Policy Brief

Access to Clean Cooking Energy in India

Beyond connections, towards sustained use

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DEUTSCHE ZUSAMMENARBEIT

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CEEW Council on Energy, Environment & Water

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Contents

List of Acronyms and Abbreviations

ALRI	Acute Lower Respiratory Infections
AP	Above Poverty Line
BCM	Billion Cubic Metre
BDTC	Biogas Development and Training Centre
BIS	Bureau of Indian Standards
BLEN	Biogas/ LPG/Electricity/Natural Gas
BPL	Below Poverty Line
CEEW	Council on Energy, Environment and Water
CCE	Clean Cooking Energy
CFA	Central Financial Assistance
CGD	City Gas Distribution
CSO	Central Statistics Office
CSP	Concentrated Solar Power
DBTL	Direct Benefit Transfer for LPG
DDUGJY	Deen Dayal Upadhyaya Gram Jyoti Yojana
EMI	Equated Monthly Instalment
E&P	Exploration and Production
EESI	Environmental and Energy Study Institute
FY	Financial Year
GAIL	Gas India Limited
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GTF	Global Tracking Framework
HAP	Household Air Pollution
HPCL	Hindustan Petroleum Corporation Limited
IARC	International Agency for Research on Cancer
ICS	Improved Cookstove
IEA	International Energy Agency
IESS	India Energy Security Scenarios
INR	Indian Rupee
IOCL	Indian Oil Corporation Limited
IPPL	Indian Oil Petronas Private Limited

KVIC	Khadi and Village Industries Commission
LPG	Liquefied Petroleum Gas
MMT	Million Metric Tonne
MMTPA	Million Metric Tonne Per Annum
MNES	Ministry of Non-Conventional Energy Sources
MNRE	Ministry of New and Renewable Energy
MoC	Ministry of Coal
MoP	Ministry of Power
MoPNG	Ministry of Petroleum and Natural Gas
NBCI	National Biomass Cookstoves Initiative
NBMMP	National Biomass and Manure Management Programme
NGO	Non-Governmental Organisation
NPBD	National Project on Biogas Development
NPIC	National Programme on Improved Chulhas
NSSO	National Sample Survey Office
OGJ	Oil and Gas Journal
O&M	Operation and Maintenance
OMC	Oil Marketing Company
PMUY	Pradhan Mantri Ujjwala Yojana
PNG	Piped Natural Gas
PNGRB	Petroleum and Natural Gas Regulatory Board
PPAC	Petroleum Planning and Analysis Cell
RGGLVY	Rajiv Gandhi Gramin LPG Vitaran Yojana
RLNG	Regasified Liquefied Natural Gas
RSP	Retail Sale Price
SDG	Sustainable Development Goals
SECC	Socio-Economic Caste Census
SNA	State Nodal Agency
TERI	The Energy and Resources Institute
UCA	Unnat Chulha Abhiyan
VGF	Viability Gap Funding
WHO	World Health Organization
WLPGA	World LPG Association

Executive Summary

The use of traditional biomass cookstoves causing incomplete combustion compounded with poor ventilation expose users to high levels of indoor air pollution and have severe adverse health impacts. In 2016, the **International Energy Agency estimated that of the global total of 3.5 million premature annual deaths from household air pollution (HAP), India alone is home to one million**. Apart from premature deaths, large numbers of people suffer from the morbidity caused by HAP. Access to clean cooking energy, therefore, is critical to the health of millions of women and children exposed to the smoke from the burning of traditional biomass. Furthermore, the use of traditional biomass for cooking also leads to the drudgery of collecting fuel, which is borne exclusively by women. The time spent by women on firewood collection and cow dung preparation prevents them from allocating time to productive activities and leisure. The 68th round of the NSSO (2011–12) reveals that over two-thirds of households in rural India still rely on firewood and chips for their cooking needs. Use of firewood and chips for cooking has declined very slowly over the years in rural India, from 78.2 per cent of all rural households in 1993–94 to 67.3 per cent in 2011–12, despite the increase in LPG use from less than 2 per cent of rural households 1993-94 to 15 per cent in 2011–12.

Given the size of the population deprived of energy access, India plays an important role in the efforts to achieve Goal 7 of the Sustainable Development Goals, that is, to provide access to affordable, reliable, sustainable, and modern energy services for all by 2030. This goal is inherently linked to Goal 3 (Ensure health and well-being for all) and Goal 5 (Achieve gender equality and empower all women and girls). To that end, the government has made significant efforts to enhance access to clean cooking energy in India. This is reflected in government policies and programmes for the promotion of biogas, improved cookstoves, and LPG. The government has also envisioned newer solutions, including electricity and piped natural gas (PNG), for meeting the energy demand for cooking in India. However, the implementation of these policies and programmes has suffered from various challenges, both at local and national levels. Further efforts are required to ensure the sustained use of cleaner fuels.

The challenges presented by affordability and accessibility of clean cooking fuel leads to the stacking of clean cooking energy with traditional biomass. Such stacking continues to expose households to indoor air pollution, resulting in adverse health impacts on women and children in particular.

The *Access to Clean Cooking Energy and Electricity - Survey of States* (ACCESS)[1] highlights the existing status and conditions of access to clean cooking energy in six Indian states having the highest population deprived of access to modern forms of energy:

- Less than 5 per cent of households used LPG exclusively. In contrast, 72 per cent of households used only traditional biomass.
- Only 22 per cent of households reported using LPG, yet more than one-third of them did not use it as their primary cooking fuel, indicating a high level of fuel stacking along with LPG.
- About 88 per cent of households not having LPG across six states in the survey reported

1 In 2014–15, CEEW, in collaboration with Columbia University, conducted the largest energy access survey of its kind in six Indian states having highest population deprived of access to modern forms of energy – Uttar Pradesh, Bihar, Jharkhand, Odisha, Madhya Pradesh, and West Bengal.

Sustained use of clean cooking energy is influenced by multiple factors like affordability of a connection, affordability of the recurring cost of the fuel, accessibility of the fuel, consumer awareness of the adverse health impacts of using traditional biomass, and success in overcoming behavioural challenges.

- As of 2011, while 53 per cent of households in India had an LPG connection, only 28 per cent used it as a primary source of cooking (Census, 2011).
- The latest, and the largest, effort by the government to improve access to clean cooking energy in the country is the Pradhan Mantri Ujjawala Yojana (PMUY), which provides free LPG connections to all SECC BPL households.
- Despite significant success in addressing the challenge of affordability of connections, and some improvements in the reliable availability of the fuel, the scheme falls short of addressing the challenges posed by affordability of the recurring cost of fuel and generating consumer awareness of the health impacts.
- Convergence of efforts aimed at generating demand for clean cooking energy and provision of reliable supply will be critical to the sustained use of clean fuels.

high recurring costs as one of the barriers to the adoption of LPG.

Shifting the focus to sustained use of clean cooking energy

Long-term health benefits can only result from sustained and universal use of clean cooking energy. Fuel stacking between cleaner and traditional fuels diminishes the benefits that accrue from the use of clean cooking energy.

Given the complex nature of the impacts of cooking energy on people, every solution must be appraised from a multidimensional lens.

- To eliminate exposure to pollution from the burning of traditional biomass, it is important to facilitate stacking between a mix of clean cooking fuels (which might be LPG, biogas, improved cookstoves, PNG or electricity), rather than one clean cooking energy option with the traditional *chulha*.
- Complementary solutions to enhance clean cooking energy access entail a collaborative effort by various ministries beyond only the energy-related ministries.

Access to clean cooking energy is not solely an energy access issue. Given that traditional cooking methods disproportionately impact women in terms of drudgery, adverse health outcomes, and lost opportunity cost of time, it is imperative to include them in the design and execution of solutions. In order to achieve significant progress in increasing sustained clean cooking energy access, there is a need to develop a coherent strategy that integrates access to clean cooking energy with the broader programmes for rural and human development.

