



# The Critical Minimum Effort for Energy Poverty Challenge in India

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## Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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## ABSTRACT

The Socio-Economic and Caste Census of 2011 shows the extent of deprivations of rural India. Around 73.4 % of families are residing in rural India, where over 77 million households depend on kerosene for lighting; 1 million use wood and as many as 1.2 million households in India remain completely in the dark. Improvement in - Access, Availability, Adequacy, and Quality of energy can contribute to poverty reduction from various aspects. From a policy-making perspective increasing access to modern energy services require, first, the integration of energy access into national development strategies, and then strong and sustainable financial, institutional, and technology frameworks must be set up. The restatement of the theory of critical minimum effort is to make a plan for the effort that needs to break the environment of inertia of energy poverty. This paper discusses the minimum effort necessary to achieve a steady secular supply of basic energy requirements for people in need. It is alarming fact that today billions of people lack access to the most basic energy services, electricity, and clean cooking facilities, and, worse, this situation is set to change very little over the next 20 years. This paper explains how to set the needed change in the orientation and execution for the service delivery mechanism of energy.

**Aims:** The restatement of the theory of critical minimum effort as a plan to achieve a steady secular supply of basic energy requirements for people in need.

**Study Design:** Descriptive analysis.

**Place and Duration of Study:** Macro-level analysis on India based on Socio-Economic and caste census of 2011.

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**Methodology:** Review-driven theoretical analysis.

**Conclusion:** Restates those large-scale actions are needed to take people out of the vicious circle of energy poverty.

*Keywords: Rural India; energy services; energy policy; critical minimum effort; energy poverty; access to energy.*

## 1. INTRODUCTION

The discussion about the arguments that link the incidence of poverty to mechanisms that urges its fabrication explains to us what causes poverty along with the wider effects that poverty has on the economic system. A wider understanding of poverty enables the incorporation of vulnerability and powerlessness entitled to poor people in defining poverty beyond quantitative measures of lower consumption and income. In this premises, lower energy consumption levels merit consideration in describing poverty. Poverty is not just about the disposable income of a household, it has dimensions of energy availability to a household to endure its need for lighting, cooking, and gainful employment [1]. Thus, energy poverty is a culmination of questions on accessibility, availability affordability sustainability of energy services entitled to people [2]. Indeed, there is a direct relationship between the privation of passable energy services and several poverty indicators such as infant mortality, illiteracy, life expectancy, and total fertility rate (Sovacool, 2013) [3]. The undebatable role of clean and reliable energy as a vital factor in poverty alleviation initiatives is applied worldwide. The enhanced access to modern energy sources provides a visible change to the developmental progression of families (Kanagawa & Nakata, 2008). From identifying the fact that energy poor are also income poor, then than mere relabeling of strategies and tactics to tackle poverty more comprehensive attitude is needed to address this. To tackle poverty, the World Bank proposes a three-pronged strategy: promoting opportunity, facilitating empowerment, and enhancing security. All these three can answer the problem of accessibility, affordability, and reliability aspects of energy poverty (World Bank,2001). Access to the most basic energy services including electricity and clean cooking energy is far from billions of people in India. India's position in the production and consumption of electricity in the world shows both attainment and potential of the sector, but it is undeniable that a large section of the population still trails for access to it and is thus exposed to energy poverty [4]. This

paper is intended to present the Theory of critical minimum effort as a plan for the energy poverty challenge in India. Professor Harvey Leibenstein has presented a general approach towards the problem of economic development of underdeveloped countries. The scope of restatement of the theory of critical minimum effort is the existence of an environment of inertia of energy poverty. Inaccessibility to adequate and affordable energy services and poverty bears a reciprocal relationship. The relationship is, in many aspects, a vicious cycle where people who lack access to cleaner and affordable energy are imprisoned in a re-enforcing cycle of deprivation, lower incomes, and the means to recuperate their living conditions and the same time using sizable amounts of their narrow income on costly and unhealthy energy sources (Bridge, 2016; Papada and Kaliampakos, 2016) [5]. Even though this paper is an attempt to restate the theory, it is not a completely theoretical approach but moreover, a pragmatic methodology is followed. This paper will start with the theoretical underpinning of the topic followed by assessment and policy implications. Beyond an exercise of futility, this slant of statement can lessen the gap between a textbook theory and a policy approach.

