

# An Analysis of Factors Affecting Energy Consumption in Urban Odisha

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## ABSTRACT

Energy consumption in the household sector is affected by many factors like income, family size, gender, education and type of occupation of the households. The aim of this study was to analyse these factors and suggest measures for the efficient use of energy in the household sector. For this data had been collected from a sample of 100 households, from the urban municipal area of Bhubaneswar, the capital of the state Odisha. The households were divided into three income groups on the basis of their monthly earning. Correlation was used to find out the relationship among income, family size and energy consumption. The study found a positive relation between income, family size and energy consumption.

**Key words:** Household energy consumption, Income, family size, age, gender.

## INTRODUCTION

Economic development of a country in the present situation is impossible without energy. Out of the total availability of energy in the World, energy consumed by the agricultural sector is 6.17%, industrial sector is 45.35%, and household sector is 13.79 % (TERI, 2012). Among all the sectors, household sector occupies a greater position in the total energy consumption as with the process of urbanization and industrialization, in the household sector there is a continuous increase in energy consumption as everybody wants to live their lives with all comfort which is impossible without energy. [1-3] But, supply of energy falls short of this increase in demand, resulting in a huge gap between demand for and supply of energy consumption globally. [3] Energy consumption in the household sector basically implies consumption of electricity for the purpose of lighting, cooling, study

and entertainment, consumption of fuel in the form of use of LPG and kerosene for cooking and water heating and consumption of oil for running of vehicles. [4] But there is a greater deviation in the energy consumption in this sector as the consumer of energy is the individual households. [5,6] The type and amount of energy consumed by them differs from one individual household to the other depending on various factors like the amount of income earned by them per month, their family size, age and level of education, space of the house. So, the household sector needs more attention towards efficient use of energy, as this is the sector where most of the energy can be saved by the households, if they use it cautiously for their day to day activities. Therefore, a proper understanding and analysis of household factors which are the major contributor to increased energy consumption is very important.

Since energy plays an important role in the sustainable development of country proper steps should be taken by the government through implementation of proper policies for ensuring efficient use to overcome the future possibility of scarcity of energy. [7] But, unless and until there is proper awareness among the households regarding efficient use of energy no government policy can be fruitful in reducing energy consumption as a whole. For this the households should be encouraged towards use of various energy saving electrical appliances which uses less energy for the same purpose, so that more amount of energy can be saved which will further help in reducing the energy gap to make required amount of energy available for the future generation. [8] So the aim of this research is to find out various ways of efficient use of energy in the household sector by analysing the effect of the household factors like income, age, gender, education and family size of the households on energy consumption.

#### **Objective**

1. Know the determining factors of energy consumption in the household sector.
2. Finding out energy saving outlets.

#### **Hypothesis**

1. Income, family size has a positive relationship with energy consumption.
2. Female members are more conscious towards energy consumption than male members of the households.

#### **Review of Literature**

Donovan and Fisher (1976) made a study on factors affecting residential heating energy consumption and found that household energy consumption is affected by factors like income, family size, number of bedrooms in the house, temperature of the environment and insulation. [9,10] Annual review of energy shows that income, age and life-style of the households, area of the house and the type of electrical appliances used by the households are the factors that

affect energy consumption in the residential sector (Schipper et al, 1989). [11,12] Studying on direct and indirect energy requirement of Dutch households, Vringer and Blok (1995) found that income of the households is the major factor that affects energy consumption. [13,14] Energy consumption in the household sector of Uttar Kannada District in the form of fuel wood is affected by deviation in region and season (Ramachandra et al, 2000). [15] Andrade (2001) found that energy consumption in the household sector is affected by family size and age of the family members of the households. Income, family size and the hours of time of staying in the home of the households are the significant factor that affects household energy consumption (Lucas et al, 2001). [16,17] Age, family size, income of the households and urbanization are the household factors that affect energy consumption (Dey et al, 2003). [18] In India family size and age of the households has a significant impact on energy consumption (Pachauri, 2004). [19] Weather and use of electrical appliances as per the weather are the factors influencing energy consumption in the household sector (Wan and Yik, 2004). [20] Cohen et al (2005) found that expenditure on energy consumption depends on income of the households. [21] A study in Australia shows that type of house and age of the households are the factors that significantly affect energy consumption (Lenzen et al, 2006). [22] Santamouris et al (2007) found that family size, area of the house and type of electrical appliances used by the households are the factors which affect energy consumption. Electricity consumption in the residential sector is affected by temperature and amount of rainfall and number of rooms in the house (Wangpattarapong et al, 2008). [23] Income and level of education of the households, price and degree of accessibility of energy are the significant factors that affect energy consumption in India and China (Pachauri and Jiang 2008). [24] Climate is a considerable factor affecting energy consumption in the household sectors of

