



# CARBON EMISSION AND SOLAR INSTALLATIONS: AN ANALYSIS OF INDIAN URBAN DWELLINGS.

APR Srinivas\*, Assistant professor, Mechanical Engineering, Lingaya's university, India. sprayagari@gmail.com

**Abstract:** *With the increasing energy demand and depleting energy resources, the world is turning towards the SUN to meet its energy needs. Annual solar radiation to earth is 1.5 quintillion kilowatt hours of energy. The paper investigates the possibility of solar installations into the PM awas yojana-urban and thereby to reduce the demand for conventional electricity generation, leading to reduced carbon emissions. The paper also gives a future direction into the possibility of reduced LPG consumptions in Indian households.*

**Keywords:** sustainability, solar water heater, carbon emission

**1. INTRODUCTION:** At the time of French revolution, in 17<sup>th</sup> century, mankind relied on animal muscle power for energy. The approximate animal muscle power was 7.5 billion watts, this was equivalent to 14 million horses and 24 million cattle. By the end of this century, firewood and windmills catered to the energy needs of mankind. Later, the era(19<sup>th</sup> century) of black gold(coal) was dawned upon. 20<sup>th</sup> century was the century of oil and natural gas, being exported from OPEC(Oil and Petroleum Exporting Countries). Then came the nuclear technology enabling the mankind with nuclear fission reactors. A complete fission of one kilogram of uranium -235 produces an energy mass of 24 million kilowatt hours and this energy is equivalent to the energy released from 3000 tons of coal. But these fossil fuels deplete in near future and the world is looking towards renewable sources of energy, solar being the most viable option. Annual solar radiation to earth is 1.5 quintillion kilowatt hours of energy. The current global energy requirements are 125 trillion kilowatt hours[1].

With the ever increasing energy demands of urban lifestyles, green house gas emissions are increasing everyday. Among renewable group of energies, solar

energy gives an advantage to cut down carbon emissions.

**2.LITERATURE REVIEW:** Chang et al suggested that the subsidy program implemented by Taiwanese government had a long term impact in the local market of solar water heaters and these solar water heaters are responsible for bringing in sustainability in Taiwan society. The dominant factors of sustainability were financial incentives, economy of scale, housing status and other economic aspects. By the time, the program was terminated, the government enforced, 'Greenhouse Gas Emission Reduction and Management Act'[2]. Juan shi et al suggested that vacuum tube solar heaters gave better year round thermal performance than gas assisted- flat plate solar water heaters. The experiments for this sake were conducted two different climatic zones of china. The work established experimental platforms to measure the real-time annual performance of solar water heaters in provinces of china[3]. Lin et al developed a procedure for estimating the payback period of residential solar water heaters (SWH) in terms of operation cost and energy savings over conventional fuels. An end user determines economically optimal solar collector area of a SWH as per the hot water consumption pattern of each Taiwanese household. Payback periods are shorter when electricity was the conventional fuel [4]. Frauke et al examined the pathways for low carbon innovation in china's changing scenario of financing and policy making, and relatively changing practices among producers and consumers of china [5].

**3.METHODOLOGY:** It is estimated that 400 million population will be added to Indian urban population, by 2050. With the growing urban population, energy demands are also increasing day-by-day. To meet the basic needs of this growing urbanism, government of India has initiated an affordable housing scheme, 'PM awas yojana-urban'. The underlying problem with the increasing urban population is the pollution created directly or indirectly. The figure 1 shows calculation methods for various carbon emissions.

This problem of pollution has to addressed with the help of newer and cleaner energy technologies. The research objective of this paper is to calculate carbon emissions in generating electricity consumed by household electric geysers. Unit of analysis is 'kg of carbon emission per kilo watt hour of electricity'

generated. The variable considered is carbon emission dependent upon SWH replacing the electricity consumed by household electric geyser.

