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Impact of Pradhan Mantri Ujjwala Yojana (PMUY) on Local Wood Energy Systems and Rural Women in India

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Abstract

The Pradhan Mantri Ujjwala Yojana (PMUY), a social welfare scheme initiated by the Government of India, aims to address the lack of access to clean cooking alternatives. PMUY is by far one of the largest clean cooking program ever. However, the implementation of PMUY faces challenges such as accessibility, availability, affordability of refills, awareness and safety concerns in remote rural areas. This study conducts a thorough analysis of existing literature drawn from scientific journals, government reports, and scientific databases to evaluate the adoption of LPG, modifications to cooking habits, and associated socioeconomic and environmental impacts. In this study, the impact analysis of PMUY is based on socio-economic, cultural, resource accessibility, and geographical parameters. This review emphasize on the need for continued research and policy interventions to address challenges and maximize the potential benefits of PMUY in transitioning households from traditional biomass to modern energy sources.

Keywords: PMUY, Indoor air pollution, Deforestation, Fuelwood, Clean cooking fuel, Energy security

JEL Classification: Q42, I38, J16, Q56, O13

Introduction

India, being the world's most populous country with around 1.4286 billion people, has seen a tremendous increase in energy demand in recent years (IEA, 2022). About 63.4 per cent of the Indian population uses biomass in the form of fuelwood for domestic purposes and fuelwood is a top priority for the rural poor. Around 681 million people in India still rely on traditional fuels i.e., fuelwood & other solid fuels, as their primary source of cooking while 688 million people lack access to clean cooking fuel (CCF) and in India, only 49% of the population has access to CCF (International Energy Agency, 2019). World Health Organization, 2018 in a report, highlights that approximately 63 per cent of the global population has access to CCF. Indian forests supply biomass as fuelwood (or firewood), chips, wood pellets, charcoal and black liquor, among others, which contributes significantly to meeting the energy requirement. Fuelwood has been used since prehistoric times as chief domestic energy source and also the commercial energy source in semi-urban areas, and is still a significant energy source for the global population (FAO, 2008; Balachandra, 2011). More than half of the wood produced worldwide is fuelwood, which is mostly used for non-industrial roundwood (Palmer and Macgregor, 2009). Over 54 per cent of the world's annual wood harvest is derived from fuelwood harvesting (Bhatt and Sachan, 2004). Countries dependent on fuelwood recognize the threat to energy source represents to their forests. High fuelwood consumption is associated with deforestation, land degradation, energy insecurity among low-income households and poor health. Lack of fuelwood, the decline of natural forests, and the negative socioeconomic effects on the rural poor are caused by unsustainable fuelwood harvesting (Ghilardi *et al*, 2009).

Currently, modern bioenergy is the largest renewable energy source worldwide (IEA, 2023). To meet the Sustainable Development Goals (SDGs) by 2030 and reach net- zero emissions by 2070, the conventional bioenergy system must give way to a more sustainable, low-carbon energy system. A higher quality of life depends on having access to clean energy (Pandey and Parthasarathy, 2019), however, many people struggle to get clean energy for basic requirements like cooking and heating. Persistent disparities still remain even though progress has been made toward the United Nations Sustainable Development Goal 7, or SDG 7, which highlights the need of universal access to affordable and clean energy by 2030 (UNDP, 2015). Modern cooking fuel options, offer health, and environmental benefits which are still inaccessible to a large number of population, especially in rural areas (Bhattacharya, 2015). This disparity in availability

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of clean cooking fuels sheds light on the importance of implementation of strong policies to address challenges affecting the uptake of clean cooking energy sources. To resolve this issue, the Union Government of India launched the Pradhan Mantri Ujjwala Yojana (PMUY), a flagship clean cooking scheme, in May 2016 with the tagline "Clean Fuel, Better Life". The scheme aims for a smoke-free rural India and intends to give eight crore individuals living in poverty a free cooking LPG connection by 2019. The Ministry of Petroleum and Natural Gas approved an additional budget of 1.6 crore in 2022 for providing new LPG connections under the "*Ujjwala Yojana* 2.0."