1. Introduction

In 2012, about 840 million people in India relied – partially or fully – on traditional cookstoves to meet their cooking-energy needs (NSSO, 2012). Due to incomplete combustion and poor ventilation, the use of traditional biomass cookstoves exposes users to high levels of indoor air pollution, resulting in severe adverse health impacts. The International Energy Agency (IEA, 2016) estimated that of the global total of 3.5 million premature deaths from household air pollution (HAP) annually, India accounts for one million. The International Agency for Research on Cancer (IARC, 2017) lists HAP from the combustion of biomass as probably carcinogenic. Women and children, who spend a majority of their time inside the household and closer to cookstoves, are disproportionately affected. Furthermore, the World Health Organization (WHO, 2007) and Pope et al. (2010) find a consistent association between HAP and increased risk of percentage low birth weight and stillbirth across several datasets from developing countries. There is also a risk of children below five years of age developing symptoms of acute lower respiratory infections (ALRI) due to exposure to smoke from traditional cookstoves (Asante et al., 2016). Women also shoulder the responsibility of collecting firewood and preparing dung cakes, which prevent them from allocating time to productive purposes as well as leisure. Traditional cookstoves have adverse environmental impacts; they emit black carbon, a short-lived climate pollutant (SLCP) that has a global warming potential 4,000 times greater than that of carbon dioxide over a 20-year span (Cross & Pierson, 2013).

Given the complex nature of the impacts of cooking energy on people, clean cooking energy solutions must be appraised from a multidimensional lens. The issue of access to clean cooking energy is neither unidimensional nor binary. Jain, et al. (2015a) use the following dimensions as material aspects of clean cooking energy access, adapted from those of the Global Tracking Framework (GTF) for the Indian context:

- **Health and safety**, pertaining to the health impacts of HAP from, and safety during, the use of a specific source of cooking energy.
- **Availability** of the primary cooking fuel[2] to the household on a regular basis.
- **Quality of cooking** associated with the primary cooking arrangement.
- **Affordability** of cooking energy source(s) when contrasted with the total monthly household expenditure.
- **Convenience of cooking**, accounting for the time taken for cooking, ease of handling cooking appliances, as well as flame control or heat intensity.

While there is no universally agreed upon definition of clean cooking energy, the term is used to refer to cooking solutions that result in low or no HAP (particulate matter and carbon monoxide) and in outdoor air pollution in the form of black carbon emissions. Having been subsidised for over three decades, liquefied petroleum gas (LPG) is now the predominant clean cooking fuel in urban India. While the government has taken steps to increase the penetration of not only LPG, but also of alternatives like biogas, PNG, improved cookstoves (ICS), and electricity-based cookstoves, there has been limited focus on the sustained use of these options. To mitigate the adverse health impacts of traditional biomass cookstoves, it is essential to devise policies that encourage fuel stacking[3] be-

2 Primary cooking fuel is defined as the fuel most used by the household for cooking. It could also be defined as the fuel used by the household for cooking the two main meals of the day.

3 The use of multiple fuels and stoves, known as fuel stacking, is a very common phenomenon where households tend to

tween clean cooking fuels and make way for a permanent shift away from traditional biomass cookstoves.

This policy brief reviews the existing policies pertaining to clean cooking energy, analyses a broad range of demand- and supply-side challenges that hinder the penetration and sustained use of clean cooking energy solutions, and proposes an interdisciplinary and multidimensional national approach for addressing these issues.

Section 2 of the brief outlines the existing policies for various clean cooking energy solutions, and assesses the achievements thus far. Section 3 examines the various challenges and policy responses to address the lack of demand and supply for clean cooking energy solutions. Section 4 elucidates the need to complement the existing focus on LPG with an equal focus on other fuels and technologies. Section 5 proposes an approach for designing a comprehensive ten-year clean cooking energy roadmap for India, that will bring together various government ministries and agencies to take this initiative forward.

use a primary fuel such as LPG only for selected cooking activities while also using other fuels for cooking.

2. Existing policies and efforts to improve access to clean cooking energy

2.1 Biogas

The National Project on Biogas Development (NPBD), launched in 1981, was the first national policy for promoting biogas plants. It was renamed the National Biogas and Manure Management Programme (NBMMP) in 2003. The programme offers Central Financial Assistance (CFA) for family-type biogas plants. MNRE provides support for training users, turnkey workers, and staff on the benefits of biogas plants and on regular operations and maintenance (O&M) requirements. The activities under NBMMP are carried out by the State Nodal Departments and Agencies, the Khadi and Village Industries Commission (KVIC), and the Biogas Development and Training Centres (BDTCs).

Against an estimated potential of 12.3 million biogas plants across the country, as of 31 December 2016, only 4.9 million (~40 per cent) had been constructed (MNRE, 2017a). An evaluation of 429 NBMMP systems across 13 states by the Comptroller and Auditor General of India (2015) revealed that only 74 per cent of installed plants were functioning. The condition of most of the non-functional plants was due to non-availability of raw material, structural (construction-related) problems, O&M challenges, and improved availability of LPG in those areas (CAG, 2015). While biogas offers great potential for unlocking access to clean cooking energy for millions, in recent years, the annual NBMMP target has not been met (Chandrasekaran, 2016). A senior official at MNRE confirmed that only 55 per cent of the NBMMP annual target for 2016–17 had been met. The completion rate has been declining over the years – 85.5 per cent in 2012–13, 79 per cent in 2013–14, 77 per cent in 2014–15, and 51.3 per cent in the 10 months of 2015–16 (MNRE, 2016).

2.2 Improved Cookstoves (ICS)

The National Programme on Improved Chulhas (NPIC), the first programme to support ICS, introduced 35 million chulhas in the period from 1986 when it was launched to 2002 when it was discontinued (MNES, 2004). In 2009, MNRE launched the National Biomass Cookstoves Initiative (NBCI) to continue R&D in ICS, with several pilot projects being launched to improve stove efficiency and to demonstrate the benefits of ICS using existing technology (MNRE, n.d.). It also included initiatives on carbon finance for biomass cookstoves to reduce prices and to increase affordability. MNRE collaborated with GIZ, Germany to develop a Programme of Activities (PoA) for a Clean Development Mechanism (CDM) in biomass cookstoves, which was submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2012 (MNRE, n.d.). To follow up NBCI, which resulted in revised standards and test protocols for ICS, the Unnat Chulha Abhiyan (UCA) was launched in 2014 with the aim of deploying 2.4 million household-level and 350,000 community-level ICS by March 2017 with an INR 294 crore budget (MNRE, 2014a). However, an MNRE official associated with UCA confirmed that only 1.3 per cent of the target was met by the date of programme completion, with much of the budget having lapsed unutilised.

2.3 Electricity-based Cooking

NITI Aayog's estimations suggest that under the 'Determined Effort' scenario of India Energy Security Scenarios 2047 (IESS), 26 per cent of rural households are expected to use electricity for their primary cooking needs by 2047 if all government rural electrification and cooking energy programmes are implemented as planned and scheduled (NITI Aayog, n.d.). At present, there is no national strategy to popularise or deploy electricity-based cooking options. Much of the success of such cooking solutions will depend on the achievement of the government's intention of electrifying all households with 24x7 supply by 2022 (PTI, 2015). However, rural electrification schemes such as the Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) in their current form merely look at electrification, but not the reliability of the electricity supply, which is just as important for the effective use of electricity as a primary source of cooking energy.

2.4 Piped Natural Gas

The central government has been promoting the use of PNG in cities by allocating domestically produced gas (which is cheaper than imports) to city gas distributors (CGDs) at a uniform price. In 2014, the government revamped the allocation policy, giving CGDs first priority for the receipt of domestically produced natural gas and helping them keep PNG prices low (PTI, 2014). As of October 2016, city gas distribution of natural gas has commenced in 45 towns and cities across the country, with pipelines under construction in at least 29 more areas (PNGRB, 2016a). Over 60 per cent of the sales of PNG in the first six months of 2016–17 came from Gujarat (PNGRB, 2016b), which is also the state with the largest number of PNG connections. To improve the penetration of PNG in other urban areas, the government allocates viability gap funding (VGF) to CGDs if required. Policies that increase the availability of PNG in urban areas help reduce their reliance on LPG; this helps in diverting LPG to rural areas.

