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BIOMASS GASIFER ELECTRICITY AND STUDY OF WILLINGNESS TO PAY

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ABSTRACT
Electricity form grid to rural consumers has not been available all the time. Throughout the day outages is a very common circumstance. Due to the dispersal of villages, the State Electricity Boards (SEBSs) have not been able to collect their dues in time. Besides, the rampant power theft is also been responsible for poor quality of power and outages. Thus, the SEBs has preferred to keep their infrastructures unutilized and paid little attention for its development. Recently, the Government of India has engaged "last mile service providers" in villages through franchisee system for the collection of revenue and also for providing electricity throughout the day. As it is still on an experimental stage and only concentrated to few villages, therefore the only alternative to villagers is to take the help of standalone off- grid devices. Amongst the standalone off-grid devices, the biomass gasification is the major source of electricity to the villagers. But, per unit cost of production of electricity is always been higher than grid electricity. Keeping the higher price in mind, would it be relevant for the villagers to know the higher amount required to be paid by them. To arrive at this additional higher amount Willingness To Pay method (WTP) is used for biomass gasification system. The biomass based power generation system has been functioning for over 8 years (1999–2007) in Baharbari village of Araria district, Bihar in India which consists of a population of 2500 people. Electricity from gasifier has been used for lighting household, pumping for irrigation, and also connected with few micro-enterprise and occasionally it is used in some marriage party.

Keywords: Biomass gasification; Electricity; Rural consumers; Willingness to pay.

1. INTRODUCTION

Micro-economic theory has fallen short in providing a possible framework within which estimation could be made in electricity. So far empirical studies on the demand of electricity have generally tend to assume that the demand for electricity has no satiation point. Electricity demand model have assumed constant price electricity (Talylor, 1975; Westley, 1989), which had implied an infinite demand at a low price. Many demand models also have not allowed for the possibility of goods at zero prices, because the price variable is in the logarithmic form for which zero has been undefined. As it has shown that the double logarithmic function is not consistent with consumer theory because it has violated the adding up condition (Deaton and Muellbauer, 1980). It also implies an infinite demand at low prices. It is an intuitive notion, that even at a zero price, the demand of some goods can be finite. Many single equation and demand system models has also not allowed the possibility of goods at zero price because the price variable has been in logarithmic form for which zero has been undefined. The examples of these models has been Stone's (1954) double logarithmic demand model; Theil's (1965) and Barten's (1966) Rotterdam model; translog model of Christensen, Jorgenson and Lau (1975) and the almost ideal demand system of Deaton and Mellbauer (1980b). Nan and Murry (1992) have developed a demand model that has overcome some of the theoretical shortcomings of the double logarithmic functional form identified by Deaton and Muellbauer (1980a). But it had still employed the logarithmic price term. Although use of a logarithmic price variable in econometric studies of electricity demand has little justification. Recent studies for example by Hass and Schipper (1998) and Beenstock et al. (1999) had demonstrated the continuing popularity and use of this variable. Several empirical studies have reflected that the electricity is just a good, consumed by domestic households. Strictly speaking this is correct as electricity has been consumed by consumers. But the demand for electricity has been a derived demand which has been essentially an input into the production of services for stock electricity to consuming equipment in the household. More over electricity can neither be consumed on its own nor can be stored in and economical way. Therefore there has been no reason to assume that electricity enters directly into a household's utility function, rather it enters indirectly through the user cost associated with services produced by the electricity to consuming equipment. Thus demand for electricity function cannot be derived using the normal constrained utility maximization procedure. Verbet (2007) has used contingent evaluation method (CVM). The method had involved in asking direct questions to individuals how much they are willing to pay for some goods or services, using hypothetical questions. Mac N. et al. (2011) in their study have estimated WTP for undergrounding electricity and telecommunication cables, Benefit accrued from undergrounding telephone cable has been valued by using stated preference data collected from an online survey. The respondents' choice has been modeled with a standard binary logit model based on random utility theory, Utility has been divided by a respondent from an alternative has been a function of the attributes of the alternative, choice invariant character and a random element. In a given choice task respondents are assumed to choose the alternative the yields the highest utility. Farhar et al. (1999) had analyzed the national poll that reported 57% and 80% samples have been willing to pay more for electricity produced in a cleaner way or from sources less harmful to the environment.

The main criticism of CVM has been the hypothetical questioning, as it relies on responses obtained from electricity users where the cost of the equipment providing alternative power supply in absence of electricity either in case of power cuts or as an alternative sources of electricity. Thus in this paper an attempt has been made to arrive at the willingness to pay by using biomass gasifier. A demand models seldom apply a Willingness to Pay as because sufficient amount of data is not available in developing countries. The standard approach of the model is to calculate a consumer surplus (CS) on the basis of linear electricity demand function. Where, the model defines a Willingness to Pay as consumer surplus and revenue equaling to the gross economic benefit. In respect of all the limitations as stated above, the demand for electricity function can be estimated economically, if sufficient data is available or it have to be carried by means of survey. The econometric approach requires at least 20 years of time data on the electricity sales. The marginal price of electricity solely depends upon an economic data such as income, the price of alternate fuels like kerosene, gas and wood, weather and demographic data. But sufficient data is not available either on the time series basis or on the regular point basis. Further, an identification problem exists as the supply of electricity data has been in time series. It may not also be possible to relate the resultant parameters of the econometric analysis for a relatively large groups existing consumers, say at the country level, to the consumers group therefore, the econometric approach has been appraisingly used for estimating the demand of electricity. A village survey may find household without access to electricity has been using kerosene while those having access to electricity use electricity for running of fans, radio; television sets etc. other form of energy consumption for example use of gas for cooking may remain in both the type of villages. The amount of kerosene displaced by electricity lighting has been a resource cost saving to the economy and the economic benefit should have been valued accordingly. Normally more electric light is used than equivalent kerosene form, the excess electricity consumption along with that used for other purpose has been the increase material consumption induced by electricity's lower price and other positive externalities and has been valued in terms of Willingness To Pay. The price paid for lighting has been an indicator of Willingness to Pay for the quality of power used for lighting.