Cooking is one of the most time-consuming chores for Indian women (Smith and Sagar, 2014). Using traditional fuel for cooking poses detrimental threats to health (Jaiswal *et al*, 2022). One of the main contributors to air pollution in homes is biomass combustion, which poses a serious risk to public health and environment (Sidhu *et al*, 2017). Every year, five to ten lakhs deaths are caused by indoor air pollution in India (Sharma *et al*, 2019). The purpose of PMUY scheme is to reduce indoor air pollution by replacing traditional cooking fuels like fuelwood with LPG (PMUY, 2016). By promoting LPG use, PMUY seeks to lower the health risks linked to exposure to smoke from traditional fuels, particularly among rural women and children. Additionally, the scheme aims to decrease deforestation and environmental degradation by reducing the demand for fuelwood (Dabadge *et al*, 2018). Access to clean cooking fuel through PMUY offers socio-economic advantages, such as time savings, higher productivity, and empowerment of women by reducing their drudgery associated with traditional cooking practices (Swain and Mishra, 2019; Tripathi, 2019). The PMUY is a significant step toward social inclusion (Srivastava *et al*, 2012). Numerous studies demonstrate continued use of the traditional cooking fuels by households as readily available biomass affects the decision of LPG adoption (Cabiyo *et al*, 2020; Sharma *et al*, 2019). Disparities in adoption of LPG is due to various factors such as affordability, accessibility, and awareness (Mani *et al*, 2020). Poor communities have used LPG to some extent, but its sustained use has been minimal due to several reasons (Jha, 2017; Kar *et al*, 2019). Large number of households struggle to switch to clean energy sources due to economic, social, environmental and cultural constraints (Patil *et al*, 2021; Kumar *et al*, 2016). In existing research, there is a significant gap in understanding the determinants affecting LPG adoption and sustained usage of LPG among rural poor communities. Thus, it's critical to understand the key drivers behind biomass consumption and LPG adoption, the impact of PMUY on the local environment, rural women and the sustained implementation of LPG among the poor.

Data Sources and Methodology

The present study aims to understand the influence of the PMUY scheme on rural women's socioeconomic status as well as on the environment. An effort has been made to understand and provide information on the current status of LPG coverage in India, advantages of using cleaner fuel and social inclusion of Below Poverty Line (BPL) households through PMUY policy. A thorough analysis of existing literature and several reports from both government as well as non-government organizations have been taken into account as part of the approach used to prepare the manuscript. The study's descriptive and exploratory approach allows for empirical investigation of the poor's inclusion in the government's policy to provide them a better quality of life.

For descriptive analysis, the researchers have relied on research papers available in various scientific databases as in ResearchGate, ScienceDirect, Google Scholar and Academia. These databases were selected as they are some of the most widely used search databases for interdisciplinary, open- access and peer-reviewed literature. There were no papers available in the database such as Scopus on PMUY scheme. The research was conducted using search string: [Title]: "Pradhan Mantri Ujjwala Yojana", "Woodfuel and Climate Change'', "traditional cooking fuel'' and "Clean energy LPG" and [Year of Publication]: 2000-2023. These keyword combinations were used to get relevant literature. This review included research articles on fuelwood from 2000 to 2023 and on PMUY scheme from 2016 to 2024.

Analysis of data

Initially, the database(s) search produced more than 100 documents. These documents were then further analysed based on their title, abstract to see their relevancy for the inclusion in the current review. Articles were included that addressed the impact of using fuelwood, LPG on health and environment and focused on PMUY challenges and the scope of development. Exclusion criteria include studies lacking relevance, inadequate or unreliable data and complex language of the literature. This study did not take reviews or meta-analyses into account. More than 60 papers in total were considered based on the inclusion and exclusion criteria. The articles screened were analysed to better understand the focus of the study. The methodology used in past studies was reviewed based on their data collection approach. The criteria for impact assessment are based on various parameters such as Economic group (Above and Below Poverty Line), Geographical, Cultural and accessibility to energy source. Resource-reach affects the acceptability of LPG in an area. Forest-rich regions where biomass availability is high, acceptability of LPG is low**.** In coal-producing states like Madhya Pradesh, West Bengal, Chhattisgarh, and Jharkhand, where coal is abundant, household reliance on alternative fuels for energy is quite low. An energy source's high consumption is correlated with its high production.