## 2. REVIEW OF LITERATURE

The framework perceived by academicians and policymakers to define poverty was extended over the year with the multi-dimensions of poverty was identified. Energy poverty was thus assimilated to this discussion as international organizations recognized the pivotal role energy services hold in a better standard of living in general [6]. The question of accessibility, affordability, and reliability of energy services are conceded to be fundamental in poverty alleviation and economic growth [3]. The constraints on any of these scales will harm the individual well-being and welfare of society in terms of poverty, ill-health, illiteracy, gender discrimination, etc [1]. Acharya [7] stated that the inverse relationship between economic development and energy poverty is multidimensional. The UN declaration of 2012 as

“International Year of Sustainable Energy for all” and 2014-2024 as “UN decade of Sustainable Energy for all” are testimonies of global acceptance of this concern. This activated international and sub-national efforts to alleviate energy poverty for millions of households across the globe [8].

The absence of a universally accepted definition of energy poverty both demands and widens the foundation of understanding energy poverty. This includes approaches based on consumption expenditure, capability entitlements, and multidimensional factors [2,9,10]. To conclude these are mainly confined to the physical availability and access, affordability, and deprivation in terms of lack of consumption and inconvenience [8].

The discussion of energy poverty in India is not a novel arena in the literature but not extremely explored too. The energy sector as a whole attracted researchers, policymakers, and market players for its growth potential. This potential is not restricted to the gap in the current demand and supply situations of energy services in India. The need for the growing population including profound growth of the middle class, energy demand by sector transformation of the economy followed by rapid urbanization asserts high pressure on the energy sector [11,12]. The poverty-ridden Indian households are always exposed to deprivation in terms of energy services used for lighting, cooking, and heating [13]. Any efforts for uplifting these households from poverty will need to address the energy poverty aspect also [14].

The studies on the incidence of energy poverty in different regions and its characteristics in India are discussed in the literature over the years. The rural-urban divide in this domain was exposed by Khandker et al. [9], as the study found income non-poor can be energy poor in rural areas of India where they correlate in urban areas. The district-level study of Acharya [7] revealed energy poverty is a common characteristic of Indian households but the extent and its determining factors vary. The association of social-economic backwardness and energy poverty in India is staggering. This was also found by Jain et al. [15] using primary level data analysis from 6 different states. Energy poverty is high in highly populated states, which points out the population pressure on the energy infrastructure of these states [16].

The methodological differences in the assessment of energy poverty helped in finding different determining factors and consequences of energy poverty in the case of India. Sadath & Acharya [17] analyzed the IHDS 2011-12 data based on the capability approach of Amartya Sen to explain the widespread energy poverty in India. Rafi et al. [5] relied on health and education outcome variables in this assessment. The study concluded that the human capital development process is adversely affected by energy poverty in India based on indicators including nutrition lack, drop in school enrollment, etc. Gupta et al. [18] found that east and northeastern states are more vulnerable to energy poverty in India, where 65 percent of total households are in the category of “more and most energy-poor” defined by the study.

On a policy level, enhancement of the current production capacity of the country from different sources and development of supply infrastructure, especially to rural areas is important. The time required and investment outflow to these projects will determine the extent of the energy poverty alleviation drive [16]. In the case of electricity, Ghosh [19] states that higher demand from rural areas should be met with both increasing grid connectivity and the promotion of decentralized renewable energy sources. The question on high public expenditure and planning to energy infrastructure in the country along with the promotion of private investment also will be critical in this regard [14].

