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Uses of Clean Cooking Fuels and Forecasting the Rate of Population Access it in India with Reference to Global World

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Abstract

People use solid fuels such as firewood, cow dung cakes, coal, and agricultural residues to prepare their milk and other purposes. The use of solid fuels for cook food in households with poor ventilation leads to household air pollution and harmful impacts on health. Energy is at the heart of many of the Sustainable Development Goals (SDGs), considering the expansion of access to electricity, the improvement of clean cooking fuels, and the reduction of wasteful energy subsidies to restrain deadly air pollution, which prematurely kills millions of people every year around the world. SDG 7 is about energy, where target 7.1 consists of two targets, i.e., 7.1.1 access to electricity and 7.1.2 access to clean cooking fuels. The present study is based on secondary data and a comparative analysis of the use of clean cooking fuels in India and around the world. It attempted to find out the differences in access to clean cooking fuels in India and the global world. It is found that India will achieve universal access to clean cooking fuels considering the rate at which the population accesses clean fuels, ignoring the other factors, but the global population will fail and only high-income countries will achieve this.

Key words:*Solid fuels, Clean cooking, Air pollution, Energy, Sustainable Development Goals*

1. Introduction

People use solid fuels such as firewood, cow dung cakes, coal, and agricultural residues to cook food and for other purposes. The burning of solid fuels to prepare food on simple cookstoves in households with poor ventilation leads to household air pollution and harmful impacts on health (CEEW, 2021). As per the report of the World Health Organization (WHO) in 2012, mostly in low and middle-income countries, nearly 3 billion people lacked access to clean or modern energy services for cooking, leading to around 4.3 million premature deaths in the world. In India, household air pollution that occurs from burning solid fuels is a significant contributor to the total disease burden, with nearly 6,00,000 deaths in 2019 (CEEW, 2021). In India, 68% of the population accesses clean cooking fuels, whereas 54% are rural and 90% are are urban,, as per a report by the the WHO. Clean cooking is one of the targets of SDG 7, where target 7.1 comprises two targets, i.e., 7.1.1 access to electricity and 7.1.2 access to clean cooking fuels. The global population without access to clean cooking remained largely unchanged from 2010 to 2018, standing at close to 3 billion (Tracking SDG7, 2020). The rate of increase in access to clean cooking has even slowed since 2012, less than the population growth in some countries. The policy should increase the rate to ensure universal access to clean cooking with SDG target 7.1.2.

In 2014, WHO issued guidelines on clean fuels and technologies for household cooking, heating, and lighting. The WHO guidelines are aimed at public health strategy makers and scientists who work with energy, environment, and related sectors to formulate and implement policies that minimize the negative impact of

household fuel burning on an individual's health. According to the new standards for clean combustion, any type of cooking stove is considered clean if its emissions meet WHO guidelines. Clean cooking energy is electricity, LPG/PNG, ethanol, solar, and improved cooking stoves based on biomass. The International Organization for Standardization (ISO) has considered a set of voluntary performance targets (VPTs) that align with the WHO guidelines. Considering VPTs for cook stoves based on laboratory testing, a stove that reaches tier 4 or tier 5 for particulate matter (PM) 2.5 emissions based on voluntary performance targets (VPTs) is classified as clean for PM2.5[1] emissions (WHO, 2014).

