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AN ATTEMPT TOWARDS ESTIMATION OF ENERGY CONSUMPTION IN THE HOUSEHOLD SECTOR OF KASHMIR VALLEY

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ABSTRACT

This paper presents some insight into the household energy consumption for major end uses in Kashmir valley. The major energy consuming end uses in the household sector are space heating, water heating, cooking and lighting. For estimating the energy consumption, a typical four room household of Kashmir valley comprising of six members has been considered. The results have been presented for the months of January and July (typical winter and summer months respectively). It is observed that during winter season, people prefer to heat only a single room. The space heating energy requirements have been estimated for heating a single room to a comfortable temperature of 18.3 ^{0}C. Water heating is one of the major thermal energy consuming end uses in the valley. It is reported that there are about 270 days annually during which provision of hot water is essential. On an average an individual requires 45 litters of hot water daily during cold months. In summer months hot water load is small. For lighting purposes incandescent lamps are widely used, however the households having consumption based tariff try to replace these inefficient incandescent lamps by more efficient compact fluorescent lamps. Lighting energy consumption has been estimated using two 100 W lamps per room and six hours of daily operation. The cooking energy consumption has been estimated using the normative value of 2.14 MJ/ person/ day as suggested by Advisory board of energy. The calculation shows that a large amount of energy is consumed for household activities in the winter season.

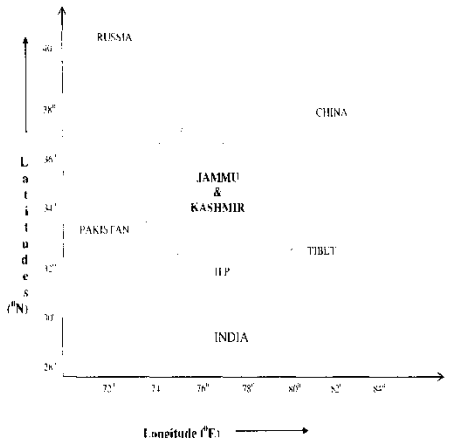
Keywords: Space Heating, Water Heating, Cooking, Lighting, Energy consumption.

INTRODUCTION

The Jammu and Kashmir state constitutes the northern most extremity of India. It comprises of three major regions which include Jammu, Kashmir and Ladakh. The state is situated between 32° 17′ N to 37° 06′N latitudes and 73°26′E and 80° 30′ E longitudes (Hussain, 2002). The site location map of Jammu and Kashmir state is shown in fig. 1. The state has three distinct climatic regions viz. Semi arctic desert areas of Ladakh, temperate Kashmir valley and sub tropical region of Jammu (Khan *et al.*, 2001). Based on various climatic variables e.g. temperature, relative humidity, precipitation, solar radiation etc, the Kashmir division of the state is classified as the cold and cloudy zone of India (Bansal and Minke, 1988). In summer the maximum of ambient temperature is in the range of 20 to 30 ^{0}C during the day and 17 to 27 ^{0}C in the night. In winters the values range between 4 to 8 ^{0}C during the day and -3 to 4 ^{0}C in the night. The relative humidity is generally high and ranges from 70 to 80 %. Annual total precipitation is about 1000 mm and is distributed evenly throughout the year. In Kashmir valley, the total number of households occupied for residential purposes are about five lakhs (GJK, 2003-04).

The urban and rural population constitute 40.3% and 59.9 % respectively.

In Kashmir valley substantial amount of energy is required for different household end uses. The major energy consuming end uses are space heating, water heating, lighting and cooking. Being a cold climatic region, the heating season starts in the month of October and ends in April.



Longitudes = 73° 26' E to 80° 30' E
Latitudes = 32° 17' N to 37° 06' N

Fig. 1. Site Location map of Jammu and Kashmir

There are about 210 days annually during which space heating is used in the valley. Water heating is one of the major energy consuming end uses in the valley particularly during winter months. There are about 270 days annually during which provision of hot water is essential (Ganai, S. A, 2006). In Kashmir valley almost 95% of the villages were electrified by the end of 2005. The most widely used form of energy for lighting purposes is LPG and electricity. However the predominant source of lighting is electricity. The incandescent lamps of 100W with luminous efficacy of 12 lumen/Watt are more commonly used luminaires (Bhat and Rubab, 2007).