Unrealistic targets and premature claims have been part of government efforts in the sector. The promising impact of schemes like *Saubhagya*, *Ujjwala Yojana* in terms of electrification, LPG coverage to households especially in rural areas needs extensive appraisal [13]. The question on accessibility, affordability, and reliability remains relevant to the new energy service enhanced the households also. The Gol (2019) found that 50 percent of electrified households were provided less than 12 hours of electricity. Dabadge et al. [20] pointed out that a household’s ability to find the cost of refilling cylinder are decisive in continuing the use of LPG provided by the different scheme, if not they will return to traditional fuels for cooking. These findings decipher that the need for enhanced focus on energy infrastructure in India is relevant and future-oriented. The scope of this study is to give a theoretical proposal for public infrastructure investment in alleviating energy poverty in India,

which in our knowledge is a first of its kind attempt in the literature.

### 3. THEORETICAL CALIBRATION

“To achieve the transition from the state of backwardness to the more developed state, where we can expect steady secular growth, it is necessary, though not always sufficient condition, that at the same point or during the same period, the economy should receive a stimulus to growth that is necessary than a certain critical minimum size” this thesis presented by Prof. Leibenstein in his book *'Economic Backwardness and Economic Growth'* (Leibenstein, 1957) to the effect that an under-developed country embarking on a career of economic development must reach up to a critical minimum effort to escape a low-income stagnation. In this paper, by restating the theory we get the gaps in the analysis rectified to explain the growth of energy supply or availability [21,22]. So here we will take the theory to the perspective of energy stagnation or the existing vicious circle of energy poverty. The present work is, by and large, non-mathematical and meant for planning the strategy. According to Leibenstein, every economy experiences the influence of growth retarding (shocks) and growth-promoting (stimulants) forces.

On the X-axis, we indicate levels of per capita energy requirement. On the Y-axis, we indicate the contribution (in terms of income rise or decline) of growth-promoting and growth-

retarding factors. Leibenstein adopts a non-linear relationship between income and income-induced growth-retardation and growth promotion. At a low subsistence level of income, the slope of GR(growth-retarding) is greater than GP(growth-promoting). At a higher level of income, (Professor Leibenstein would term this as the 'critical minimum level'), the slope of GP is greater than that of GR. Points E and F are both these positions. Any displacement which lands the system at a level between E and F would lead to forces that bring the system back to equilibrium E. A displacement beyond the level of income F would lead to cumulative growth. Professor Leibenstein's thesis is that small displacement from E does not land the system into the area of cumulative growth. The displacements in terms of stimulants must be greater than the area indicated by EF. Any shock which lands the system from a level beyond F to a level between E and F would make the economy relapse to E. The rationale for the non-linearity is more suitable if we consider this relation in the energy poverty context. As the production level goes up, the availability increases with the increased population who demand more energy services. After reaching a maximum level, this demand will decelerate. Population pressure on the energy demand becomes a hurdle only if the level of supply of energy is slow [23-25]. The growth-promotion activities, in general, assert the values with greater intensity as income levels rise. The retardation forces, however, have a maximum value.

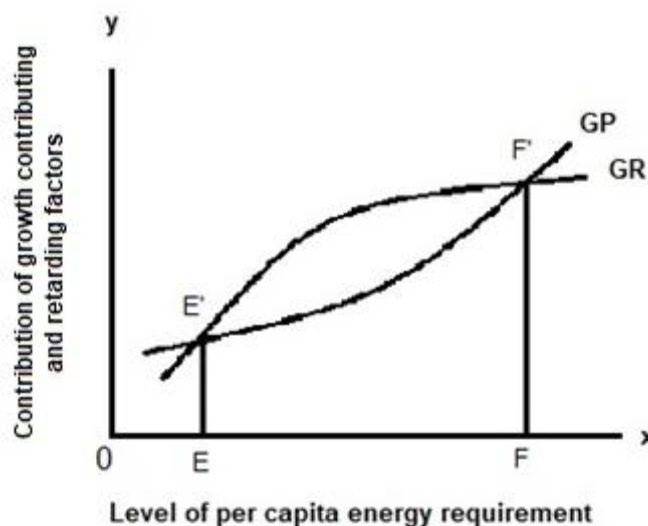


Fig. 1. Impact of growth contributing and growth-retarding factors on Energy requirement