1. Particulate matter is sum of all solid and liquid particles suspended in air many of which are hazardous

So many researchers all over the world have studied about the accessing clean cooking fuels and technologies and their determinants. However, a comparative analysis of clean cooking fuel use in India and the global world has not been found. D'sa and Murthy (2004) stated that various factors determined the choice of clean fuel as a cooking fuel, such as household price, income, accessibility, price, and the availability of multiple fuels. Fuel choice disparity exists between rural and urban households and also across states (Kumar, Viswanathan, and Kumar, 2005). Affordability plays a major role, while the pro-rich and pro-urban bias supply of fuels through public followers and distribution systems has also influenced the observed variation in consumption patterns across states and over rural and urban areas. Pohekar et al. (2005) found that India follows an income-based ladder, starting with fuelwood and ending with sophisticated fuels like liquefied petroleum gas (LPG) and electricity.Ouedraogo (2006) found that the use of firewood reduces when the income of households increases. Low household standards, household size, and high frequency of cooking certain meals using wood fuel as cooking energy Danesh Miah et al. (2009) stated that biomass fuel use per family per day largely depends on family size, family income, amount cooked, and burning time. Eric Johnson (2009) found that LPG is more efficient than charcoal in its production and considerably more efficient in cooking. Pandey and Chaubal (2011) found that educated females between 10 and 50 years of age, average household education index, regular salary, and monthly per capita consumption expenditure have a positive and significant impact on the use of clean cooking fuels, whereas below the poverty line, belonging to reserved caste categories, family size, and size of farmland have a significant negative linkage. Takama et al. (2012) revealed that ignoring the price and uses of cost factors, high wealth, and product-specific factors affects stove and fuel choices. They stated that consumer preference for higher-quality fuels and stoves tends to increase with increasing wealth. Hager and Morawicki (2013) found fuel sources and energy required to properly cook vary due to fuel source, appliance, and consumer behavior status. Choices of individual preparation and cooking are the main determinants of energy consumption in a country. Duan et al. (2014) stated that there was a negative correlation between income level and solid fuel use. According to Smith and Sagar (2014), there are more fundamental barriers to treating household air pollution seriously in India, including a refractory bias against rural areas illustrated by slow growth in rural female education and status; that is, rural women do not want to change away from biomass but rather do things just as their mothers did. Karimu (2015) found education, availability of LPG, access to modern infrastructure, household location, and income were the key factors that influenced the choice of modern fuel. Rahut et al. (2016) reviewed female-headed households; household heads with a higher level of education and urban and wealthy households are more likely to use modern energy sources such as electricity and LPG and are less likely to use solid fuels. Troncoso and Silva (2017) found that subsidies for LPG have substantially contributed to accelerating the transition from solid fuels to clean fuels for cooking. Poblete-Cazenave and Pachauri (2018) stated that as long as incomes rise and the relative difference between the prices of biomass and cleaner fuels decreases, households will transition to cleaner cooking fuels. Paudel et al. (2018) found that decreasing poverty and increasing educational level significantly increase the probability of switching from dung fuel to higher-level alternative fuel types such as gas, wood, and household shrubs. Rahut et al. (2019) stated that low-income families with a lower level of household education are likely to depend on dirty fuel, while household heads with higher human capital and physical and financial assets are more likely to use modern fuel. Sharma et al. (2019) stated that income linkages with LPG use may be weak in regions with a high prevalence of home-produced or collected solid fuel consumption. Gould et al. (2020) found that education leads to LPG adoption, but not through attitudinal changes. Choudhuri and Desai (2020) found women's access to salaried work and control over household expenditure decisions are associated with the use of clean fuels.

Kapsalyamova et al. (2021) stated that households with higher expenditure per capita or larger dwelling unit areas are less likely to use solid fuels for cooking and are more likely to use clean fuels. Neto-Bradley et al. (2021) identified awareness and access to subsidy programs, safety concerns, and weak community networks as key barriers to choosing clean fuels. Hsu et al. (2021) stated that promoting LPG usage through microloans for equipment is likely to be both commercially viable and beneficial to health through decreased use of polluting biomass fuels and household home-produced

Many studies have found that various socio-economic factors are the determinants of clean cooking fuels. It is also found that dirty cooking fuels have a direct and indirect impact on socioeconomic health as well as the environment.

2. Objectives

The present study attempts to find out the following objectives:

1. To analyze comparatively clean cooking fuel use between India and the global world.
2. Forecasting the uses of clean cooking fuels in India and the global world till 2030
3. To identify the government policies to improve the use of clean cooking fuel in India.