Hong Kong (Lee et al, 2009).<sup>[25]</sup> Another study in Hong Kong shows that in the residential sector climate and family size are the factors that affect energy consumption (Chung et al 2011).<sup>[26]</sup> Energy consumption is affected by the amount of income, age and family size of the households (Yun and Steemer, 2011).<sup>[27]</sup> Area of the house, number of bedrooms, electrical appliances, social class and age of the head of the households are the major household factors that affect energy consumption (McLoughlin, 2012).<sup>[28]</sup> Energy consumption in the household sectors of Netherland is considerably influenced by family size, type of house, floor area of the house and hours of using electrical appliances (Bedir et al, 2013).<sup>[29]</sup> Factors like level of education and family size of the households affect energy consumption for the purpose of cooking (Ogwumike et al, 2014).<sup>[30,31]</sup>

## MATERIALS AND METHODS

The data is collected from a sample of 100 households selected randomly from a municipal area of urban Bhubaneswar. The population of the city is 8,43,402, of which 52.9% are male and 47.09% are female. The literacy rate of the city is 82.96% of which 45.44% female and 54.55% male are literate (Census 2011). The data are collected through schedule directly from the respondents through personal interview. The information required for the study collected about the monthly income of the family, number of members in the family, age, gender, education and type of occupation of the households, amount of total monthly expenditure and monthly expenditure on energy consumption in terms of type and hours of electrical appliances used, type and

amount of fuel (LPG, Kerosene) used per month and amount of oil used per month (in terms of litres) for running of vehicles. Data analysis is done by SPSS 21.0. Correlation is used to know the relationship between income and family size with energy consumption.<sup>[32,33]</sup>

To achieve the above objectives, the paper has been divided into 2 sections out of which the first section discusses the role of household income, family size, age and gender in energy consumption and the second section analyses various measures to save energy in the household sector.

### Role of Household Income, Family Size, Age and Gender in Energy Consumption in Study Area

There are many factors in the household sectors like income, family size, age and gender of the members of the household which affect energy consumption.<sup>[34]</sup> This section discusses about the effect of these factors on energy consumption on the basis of data collected from the study area.<sup>[35]</sup>

### Effect of Income on Energy Consumption

To know the effect of income on energy consumption, there should be analysis of monthly expenditure on energy consumption by the households of the study area. For this, the households have been divided into three income groups as per their monthly income i.e. low income group (<Rs.15,000), middle income group (Rs.15,001-Rs.40,000) and high income group (>Rs.40,000).<sup>[35]</sup> Table 1 shows the amount of monthly expenditure on energy (i.e. on power, fuel and oil) by the households out of their total monthly income.

Table 1: Average monthly expenditure on energy consumption

Income group	Avg. monthly expenditure on HHEC (in Rs.) per family	Avg. monthly expenditure on power consumption (in Rs.) per family	Avg. monthly expenditure on fuel consumption (in Rs.) per family	Avg. monthly expenditure on oil used in vehicle (in Rs.)
LYG	1523.33	754.31	338.47	430.55
MYG	2844.3	1517.54	362.13	964.63
HYG	7296.82	4883.5	394.81	2,018.51
<b>Total</b>	<b>11,664.45</b>	<b>7,155.35</b>	<b>1,095.41</b>	<b>3,413.69</b>

Source: Primary data

(LYG - Lower income group, MYG - Middle income group, HYG - High income group, HH - Households, EC - Energy consumption, Avg. - Average)

It is observed from the above that average monthly expenditure on households energy consumption is Rs. 11664.45 out of which LYG spend Rs. 1523.33 and MYG spend Rs. 2844.3 and HYG spend 7296.82 on an average. So, this implies that average monthly expenditure on household energy consumption by the HYG is the highest, as their monthly income is more than the other two income groups.