2.5 Liquefied Petroleum Gas

While the central government has been providing LPG subsidies in various forms since the 1970s, its latest efforts have been geared towards the more focused targeting of beneficiaries. The Direct Benefit Transfer for LPG (DBTL) attempts to curb leakages by transferring the subsidy directly into the bank account of beneficiaries. The 'Give It Up' campaign encourages well-off households to give up their subsidy, so that the benefits can be diverted to households that most need them. The campaign has seen over 10.5 million people volunteering to give up their subsidy (MyLPG, 2017). To complement this voluntary programme, the government also made the subsidy unavailable to households where the primary consumer or his/her spouse has taxable income of more than INR 10,00,000 in the previous financial year (Raghavan, 2015).

The government's current flagship programme, the Pradhan Mantri Ujjwala Yojana (PMUY), with a budget of INR 8,000 crore, subsidises the connection cost to provide LPG to BPL households against the name of the female head of household, with BPL identified as in the Socio-Economic Caste Census (SECC) 2011 (MoPNG, 2016a). PMUY households get a cylinder and a regulator; they need to pay for the gas stove and for the first refill (upfront or through later instalments). The payment instalments are recovered from the subsidy received on the refills. The households pay the market price for cylinders until the costs of the gas stove and of the first refill are recovered. Against the first-year target of providing 15 million connections, PMUY has already provided 22 million connections (FE Bureau, 2017; MoPNG, 2017a).

The government has also attempted to improve access to LPG by expanding the distributor network in rural areas through the Rajiv Gandhi Gramin LPG Vitaran Yojana (RGGLVY). This scheme helped increase the share of rural distributorships from 14 per cent since its launch in 2009–10 to over 40 per cent in 2016–17 (Dubey, 2017). RGGLVY was succeeded by the

Unified Distribution Guidelines, which relaxed the eligibility and financial criteria for distributorships in an attempt to rapidly expand the LPG network, while mandating that distributors develop infrastructure for the home delivery of LPG cylinders to reduce barriers to refills (MoPNG, 2016b).

However, the government's strategy for increasing LPG usage must go beyond expanding the distribution of connections; it must also promote the sustained use of LPG as a primary cooking fuel. It is likely that few PMUY beneficiaries are returning for refills (Jha, 2017), implying that households might have LPG but are still using traditional biomass cookstoves for their primary needs.

3. Penetration and sustained use of clean cooking energy in India

The 68th round of the NSSO (2011–12) reveals that over two-thirds of households in rural India still rely on firewood and chips for their cooking energy needs. Use of firewood and chips for cooking in rural India has declined very slowly over the years, falling from 78.2 per cent of all rural households in 1993–94 to 67.3 per cent in 2011–12, despite the increase in LPG use from less than 2 per cent of rural households 1993-94 to 15 per cent in 2011–12.

The ACCESS[4] study revealed that only 14 per cent of households in rural areas reported using Biogas, LPG, Electricity and Natural Gas (BLEN) as their primary source of energy for cooking (Jain, et al., 2015a). Connections of ICS, biogas plants, or LPG do not necessarily translate into people having access to clean cooking energy (Jain, et al., 2015a). Hence, there is a need to understand access to clean cooking energy beyond the device or the connection, and instead to address the issue from a multidimensional perspective of health and safety, availability of fuel, affordability and convenience of the solution, and quality of the cooking.

3.1 Demand for clean cooking energy

Demand for clean cooking energy is determined by several factors, both within and beyond the purview of economics. Awareness of the impact of traditional biomass on the health of women and children could influence the adoption of clean cooking energy. According to ACCESS, over 50 per cent of households that acknowledged the impact of traditional cookstoves on the health of family members were interested in getting LPG, as compared to 36 per cent of households that did not think so. Income level, stove and fuel prices, and availability and reliability of distribution infrastructure are the major factors contributing to fuel switching for households (Heltberg, 2004). Some documented factors that influence household demand for clean cookstoves include cash outlays for procuring fuel, lack of awareness of banking products, and perceived difficulties in gaining access to bank loans (GIZ, 2014). Pandey & Chaubal (2011) emphasise the role of education and income in the adoption of clean cooking energy in rural India.

This section discusses some of the key factors that influence the demand for clean cooking energy in India.

LPG

- About 96 per cent of SECC non-BPL households not using LPG cite the high upfront cost of securing a connection as an issue (Aklin et al., 2016). Hence, while BPL households benefit from free LPG connections under PMUY, the upfront cost could be a barrier for non-BPL households in securing these connections.
- Limited awareness about the impact of burning solid fuels on health, and ignorance of the benefits of cleaner cooking fuels, influence bottom-up demand. According to the ACCESS, despite the fact that 72 per cent of households using traditional biomass are aware that this fuel has adverse impacts on their health, only 59 per cent believe that LPG has positive health ben-

4 In 2014–15, the Council on Energy, Environment and Water (CEEW), in collaboration with Columbia University, conducted the largest energy-access survey of its kind in six Indian states having the largest population deprived of access to modern forms of energy—Uttar Pradesh, Bihar, Jharkhand, Odisha, Madhya Pradesh, and West Bengal.

efits over traditional cooking fuel (Jain, et al., 2015a).

- A steering committee on indoor air pollution constituted by the Ministry of Health and Family Welfare has acknowledged the impact of burning traditional biomass on the health of women in India, and emphasised the need for government intervention to ensure the ubiquitous availability of clean cooking fuels. The health department seeks to include village health and sanitation committees in efforts, campaigns, programmes, and policies to bring about a behaviour change resulting in a shift away from traditional biomass for cooking (Rao, 2016).
- The misperception among households that LPG is more expensive than market-procured traditional fuel also influences their demand for clean cooking fuels (Jain, et al., 2015a). Awareness-raising campaigns by the government have not analysed nor communicated the cost of using LPG compared to other clean cooking energy solutions.
- According to ACCESS, 92 per cent of households with the chulha as their primary cooking arrangement reported cooking as being a difficult or time consuming activity, and 51 per cent reported it as both, whereas only 4 per cent of households using LPG as their primary cooking fuel reported it as such (Jain, et al., 2015a), indicating high levels of user satisfaction for LPG.

The proportion of households satisfied with their primary cooking fuel is the highest among those using LPG. Further, of the households using biogas (both as primary and secondary cooking fuel), over 50 per cent reported satisfaction.

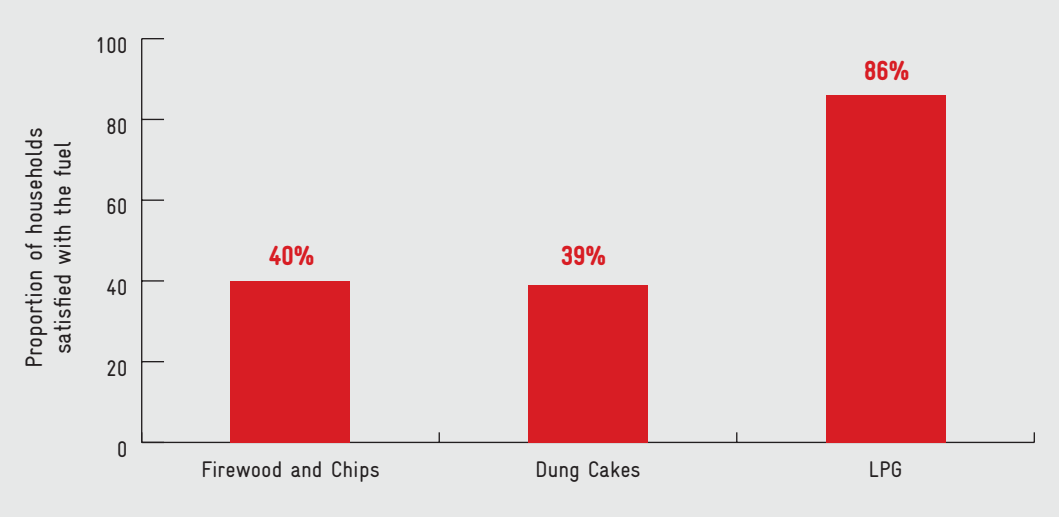
Biogas

- NBMMP provides support for communication and publicity, but according to ACCESS, only 36 per cent of the households surveyed were aware of the existence of biogas as a cooking fuel. Additionally, only 1.16 per cent of households had used biogas, and only a fifth of those users were still using their biogas plants. However, MNRE does budget for communication and awareness generation through the State Nodal Agencies (SNAs), who use radio, television, print, and demonstrations at farmers fairs to promote biogas.
- User satisfaction is central to ensuring the sustained use of biogas plants, as ACCESS revealed that over 50 per cent of biogas users are satisfied with their plant. The scheme provides a user training course and a training programme for rural entrepreneurs. However, it does not provide for capacity building in the private sector.