3. Methodology

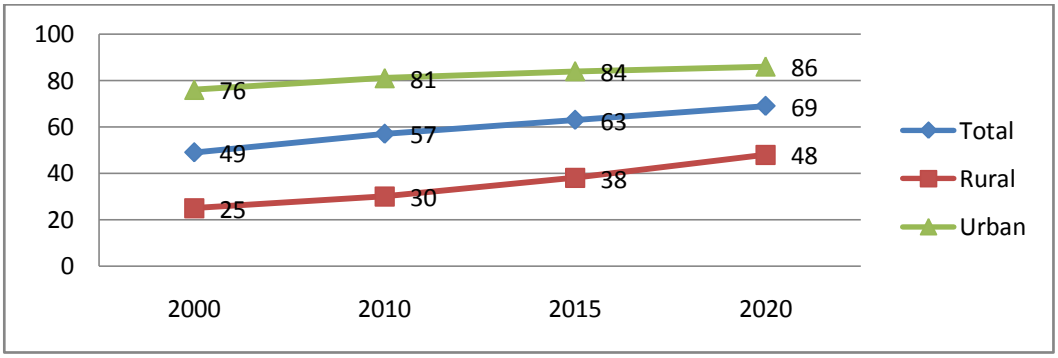
The present study is based on secondary data. Secondary data are collected from different sources like books, journals, government official websites, and international organizations. It is based on the use of clean cooking fuels in India and around the world. The data are analyzed in a simple table, pie chart, percentage, histogram, trend line, and forecast using a time series expert modeler with the help of Excel and SPSS.

4. Rate of population access to clean cooking fuels in India and the global world

The United Nations Development Program (UNDP) set 17 Sustainable Development Goals (SDGs) in 2015, and among these goals, SDG 7 is Affordable and Clean Energy. Target 7.1.2 of SDG 7 looks at the proportion of the population that uses primary clean fuels and technologies. According to the SDG 7 Tracking Report 2020, about 2.6 billion people in the world lack access to clean cooking fuels and technologies. Global access to clean fuels increased by only 1 percent annually between 2010 and 2019, and if it continues, only 72 percent of the population will have access to such fuels and technologies by 2030. To achieve the target of universal access, the rate of increase needs to be greater than 3 percentage points per year. Some countries have shown encouraging results in moving towards this target. There are variations in access across the global world due to different regimes like policy, economics, and social behavior.

The population had access to clean cooking fuels. It was 57%, 63%, and 69% in 2010, 2015, and 2020, respectively. In Figure 1, the overall world population accessing clean cooking fuels trend line is in the middle between urban and rural areas. While urban areas are above, rural areas are below the overall world since in urban areas more people access clean cooking fuels than in rural areas over different periods.

Figure 1: Percentage of Population access Clean Cooking fuels in Global World



Source: World Bankhttps://data.worldbank.org/indicator/EG.CFT.ACCS.ZS

Table 1: Percentage of population accessing clean fuels in the world

Year	Total	Rural	Urban
2000	49	24	76
2005	52	26	78
2010	57	30	81
2015	63	38	84
2020	70	48	86
2025*	77	65	88
2030*	86	77	91

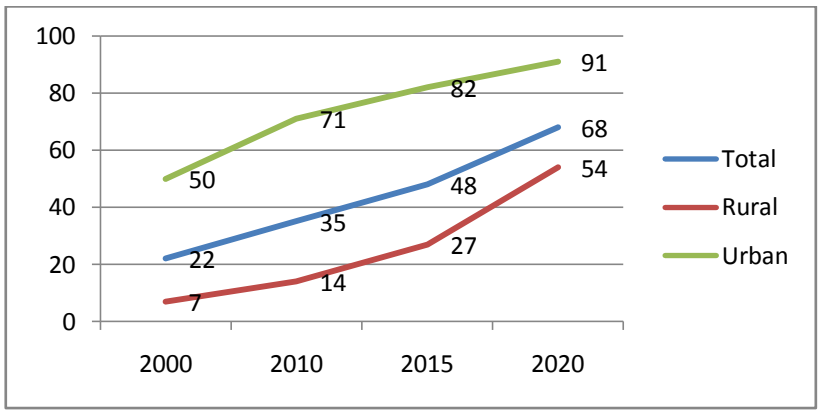
Source: World Bank

https://data.worldbank.org/indicator/EG.CFT.ACCS.ZS

*Forecasting value using time series expert modeler

Table 1 shows forecasting the rate at which the population will access clean cooking fuels till 2030 using the traditional time series model. It was found that the total population of the world failed to achieve universal access to clean cooking fuels by 2030, since only 86% of the world population will have access to clean cooking fuels, compared to 91% of the urban population and only 77% of the rural population.