Further the table shows us that LYG group spends Rs. 754.31 on electricity, Rs. 338.47 on fuel and Rs. 430.55 on oil used in vehicle. Whereas MYG spends Rs. 1517.54 on electricity, Rs. 362.13 on fuel and Rs. 946.63 on oil from a total of Rs. 2844.3 on an average per family as compared to that of spending of Rs. 4883.5 on electricity, Rs. 394.81 on fuel and Rs. 2,018.51 on oil (average per month) by the HYG. Thus the HYG spends more than both the MYG and LYG on each type of households energy consumption (i.e. power, fuel, oil). So, this shows that the higher the level of income, higher is the amount of spending on energy consumption.

The data given in the table revealed that out of a total monthly households expenditure of Rs. 11,664.45 on energy consumption, expenditure on power is Rs. 7155.35 which is the highest among oil consumption of Rs. 3,413.69 and fuel

consumption of Rs. 1,095.41 of. This is shown in the diagram 1 below.

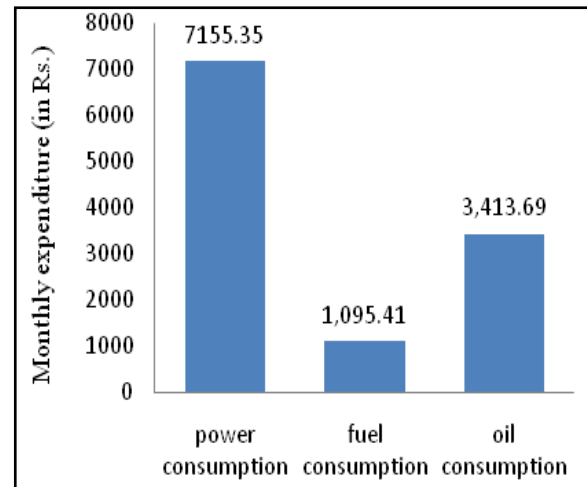


Figure 1: Total avg. monthly expenditure on electricity, fuel and oil per family (in Rs.)

The bar representing the expenditure on power consumption is the highest than that of the bar representing fuel and oil consumption.

### Effect of Family size on Energy Consumption

Family size plays an important role in affecting energy consumption. For this the households have been divided into two groups, i.e. one is families having three members and another is families having more than 3 members. The table 2 shows the effect of family size on energy consumption.

Table 2: Effect of family size on energy consumption

Income group	No. HHs having family members <=3(in percentage)	No. HHs having family members >3(in percentage)	Monthly expenditure on energy consumption (HHs having family members <=3 in avg.)	Monthly expenditure on energy consumption (HHs having family members >3 in avg.)
LYG	44.44	55.56	627.5	686.75
MYG	25.45	74.55	1468.393	1544.70
HYG	14.82	85.18	3079.375	5219
Total	-	-	-	-

Source - Primary data

It can be seen from the above that households having more family members consumes more energy among all the three income groups than that of households having less family members. Monthly average spending on energy by the households having less than three family members is Rs. 3079.375 which is less than that of Rs. 5219 by the families having more

than three members. This shows higher the family size, higher the energy consumption.

### Effect of Age of the Households on Energy Consumption

Age of the households is one of the important factors affecting energy consumption. So, energy consumption of the households having less old persons and children varies from that of households



having more children and old persons. This is shown in the table in the next page.

Table 3: Amount of energy consumed on the basis of age of the households

Income group	Monthly expenditure on HHEC(in Rs. in avg.)		Monthly expenditure on HHEC(in percentage)	
	Monthly expenditure on HHs having more children and old person	Monthly expenditure of HHs having less children and old person	Monthly expenditure on HHs having more children and old person (in percentage)	Monthly expenditure of HHs having less children and old person (in percentage)
LYG	8,982.5	4,790	35.54	18.95
MYG	40,482.9	41,772	49.22	48.34
HYG	58,505	25,199.5	69.89	30.11
<b>Total</b>	<b>1,07,977</b>	<b>71,761.5</b>	<b>154.65</b>	<b>97.40</b>

Source: Primary data

It shows that monthly expenditure on energy consumption of families with more children and old persons is 1,07,977 which is more than that of families having less children and old people as their expenditure on energy consumption is Rs. 71,761.5. In terms of per cent age also, monthly expenditure on energy consumption of households having more children and old persons is 154.65% which is higher than that of 97.4% of households having less children and old persons. This can be further seen through the diagram 2 shown below.

The bar representing percentage of monthly expenditure on energy consumption of households having more children and old persons is higher as compared to the bar representing that of households with less children and old person. So, the study finds that families having more children and old persons consume more energy than that of families with less children.