Figure 1:

Proportion of households satisfied with their primary cooking fuel

Source: ACCESS, 2015



- Upfront costs for household biogas plants are steep (~INR 20,000 for 1m^3). The subsidies provided range between INR 5,500 and INR 15,000 for a 1m^3 plant, and are given in two instalments. Hence, households need to pay a substantial amount upfront (MNRE, 2017a). In the ACCESS survey, of the unsatisfied users of biogas plants, 36 per cent reported capital cost as an issue (Aklin et al., 2016). Further, other government schemes such as PMUY affect consumer perception of, and willingness to pay for, biogas plants.
- NBMMP promotes loans from banks and microfinance institutions (MFIs). However, there is a lack of promotion of end-user finance guidance for market-led initiatives. Access to finance for households to cover their share of upfront costs for biogas plants is a major barrier to the upscaling of the technology.

Improved cookstoves

- NITI Aayog's less pessimistic India Energy Security Scenario (IESS) predicts that 35 per cent of rural households will still be reliant on biomass for cooking by 2032, and 20 per cent of households will be reliant by 2047, and it also predicts that biomass will be mostly used in ICS. Thus, in the short term, ICS will continue to be in demand to meet the cooking energy needs of rural households (NITI Aayog, n.d.). The National Draft Energy Policy by NITI Aayog also stresses the importance of firewood use and fuel stacking in the medium term, and therefore the need to invest in better ICS technology and a more efficient ICS ecosystem (NITI Aayog, 2017).
- ACCESS revealed that only 1.5 per cent of households had ever used ICS, and that just over half of these households were still using their ICS (Aklin et al., 2016). Only 16 per cent of households were aware of the existence of ICS, indicating that awareness generation is key to ensuring the adoption of ICS. However, the budget assigned in the scheme for ICS is only 5 per cent of the total. Donors such as GIZ have also supported UCA, including through inputs to the scheme, awareness creation, and stakeholder capacity building.
- Sustained use of ICS will be incumbent upon user satisfaction (GIZ, 2014; Lambe & Atteridge, 2012). ACCESS revealed that 89 per cent of unsatisfied users found their ICS too difficult to use (Aklin et al., 2016). UCA had no clear proposal for assessing local user needs prior to R&D activities and the distribution of ICS.
- An effective implementation strategy, as has been done for LPG or PNG, has yet to be designed for ICS. Most initiatives in this area receive funds from donors and entrepreneurs, while the budgets allocated under UCA remain unused.
- ACCESS revealed that 47 per cent of ICS users find their stoves too costly (Aklin et al., 2016). ICS cost between INR 1,400 (natural-draft) and INR 3,200 (forced-draft) without subsidies (Jain, et al., 2015b). UCA was meant to provide subsidies ranging from INR 300 to INR 800 per ICS. However, out of a budget of INR 294 crore available over four years ending 2017, only INR 20.61 crore was spent over 2015-17(MNRE, 2014b, 2017b).
- Some enterprises partner with microfinance institutions to provide consumer finance options to households. However, most have not incorporated consumer financing into their business models in a significant manner (Shrimali et al., 2011) and this issue has not been addressed in UCA. UCA had scope for CDM benefits. However, this was reserved for programme implementers.

Electricity-based cooking

- The lack of policies promoting the use of electric stoves has resulted in low awareness of electric and induction stoves. ACCESS revealed that although 1.37 per cent of rural households made use of an electric or induction stove, only 0.01 per cent of

households used it as primary cooking energy (Aklin et al., 2016).

- A recent study showed that when given the choice between various CCE solutions, users preferred electric stoves over other solutions (Lewis et al., 2015), indicating that there is a lack of understanding of consumer preferences in current clean cooking policies.

PNG

- Demand for PNG in urban areas has largely been driven by its convenience and lower recurring cost compared to LPG and electricity.
- However, the steep cost of connection for PNG (INR 5,000 plus other charges) can limit its affordability among the lower economic strata, even in urban areas.
- There are regional imbalances in consumption of PNG, with a few states like Gujarat, Maharashtra, and Uttar Pradesh accounting for 65 per cent of consumption, while a large number of states have no access to gas (MoPNG, 2017b).

3.2 Supply of clean cooking energy

The challenges in the supply of clean cooking energy can be associated with the device or fuel in particular (fuel-specific challenges in supply) or with the sector as a whole (sector-wide challenges in supply). The following section summarises the key challenges in the supply of each of the potential primary clean cooking energy fuels in India.

3.2.1 Fuel-specific challenges in supply

LPG

- MoPNG has announced a requirement of INR 30,000 crore investment in augmenting and enhancing the LPG infrastructure over the next few years, which is to be covered by the three OMCs (FE Bureau, 2017).
- Due to affordability constraints of newly connected rural households, rural distributors face a risk of encountering low demand for refills (Jha, 2017). The application fee of INR 2,500 to INR 10,000 is non-refundable, and the security deposit of INR 2 to INR 5 lakh may be forfeited on account of malpractice, thus putting distributors at financial risk (MoPNG, 2016b).
- With increasing LPG use, additional concerns are emerging around effective monitoring and control of corruption among registered and unregistered distributors (NCH, 2013), although measures such as the rating of distributor performance should limit some of this risk. MoPNG is working with agencies to use data intelligence to monitor the distributor's performance and adherence to safety guidelines across districts in India (SocialCops, 2017).
- Incentives for technical improvement of gas stoves are currently not covered by policies. Stove manufacturers face the challenge of manufacturing stoves of higher efficiency at an affordable cost. BIS-marked stoves have a minimum efficiency of 68 per cent (BIS, 2002), while newly developed models with efficiencies of 90 per cent are relatively expensive (ESMAP, 2015).
- The federation of LPG distributors of India has raised concerns about the safety of cylinders. They report that more than 90 per cent of economically backward targeted beneficiaries do not meet the safety parameters required for the installation of a connection. OMCs do not provide pilferage-proof cylinders, and no safety awareness campaign has been launched to create awareness among the targeted beneficiaries (Business Line, 2016).

Biogas

- In the ACCESS, 71 per cent of unsatisfied biogas users found that the plants broke down far too often (Aklin et al., 2016). Despite this, the models approved by MNRE include the traditional fixed-dome

design that have received such complaints. (MNRE, 2014a).

- MNRE approved new models of prefabricated plants in 2014–15 (MNRE, 2017a), which offer more resilient solutions. However, these will need to be promoted effectively.
- Budgetary expenditure on NBMMP has increased from INR 55 crore in 2015–16 to INR 100 crore in 2016–17, with INR 134 crore planned for 2017–18. Yet this comprises only ~0.50 per cent of the corresponding LPG subsidies (MNRE, 2017b; MoPNG, 2017c).
- O&M constraints prevail due to dung, water, climate, and usage requirements (Jain, et al., 2015b). In the ACCESS survey, 60 per cent of unsatisfied users found biogas plants difficult to use, and 82 per cent cited maintenance as a barrier to the sustained use of their plant (Aklin et al., 2016). NBMMP provides a five-year warranty for turnkey workers to conduct maintenance of traditional plants.
- Another challenge for the sector lies in the need to repair non-functional plants (MNRE, 2014b). The budget for repair has been capped at 5 per cent of the overall budget, but the last annual report did not provide any information on the status of the repair of old plants (MNRE, 2017a).
- According to ACCESS, only 10 per cent of biogas users used a community biogas plant (Aklin et al., 2016). Community biogas plants based on alternative sources such as sanitary toilets, municipal waste, and underground irrigation have yet to be scaled up (Jain, et al., 2015b).