Over the years, a significant transition has been seen from traditional methods to clean cooking fuels such as LPG

and PNG when the Union government in 2009 launched the Rajiv Gandhi Gram LPG Vitrak Yojana (RGGLV). The RGGLV Scheme name was later modified and relaunched as the Pradhan Mantri Ujjwala Yojana (PMUY) in 2016. Since then, a number of studies – Dabadge, 2018; Swain and Mishra, 2020; Gill-Wiehl *et al,* 2020; Ranjan and Singh, 2020, have analysed PMUY scheme impact on fuelwood and LPG use in India. Majority of the past studies conducted were either descriptive in nature or regional analysis. This study examines how the PMUY progressed over time and for that, relying on policy documents comes with certain limitations, such as a lack of understanding about contextual factors that may impact policy. This paper analyse the impact of PMUY on the environment, health, social, economic and cultural facets.

Results and Discussion

Fuelwood as a principal source of energy

Fuelwood is the chief domestic energy source in rural and semi-urban households in developing nations (Bhatt and Sachan, 2004). Fuelwood is used by around 49 per cent of Indian households for cooking (Bhattacharya, 2015). Other commercially available sources of energy remain unpopular among the local population due to poor accessibility, low socio-economic standing, high costs, and low availability of alternative energy sources (Pandey and Chaubal, 2011). The fuel choices are influenced by numerous factors, such as household size, lifestyle, ethnicity, education level, geography, climate, subsidies, energy supply factors, price, availability, and accessibility (Das and Srinivasan, 2012; Das *et al*, 2014). Even in India, people use fuelwood even when other alternative sources of energy are easily available (Jaiswal and Bhattacharya, 2013). Energy needs of the local inhabitants are fulfilled by utilizing biomass from the forests (Pandey, 2002). Sustainable use of forests and their resources is a multifaceted issue that takes into account the socio-economic status of communities that depend on forests, as well as societal needs and cultural and ethical values (Chettri and Sharma, 2009). In rural areas of developing nations, wood is extensively utilized, especially in areas where they are easily available and accessible (Gupta *et al*, 2020). Fuelwood is used by communities for a variety of purposes, mostly for building houses and cooking, which leads to overuse and accelerates deforestation (Gupta and Kohlin, 2006). Table 1 presents the Forest Survey of India (FSI) estimation; a gradual but significant increase in the estimated yield of wood from Trees Outside Forests (TOFs) seen from 2011-2019 (Dhiman, 2021).

Table 1: Trend in Production of Wood from Trees Outside Forests (TOFs) in India

Year	Wood Production (in Mm^3/annum)
2011	44
2015	69
2017	75
2019	85.16

Source: Dhiman (2021)

According to FAO forecasts, which are shown in Table 2, the use of fuelwood in developing countries has peaked and will gradually fall in the ensuing decades, provided stringent regulations are implemented to restrict its use (Broadhead *et al*, 2001). Shrivastava and Saxena, 2017 estimated the annual production and consumption of fuelwood in India. Production of fuelwood is estimated as 385.25 million cum, which is comparatively higher than its consumption, estimated as 333 million cum.

Table 2: FAO estimates of Fuelwood consumption (in million cubic metres) to 2030 in the major developing regions

	2010	2020	2030
South Asia	372.5	361.5	338.6
Southeast Asia	139.1	107.5	81.3
East Asia	186.3	155.4	127.1
Africa	485.7	526.0	544.8
South America	107.1	114.9	122.0

Source: Adapted from Broadhead et al, 2001

Despite repeated claims of government and various reports suggesting that fuelwood usage is low now or in the near future (Mottaleb and Rahut, 2021), the ground reality represents a completely different picture (Mani *et al*, 2021). The International Energy Agency, 2006 found, as depicted in Table 3, that by 2030, population growth will result in 2.7 billion people relying on biomass.

If the current trend of using biomass persists, 580 million people in India will be dependent on fuelwood for domestic use by 2030 (International Energy Agency, 2017). This is due to a major shortcoming of the PMUY scheme. The scheme lack follow-up mechanisms to ensure the sustained use of LPG after the initial connection is provided. While many BPL households have benefited from the scheme, consistent usage remains limited. This gap between policy rollout and actual usage raises concerns about the effectiveness of the scheme. Moreover, the absence of targeted incentives to encourage regular refills has further discouraged sustained use of LPG among economically disadvantaged families. Several reports indicate that only a small percentage of distributed cylinders are being regularly refilled, which directly undermines the core objectives of the PMUY (CAG Report, 2019).