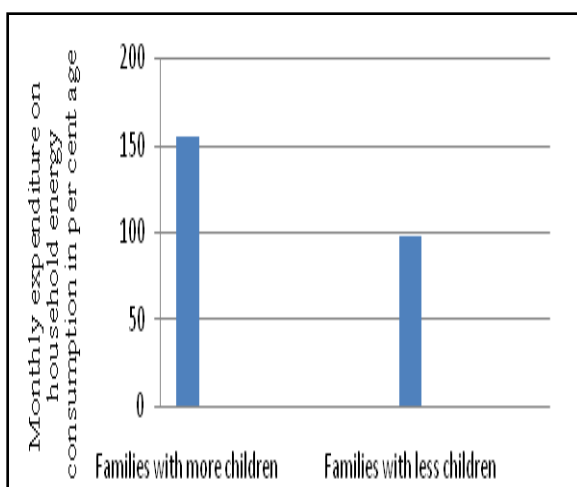


Figure 2: Monthly expenditure on household energy consumption (in per cent age)

### Effect of Gender on Energy Consumption

Consumption of energy also varies on the basis of gender of the households, which is shown in the table 4 below.

The consumption of energy by male member is 174.78% which is higher than that of 125.22% of energy consumed by female members. This is shown in the diagram 3 below.

Table 4: Percentage of energy used by male and female members of each income group

Income group	Percentage of male and female members using energy	
	M	F
LYG	50	50
MYG	61.82	38.18
HYG	62.96	37.04
<b>Total</b>	<b>174.78</b>	<b>125.22</b>

Source: Primary data

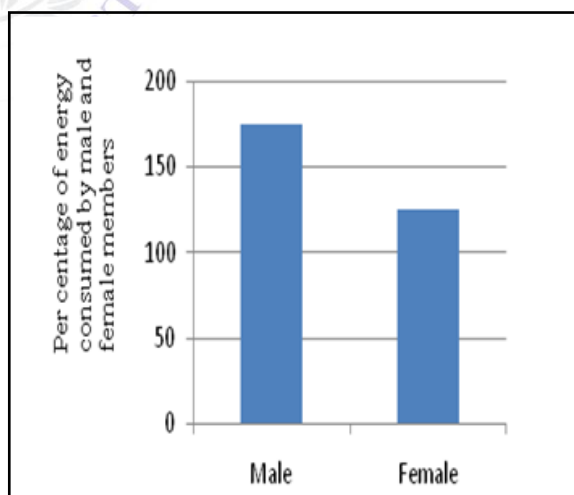


Figure 3: Per cent age of energy consumed by male and female members

The bar representing male members in the diagram is higher than the bar representing female members consuming energy. So, the diagram clearly indicates that male members consume more energy than female members.

As availability of energy in the present time is less as compared to its demand, households need to be more conscious towards energy saving. So, the effect of gender on consciousness towards energy consumption is shown in the table 5 shown below.

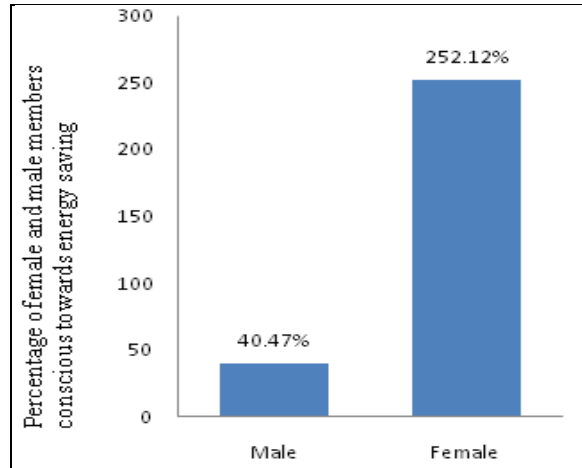
**Table 5: Consciousness of male and female members towards energy saving**

Income group	No. of male and female conscious towards energy saving(in percentage)	
	M	F
LYG	22.22	77.78
MYG	14.55	85.45
HYG	11.11	88.99
<b>Total</b>	<b>47.88</b>	<b>252.22</b>

Source: Primary data

It can be seen that 252.22% of female members are conscious towards energy saving which is more than that of 47.88% of male members. Thus the table reveals that female members are more conscious towards energy saving than that of male members. This is further shown in the diagram 4 below.

The diagram shows that female are more conscious towards energy saving than the male members.