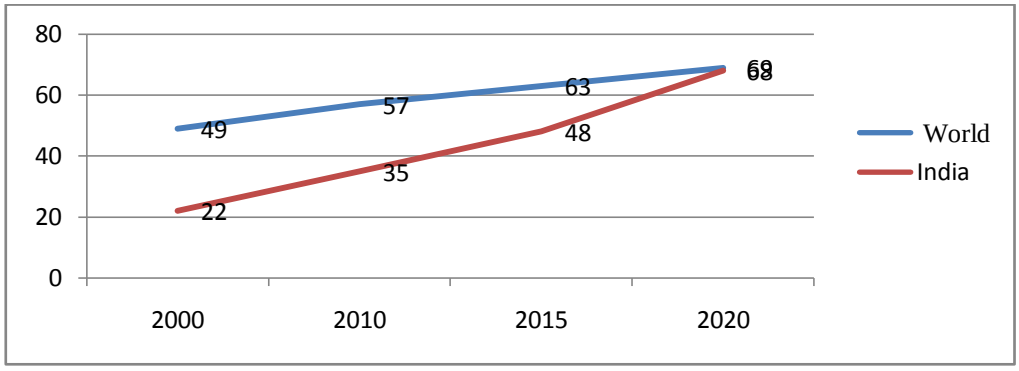
Figure 2: Rate of Population access to Clean Cooking fuels in India



Source: World Bankhttps://data.worldbank.org/indicator/EG.CFT.ACCS.ZS

Figure 2 revealed that the percentage of the urban population is higher than that of the rural population, and overall, they access clean fuels over different periods. In 2000, 22% of the Indian population accessed clean cooking fuels, which increased to 68% in 2020. In rural areas, it was only 7% and 50% in urban areas in 2000. In 2020, it will be 54% in rural areas and 91% in urban areas.

Figure 3: Accessing Clean Cooking Fuels in India and Global World (Population %)



Source: World Bankhttps://data.worldbank.org/indicator/EG.CFT.ACCS.ZS

Figure 3 shows the simple trend lines for accessing clean fuels in India and the global world. It was found that in the initial year 2000, there was a large gap between two trend line curves. But the gap reduces when curves move from 2000 to 2010, 2015, and 2020. In 2000, the gap was 27%, i.e., the Indian percentage of the population that has access to clean cooking fuels compared to the world is less than 27%.11%, The gap in the rate of population access to clean cooking fuels was reduced to 22%, 11%, and 1% in the years 2010, 2015, and 2020, respectively. Thus, the gap in the percentage of the population that accesses clean cooking fuels in India and the world reduced, and it was almost the same in 2020, i.e., 69% in the world and 68% in India. If compared with the rest of the world, India has significantly improved access to clean cooking fuels.

Table 2: Rate of Population accessing clean cooking fuels in India

Year	Total	Rural	Urban
2000	22	7	50
2005	29	10	61
2010	35	14	70
2015	48	27	82
2020	68	54	92
2025*	88	87	98
2030*	108	128	105

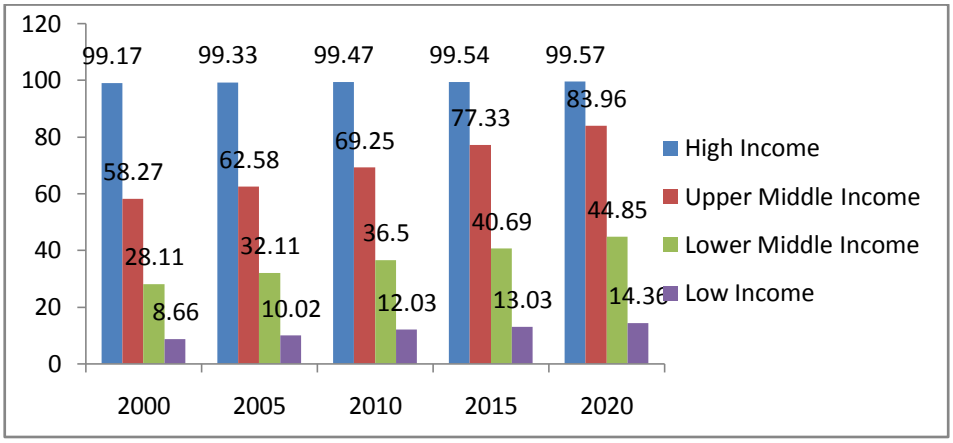
Source: World Bank

https://data.worldbank.org/indicator/EG.CFT.ACCS.ZS

*Forecasting value using tradtitional time series expert modeler

Table 2 shows the prediction of accessing clean cooking fuels, and future predictions are considered based on the rate of population access to clean cooking fuels in the past few years. It is observed that clean cooking fuels will be accessed by 100% of the population of India by 2030 in both rural and urban areas, which implies that the target of 7.1.2 universal access to clean cooking fuels by 2030 will be achieved. However, the percentage of the rural population that accesses clean cooking fuels was very low in the beginning, but from 2010 on, growth became very fast, i.e., 14% in 2010, 27% in 2015, and 54% in 2020.