Improved cookstoves

- According to ACCESS, 93 per cent of unsatisfied ICS users reported their stove as having broken too many times (Aklin et al., 2016). Although the budget for UCA includes outlay on R&D, it is less than 2 per cent of the total funds allocated for this purpose (MNRE, 2014b). Issues of R&D, fiscal support for manufacturing, and after-sales service have limited the expansion of the market (NITI Aayog, 2017).
- A senior official at MNRE confirmed that targets set by the SNAs in the current financial year have been extremely low, failing to meet the ambitions of UCA. Similarly, monitoring and evaluation has been assigned only 7 per cent of the budgeted funds. Although third-party monitoring has been included as a requirement in the scheme, there is no evaluation of the sustained use of the cookstoves disseminated under the programme.
- The test centres provide facilities to ensure the required standardisation of stoves and have enabled the approval of 53 ICS models from 31 manufacturers. However, there is a lack of guidance for consumers on the performance differences between the different types of stoves available in the market.
- Despite decades of government intervention, there is a dearth of manufacturers that meet the required quality standards. Even fewer manufacturers have achieved profitability and scale (NITI Aayog, 2017).
- UCA has made it mandatory for the stove seller to provide maintenance services for a duration of three years following dissemination (MNRE, 2014a). However, 80 per cent of ICS users reported poor maintenance as an issue (Aklin et al., 2016). Further, the policy does not provide a plan for maintenance beyond the three years.
- The cost of fuel for ICS should be comparable with the cost of fuel for other clean cooking energy solutions. UCA has not focused on the future of fuels for ICS. Since households are already paying for biomass (Jain, et al., 2015a), it makes better economic sense if the households paid for a consistent and more efficient fuel such as pellets. Standardisation of fuel (such as pellets) also enables better and more reliable benchmarking of the quality and efficiency of ICS. This necessitates investment and policy support to create a network of manufacturers and suppliers.

Electricity-based cooking

- The lack of universal electricity access in rural households is a major deterrent to electricity-based cooking. However, the National Energy Policy envisions 100 per cent electrification by 2022 (NITI Aayog, 2017) and emphasises the need to plan for the additional capacity that would be required to substitute other cooking fuels with electricity.
- The environmental impact of grid electricity is another cause for concern. India relies on coal for power generation, with 77 per cent of gross power generation in 2015–16 coming from coal (CSO, 2017), and involving substantial greenhouse gas emissions, with the thermal efficiency of the entire value chain being limited to around 13 to 14 per cent (Jain, et al., 2015b).
- Investments will be required to increase the share of renewable energy sources, and matching these with adequate investments in transmission and distribution to avoid curtailment. MNRE's budgetary expenditure on renewable power increased to INR 3,800 crore in 2016–17 (MNRE, 2017b), while the expenditure on power development and strengthening was INR 5,338 crore in 2016–17.
- If households were to rely completely on electricity for cooking, energy efficiency of induction cookstoves would be an important factor. Electricity tariff structures would also have to be comparable with the cost of alternatives such as LPG.

PNG

- The price of natural gas is fixed by the government biannually, leading to dependence on global gas markets and impacting the profit margins of upstream explorers (Kar & Vaid, 2016).
- Natural gas imports have increased to serve 35 per cent of consumption in 2015–16 (CSO, 2017). Requirements for infrastructural expansion have led to surging investments in LNG regasification terminals and natural gas transmission pipelines (PNGRB, 2013).
- Infrastructure for distribution of PNG is inadequate, and will require further investments. As of 2013, only 3 per cent of urban households in India had PNG connections (MoPNG, 2017b).
- There are regional imbalances in access to gas due to lack of pipeline infrastructure in states like West Bengal, Bihar, Jharkhand, and Odisha (MoPNG, 2017b).

Solar cooking

- Solar thermal cookers do not offer the convenience and reliability of other CCE sources. Solar cookers require manual solar tracking and do not allow for user control of heat intensity, quick start-stop operation, nor control of the time spent on cooking (MNRE, 2017b).
- Solar thermal cookers cannot be used to cook all types of Indian meals, for example, chapatti. Hence, in their current form, they are not viable as a primary cooking solution.

3.2.2 Sector-wide challenges in supply

Access to finance

- Finance is essential to meet enterprise needs for marketing, distribution, and after-sales services, as well as for scaling up of operations. Initiatives supported by donors have proved less effective in becoming sustainable due to their inability to provide finance after the end of projects, or because of a shift in priorities (Zerriffi, 2011).
- Entrepreneurs need to partner with institutions providing consumer finance (Shrimali et al., 2011), but they face barriers such as high interest rates, high transaction costs, and complex collateral requirements (Tripathi et al., 2016).
- Women entrepreneurs face additional barriers, and only 27 per cent have access to institutional finance (IFC, 2014).

Institutional support

- Institutions have played a substantial role in the dissemination of CCE solutions. However, several government initiatives have used a top-down governance approach, with poor inter-ministerial and inter-governmental coordination, and lacked the participation of entrepreneurs and communities (Balachandra, 2011).
- Rural entrepreneurs face institutional difficulties such as complicated procedures for setting up businesses and complex regulatory procedures like taxation and construction permits (Tripathi et al., 2016).
- Lack of capacity-building support has led to lack of entrepreneurial skills, coupled with lack of knowledge transfer between research agencies and the private sector (Tripathi et al., 2016).

4. From connections to sustained use: Complementing LPG with other clean cooking energy solutions

4.1 What is sustained use and why is it important?

Over 2.8 crore LPG connections have already been provided under PMUY as of August 2017. While more than half of the targets on connections have been achieved, there are no measurable targets on sustained use of the fuel (MoPNG, 2016a). Studies have highlighted that long-term health benefits can only result from the sustained and universal use of clean cooking energy. Hence, there is a need to simultaneously emphasise and facilitate the sustained use of clean cooking fuel among households. **Sustained use of clean cooking energy implies continued use of a fuel as the primary cooking fuel without occasional relapses to traditional biomass.**[5]

The focus of PMUY thus far has been on providing LPG connections to SECC BPL households across India. This is a step in the right direction because it enables BPL households to overcome the initial hurdle of a significant cash outlay for getting a connection. However, as of 2011, while 53 per cent of households in India had an LPG connection, only 28 per cent used it as the primary source of cooking (Census, 2011). This implies that despite paying for the connection, over half of the households having LPG were not using it as their primary cooking fuel. Given that households received free LPG connections under the PMUY scheme, it would be useful to know how the sustained use of the fuel is evolving. In the ACCESS, of the households that reported using LPG, over one-third did not use it as their primary cooking fuel, indicating a high level of fuel stacking along with LPG.

The challenges to the adoption of LPG under PMUY are discussed below.

Affordability of fuel

- About 88 per cent of households not having LPG across six states in the ACCESS survey reported high recurring costs as one of the barriers to the adoption of LPG (Jain, et al., 2015a).
- Under PMUY, households have to incur the cost of the LPG stove and of the first refill. While households can avail a loan for the same, this amount is recovered from the subsidy availed by the consumer on the purchase of each refill. This could affect the capacity of the households to purchase subsequent refills. Further, the policy prioritises customers making upfront payment for the LPG stove and the refill over those opting for payment in instalments.
- It is encouraging to note a strong willingness to adopt LPG. Of the households not using LPG in the six states surveyed, 48 per cent expressed interest in getting LPG. Over half of these interested households are willing to spend INR 300 or more in a month (INR 450 or more in six weeks) to use LPG for all cooking needs (Aklin et al., 2016).
- About 43 per cent of households across Bihar, Jharkhand, Madhya Pradesh, Odisha, Uttar Pradesh, and West Bengal (Jain, et al., 2015a) do not spend any real money to

5 For an understanding of sustained use, refer to the multidimensional framework on cooking energy access (Jain, et al., 2015a).

Aligning cash flows

The last three-year average price of a subsidised LPG cylinder of 14.2 kg is about INR 429 (IOCL, 2017). Assuming a cylinder lasts for six weeks (the median number of cylinders used by households with LPG as the primary fuel is nine per year), the household would have to spend INR 429 every six weeks for a refill.