**Figure 4: Percentage of male and female members' conscious towards energy saving**

**Statistical Method:** correlation is used to find out:

- (i) Relationship between income and monthly household expenditure on energy consumption.
- (ii) The relationship between family size and monthly household expenditure on energy consumption.

## RESULT AND DISCUSSION

The correlation between income and monthly expenditure on energy consumption is shown in the table 6 below.

**Table 6: Correlation between income and monthly household expenditure on energy consumption (HHEEC)**

		HHEEC	Income of the households per month
HHEEC	Pearson Correlation	1	0.828**
	Sig. (2-tailed)		0.000
	N	100	100
Income of the households per month	Pearson Correlation	0.828**	1
	Sig. (2-tailed)	0.000	
	N	100	100

**\*\*Correlation is significant at the 0.01 level**

Source: Computation of Pearson Correlation [36,37] has been done through SPSS 21.0 Software

The correlation between monthly expenditure on energy consumption and income was positive and significant ( $r = 0.828$ ), implying that household expenditure on energy consumption increased with increase in income. Thus the table showed that households of high income group consume more energy than that of middle

and low income group per month as their income was more as compared to other two income groups.

To see the relationship between family size and monthly expenditure on energy consumption correlation analysis has been used which is shown in the table 7 below.

**Table 7: Correlation between family size and monthly expenditure on energy consumption**

		HHEEC	Family Members Per Household
HHEEC	Pearson Correlation	1	0.305**
	Sig. (2-tailed)		0.002
	N	100	100
Family Members Per Household	Pearson Correlation	0.305**	1
	Sig. (2-tailed)	0.002	
	N	100	100

**\*\* Correlation is significant at the 0.01 level**

Source: Computation of Pearson Correlation has been done through SPSS 21.0 Software

The correlation between family size and household energy consumption per month was positive and significant, which implied that monthly expenditure on energy consumption increased with increase in family size of the households. Thus the table revealed that households having more family members consume more energy per month than that of households having less family members.

## MEASURES TO SAVE ENERGY

As household sector plays an important role in raising demand for energy, steps should be taken care of for saving energy by the households for the future generation for which efficient use of energy is the only way. [38]

There are many ways to save energy in the household sector, some of which are discussed below.

### (i) Insulation of the House

Households can save energy by insulating their house. This will not only save energy but also reduce the energy bills of the households which further reduce household expenditure. [39-41]

### (ii) Heating of Water

Consumption of fuel (use of LPG, kerosene) for heating of water can be saved by using various energy efficient heating systems which use less energy. [39,41]

### (iii) Household Appliances

Energy consumption (Electricity or fuel consumption) can be reduced by using best energy star rated appliances that use less energy and also reduce expenditure of the households on energy. [39-41]

### (iv) Use of Compact Fluorescent Bulbs (CFLs)

Ample amount of energy can be saved through use of CFL bulbs for lighting purposes by the households. [39-41]

### (v) Household Practices

To reduce energy use in the house, the households should take care of following steps: [39-42]

- They should switch off the lights and household appliances when they are not in use.

- Doors and windows should be closed while using the air conditioner (AC).
- The households should paint their house with light colour paint as it reflects the heat of the Sun.
- The households should plant trees around their house which will help to reduce the heat of the air.
- Temperature of the refrigerator should be set between 30<sup>o</sup> to 42<sup>o</sup> F.
- The clothes should be washed with cold waters.
- Water heater temperature should be set at 120<sup>o</sup> while heating the water.
- Households should purchase laptops than computers as it consume less energy than the computers.
- The chargers should be unplugged when the battery will be fully charged and when the chargers are not used for charging any appliances.

## CONCLUSION

The study is an analysis of the various household factors that affect energy consumption. The co-correlation result revealed that there is a significant relationship between income and energy consumption. This implies that energy consumption is more among highest income group than that of middle and low income group as they are using more electrical appliances and for longer hours because of their higher income. The correlation analysis between family size of the households and energy consumption reveals that those households having more family members consume more energy than that of households having less family members. It is further found that a household having more elderly persons and children consume more energy which implies age is also another significant factor that affects energy consumption. The paper also discusses about efficient use of energy in the household sector. It finds that insulation of the house, energy efficient heating systems, energy star rated household appliances, CFL

bulbs and household practices are the various instruments through which more amount of energy can be saved in the household sector. Thus it is the mutual responsibility of the state as well as the individual households to achieve energy efficiency so that ample amount of energy will be available in the future.

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