Figure 4: Rate of Population Accessing Clean Cooking Fuels in Different Income Group of World



Source: World Bank https://data.worldbank.org/indicator/EG.CFT.ACCS.ZS

In Figure 4, the percentage of the world population of different income-group countries that access clean cooking fuels is shown. It is revealed that in high-income countries, approximately 100 percent of the population has access to clean cooking fuels over the years. It is seen that upper middle-income countries' percentages of the population accessing clean cooking fuels have increased at a constant rate over the years, as shown in Figure 4. In around 80 countries, 84% of the population will access clean cooking fuels in upper-middle-income countries in 2020. The lower-middle-income countries'periods, population accessing clean cooking fuels increases over the different periods but lower-upper-middle-classlowerupper-middle-class countries It was found that only 45 percent of the population will access clean cooking fuels in lower-middle-income countries in 2020. Again, in low-income countries, the population accessing clean cooking fuels is approximately very low, i.e., only 9% of the population accessed clean cooking fuels in 2000, and even in 2020, it is only 14% of that population.

It can be statedthat from Figure 4, income is the main determinant of accessing clean cooking fuels since in high-income countries, 100% population access clean cooking fuels. It is also reflected from Figure 4 that the access to clean cooking fuels is 84%, 45%, and 14% in upper-middle-income, lower-middle-income, and low-income countries, respectively, in 2020.

Table 3 : Different income group countries population (%) accessing clean cooking fuels

Year	High income	Low income	Middle income	Upper Middle income	Lower middle income
2000	99	9	26	58	26
2005	100	10	45	62	31
2010	100	12	52	69	38
2015	100	13	60	78	47
2020	100	15	70	84	59
2025*	100	17	80	89	71
2030*	100	18	92	95	82

Source: World Bank https://data.worldbank.org/indicator/EG.CFT.ACCS.ZS

***Forecasting value using time series expert modeler**

Table 3 shows that only high-income countries with a 100% population will access clean cooking fuels by 2030, but low-income countries will not be able to universally access clean cooking fuels by 2030. Among different

income group countries, only 18% of the population will be accessed clean fuels in low-income group countries by 2030, where middle income is at 92%, upper middle income is at 95%, and lower middle income is at 82%.

Table 4: Cooking fuels used in India

Area	Firewood	LPG	Dunk Cake	Others	No Cooking
Rural	44.5	48.3	5.5	1.1	0.6
Urban	5.6	86.6	0.5	3.2	4.1
India	31.2	61.4	3.8	1.8	1.8

Source: NSS 76th Round, 2018

Table 4 shows the different sources of cooking fuel used in India. In India, 61% of households use LPG as a cooking fuel, i.e., accessing clean cooking fuels. Considering the urban and rural areas, 87% of households access clean cooking fuels in urban areas and only 48% in rural areas. Firewood is the main source of cooking fuel in rural India since 45% of rural households use it, compared to 6% in urban area.

5. Indian Government Policies to improve clean cooking fuels

Throughout this paper, we found poor access to clean cooking fuels in rural areas of India in the earlier period. To improve this poor access to clean cooking fuels, the government has started various schemes for LPG that is easily accessible and affordable for low-income families.

Direct benefit transfer for LPG (DBTL) was launched on June 1, 2013, while 291 districts were covered first, and later it was extended to whole districts of the country to provide subsidies directly in beneficiaries' bank accounts (Ministry of Petroleum and Natural Gas, Government of India). The main objectives of this program are to remove subsidy diversion and clear out fake connections.

The 'Give It Up campaign was launched on March 27, 2013 for middle-class families give up their LPG subsidy and it could be transferred to low-income families. Through this program, around 1.13 million people have given up their subsidies.