About 40 per cent of households across the six states covered under the ACCESS spent INR 428 or more in six weeks on their cooking fuel (Aklin et al., 2016). These households could use LPG for all their cooking needs if they were allowed to stagger their payments over the six-week period. If we consider only those households who pay something for their cooking energy already (about 56 per cent), more than two-thirds of them would find LPG affordable at current prices provided its purchase could match their cash-flow requirements.

procure their cooking fuel. Enabling complete transition to LPG for such households will be a challenge.

- About three-quarters of the fiscal subsidy burden has been borne by the government since the launch of the Direct Benefit Transfer for LPG (DBTL) in 2015 (PPAC, 2017a). If subsidies were to be reduced, it could exacerbate the affordability concerns of BPL consumers.

Accessibility of fuel

- For households using LPG, the median one-way distance to procure an LPG cylinder ranged from 3 km in West Bengal to about 11 km in Madhya Pradesh, indicative of the hardship in accessing the fuel (Jain, et al., 2015a), especially as home delivery of LPG was not available in rural areas until last year when the new unified guidelines for LPG distributorship were released. However, whether the new guidelines have resulted in actual change on the ground and whether they have eased hardship in rural areas has yet to be validated by an independent monitoring and evaluation exercise.
- The government aims to set up 10,000 new distributorships to provide and support connections and refills under PMUY. Most of these distributorships will come up in rural areas to cater to unserved consumers (MoPNG, 2016b). However, only 870 distributors commissioned operations between April 2016 and March 2017, and only 1,150 letters of intent were issued by the end of financial year 2016–17, against a commitment of 10,000, which is indicative of the slow pace of addition (Kumar, 2017; PPAC, 2017b).
- Moreover, even the limited addition of distributors that took place in 2016-17 has been skewed towards urban and urban/rural (comprising over 55 per cent of the additions), despite an existing large base of urban/urban–rural distributors (Figure 3).
- Further, the high cost of distribution of LPG cylinders in remote and difficult terrains has affected the delivery of cylinders to households (Wang, 2014). Despite the increase in the number of distributors, the transaction cost will continue to play an important role in determining the regular delivery of refills.

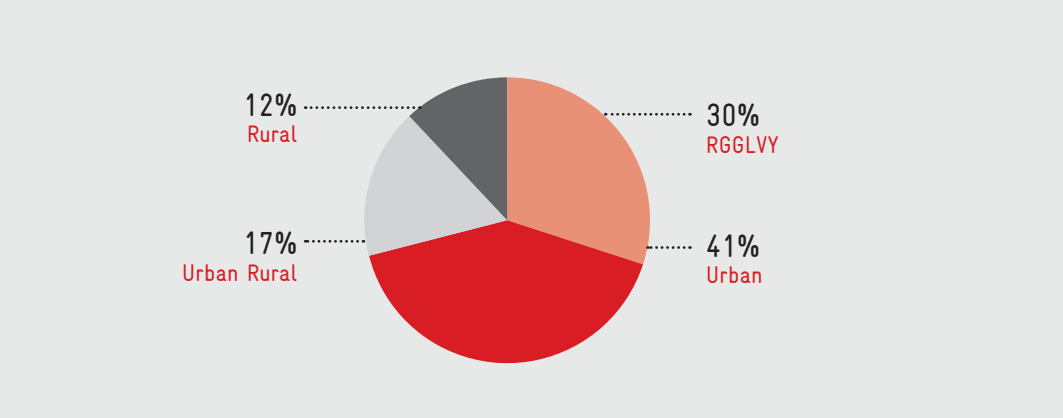


Figure 2:

Proportion of LPG distributors by type as of March 2017

Source: PPAC, 2017b

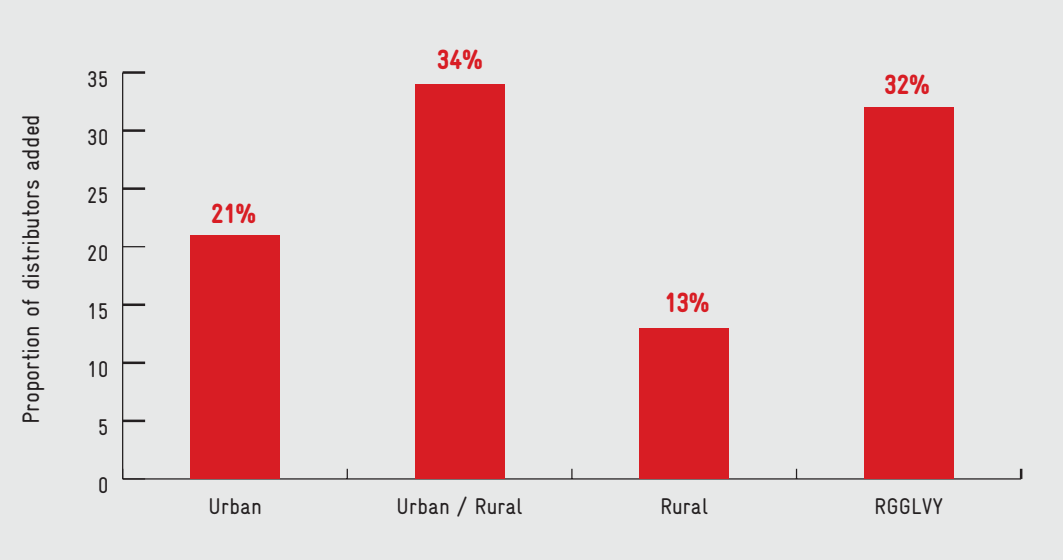


Figure 3:

Addition of LPG distributors by type between April 2016 to March 2017

Source: PPAC, 2017b

Dependence on imports

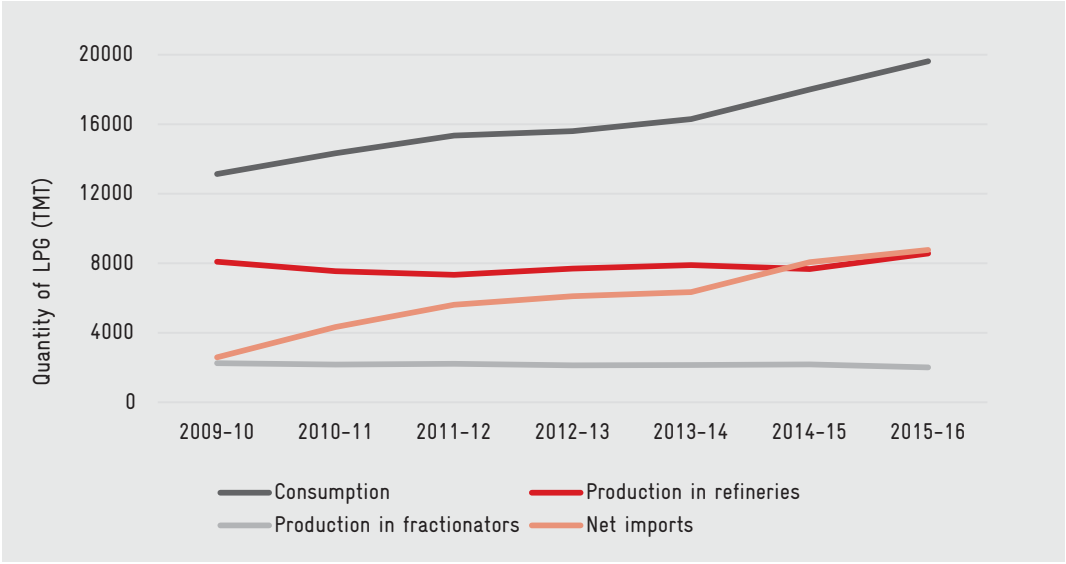
The increased use of LPG for cooking is reflected in the rise in LPG consumption by 9.8 per cent in 2016-17 to 21.5 million metric tonnes (MMT) (PPAC, 2017b). This growth in demand was met by increasing LPG imports, which comprised 51.2 per cent of the demand in 2016–17. As of 2015–16, India already imported 87.1 per cent of crude oil and 34.6 per cent of natural gas (MoPNG, 2016a). India's oil minister has predicted that the total demand for LPG will reach 35 MMT by 2031–32 (Pathak, 2017), leading to additional infrastructural requirements, including production, import, pipeline, and bottling facilities. The majority of domestic production—81 per cent in 2015–16—takes place in refineries for domestic and imported crude oil, while the remaining production takes place in natural gas fractionators (MoPNG, 2016c).

