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# Estimation of Domestic Energy Consumption and Carbon Emission in Mid Himalayan Region of Himachal Pradesh, India

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**Abstract**

The fuel consumption pattern in the study area indicated that the major fuels used were electricity (100%), wood (93.3%), crop residues (46%), kerosene (22.7%) and LPG (93.3%) whereas biogas and, coal were used in negligible quantities (0.67%), that too, in specific areas. Per capita household consumption of fuelwood, kerosene, LPG and electricity was found to be 60.66 kg, 0.49 liters, 1.41cylinders, 137.08 kWh respectively. Estimated annual $Co_2$ emission in rural areas of Solan block was worked to be 103.92 tonnes for kerosene; 282.14 tonnes for LPG; 7.79 tonnes for electricity and 7092.1 tonnes for fuelwood.

**Keywords:** Energy consumption, rural area, carbon emission

## Introduction

India faces a formidable challenge in providing adequate energy supplies to users at a reasonable cost. In the last six decades, India's energy use has increased by 16 times and the installed electricity capacity by 84 times.

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India's energy consumption has been increasing at a relatively fast rate due to population growth and economic development, even though the base rate may be low.

The per capita electricity consumption in India is just 566 KWh and is far below most of other countries or regions in the world. Even though 85% of villages are considered electrified, around 57% of the rural households and 12% of urban households, i.e. 84 million households in the country, do not have access to electricity. Electricity consumption in India is expected to rise to around 2,280 billion kWh by 2021-22 and around 4,500 billion kWh by 2031-32 (Garg, 2012).

The country, though rich in coal and abundantly endowed with renewable energy in the form of solar, wind, hydro and bio-energy, has very small hydrocarbon reserves (0.4% of the world's reserve). India, like many other developing countries, is a net importer of energy, more than 25 percent of primary energy needs being met through imports mainly in the form of crude oil and natural gas.

Per capita energy consumption in India is 3.7 times that of Japan, 1.55 times that of the United States, 1.47 times that of Asia and 1.5 times that of the world average. Thus, there is a huge scope for energy conservation in the country. India's demand for oil in 2015 is expected to be 41% higher than in 2007 and almost 150% higher in 2030.

India currently emits approximately 4% of global GHG emissions. However, its per capita emissions are only one-quarter of the global average and less than one-tenth of those of most developed nations. India has committed to reducing the emissions intensity of its economy to 20% – 25% below 2005 levels by 2020 and that per capita GHG emissions will not exceed those of industrialized nations.

The climate-focused instrument that is influencing deployment of renewable energy technologies in India is National Action Plan on Climate Change (NAPCC), which was released in June 2008 with the aim of promoting development goals while addressing GHG mitigation and climate change adaptation. NAPCC suggests that up to 15% of India's energy could come from renewable sources by 2020.

The total power from renewable energy in the country as on May 2013 is 28446.05 MW. About 4.655 million biogas plants have been installed in the country as on May 2013 and the solar water heating systems with 6.98 million $m^2$ of collector area have been installed in the country (Akshay Urja).

Himachal Pradesh is a hilly state of India having a geographical area of 55,673 km² with population of 6,856,509, comprising of 12 districts. The state is divided into four agro-climatic zones. Low hills (altitude up to 1,000 meters amsl); Mid hills: (altitude between 1,000 and 2,000 meters amsl); High hills: (altitude between 2,000 and 3,000 meters amsl,); Cold and dry zone: (altitude above 3,000 meters amsl). In Himachal Pradesh the contribution of fuel wood as a source of energy is not limited to rural energy systems only, but urban areas too account for a share of fuel wood consumption which contributes to the disruption of rural energy supplies. The important conventional fuel in the state is electricity which is presently available in abundance in the state at subsidized rates.

Since the energy demand is increasing continuously with the developmental growth in various sectors and population growth, the fossil fuel consumption is also increasing despite the fact that the Renewable Energy Technologies (RETs) have also been provided by the government on subsidized rates to meet out the energy demand of the rural masses. However, the fact is that the actual functioning of RETs was neither monitored nor the necessity of their subsequent upkeep and replacement was ever assessed. The energy demand and supply varies with change in climatic and geographical conditions due to which the fuel consumption pattern also changes which needs to be studied. Considering the above facts it was pertinent to conduct a study on energy consumption pattern in rural areas.

## Methodology

The Solan block of district Solan, Himachal Pradesh was purposely selected being one of the most developing areas for energy consumption. The sample size of 150 households was drawn from selected villages. Thereafter the farmers/respondents were classified on the basis of 3 categories, viz. caste, land holding and income. The primary data were collected on a well developed pre tested questionnaire.

