

Assessment of access to electricity and the socio-economic impacts in rural areas of developing countries

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Abstract

The purpose of this study is to reveal relations between access to electricity and advancement in a socio-economic condition in rural areas of developing countries. Recently, multi-dimensional aspects of poverty, for example, economy, education, and health, has been increasingly focused on, and access to modern energy such as electricity is one possible solution. As a case study, we have analyzed unelectrified rural areas in Assam state, India. We have developed an energy-economic model in order to analyze the possibility of electrification through dissemination of electric lighting appliances as well as applied multiple regression analysis to estimate the socio-economic condition, a literacy rate above 6 years old, in the areas. As a result of the case study, the household electrification rate, the 1000 km² road density, and sex ratio have been chosen as the explanatory variables of the literacy rate. Moreover, the model analysis shows that complete household electrification will be achieved by the year 2012. In combination with the multiple regression and model analysis, the literacy rate in Assam may increase to 74.4% from 63.3%.

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1. Introduction

Poverty is a major obstacle for sustainable development of not only developing countries but also the entire world. It has been the main objective of the bilateral and multi-lateral donors, together with economic growth. Nowadays, poverty is defined as low attainment of social condition, for example, education, health, and nutrition in addition to economic deprivation. One way to cope with this multi-dimensional aspects of poverty is to promote opportunity (World Bank, 2001), and one of the opportunities is access to modern energy such as electricity. In many literatures related to condition of energy consumption in rural areas of developing countries, the term “energy access” is used to refer to the situation where people can secure the modern energy, which is commonly consumed in developed countries, at affordable prices (Bhattacharyya, 2006, in press; Spalding-Fecher et al., 2005). The definition of the term “energy poverty” is, then, the situation in which

energy access is not established yet (Pachauri et al., 2004; Sagar, 2005).

Works dealing with developmental issues from the field of energy can be mainly divided into three categories, and their characteristics and references are the following:

- Descriptive study (Aggarwal and Chandel, 2004; Bastakoti, 2003; Dung et al., 2003; Gangopadhyay et al., 2005; Rehman et al., 2005)—It describes current situations of energy demand or consumption as well as policy and program in developing countries. It also investigates critical components of the policy and programs, and evaluates the outcomes. Although it includes various aspects of the policy and programs such as legal, social, and fiscal, most of the study is qualitative evaluation, which is highly case-oriented, and it is difficult to obtain ideas applicable to other areas.
- Experimental study (Bhattacharya et al., 2002; Chakrabarti and Chakrabarti, 2002; Masera et al., 2000; Wijayatunga and Attalage, 2002)—It tests technological

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or economic efficiency of devices or appliances in order to compare technologies adopted by rural households. It measures not only the data of energy demand, consumption, and expenditure but also emissions of hazardous pollutants, which cause indoor pollution. Although it contains highly disaggregated or highly precise data, policy implication to promote these technologies is not sufficiently discussed based on the results.

- Analytical study (Bailis et al., 2005; Biswas et al., 2001; Howells et al., 2005; Mathur et al., 2003; Pachauri et al., 2004; Parikh and Ramanathan, 1999)—It analyzes energy demand or consumption structure of a developing country, and applies an analytical tool to energy demand and supply structure at village, regional, and national level, taking into account economic and technological parameters. It contains model analysis, which is divided into top-down and bottom-up modeling approaches. Moreover, it can incorporate emissions associated with energy consumption such as greenhouse gas emissions and government policies, for example, environmental tax.

There are a large number of literatures for the descriptive and experimental studies. In contrast, there are a limited number of researches categorized as the analytical study. In particular, few researches estimate socio-economic effects of results of analyses. Given that nowadays poverty is regarded as a lack of socio-economic welfare, it is unavoidable to consider socio-economic impacts of transition or improvement of energy sources consumed in developing countries. With respect to this point, the model analysis with a bottom-up modeling approach, in combination with the estimation of socio-economic aspects, has a

potential to reveal the links between energy access improvement and poverty eradication as shown in the previous work of the authors (Kanagawa and Nakata, 2007). Therefore, we have developed an energy-economic model with bottom-up modeling approach and applied it to rural areas of developing countries in order to clarify the possibility of energy access improvement. Furthermore, socio-economic impacts are incorporated into the analysis.

2. Energy and poverty

2.1. Energy and Human Development Index (HDI)

Energy influences socio-economic condition of developing countries as shown in Fig. 1. In particular, access to modern energy like electricity will drastically improve the quality of life of those who do not have yet. There has also been increasing attention on poverty reduction through energy access improvement among international organizations in the energy field. For example, recently the International Energy Agency (IEA) has been focusing on the topic through the improvement of energy demand and supply situations in developing countries, devoting a chapter to explain the roles of energy for the development in its World Energy Outlook 2002 (IEA, 2002). It mentions that some 2.4 billion people depend on traditional biomass such as wood, agricultural residues, and dung for their cooking and heating demand and that there is one fourth of the world's population, about 1.6 billion people, who does not have access to electricity. Furthermore, most of them are in rural areas. It is estimated that 2.6 billion people will not improve their energy situation for cooking and heating and 1.4 billion people will not have electricity access by 2030. The lack of energy access also causes

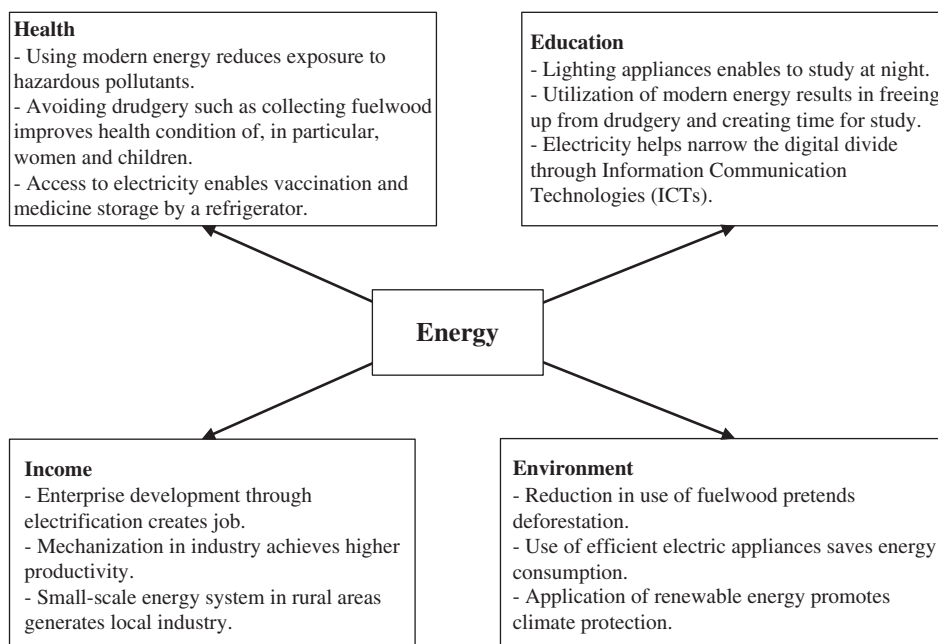


Fig. 1. Links between energy and other components of poverty.

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