ENERGY CONSUMPTION ESTIMATION

For the estimation of energy consumption for major end uses, a typical household of Kashmir valley comprising of four rooms with six persons has been considered. The dwellings of floor area ~100 m^2 are more popular dwellings in the valley. The heat loss from a small family residence in Srinagar (floor area~100m^2) is about 602.7 W/^{0}C (Sharma, 1984). It is being observed that during the heating season people prefer to heat a single room in order to reduce their space heating load. The living room of dimensions 3.6m x 4.2m x 2.7m is suitable for a typical six member household. The typical characteristics of the room parameters are presented in Table. 1. In a steady state, the heat loss consists of six principal parts, heat loss through walls, ceiling, floor, doors, windows and an air infiltration. The total heat loss coefficient for the room is expressed as

$$H_{loss} = \Sigma UA+N\,(\rho C_p)_{air}\,V/3600$$
$$= \Sigma UA+NV/3 \qquad (1)$$

where U is the thermal transmittance, N is the number of air changes per hour, V is the volume of air and $(\rho Cp)air=1.2$ kJ/m^3 ^{0}C is the volumetric thermal capacity of air.

The monthly energy requirements for space heating is calculated as

$$E_{SH}\ (kWh) = 0.03\ N_h\ H_{loss}\ (T_i - T_o)$$
$$= 0.72\ H_{loss}\ (T_i - T_o) \qquad (2)$$

Where N_h is the number of hours in the day. The heat loss factor for the room is about 278.07 W/^{0}C.

Table 1. Heat Loss Factor for a typical room in Kashmir valley.

Description	Specification	Area (m^2)	U-factor (W/m^2 ^{0}C)	Heat loss factor (W/ ^{0}C)
Walls	1.25cm CPL* + 20cm Br* + 1.25cm CPL	36.80	3.57	131.39
Ceiling	5cm CPL+20cm RCC* + 1.25cm CPL	15.12	4.80	72.57
Windows	Single Glazed with 1mm glass panes	4.05	4.86	19.68
Doors	Wooden	1.89	3.76	7.10
Floor	Perimeter	15.6m	1.29 (W/ m^{0}C)	20.12
Ventilation	rate of 2 ach ~ Volume of air (40.82m^3)		_	27.21
Total heat loss coefficient (H_{loss})				278.07 (W/ ^{0}C)

* CPL – Cement Plaster Br - Brick RCC – Reinforced Cement Concrete ~ach Air Changes per hour

In order to keep space comfortable at 18.3 ^{0}C, the heating energy consumption for the month of January (when the mean outside temperature is 5^{0}C) is about 9.5 GJ. The buildings in Kashmir are constructed using construction materials and architectural design which does not suit the climatic conditions of the valley. There can be significant reduction in heating load by using proper selection of building materials e.g. mud straw plaster can be used instead of cement plaster, double glazing in windows instead of single one.

Due to prolonged winter, hot water is used almost throughout the year. Even in summer water temperature is quite low (5 to 15^{0}C). The various factors affecting the domestic hot water consumption are family size, the age of the family members and required

temperature at the point of use (Papakostas et. al, 1995). Presently water is heated through gas, kerosene, fuel wood and electricity. These water heating systems are highly inefficient owing to the lack of proper insulation and thermostat (Ganai, S. A, 2006). The monthly consumption of hot water for a typical six member household is shown in fig.2. From figure it is clear that hot water load is minimum in July to August. The useful energy consumption for water heating is estimated using

$$E_{WH}(J) = \rho V C (T_f - T_i) \quad (3)$$

Where ρ is the density of water (1kg/liter), Vis the volume of water required, C is the specific heat of water (4186 J/ kg ^{0}C), T_i and T_f are the supply temperature of water and the temperature at which hot water is delivered.