The carbon emission from conventional fuels was calculated on the basis of emission factor which is for kerosene (3.149), LPG (2.983), wood (1.747) and electricity (0.00085) (Greenhouse protocol).

## Results and Discussion

The flowing are the salient results of the survey carried out in the study area:

The pattern of fuel consumption indicated that the major fuels used were fuel wood (93.3%), crop residue (46%), kerosene (22.7%), LPG (93.3%) and dung cakes (20 %). Biogas, sawdust and coal were used in negligible quantities (0.67%), that too, in specific areas (Fig. 1). Aggarwal (2009) carried out a study to identify the fuel consumption pattern in rural areas of the Himachal Pradesh. The study revealed that the present level of fuelwood consumption by households (95.2%), kerosene (38.4%), LPG (70%) and crop residues (94.5%).

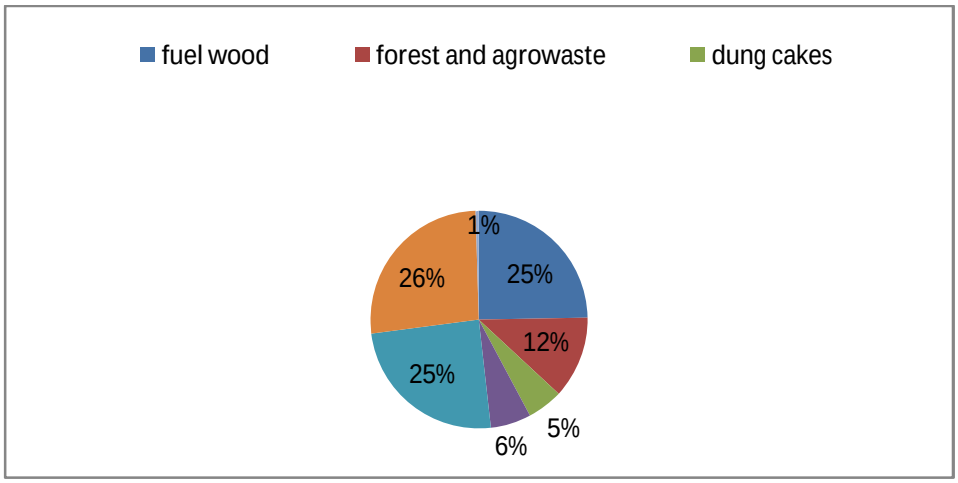


Fig. 1. Fuel consumption pattern in rural areas under study

Per capita household consumption of fuelwood, kerosene, LPG, electricity was found to be 60.66 kg, 0.49 litres, 1.41cylinders, and 137.08 kWh. The electricity was used by 100% households and being used mainly for lighting purpose in rural areas. The crop residues consisted of maize and wheat stalks and forest residues consisted of pine cones and needles and other wood, dried plant waste, bushes etc (Fig. 2).

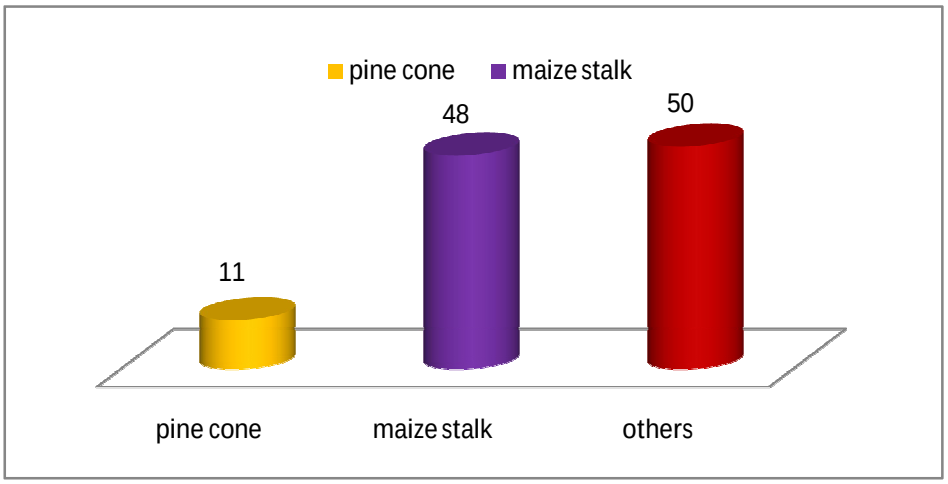


Fig. 2. Crop residues consumption in rural areas under study

Fuelwood was mostly collected by women along with children and men in some villages from the forests located 1to 5 km away from home and brought on head and back load. Most of the households (97.8%) took 1-3 hours to collect fuel wood in the areas under study. The households preferred wood (42.7%) and LPG (47.4%) as fuel in all income groups for cooking. Electricity was most preferred for lighting.