2. ESTIMATION OF WILINESS TO PAY AND ABILITY TO PAY FOR ELECTRICITY

Frequent interruptions in the power supply have resulted in the widespread use of stand-by equipments and /or rescheduling of production to minimize the impact of anticipated outages. Therefore, it has been argued that the main outage cost has to be reflected in use of back-up power generation. So consumers' Willingness To Pay could be determined by use of data on cost of back-up power that, consumers have incurred to ensure a reliable power supply. This cost should include the cost of investing in generators or other captive power units from renewable energy, costs of diesel pumps to meet their fuel requirements when supplies from grid-based supply system has been interrupted. The measure of the Willingness To Pay for electricity therefore can be taken to be the difference between the cost of captive power generation using alternative energy sources (mainly diesel or renewable) by large low tension (LT) and high tension (HT) consumers and the tariffs set forth by the State Electricity Boards (SEBs) for these different category of consumers. For example, in case of agricultural consumers it has been the difference between the cost of running diesel pump-sets and the cost of electric pump-sets at SEB tariffs.

3. METHODOLOGY

3.1 The model

Mathematically, the following equations could be used for estimating the willingness to pay or part of different categories of consumers:

$$W_i(year) = \frac{C_i(year) \times CRF + F_i(year) + M_i(year)}{U_i} - T_i(year) \quad (1)$$

$$CRF = \frac{r}{1-(1+R)^{-n}} \quad (2)$$

Where:

W =Willingness to Pay for electricity at a price for a given year which has been expressed in Rs/kWh;
C = The real capital cost (including installation charges) at a price for a given year expressed in Rs;
CRF = Capital Recovery Factor (interest and depreciation);
F = Annual fuel cost for a given year's price expressed in Rs;
M = Annual maintenance cost for a given year expressed in Rs;
U = Annual electricity consumed by the captive unit expressed in kWh;
T = Electricity tariff for a given year expressed in Rs/kWh;
i = The activities like captive generation or pumping;
r = The annual rate of interest at prevailing financial institution's rate;
n = Anticipated life of the device expressed in years.

3.2 Limitation of the model

The following may be the limitations of the model:

i) Consumers who have not installed back-up power. The information they like to provide the value to place for supply of reliable power supplies which has been likely to be less than the cost of the back-up supplies. Willingness to Pay by this category of consumers is ikely to exceed the existing tariff which may not be reflected in the methodology.

ii) For consumers who have installed back-up supplies, the methodology only tells that their Willingness to Pay has been at least equal to the cost of back-up power. But chances have been there that Willingness to Pay may exceed the existing tariff level. Thus the proposed methodology may give little, if any, information actual willingness to pay and how much higher it may go.

4. RESULTS AND DISCUSSION

The following are the data for the equation (1) and (2) which is being provided in Table 1.

Table 1: Data for willingness to pay (WTP)

Sl. No.	Explanatory variables	Units	Amount
1.	C (Real capital cost including installation charge at a price for a given year	INR (Lakhs)	28.35
2.	CRF Capital Recovery Factor [interest and depreciation]	Percentage	25
3.	F (Annual fuel cost for a given year's price	INR (Lakhs) assuming the plant would run 16 hours per day	22,704
4.	M (Annual maintenance cost for a given year)	INR (Lakhs)	2.83
5.	U (Annual electricity consumed by the captive unit)	kWh/year	2100
6.	T (Electricity tariff for a given year)	INR/kWh	4.60
7.	i (The activities like captive generation or pumping)		Generation
8.	r(The annual rate of interest at prevailing financial institution's rate)	Per cent	12
9.	n (Anticipated life of the device expressed in years)	No. of years	10

INR= Indian National Rupee
Total power generation = 50 kWh of which 7 kWh is internally consumed

Table 2 (WTP) for households with and without subsidy

l. No.	Willingness to Pay (WTP)	INR/Kwh
1.	Without subsidy	4.69
2.	With subsidy	2.77

5. CONCLUSIONS

It has been evident from the above that the households has Willingness to Pay (WTP) more by INR 4.69 and 2.77 per kWh respectively with and without provision of subsidy. This means that the total amount the village households could pay for every kWh of power has been INR 9.29 and 7.37 per kWh with and without subsidy respectively as they have not got uninterrupted power supply for the entire day. Interruptions in power supply cannot be always be attributed to grid failure but it may also happen due to rampant power thefts in the villages by means of hooking. In India it has been estimated that of the total power provided by the entity (herein the SEBs) at least 20 per cent of it has been stolen away by hooking.

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