Impact of woodfuel on human health and environment

Impoverished people still use traditional fuels for cooking and lack access to crucial information. Indoor air pollution caused by the use of fuelwood is even more hazardous than the outdoor air pollution (Palmer and Macgregor, 2009).

Table 3: Dependency of People (in Millions) on traditional biomass

Countries	2004	2015	2030
Sub-Saharan Africa	575	627	720
North Africa	4	5	5
India	740	777	782
China	480	453	394
Indonesia	156	171	180
Rest of Asia	489	521	561
Brazil	23	26	27
Rest of Latin America	60	60	58
Total	2,528	2,640	2,727

Source: International Energy Agency, 2006

Burning of biomass poses long-term chronic and health effects including lung cancer, cardiovascular diseases (CVD), and chronic respiratory disorders for women who prepare and cook food in their homes, as well as children accompanying them while they do household chores (Kaur-Sidhu *et al*, 2019; World Health Organization, 2023). Moreover, women may have to spend several hours a week in some regions to collect fuel, at the expense of other activities (Pandey, 2002). According to a World Health Organization report, the amount of smoke that women inhale when cooking with biomass or unclean fuel is equal to 400 cigarettes burned in one hour (James *et al*, 2020; Sidhu *et al*, 2017). The 2019 State of Global Air report states that prolonged exposure to air pollution is the fourth largest cause of mortality worldwide, trailing only high blood pressure, dietary disorders, and use of tobacco (State of Global Air Report, 2019). Prolonged air pollution exposure is the cause of approximately 7 million deaths every year. In India alone, it is the cause of nearly 1.6 million deaths annually. Of these, lives of children under the age of five accounted for over 200,000 (World Health Organization, 2014). As per a study conducted by the Energy Policy Institute at the University of Chicago (EPIC) in 2021, air pollution has resulted in a nine-year reduction in the life expectancy of Indians, as shown by the Air Quality Life Index (AQLI). The research claims that "pollution levels that are 10 times worse than those found anywhere else in the world" are inhaled by 480 million people in north India, and that these high levels have gradually extended to other areas as well. The report says that people living in the capital, Delhi, might witness an improvement in life expectancy of up to 10 years if air pollution were lowered to the level recommended by the World Health Organisation (WHO), which is 10 µg/m³.

Wood fuels are often considered as polluting fuels because of their emissions, which have adverse impacts on millions of people who use it for cooking in their homes (Alam *et al*, 2016). Other environmental impacts include unsustainable fuelwood harvesting, which can deplete forest stocks or cause deforestation, which in turn contributes to climate change (Bailis *et al*, 2015; Arnold et al, 2016). Unsustainable fuelwood harvesting has greatly contributed to erosion and biodiversity loss due to reduction in forest cover. About 55 per cent of the households in India use traditional fuels, according to the National Family Health Survey (NFHS-4). Biomass combustion in households may be the second largest source of near-term warming, and thus contributes to climate change. Burning of fuelwood is becoming a significant contributor to global warming, and a barrier to India fulfilling its Nationally Determined Contributions (NDCs). Carbon dioxide, methane, and nitrogen oxide are released when wood, charcoal, animal dung, and agricultural wastes burn inefficiently (Bailis *et al*, 2015). Greenhouse gases like methane and nitrogen dioxide are more potent than CO_2 and other pollutants. Additionally, the conventional utilization of biomass also releases soot, or black carbon, a transient aerosol with a 1,500 times more potential for global warming than carbon dioxide. According to UNEP estimates, domestic sources account for 43 per cent of the world's emissions of black carbon (CCAC). The use of biomass in cooking does not only depend on combustion to have an impact on the climate (Khanwilkar *et al*, 2021). The existing methods of harvesting fuel put immense pressure on forests and significantly increase the total intensity of the fuel source (Pandey, 2002; IPCC 2019a). As a result, the availability of clean cooking fuels has become a significant global issue.