Pradhan MantriUjjawalYojana (PMUY) was started in 2016 to help females from families below the poverty line (BPL) get LPG. The main objectives of this programme were to empower women and avoid health risks that result from the use of solid fuels for cooking. Under this world-wide clean cooking energy program, more than 80 million Indian households benefited between 2016 and 2019. As per the 76th round of the NSSO, 48% of rural households are using LPG in India.

In India, the cost of piped natural gas is less than LPG. As per data released by the Petroleum Planning and Analysis Cell (PPAC) in September 2021, 8,217,913 were connected in the country. However, around 29 crore households were not connected yet due to a lack of infrastructure to deliver natural gas through pipes for the purpose of domestic cooking.

The Union ministry of power launched the "Go Electric" Campaign on February 2021with aim to creating awareness among the masses about the advantages of preferring electrical cooking appliances such as induction cooktops, electric pressure cookers, etc. In some events, Union Power Minister RK Singh has highlighted the practice of clean and safe electric cooking and advised people to use e-cooking, which is advantageous to consumers due to the low heat waste during the cooking process (Sinha, 2022).

6. Summary of findings

The following findings are identified throughout the analysis and discussion of this paper:

i. It was found that 69% of world population accessed clean cooking fuels, 86% in urban areas and 48% in rural areas in 2020.

ii. In India, 68% of the population accessed clean cooking fuels in 2020. The majority of urban population accessed clean cooking fuels (91%), while in rural areas it was less than urban (54%)

iv. It is found that access to clean cooking fuels varies on the basis of the income of the countries. In high-income countries, 100% of the population has access to clean cooking fuels. It is 84%, 54%, and 14% in upper middle, lower middle, and lower income countries, respectively in 2020. It is also seen that the growth rate of population access to clean fuels is very low in low-income countries.

v. As per NSS 76th round 2018, 61 percent of Indian households using LPG, of which 48% are rural and 87 are urban.

vii. It is found that only around 5% of Indian households use electric cooking, of which nearly 10% are urban and 3% are rural (Agarwal et al,, 2021).

viii. Most Indian households do not use LPG in cooking due to various reasons like high connection costs, monthly expenses, required documentation, and too much available traditional biomass, and prefer to cook with firewood (Agarwal et al., 2021).

ix. SDG 7.1.2: Universal access to clean cooking fuels by 2030 will not be achieved if such a growth rate continues, but interestingly India will be achieved if such a growth rate continues.

x. It is clear that only high-income countries will achieve universal access to clean cooking fuels by 2030, but remaining different groups like low-income, upper-middle-income, lower-middle-income countries will not.

7. Policy implications

To achieve universal access to clean cooking fuels by 2030, the following recommendations are put forward to improve the use of clean cooking fuels in India as well as in the global world:

i. To achieve the target of universal access to clean cooking fuels by 2030, every nation needs to take more initiatives and large-scale investments.

ii. The government should take more initiative to provide efficient energy for cooking and create awareness programs about the use of dirty fuels that impact health as well as the environment.

iii. The Government must provide training to the community, especially women, on how to use clean cooking fuels efficiently.

iv. The government should take the initiative to provide LPG home delivery services to 100% of the customers and also make available centres that would be the nearest to the customers.

v. The government should adopt a policy that enables every household to use e-cooking efficiently at a stable price.

vi. Most of the researchers stated that level of women's education is one of the factors that impact the use of clean cooking fuels, and so the government has also given priority to women's education to make use of clean cooking fuels efficiently.

8. Conclusion

Accessing clean cooking fuel is one of the indicators of SDG 7 universal access by 2030.Considering the current scenario of clean cooking fuel access in the developing world, the target of universal access to clean cooking by 2030 as per SDG 7 of the United Nations, 2015 cannot be achieved. It will depend on various factors, including large investments, stakeholder participation, and a dynamic strategy and policy apparatus. To enhance the rate of access to clean cooking around the world, it has been estimated that a large-scale investment would need around $4.4 billion annually (Sinha, 2022). In India, most households use traditional solid fuels in cooking, even if they have LPG, which impact on environment and personal health problems, especially for women and children. Thus, effort should be given to the transition of traditional solid fuels to more energy-efficient modern cooking fuels to reduce smoke emissions, time needed to procure fuel, and time spent cooking. Most of the rural

women are illiterate and they don't about the adverse effects of solid fuels,that so the government and local agencies should give priority to women's education and awareness programs on clean cooking fuels.

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