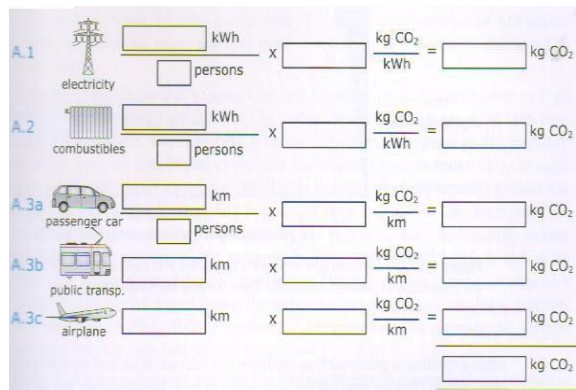


Figure 1: Annual private direct CO<sub>2</sub> emissions[1]

The average solar insolation in india is 200MW/square kilometre. From the entire land available in India, only 12.5 %.i.e 0.413 million square kilometre could be used for solar installations. This results to a solar power of 8 million Mega watts per year[09].Usually, only one geyser would be functional at a given time in a house.

The number of houses being constructed in PM awas yojana-Urban are in the style of apartments, having 14 floors, with six houses in a floor. Thus, the water capacity of solar water heaters must be calculated and is as shown in the table 1. The water for taking a bath per person is usually 5 liters as per Indian living standards.

**3.1 HYPOTHESIS:** Solar energy installations would completely nullify the carbon emissions in generating the electricity needed for household electric geysers.

**4.ANALYSIS AND DISCUSSION:** With the given standards of urban living, every household has an electric geyser, thereby contributing to carbon emissions. According to IEA 2008 survey, India stands fourth in the list of pollution with Delhi NCR being the most polluted [1]. The world is moving towards clean and sustainable forms of energy, and Solar energy is the most viable option, given the annual insolation received in India.GOI has stated the carbon factor of conventional electricity production to be 0.85 kg CO<sub>2</sub> per kwh [7]. The average wattage of

electric geysers used in India is 1000kwh[8]. Table 2 shows the annual carbon emission by 2050 due to conventional electricity consumption of geysers. The emission is calculated to be 0.0203 million mega tons of carbon every year. This emission is completely nullified since the geysers would be used as a storage tank of the solar water heater and would be never used to heat the water. Thus, 24 million mega watt hour of energy could be utilised for rest of the purposes or seldom needs to be generated. The number of SWH installations in a year are approximately thirty thousand depending upon the construction of apartment buildings.

Table 1: Solar installations and Capacity

Parameter	Value
Water needed per tower	5*6*14= 420 liters per day= 500 liters(approx)
Solar installation capacity	500 liters of water
Water needed	400*10 <sup>6</sup> *5=2000*10 <sup>6</sup> liters
Number of towers	400*10 <sup>6</sup> /(14*6*5)=9,52,381
Number of SWH installations	9,52,381
Panels needed per year	9,52,381/(2050-2018)=29,762

Table 2: added pollution to India’s climate by 2050

Parameter	Value
Increase in urban population	400*10 <sup>6</sup>
Equivalent families(average head count is 5)	80*10 <sup>6</sup>
Equivalent households	80*10 <sup>6</sup>
Equivalent number of geysers	80*10 <sup>6</sup>
Average wattage of geyser	1000KWH
Annual electricity consumption of	80*10 <sup>6</sup> *1000*10*30=24*10 <sup>9</sup> 12 KWH = 24 million mega watt hour

geysers	
Carbon emission in the electricity generation	$24 \times 10^{12} \times 0.85 = 40.8 \times 10^{12}$ kg = 0.0203 million mega tons of carbon

**5.CONCLUSION:** By 2050, the increased Indian urban population becomes responsible for a carbon emission of 0.0203 million mega tons, considering electric geysers alone. This could be nullified by adapting newer technologies like solar energy installations. With an hour of daily usage, these solar water heater installations would also reduce the annual expenditure of an average household by thirty thousand in Indian national rupee. The pay-back period of solar installations is three to five years[10]. The same installations could also be utilised in reducing the LPG consumptions in households. Most of the houses use pressure cookers to cook food. The pressure cooker converts water into steam. This needs sensible heat to raise the temperature of water to boiling point and latent heat of water to convert water into steam at the boiling point. If the already solar heated water is poured in the cooker, it reduces the amount of time and gas needed to raise the water temperature by the sensible heat difference.

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**Bibliography:** The author APR Srinivas is a post-graduate in Mechanical Engineering from National Institute of Foundry and Forge Technology, Hatia. He practices Mechanical Engineering at Lingaya's university in the capacity of Assistant professor.