The progress of LPG in India

The fifth National Family Health Survey (NFHS–5) carried out in 2019–21 by the Ministry of Health and Family Welfare, found that LPG or piped natural gas is the foremost fuel used by around 42 per cent of rural households and 88.6 per cent of urban households for cooking. According to the survey, roughly 56 per cent of people still rely on conventional fuels, including kerosene, wood, biomass, animal dung cakes, and agricultural wastes. About 27 per cent of Indian homes use LPG, which is the second most popular cooking fuel, according to the National Sample Survey Office (NSSO, 2007). Kerosene is used by roughly 7 per cent of families, while the remaining 8 per cent utilize fuels like electricity, natural gas, or biogas. The combined use of LPG and conventional biomass cookstoves has an impact on health due to fuelwood use; yet the use of LPG jointly reduces the amount of fuelwood requirement in per day cooking (Baquié and Urpelainen, 2017). Therefore, it is crucial to understand the key drivers behind the poor adoption of clean fuels.

Bharat Petroleum (BPCL), originally known by the name Burmah Shell, launched LPG in 1955 for the first time in India. The 1971 India-Pakistan War raised concerns regarding energy security and due to this, the company was nationalized. Just 2,000 Indane LPG connections were

there in India in 1965. In the 1970s and 1980s, LPG stoves started replacing kerosene stoves in Indian households, despite initially not being adopted by consumers due to safety concerns. Since its introduction in the 1970s, LPG was one of the highly subsidized types of produce in India, which has been the primary driver in the growth of LPG in India. However, adoption in rural India was relatively limited because of the hefty pioneer cost of the LPG connection for rural homes. Having an LPG connection was more of a luxury in the 1990s than it was a universal public utility. Since the introduction of PMUY in May 2016, according to government data the percentage of LPG coverage has expanded from merely 62 per cent in 2016 to 104.1 per cent in 2022. In the recent nine years, India's LPG use has increased significantly. From 14.52 crore in April 2014 to 31.36 crore in March 2023, the number of active domestic LPG consumers increased, as shown in Figure 1. Additionally, on March 24, 2023, the Union Cabinet approved a subsidy of Rs. 200 for each 14.2 kilogram cylinder, up to 12 refills per year, for PMUY beneficiaries. In the past, obtaining a new LPG connection required a waiting period, and receiving an LPG refill cylinder would take 7–10 days. Nevertheless, cooking gas connections may now be made on demand, and refills can be obtained in the majority of places in less than a day.

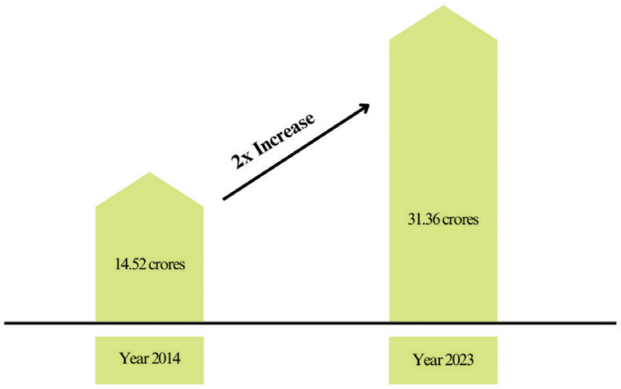

Figure 1. Number of LPG consumers in India
Source: PMUY, Ministry of Information and Broadcasting, GOI (2019)

The PMUY has been one of the most notable growth engines in the nation's women's socioeconomic status shift (Pandey and Parthasarathy, 2019). In the nation, there are 314 million active residential LPG connections as of April 1, 2023, according to data from the Petroleum Planning and Analysis Cell (PPAC). Initially, 5 crore women from BPL homes were to be connected to LPG.