Crude oil refining capacity stands at 230 MMTPA from 23 refineries, and planned expansions will increase this to 236 MMTPA (MoPNG, 2016c). India imports LPG from various countries, including the Middle East countries, through a network of 298 OMC terminals and depots (MoPNG, 2017b), with plans for capacity additions to meet demand. Pipelines facilitating LPG transportation around the country have a combined capacity of 5.33 MMT (MoPNG, 2016c), and additional pipelines are under construction (PTI, 2016). Oil marketing companies (OMCs) also plan to increase LPG bottling capacity to 21 MMTPA (Prasad, 2017) from the current 15.6 MMTPA (PPAC, 2017b).

Figure 4:

LPG production, imports, and consumption (2009–10 to 2015–16)

Source: MoPNG, 2016c



The existing condition of the import infrastructure and supply chain will pose a challenge to efforts to increase LPG imports significantly under PMUY (NITI Aayog, 2017). The increasing dependence on direct and indirect imports to satisfy the rising demand for LPG is a cause for concern. Not only will it increase India's existing dependence on imports, but it will also expose one of the most basic needs of households to market fluctuations and vulnerabilities. In addition, it will take away from investments in alternatives for clean cooking energy that might be sustainable for households in the long run.

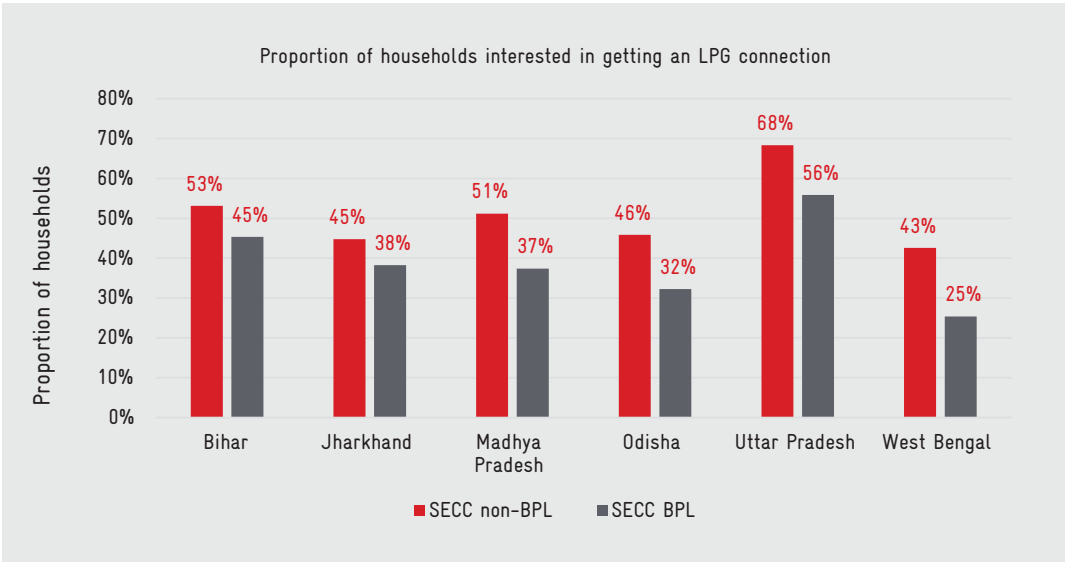
Expanding coverage for sustained use

- PMUY in its current form targets SECC BPL households, leaving out all SECC non- BPL households, many of which may not have access to clean cooking energy. It might be equally important to target SECC APL rural households for increasing sustained use of LPG across the country.
- SECC non-BPL households exhibit greater willingness to adopt LPG, as well as express greater readiness to pay for its regular consumption.

Figure 5:

Comparison of willingness to pay for LPG connections between SECC BPL and SECC non-BPL households

Source: ACCESS, 2015; PPAC, 2017b



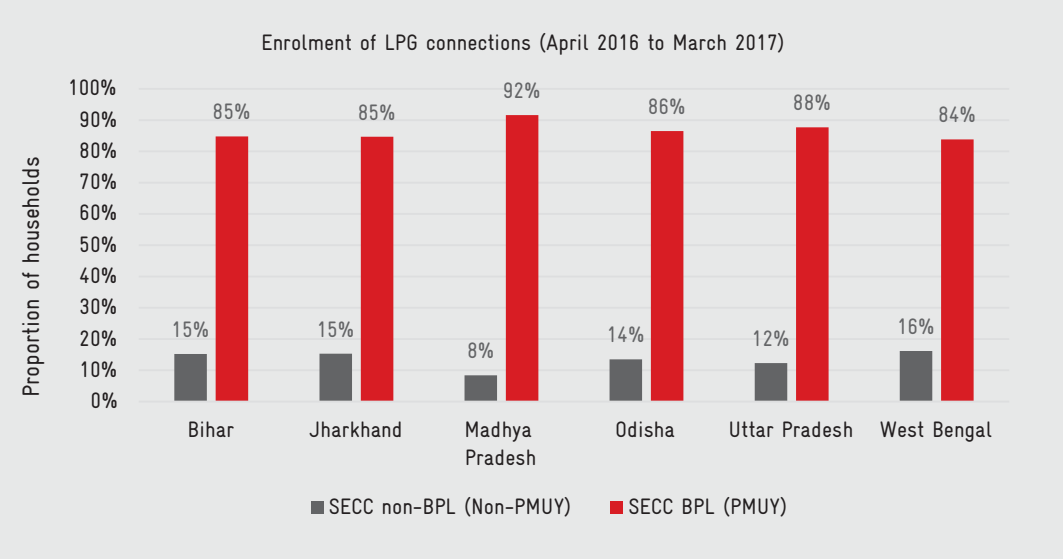


Figure 6:

Comparison of uptake of LPG connections among SECC BPL vs SECC non-BPL households

Source: Source PPAC, 2017b

- Further, 47 per cent of SECC non-BPL households are spending INR 428 or more in six weeks, as opposed to about 33 per cent of SECC BPL households. This indicates that SECC non-BPL households are much more likely to sustain regular use of the fuel as compared to BPL households.

Government actions such as establishing a reliable supply chain and providing financial support through subsidy and microfinance schemes are essential to ensure the further expansion of LPG (WLPGA, 2014). However, a complete transition to LPG could be a constraint for cash-strapped households in the short to medium term, leading to stacking with other fuels until households can afford to adopt sustained use. Hence, it is imperative to consider complementing LPG with other clean cooking energy solutions in order to facilitate stacking between cleaner fuels and cookstoves. This would require focused efforts to understand and then to evaluate the demand, utility, and feasibility of various clean cooking energy options. Given the limited resources and the urgency of the problem, it is important that these efforts should be directed at priortising clean cooking energy options that meet the needs of all households in an affordable, convenient, and sustained manner.

5. A multidimensional approach to promote sustained use of clean cooking energy

Access to clean cooking energy is not solely an issue of energy access but rather multidimensional. Given that traditional cooking methods disproportionately affect women in terms of the drudgery involved, adverse health outcomes, and lost opportunity cost of time, it is imperative to include them in the design and execution of solutions for clean cooking energy access. In some countries, the inclusion of women in the LPG distribution supply chain has resulted in increased LPG adoption (WLPGA, 2014). Moreover, to ensure continued affordability of clean energy sources, it is essential to couple these interventions with rural income-generating activities, thereby ensuring that the marginal increases in income are used to meet the clean energy needs of households. Leveraging local institutions and self-help groups to facilitate access to avenues for income generation might help households shift to cleaner fuels and sustain their use in the long run. As discussed above, the government should also target SECC non-BPL households to increase the adoption of clean cooking energy. To achieve this goal, the government may not need to support any capital subsidy for non-BPL households, and the loan facility for the security deposit (or the LPG stove and the refill) could be provided to such households to reduce their one-time outlay.