The growth-promotion forces, perhaps, have such a maximum value but this maximum lies above that of the growth-retardation forces. The mechanism of a slow (steady) growth, therefore, cannot take the system out of the rut. What is required is a big push, a quick dash. a sizeable displacement from a low level to high level per capita income through a fast rate of growth of per capita come. Leibenstein believes that it is not obligatory to make the critical minimum effort in a single stroke .it can be split up into a series of smaller efforts provided those are optimally timed. So, there should be an investment of at least of that level which can raise per capita energy level to have a sustained supply of energy. The generation of stimulants depends upon the motivation and attitudes of the people and the incentives to which they respond [26-28]. The rationale of the critical minimum effort thesis rests on the expansion of positive-sum games and such activities can be undertaken by growth agents who have the capabilities to carry out growth contributing activities. Growth agents can be categorized as entrepreneurs, investors, discoverers, teachers of new skills. They can promote growth by exploring new investment opportunities, inventing new techniques, discovering new resources, and spreading new ideas.

#### 4. ASSERTION AND ASSESSMENT

Why the theory of critical minimum effort can be the theoretical backing for the energy poverty alleviation strategy for India can be answered under four heads of minimum efforts. 1) To overcome internal diseconomies: the need for minimum efforts arises to overcome the internal diseconomies. Such diseconomies appear due to indivisibilities of production factors. The main idea of this argument is that government should work on a large scale to neutralize the adverse effects of diseconomies. For example, Solar energy is a solution as an off-grid alternative for remote areas and suburban areas. By government investing on a large scale for a particular area can ensure the ease from diseconomies that may have to be bear by individuals if they take up small efforts.2) balanced growth: the need for critical minimum effort arises to achieve complementarity of energy demand and balanced growth. When states provide the basic infrastructure the basic minimum need of different sections of the economy are met and balanced growth is ensured. Investments that can ensure the supply of energy to hospitals, schools, industries, and

households have to meet in a single stroke to make particular areas energy sufficient. Here the critical minimum effort is needed. By just providing to industries or households cannot bring such a favorable outcome.3) to overcome depressants: there is a need to overcome autonomous depressants and the depressants induced by the growth process. This necessitates a minimum investment to create overhead capital for additional pressure by the expansion or innovation. The issues in the distribution, the inability of the market, and how people get used to all new facilities can be considered here.4) to generate growth momentum: minimum efforts are needed to generate momentum for steady growth. A proper environment in the form of institutional changes and attitudinal behavior needs to be created. This requires human and financial endeavors and minimum effort is the basis of this. Hence, there is a need for critical minimum effort. One of the biggest criticisms of the theory was the direct relation between per capita income and population growth. But it holds if we consider per capita energy requirement and population growth. The independence between Growth promoting and Growth retarding forces also works in the case of energy demand and supply context.

India is witnessing an exceptional demand for energy and a mounting deficit in power supply. India's substantial and sustained economic growth is consigning huge demand for its energy supplies. A stern effort by government-mandated by the demand and supply inequality to supplement energy supplies as India faces severe energy supply constraints. Primary indicators of energy poverty in a country are the lack of access to clean and efficient energy sources. Pachauri [8] found a positive relationship between wellbeing and the use of clean and efficient energy resources. They also concluded that the use of access and consumption of clean and efficient energy increases wellbeing. This shows the importance of the economic development process is needed by assimilating the needed output of energy to address both energy poverty and economic poverty. Elahee [29] explains that access to energy is the tool for poverty alleviation. The association between access to energy and growth is entrenched. Under the shocks of high population growth rate and increase in fuel prices, energy access will be a severe problem in developing nations in the coming time. The results show that any steps towards economic growth can make a positive impact on reducing