Subsequently, the project was expanded with an increased goal of 8 crore LPG connections. On January 31, 2022, the PMUY phase 2 aim, Ujjwala 2.0, was achieved. The PMUY beneficiaries' per capita consumption grew under Ujjwala 2.0, rising from 3.01 refills in 2019–20 to 3.66 refills in the fiscal year 2021–2022. About one lakh persons were engaged by the LPG distribution system once PMUY was put into place. In order to assist people in switching to clean home energy sources, the Ujjwala Yojana offers free LPG connections to 37 million women who fall below the poverty line (WHO, 2018). The social and economic conditions of Indian families have greatly improved as a result of this massive increase in LPG coverage (Kalli *et al*, 2022). PMUY guarantees a better standard of living and financial security for women residing in rural areas based on expenditure, health, time, and numerous other factors (Alkon *et al*, 2016). PMUY has greatly enhanced the lives of women across the country (Sharma *et al*, 2019). In 2020, 61 per cent of rural homes and 95 per cent of urban households in India used LPG as their major cooking fuel, accounting for around 71 per cent of all Indian households (Mani *et al*, 2021). The PMUY scheme, which promotes smokeless kitchens, has mostly benefited women in Uttar Pradesh, Madhya Pradesh, West Bengal, Bihar and Rajasthan (Pandey *et al*, 2021; Smith and Sagar, 2014). Table 4 illustrates the top 20 states with the most connections released under the PMUY Scheme.

Table 4: Top 20 states with most connections in year 2019 released under PMUY

State	Number in Lakhs
Uttar Pradesh	147.8
West Bengal	88.8
Bihar	85.7
Madhya Pradesh	71.8
Rajasthan	63.9
Odisha	47.5
Maharashtra	44.4
Assam	34.9
Jharkhand	32.9
Tamil Nadu	32.4
Karnataka	31.5
Chhattisgarh	30.0
Gujarat	29.1
Punjab	12.3
Jammu and Kashmir (incl Ladakh)	12.0
Telangana	10.8
Haryana	7.3
Uttarakhand	4.0
Andhra Pradesh	3.9
Tripura	2.7

Source: Ministry of Information and Broadcasting, 2021

Challenges to adoption of LPG in India

Due to the accessibility and relative affordability compared to LPG, people continue to rely more on traditional fuels such as fuelwood (Mani *et al*, 2021). Even if PMUY has attained the milestone of providing new connections, a variety of factors influence its adoption and long-term viability (Yadav *et al*, 2021). The National Family Health Survey (NFHS-V) presents a more grounded view of actual usage. Although the government claims 98 per cent national LPG coverage, the real increase in clean fuel usage was just 20% from 2015–16 to 2019–20. In Bihar, for instance, clean fuel usage increased from 17 per cent to 37.8 per cent, indicating that a majority of households still rely on traditional sources like firewood (NFHS-V, 2021). The Comptroller and Auditor General (CAG) of India also identified serious lapses in data integrity and beneficiary selection. Over 12.46 lakh records contained mismatched names, and there were instances of cylinders being issued to ineligible individuals such as minors or duplicate entries. Moreover, installation-related safety concerns were noted in over 18,500 cases due to non-compliant equipment or improper procedures (CAG Report, 2019). These numbers illustrate that ownership of a connection does not necessarily translate into sustained adoption. Government data highlights rapid progress but field-based studies and independent reviews show that access alone does not guarantee consistent usage (Dubey, 2022). According to a study conducted by Gould *et al*, 2020, high number of families registered in PMUY, but never bothered to regularly refill their LPG cylinders (Kar *et al*, 2019; Ekholm *et al*, 2010; Patil *et al*, 2021). According to a study conducted by Gupta *et al* 2019 , PMUY has increased LPG connections in north India, but over 98 per cent of those households still use traditional cooking stoves, or chulha, for heating and cooking. The survey was done in the states of Bihar, Madhya Pradesh, Rajasthan, and Uttar Pradesh. In a state like Bihar, 88.70 per cent of the population lives in rural areas, and nearly half (49.16%) is still illiterate. High refilling costs, limited awareness, low socio-economic status, safety concerns, lack or delayed delivery of LPG and easy availability of biomass attributes for the discontinuance of the scheme (Cabiyo *et al*, 2020, Kumar *et al*, 2016; Rahut *et al*, 2014). A study by Mottaleb and Rahut (2021) found that fuelwood accounted for 15% of total energy expenditure. This shows a lower level of LPG uptake among households. Fuelwood stacking is a social and cultural ritual in rural India (Yadav *et al*, 2021). This has been observed that LPG cylinders from PMUY are used for local business eatery, teashop, and sweetshop to save money as commercial cylinders costs around Rs. 1800 for 18.5kg cylinder in different parts of India (Srinivasan & Carattini, 2020). Swain and Mishra (2019) emphasized that many households face numerous socioeconomic, cultural, and environmental limitations to switch to clean sources of energy. Various studies discovered an equation between households' energy decisions and their income (Agarwal *et al*, 2020; Das and Srinivasan, 2012). Education level influences a household's adoption of affordable and clean energy in addition to household income. Small and marginal farmer households typically spend more money each month than they bring in. This lack of financial capital has seriously impeded the adoption of LPG. The ability to secure an LPG connection is negatively correlated with the distance to the nearest LPG distribution facility (Das *et al*, 2014). The household head's level of literacy has a great impact on LPG adoption (Miller and Mobarak, 2013). According to some studies, fuelwood is an excellent good for households with low income and an inferior commodity for high-income households (Palmer & Macgregor, 2009). Furthermore, some research predicts that fuelwood use will remain high for a very long time, particularly in rural families (Arnold *et al,* 2006; Kumar *et al*, 2016). Price is not the only factor influencing the switch from wood to modern fuels, according to Gupta and Köhlin (2006). Convenience and supply reliability also play a role. Financial mismanagement is another critical concern.

