. Expansion in the socio-economic opportunities is critical to the achievement of overall development of a country.

7. CONCLUSION

Access to modern energy resources is essential to the human development in the form of education, employment, ability to lead a long and healthy life. Given such a background, we attempted to analyze the relationship between energy poverty and human development in India at the state level. We have used the household level data of India Human Development Survey (IHDS) collected in two rounds in 2004-05 and 2011-12. We have also used the 2001 and 2011 census data, Sample Registration System (SRS) life tables of 2004-2008 and 2011-2015 and the Central Statistical Organisation (CSO) data on GSDP percapita for the corresponding period.

Empirical results confirm that, even though energy poverty is still quite high in India, various policies of the governments to expand access to modern energy services has created positive impact on the socio-economic front like improvement in HDI in India. It is observed that the states with lower energy poverty have higher human development indicating a negative correlation between the two. Among the components of HDI, MEPI has highest correlation with GSDP percapita followed by education and life expectancy index. Further, the strength of negative correlation between HDI and MEPI has increased during the study period. Finally, there is positive relationship between confidence index and human development and negative relationship between confidence index and energy poverty.

Findings of the study have several policy implications. First, strong negative relationship between energy poverty and various components of human development shows that improving the energy poverty should be the top priority of the government. Second, among the components of human development, energy poverty has a stronger negative correlation with income compared with the other components shows that the livelihood of the people is most affected; therefore, lifting people out of energy poverty is crucial to improve the livelihood and overall human development. Third, strong positive relation between confidence of the people in government institutions as represented by confidence index and human development, and energy poverty shows that the government at all level, namely central, state and local bodies are very crucial in improving human development and decreasing energy poverty. This finding is on very much expected line considering that a large section of the populations still lives in poverty and the role of the government is very much necessary to improve the living conditions of the poor.

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