energy poverty directly. So, using a growth theory to make a plan for the energy poverty challenge is quite admissible. Jain [5] explored the problems related to energy consumption faced by the Indian rural and urban households. The results showed that energy poverty in rural areas of India is about 89% and 24% in urban areas of India. It was also concluded that 56% of households in India have access to electricity facilities. Realizing the gravity of rural energy poverty and the role of electricity in driving inclusive growth in rural areas, India's government has launched successive rural electrification programs [30,31]. The flagship Rajiv Gandhi Grameen Vidhyutikaran Yojana (RGGVY) scheme was launched in April 2005 with a 90% subsidy and 10% loan to make up the total project cost in an attempt to electrify all the reported un-electrified villages. The RGGVY scheme is also intended to support electricity for agriculture and small and medium-sized industries. This has serious implications on overall rural development, employment creation, and poverty alleviation. The Remote village electrification (RVE Program) initiative is for providing basic lighting/electricity facilities to renewable energy sources in remote villages and settlements which are not electrified and where grid connectivity is either not feasible or not cost-effective. The Jawaharlal Nehru National Solar Mission was launched on 11th January 2010 intends to improve energy access in India's hinterland, which is harshly affected by the adversities of energy poverty. The Pradhan Mantri Sahaj Bijli Har Ghar Yojana-Saubhagya was launched by the Government of India to achieve universal household electrification by March 2019. The Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) targeted and fulfilled 100% village electrification on April 28, 2018, but the claim is based on the measure that, a village is electrified if 10% of households of any particular village is connected to electricity grid along with basic public places.

However, in practice, all these objectives have not been met by any schemes as times move the energy demand from modernized urban India and depriving rural India. Although these programs composed low improvement in terms of access to the grid electricity system, there are significant challenges in improving the reliability of the power supply in the country. The current subsidy scheme gives greater benefit to the urban sector and richer households and has for the most part failed to shift energy consumption patterns in rural areas. The inability to generate

growth momentum by establishing minimum effort in both direct and indirect institutions can be blamed here. To foster energy infrastructure that generates and delivers electricity to each household, an exorbitant sum of money has to be invested first. Access to modern energy is also far for developing countries like India because of the deficiency of high technologies for innovations. Here the external aids are seen as the only way out to overcome energy poverty and development initiatives. Experts disagree whether there are short-term solutions to long-term problems. Nevertheless, it has to be recognized that countries have to take some steps to provide facilities to their people on a short and emergency basis. The unanswered energy demand from rural and growing urban sector pressurize on policymakers and all programs by the government are of this sort. The initiatives for large-scale actions are very rare. The theory of critical minimum effort in this context very clearly explains the need for such big actions that small programs cannot give a steady sustaining answer. Investing in renewable energy resources is considered a new alternative as they are reliable, affordable, and healthier for human life. Even if renewable energy technologies require low cost, the capital costs are very high. We have to realize the fact that private parties will not invest unless it is commercially viable and beneficiaries of these initiatives are often economically ill class.

## 5. POLICY IMPLICATIONS

Energy poverty is only a part of larger economic deprivation, but it's one of the best ways out of it too. Energy poverty eradication means ensuring affordability, accessibility, and reliability of energy services—preferably from sustainable-energy sources—that will prompt good health, a prosperous environment, and a sounder economy. But the basic nature of such initiatives needs to be checked with international experiences in similar conditions. Private developers-based rural electrification funds models were used in Cambodia, Mali, and Madagascar. Co-operative ventures where ownership by consumers and external support from government models of Bangladesh and Nepal also show an approach. The countries in the category of developing phase and below have to allocate their limited resources to many priorities, in which decisions on choosing short-term vs long-term priorities are critical. Highly populated countries like India with rural agrarian households are the forerunners for this welfare

care attention, assimilating their basic developmental aspirations in the public fund allocations need better understanding.