While stacking of fuels and cookstoves is a reality, the aim should be to ensure that the stacking takes place between cleaner cooking energy options. Bringing clean cooking energy to millions of households presents a considerable opportunity for entrepreneurs. They will need to engage in smart customer-centric product design, cost-effective manufacturing, and reliable post-sales maintenance, with each stage likely to require public and private investment in R&D and skills development and extensive policy support. NITI Aayog has stressed the importance of a comprehensive strategy to support market-based clean cooking solutions.

India is set to be an integral part of Goal 7 of the Sustainable Development Goals, which looks to provide access to affordable, reliable, sustainable, and modern energy services for all by 2030. The existing mapping (NITI Aayog, 2016) of ministerial responsibilities in achieving the SDG targets envisages the engagement of the Ministry of Power (MoP), MoPNG, MNRE, the Ministry of Coal (MoC), and the Ministry of Tribal Affairs for the realisation of Goal 7. However, it is essential that ministries beyond the realm of energy also cooperate in achieving this target, given the multidimensional nature of the challenge. India's limited progress on providing sustained clean cooking energy access is partly due to the lack of a coherent strategy which does not pursue access to clean cooking energy within the broader plans of rural and human development. The National Draft Energy Policy proposed by NITI Aayog suggests the need for an integrated national programme for clean cooking energy, which will coordinate efforts in the areas of cooking fuels, efficient cookstoves, and related R&D (NITI Aayog, 2017).

- In this context, we propose an inter-ministerial consultation to design a comprehensive ten-year roadmap for providing clean cooking energy access for all in India. The roadmap will lay down a detailed strategy for various ministries and government

agencies, based on their respective capacities and incorporating their suggestions.

- An overview of the potential roles and relevance of the concerned ministries is presented in Table 1. The roles envisaged for the ministries are tentative and should evolve, and be reassessed periodically, based on the objectives of the engagement.
- Such an action plan for ensuring wider and more affordable access to clean cooking energy would need a comprehensive monitoring and evaluation framework that tracks progress against individual intra-ministerial and collective inter-ministerial policy targets at both national and local levels.

Table 1: Tentative roles envisaged for various ministries to ensure sustained access to clean cooking energy

Ministry	Potential roles in clean cooking energy	Relevance	Relevant schemes currently in place
Ministry of New and Renewable Energy	• R&D support for development of efficient ICS and solar cookers • R&D support for continuous improvement in biogas technology • Support for markets for suppliers of fuel (pellets, agro residue, etc.)	• Lack of efficient ICS and solar cookers • Scope for biogas technology development • Scope for innovation in implementation model • Improve supply chain for ICS and biogas	• National Biogas and Manure Management Programme (NBMMP) • Unnat Chulha Abhiyan (UCA) • Jawaharlal Nehru National Solar Mission (JNNSM)
Ministry of Petroleum and Natural Gas	• R&D support for development of efficient gas cookstoves • Alignment of supply with demand • Awareness generation on health impacts of using traditional fuels	• Lack of efficient gas cookstoves • Lack of reliable supply of fuels/ technology	• Pradhan Mantri Ujjwala Yojana (PMUY) • Direct Benefit Transfer for LPG (DBTL) • Unified Guidelines for Selection of LPG Distributorships
Ministry of Health and Family Welfare	• Generate awareness through Accredited Social Health Activist (ASHA) workers • Provide budgetary support for awareness campaigns • Ensure effective measurement of HAP	• Lack of awareness of negative impact on health resulting from use of traditional fuels in rural areas	• National Health Mission (NHM) • Community Action for Health (CAH)

Ministry	Potential roles in clean cooking energy	Relevance	Relevant schemes currently in place
Ministry of Women and Child Development	• Promote self-employment and entrepreneurship among women • Impart training to improve skills for employability • Conduct pilots to link livelihoods with clean cooking energy	• Lack of support for women in starting enterprises • Lack of technical and entrepreneurial skills in rural areas	• Support to Training and Employment Programme for Women (STEP)
Ministry of Rural Development	• Facilitate access to enterprise finance • Promote scalable business models • Provide training support to self-help groups (SHGs) and entrepreneurs • Promote awareness of CCE technologies	• Difficulty in gaining access to enterprise finance • Lack of technical and entrepreneurial skills in rural areas	• Deendayal Antyodaya Yojana (DAY-NRLM) • Advancement of Rural Technologies (ARTS) • Saansad Adarsh Gram Yojana (SAANJHI) • Rural Diksha
Ministry of Micro, Small and Medium Enterprises	• Facilitate access to enterprise finance • Provide support for mentoring, incubation, and commercialisation • Promote entrepreneurship among women and youths • Create database of business models • Provide quality management tools	• Difficulty in gaining access to enterprise finance • Difficulty in building capacity • Lack of entrepreneurial skills • Lack of scalable business models • Lack of quality monitoring standards for enterprises	• Prime Minister's Employment Generation Programme (PMEGP) • A Scheme for Promotion of Innovation, Rural Industry and Entrepreneurship (ASPIRE) • Market Promotion Development Assistance (MPDA) • Women Entrepreneurship (TREAD) • Quality Management Standards & Quality Technology Tools (QMS/QTT)
Ministry of Skill Development and Entrepreneurship	• Provide training support for technology development and maintenance • Promote entrepreneurship among women and youth	• Lack of technical knowledge and entrepreneurial skills among women and youths	• Pradhan Mantri Kaushal Vikas Yojana (PMKVY)

Ministry	Potential roles in CCE	Relevance	Relevant schemes currently in place
Ministry of Panchayati Raj	• Support awareness and marketing campaigns through Gram Sabha meetings • Disseminate ICS and biogas at village level	• Lack of institutions on the ground to build awareness of CCE • Lack of on-ground support for deployment	• Gram Panchayat Development Plan • Gramoday se Bharat Uday Abhiyan
Ministry of Agriculture and Farmers Welfare	• Facilitate implementation of NBMMP • Undertake capacity building for construction and maintenance of biogas plants • Provide monitoring and evaluation support for installed plants • Extend financial support for small farm holders	• Lack of monitoring and evaluation of biogas plants • Lack of financial support • Lack of skilled manpower for O&M of plants	• National Mission for Sustainable Agriculture (NMSA) • National Project on Organic Farming (NPOF) • Rashtriya Krishi Vikas Yojana (RKVY)
Ministry of Statistics and Programme Implementation	• Provide monitoring and evaluation support for installed/planned plants and cookstove deployment schemes • Provide tools to support decision making • Provide tools for socio-economic evaluation	• Lack of technology monitoring and evaluation in past and current government schemes • Lack of planning at micro level • Lack of socio-economic evaluation	• Infrastructure and Project Monitoring Division (IPMD) • Twenty Point Programme (TPP) • Members of Parliament Local Area Development Scheme (MPLADS)
Ministry of Science and Technology	• R&D support for development of innovative cooking technologies • R&D support for technology upgradation • Knowledge management support, including database of technologies • Awareness promotion of CCE technologies	• Lack of efficient CCE technologies • Lack of central database with available CCE technologies • Scope for cooperation with Asia-Pacific countries in technology development • Lack of sustained adoption of CCE technologies among women	• Clean Energy Research Initiative (CERI) • Technology Development Programme (TDP) • Science for Equity Empowerment and Development (SEED) • Access to Knowledge for Technology Development and Dissemination (A2K+) • Asian and Pacific Centre for Transfer of Technology (APCTT) • Technology Development and Utilisation Programme for Women (TDUPW)

Ministry	Potential roles in CCE	Relevance	Relevant schemes currently in place
Ministry of Power	• Look beyond provision of electricity connections and instead focus on reliability of electricity supply • Generate awareness of the health benefits of using electricity-based cookstoves	• Low penetration of electricity-based clean cooking solutions	• Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY)
Ministry of Environment, Forest and Climate Change	• R&D support for developing efficient clean energy cookstoves	• High global warming potential of black carbon • Wide-ranging impacts of household and outdoor air pollution	• Control of Pollution (CP) • Forest Conservation (FC) • Clean Technology (CT)

Source: CEEW Analysis, 2017

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