Level of awareness about the use of various energy devices was low although some people had information about the energy devices like pressure cooker (100%), solar light (94%), biogas (69.4%), polyhouse (89.4%) (Fig.3). Total $Co_2$ released per year was Kerosene -1.25 tonnes; LPG – 3.39 tonnes; electricity - 0.09 tonnes and wood 85.11 tonnes (Fig. 4).

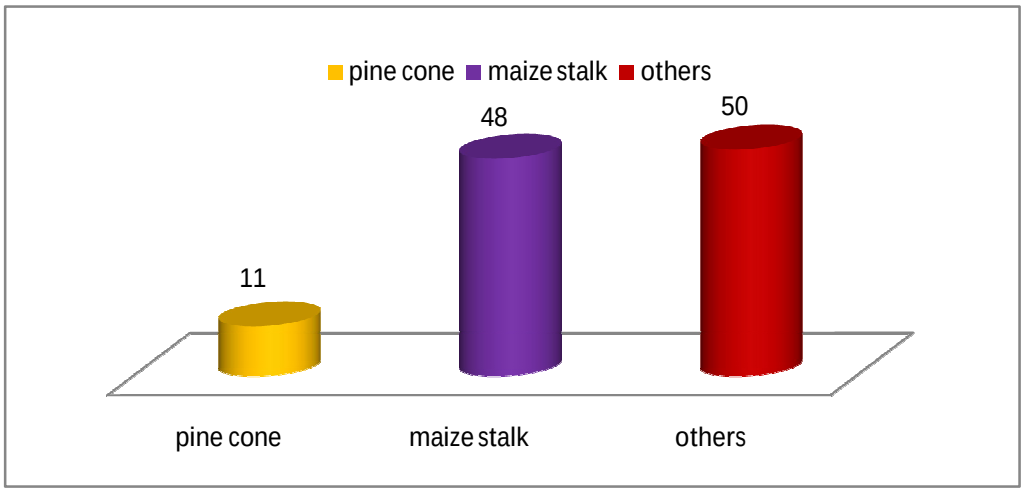


Fig. 3. Awaereness level of households about renewable devices

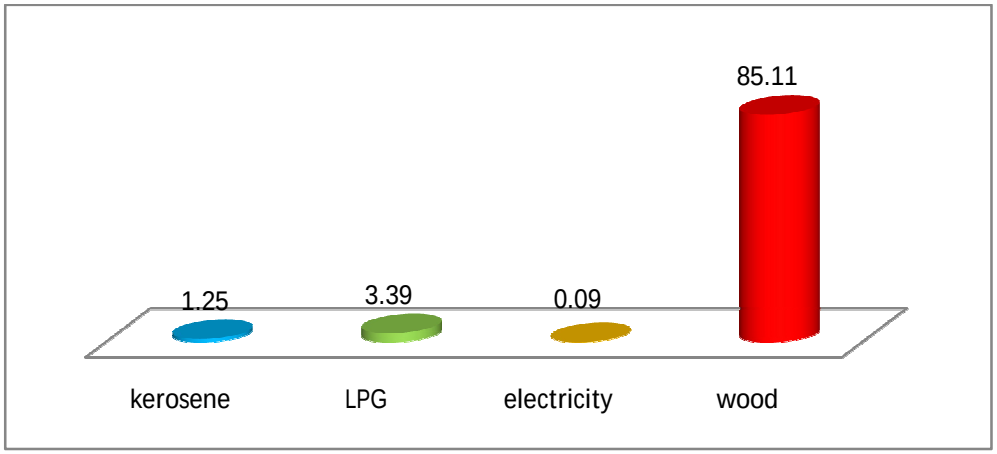


Fig. 4. $CO_2$ emission from fosile fuels burning in study area

## Conclusions

The study revealed that (93.3%) of households used fuel wood for cooking and heating and (22.7%) of households used kerosene for cooking despite the bulk use of LPG (93.3%) and electricity (100%). The $Co_2$ emission from burning of conventional energy was 396.56 tonnes per year. It was observed that people were not aware of the use of Renewable Energy Technologies (RETs) which could reduce the burden on conventional fuels as well as reduces the GHG emissions. Therefore, unless remedial measures were immediately taken, we cannot hope for a better tomorrow.

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