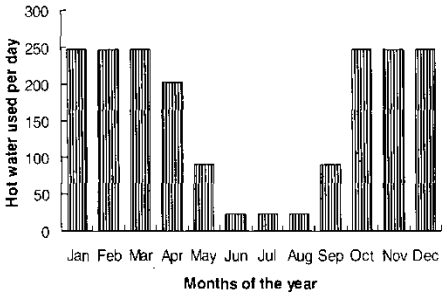


Fig. 2. Monthly hot water Load for a typical six member household in Kashmir

It is assumed that an individual requires 45 liters of water/ day in the month of January and 23 liters of water/ day in the month of July (Ganai, 2006). The supply temperature of water in January and July is 1^0C and 10^0C respectively. It is reported that for domestic activities water is required at the temperature of 40^0C (Gadgil, 1987). The energy consumption for cooking has been estimated by many researchers and agencies using different criterion and approaches (Sinha and Joshi, 1994). Their estimates vary in the range of 2-2.4 MJ/person/day. In this study the energy consumption for cooking has been estimated using the normative value of 2.14 MJ/ person/day recommended by the Advisory Board of Energy (ABE, 1985). The energy required for lighting is estimated using two 100W incandescent lamps per room in four rooms with five hours of daily operation. The summer remains for three months from June to August. Space cooling is not a major concern in the valley. For cooling purposes, electric fans are used in the urban areas. The energy required for cooling is estimated using 16 hours of daily operation of two fans.

RESULTS AND DISCUSSION

The energy consumption for various end uses in winter and summer month is shown in Table 2. The total energy consumption in the month of January is 11.55GJ and that in July is 1.08GJ. The energy consumption patterns in the month of January and July is shown in figures 3 and 4 respectively. The large energy consumption in winter is due to huge space heating demand in the valley. The calculation results show that space heating constitutes the largest portion of energy consumption (82%). The next major energy consuming endues is water heating (10.12%), followed by domestic lighting

(4.4%) and domestic cooking (3.2%). In summer conditions the energy consumption for space cooling is 15.7 %, for cooking is 35 % and that for lighting is 47 %. Least energy consumption is for water heating (2.0 %).

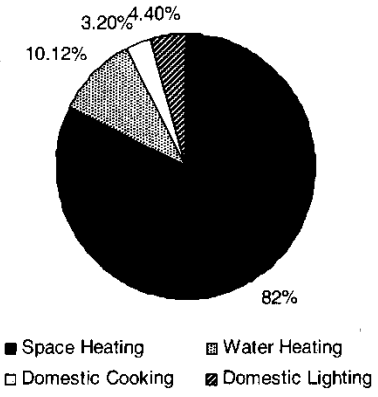


Fig. 3. Energy consumption pattern in January

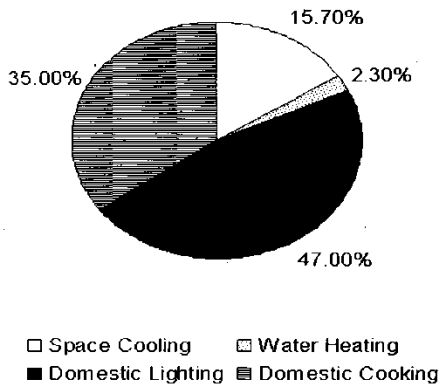


Fig. 4 Energy consumption pattern in July

Various steps which can be taken to reduce the energy consumption in the household sector are

1) Instead of Incandescent lamps, energy saving compact fluorescent lamps can be used
2) The building envelope (walls, floor, and ceiling) can be insulated to minimize the heat losses. Efforts need to be put forth to classify the better and cost effective insulating materials for building envelope.

Table 2. Estimated Energy consumption for major end uses in January and July (typical winter and summer months)

Winter Month (January)		Summer month (July)	
End-use	**Energy Consumption (GJ)**	**End-use**	**Energy Consumption (GJ)**
Space Heating	9.5	Space Cooling	0.17
Water Heating	1.17	Water Heating	0.02
Domestic Lighting	0.51	Domestic Lighting	0.51
Domestic Cooking	0.38	Domestic Cooking	0.38
Total Consumption	**11.56**	**Total Consumption**	**1.08**

3) The dwellings should incorporate the passive solar features to the extent possible.

4) Efforts should be made to improve the thermal efficiency of indigenous space heating and water heating systems.

5) Solar thermal devices like box type solar cookers, solar water heaters and solar photovoltaic lighting systems should be made available to the local populace at an affordable price.

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