Although the Pradhan Mantri Ujjwala Yojana (PMUY) has expanded access to LPG across rural India, its implementation reveals persistent structural challenges. Only 61% of households used LPG for cooking in 2018, contrary to higher official claims (Jacob and Jha, 2019). Numerous factors influence the decision on energy, such as the family's composition, income, house type, age of the head of the household, productivity of family members, energy preference, cultural beliefs etc. (Pandey and Chaubal, 2011; Behera *et al*, 2015; Dash *et al*, 2018 ; Mottaleb and Rahut, 2021; Das *et al*, 2014). High refill costs and inadequate rural distribution infrastructure continue to limit sustained adoption (Shah, 2022; Shrivastava, 2022).Considering the data that is currently accessible the factors impacting energy choice were divided into three main categories: household dimensions, energy dimensions, and other dimensions by Sharma and Dash, 2022 as depicted in Table 5.

Developing nations have endeavored to concentrate on achieving affordability and accessibility for sustainable energy (Bruce *et al*, 2017). LPG has become more popular as a cooking fuel worldwide. The chance of households switching back to traditional fuels is largely due to low income (Jha, 2017, Kar *et al*, 2019). Government statistics indicate that a significant number of people are enrolled under PMUY; yet, the frequency of use indicates that families enrolled in the PMUY have reported using LPG occasionally (Mani *et al*, 2020). Limited refills among beneficiaries, accessibility to kerosene, coal and biomass limit the adoption of LPG (Khanwilkar *et al*, 2021). It is observed that certain households use both LPG and fuelwood for cooking (Mukopadhyay *et al*, 2012). The government used to offer a price subsidy for LPG cylinder refills in the past (Kumar *et al*, 2016) but with limited disposable income, the poor face issues in refilling LPG cylinders even at a subsidized price

Table 5 : Factors Impacting Household's Energy Preferences

Household's Dimensions	Energy Dimensions	Other dimensions
1. Demographic elements	**1. Affordability and accessibility**	• Taste and preferences
• Age of the household head (HH)	• Cost of LPG connection	• Awareness
• Education level of HH	• Refilling cost of LPG	• Cultural beliefs
• Total no. of children in the household	• Distance to fuel collecting place	
	• Time spent in collection of fuel	
• Decision-makers in household	**2. Satisfaction in using depends on**	
2. Physical elements	• Availability	
Total land owned, livestock owned, type of house	• Cost	
	• Safety	
3. Income and expenditure	• Maintenance service	
• Source of income		
• Monthly expenditure		

Source: Adapted from Sharma and Dash, 2022.

(Tripathi, 2019). The high-end households were the primary recipients of the LPG subsidy, and the majority of these subsidies were used in urban areas (Kumar and Mehta, 2016). Another significant shortcoming is the overemphasis on connection numbers as a measure of success. Providing initial access to LPG is only the beginning. For this transition to become permanent, consistent behavioral reinforcement and affordability support are essential. Shifting from traditional cooking fuels to LPG involves a series of behavior changes, from initial unfamiliarity to habitual use. The current structure of PMUY primarily supports the access phase, with limited intervention in behavior reinforcement or continued financial support. For the impoverished in rural areas to use LPG as their main cooking fuel source, affordable doorstep delivery of LPG cylinders is required. Establishment of mobile refill stations in remote areas can also help bridge the accessibility gap and promote sustained adoption of clean energy solutions.