Then having a sound strategy, the huge investment needed to fund these strategies is the crux of the problem. Oppressive conditions and interest rates make the helping hands of international organizations like the World Bank and the IMF less attractive. The government is expected to perform a coordinative to tap developmental funds from international bodies, bring public/private partnerships, establish investment-friendly institutions for formal banking and other financial institutions including micro finances. The strictures on the critical minimum effort thesis might perhaps appear to be somewhat too drastic. Professor Leibenstein himself does not derive any policy conclusions from his thesis. It does appear obvious that only a large production of energy employing a large Stimulant can provide a solution. This is hardly an edifying conclusion for those underdeveloped countries that cannot afford a large displacement as a result of internal forces. It is not just about raising the needed investment to minimize the energy gap but allocating this to the most sustainably productive needs. The over-focus on big ventures mainly non-renewable resource-based plants and electrical transmission lines. In India, there is great attention to energy poverty concern to reach development goals set by the Government, which implies an increase in India's energy needs. In a climate of change and environmental consciousness, sustainability should be given higher preference. Intensive analysis of energy poverty and its implications—considering the themes of sustainability, affordability, energy security, as well as the tremendous amount of energy needed to fill the existing gap urgent attention is needed to increase energy availability for commercial use, power generation of all forms intensively, preferably with cleaner fuels, intensify rural electrification, improve energy efficiency to reduce power consumption and requirement. From here the policy implications of critical minimum effort theory are highlighted. The subsidy lending strategy that is followed as a solution for energy poverty in India will end up with more wounds to the system in the future. The impacts and indirect costs associated with easily available resources should be considered when subsidies are given, such as the environmental cost of the fuels. For example, the policy efforts and attention on the energy needs of cooking in rural India were not adequate to

improve the efficiency and cleanliness of this basic service. Policies stick around the volatility of LPG subsidies and subsidies provided to solar products and cost a huge liability on expenditure. But steps towards larger production and supply are rare in the last few decades. This large investment should be in institutionalizing renewable sources. Unless such a push from the side of government is undertaken by time, we will try to substitute non-renewable energy sources because of environmental commitments but the process of procuring non-renewable sources will lag. These substitution lags will necessitate the critical minimum effort from the government and no smaller efforts can make the change. On other hand, new campaigns like Make in India, Digital India, Atmanirbhar Bharat are going to make a new burden on energy demand in India. So here any small efforts will give additional energy which will be eaten up by the additions to the demand which may come in the wake of the additional energy, and therefore the expected generation of a cumulative process of poverty alleviation won't be stimulated by the effort. What is required is an initial substantially large volume of investment that may create conditions that should outweigh the growth of energy demand, i.e., if necessary, the initial effort or the initial series of efforts must be over a specified minimum magnitude. For example, the focus of the Ministry of New and Renewable Energy policies has shifted from small off-grid systems to grid-connected renewable energy. Renewable energy installed capacity increased 226% in the last 5 years (Ministry of New and Renewable Energy (MNRE), Government of India (2021). We know with further liberalizing policies commercializing energy sources on full fledge is near reality. Commercial energy sources will permit the use of modern technologies that transform the entire production process at the factory level, in agriculture, and within the home. The resulting increase in productivity generates higher incomes and increases the capacity of people to explore and develop their capabilities. It is quite clear that people demand more energy as their incomes rise and that increased use of modern energy by households is a key element in the broader process of human development.

## 6. CONCLUSION

Energy poverty distracts all facets of human welfare like agriculture productivity, access to water, education, health care, and job creation, etc. Even if energy is not considered as a basic need of human existence, it is certainly basic for



the delivery and provision of basics such as food, clean water, shelter, health, and educational services, etc. Redesigning of energy systems and associated economic and welfare policies have to ensure a pro-poor focus that will ensure accessibility and affordability of energy in key economic sectors that the poor rely on such as health, water, education, agriculture, and transport. The restatement of critical minimum effort theory is such an attempt of redesigning which stresses that large-scale actions are needed to take people out of the vicious circle of energy poverty. The critical minimum theory was criticized as it is not logically stable and empirically proven as a growth and development theory. But coming to energy poverty management in an energy demand and supply analysis, the critical minimum theory is logical and needed in many senses like to overcome diseconomies and structural establishment of several institutions. Poor people in India have minimal access to clean, reliable, and efficient energy sources. This is a result of low income, weakness in energy service delivery, ineffective and regressive subsidies, and gender discrimination in policy planning, and lack of awareness about the harms of popular fuels and technologies, and corruption in getting connections. Here the critical minimum effort is necessitated as a strategy to challenge energy poverty. One among them is to tackle the substitution lag which will come by the choice between delivering energy services from renewable sources and non-renewable sources.

## COMPETING INTERESTS

Author has declared that no competing interests exist.

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