Decarbonising the Cooking Sector

Introduction

Highlights

- Higher emission intensity of energy (tCO_2/MJ) for cooking sector by 2030 (w.r.t. 2010 levels).
- Affordability and accessibility of LPG are still a concern, especially among the rural poor.
- Cleaner grid with higher mix of renewables will help decarbonise electricity-based cooking.

Over the past few years, India has experienced significant changes in its energy-consumption pattern, especially in the cooking sector. The Pradhan Mantri UJJWALA Yojana (PMUY), launched in 2016, has helped people transition from cooking using traditional biomass to energy-efficient liquefied petroleum gas (LPG). As the consumption of LPG grew, India's reliance on imported fuel increased as well. The consumption of LPG doubled over the past decade, and India imported LPG worth INR 49,939 crore in 2018-19 (PPAC, 2018, 2019a). Such heavy dependence on import poses a risk to the energy security of the country.

Moreover, LPG is a carbon-intensive fuel. The increased use of LPG has coincided with an increase in greenhouse gas (GHG) emissions from India's cooking sector. Emissions from India's residential and commercial sector rose from 89 $MtCO_2e$ in 2010 (MoEFCC, 2015) to 126 $MtCO_2e$ in 2014 (MoEFCC, 2018). The main contributors to these emissions are LPG, kerosene, and other fuels used for cooking and lighting. Emissions from the cooking sector contributed to about 6% of India's overall energy-based emissions in 2014[1].

Till 2011-12, about 83% of India's rural population depended on biomass (compared with only 30% of the urban population)(NSSO, 2014). Extensive use of biomass—in tandem with its incomplete combustion—generates high levels of particulate matter, leading to serious health impact and developmental challenges (Mishra et al., 1999; Pokhrel et al., 2005; Bhargava et al., 2004; Chakraborty et al., 2014; Bruce et al., 2015). The Global Alliance for Clean Cookstoves estimated that about 40 crore people in India are exposed to indoor air pollution, especially from cooking (GACC, 2013). To address these challenges and meet Sustainable Development Goal 7[2], the Government of India introduced schemes and policies such as Rajiv Gandhi Gramin LPG Vitrak under the Vision 2015 (2009), Pratyaksha Hastaantarit Laabh (PAHAL) (2014), and PMUY (2016).

Adoption of LPG

Urban areas were always more inclined to adopt modern cooking fuels like LPG. This was mainly due to the affordability and easy accessibility of LPG for the urban sector. With increasing monthly per capita expenditure (MPCE), a substantial shift can be seen towards the use of LPG. Figure 1 shows the pattern of cooking fuels used in rural and urban households, in 2011-12. Firewood was the major cooking fuel across all income classes in rural areas and, to some extent, in urban areas.

[1]The emissions for cooking sector don't include CO_2 emissions emitted from biomass burning as it is considered to be CO_2 neutral. As per the Intergovernmental Panel on Climate Change methodology, CO_2 emissions from the combustion of biomass are captured within the CO_2 emissions in the Agriculture, Forests and Other Land Use (AFOLU) sector, and hence not accounted for in the energy sector.

[2] Ensure access to affordable, reliable, sustainable, and modern energy for all.

The pattern of LPG use for the same MPCE was different for urban and rural areas, which can be attributed to the lower LPG accessibility in rural areas.

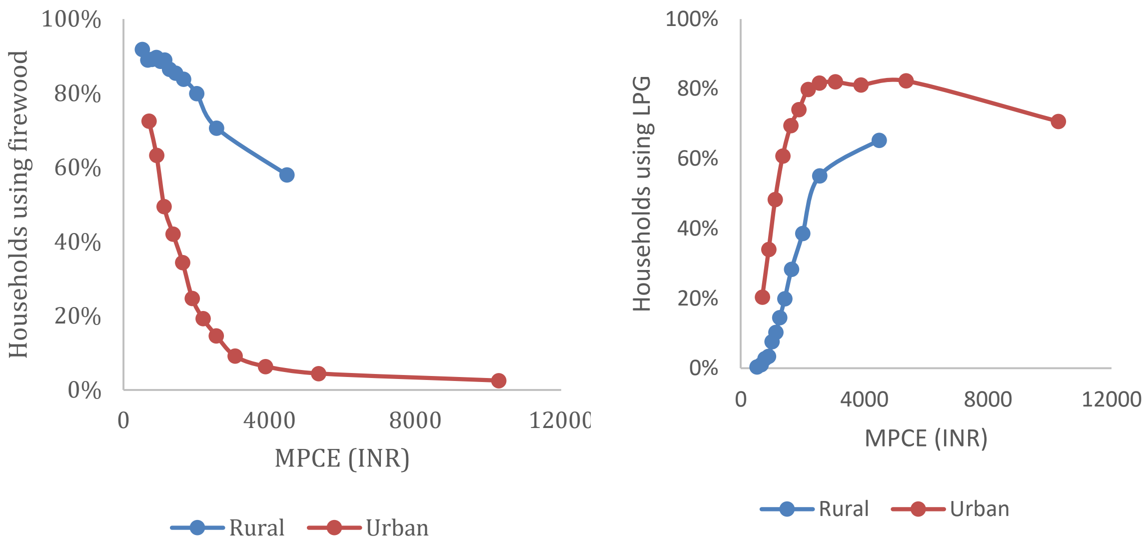

Figure 1: Variation of cooking fuel use with MPCE (2011-12)