Conclusions and Policy Implications

Affordability, accessibility and adaptability are the main determinants of PMUY success, and to make LPG India's only clean cooking solution in the long run, the PMUY scheme needs to be restructured. Initially there was some hesitation in the villages to use LPG for cooking Chapatis (bread) as women were thinking the gas is not safe for the health. Several studies discuss about the impact of PMUY on environment, health, economic and social status of women but little-to-nothing has been done to develop a pro-poor approach that would encourage the adoption and continued use of cleaner cooking fuels. Field based survey studies are very limited to assess the use of LPG since its implementation, and how COVID-19 impacted the demand and supply chain of LPG. Some studies discussed that majority of households were not receiving subsidies and were using LPG cylinders at normal rates, leading to financial challenges, particularly during the COVID-19 pandemic. Most of the studies focused on pre-dominant descriptive nature of evaluation, reliant on government datasets like NFHS (National Family Health Survey), ACCESS dataset by CEEW (Gill-Wiehl *et al*, 2020), National Sample Survey Office, NSSO (Ranjan and Singh, 2020) and Petroleum Planning and Analysis Cell, PPAC (Dabadge, 2018), assuming it to be 100 per cent authentic and reliable, which is not true. For instance, if a household has an LPG connection but does not use it, they consider that LPG is not accessible to them. This reliance on descriptive evaluations complicates the analysis of PMUY's impact. High availability of traditional fuels such as fuelwood, coal in an area is directly linked to their high consumption despite having access to cleaner cooking fuels such as LPG. It means high resource reach (biomass) is directly associated with poor acceptability of LPG in an area and vice-versa. There are other challenges in transporting LPG cylinder in the remote Himalayan villages due to their terrain and distances. Few previously done studies have considered a small sample size. . More survey based studies are required at the village level to check the current status of LPG coverage and the factors influencing adoption of LPG under PMUY. Further research is required to provide a framework on how the policy can be restructured to attain maximum LPG usage. The most frequent cause of households' reliance on conventional cooking fuels is lack of awareness. The accomplishment of the Global Goals can be aided by educating households about the advantages of LPG through Self Help Groups (SHG). For a more accurate assessment of the scheme's effectiveness, future studies should integrate field data, newspaper investigations, and independent surveys. This would help bridge the gap between the official narrative and lived realities. Moreover, policy should focus more on long-term behavioral nudges, community-led adoption efforts, and sustained financial mechanisms, rather than relying solely on connection metrics.

Way forward

To ensure sustained use of LPG and to improve its effectiveness, the issues in the current policy should be addressed with the mid-course policy changes. Subsidies are already available to BPL households under PMUY but there is need to lower the refill cost and timely distribution to make LPG accessible to the poor. LPG will not be adopted unless it is made cheap. Proper monitoring is required to check that no Above Poverty Line (APL) households takes the LPG connection by submitting false information under PMUY. Furthermore, the government is advised to promote the use of technology for accurate and trustworthy data, as well as the proper distribution of cylinders, in order to discourage the illegal sale, commercialisation, or collection of LPG cylinders for private usage by people. In rural places, women use fuelwood to cook because they feel it tastes better than food cooked with LPG. The government and other stakeholders, such as NGOs, must change people's attitudes by organizing capacity building programmes that emphasize the health and environmental impacts of burning fuelwood. To lessen reliance on conventional cooking fuels, the government should raise the MGNREGA coverage in India. To ensure universal coverage of LPG as a cooking fuel, providing poor households with access to clean cooking fuel should be made a national priority in order to meet SDG's 2030 target. This can be further achieved by focusing on community-led initiatives, coupled with an innovative financial model that makes LPG adoption more practical for low-income households. When local communities take ownership—through self-help groups, cooperatives, or village-level monitoring—they're more likely to spread awareness and support consistent usage. At the same time, flexible payment systems like pay-as-you-go models or micro-financing options could ease the upfront cost burden, helping households make the switch without financial strain. Together, these approaches can complement existing subsidies and awareness efforts by making the transition to clean cooking more accessible, affordable, and sustainable in the long run.

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