With the launch of the PMUY scheme in 2016, LPG uptake has increased considerably. More than 8 crore connections have been sanctioned under this scheme, as on September 2019 (PPAC, 2019b). The cooking sector's energy consumption decreased from 4,439 PJ in 2007 to 4, 162 PJ in 2017[3]. This may be attributed to the efficiency gains from clean and modern cooking fuels and technological improvements (Singh & Setiawan, 2013). The PMUY scheme has improved LPG accessibility in villages and lower-income urban households. The growth in LPG demand has meant a marginal increase in emission intensity of the sector (as shown in Figure 2), a trend that will further increase in the future. But, owing to further reduction in energy demand for the cooking sector, it is likely that the increase in the share of emissions from the sector will only be marginal (CSTEP, 2018)

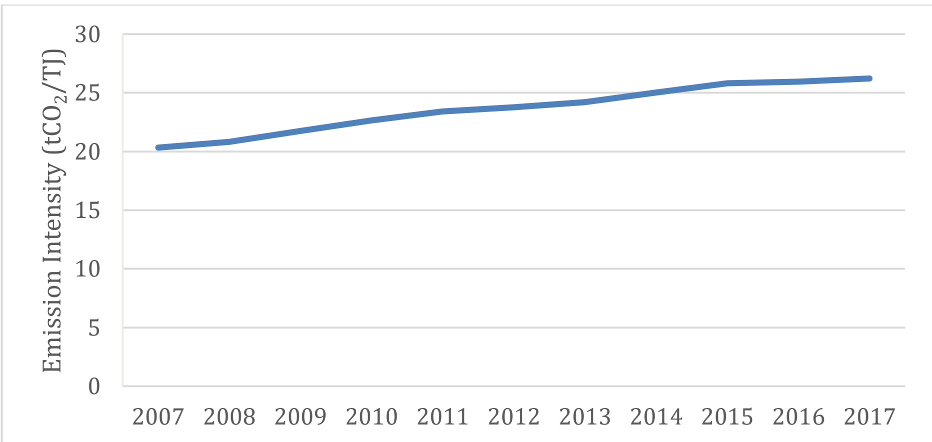

Figure 2: Historical demand and emissions from the cooking sector

[3] This includes the energy from kerosene used for lighting as well.

Shift to Electricity-Based Cooking

Even though PMUY has helped in transitioning towards modern, clean[4] cooking fuels, affordability and accessibility continue to remain an issue at the lower strata of the rural sector (CEEW, 2018). To promote India's energy security (by reducing the demand for LPG import), more efficient technologies, such as electricity-based cooking, have to be encouraged.

The cooking-energy requirement has been changing over the years, based on variations in the lifestyle of the people. India is diverse in its food habits and preparation styles—the type of vessels used, time taken for cooking, and so on. An average household will use about 1,250 kg of wood or 108 kg LPG (~ 8 cylinders) or approximately 950 kWh of electricity[5] in a year for its cooking requirements. Table 1 shows the fuel use and emissions for various cooking technologies.

Table 1: Quantity of fuel used and emissions for various cooking technologies in a year

Cooking Technology	Calorific Value (TJ/kt)	Efficiency of Cookstove (%)	Quantity of Fuel Used/HH	Emission Factor	Emissions (kg CO_2e)
Fuelwood -Traditional	15.67	13%	1,254 kg	7.54 tCO_2e/TJ[6]	148
Fuelwood – Improved Cookstove	15.67	30%	544 kg	7.54 tCO_2e /TJ	64
LPG	47.30	50%	108 kg	63.24 tCO_2e /TJ	322
Piped Natural Gas	48.00	50%	106 kg	56.24 tCO_2e /TJ	287
Electricity	-	75%	946 kWh	0.82 tCO_2/MWh[7]	776[8]

Electricity-based cookstoves—with a thermal efficiency of about 75%—will help further reduce the cooking energy demand. However, India has a high dependence on fossil fuels for generating electricity, which again leads to significant GHG emissions. The increasing penetration of renewable sources of energy into the electricity mix could help mitigate this concern. Though the average emission factor for the Indian electricity system was 0.82 $kgCO_2$/kWh in 2017-18, the figure is expected to reduce in future, as the share of renewable sources of energy increases. As per India's Nationally Determined Contributions (under the Paris Agreement), 40% of the country's installed capacity by 2030 will be based on non-fossil sources. The average emission factor of the power-generation sector is expected to reduce to 0.604 t CO_2/MWh in 2021-22 and to 0.524 t CO_2/MWh by the end of 2026-27, with the influx of renewable energy in the grid (CEA, 2018).

Conclusion

The optimal approach to decarbonise cooking is to start using a clean and low-carbon fuel. It is essential to ensure that the shift to modern, clean cooking fuels and the use of energy-efficient

[4] As per IEA, access to clean cooking facilities means "access to (and primary use of) modern fuels and technologies, including natural gas, LPG, electricity, and biogas, or improved biomass cookstoves that have considerably lower emissions and higher efficiencies than traditional three-stone fires for cooking".
[5] Assuming that an Indian household requires 7 MJ of cooking energy in a day, as per India Energy Security Scenarios, 2047
[6] Includes CH_4 and N_2O based emissions
7 Emission factor of Indian grid for 2017-18
8 This value includes only CO_2.

technologies go hand-in-hand. Transition to electricity-based cookstoves will offer similar or higher decarbonisation outcomes and lower the risks on energy security.

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