

# Roadmap for Access to Clean Cooking Energy in India

Sasmita Patnaik, Saurabh  
Tripathi, and Abhishek Jain

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A traditional cookstove being used even as LPG cylinders in the distance remain unused.



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Sasmita Patnaik, Saurabh Tripathi, and Abhishek Jain

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**In nine years of operations**, The Council has engaged in over 230 research projects, published over 160 peer-reviewed books, policy reports and papers, advised governments around the world nearly 530 times, engaged with industry to encourage investments in clean technologies and improve efficiency in resource use, promoted bilateral and multilateral initiatives between governments on 80 occasions, helped state governments with water and irrigation reforms, and organised nearly 300 seminars and conferences.

**The Council's major projects on energy policy** include India's largest multidimensional energy access survey (ACCESS); the first independent assessment of India's solar mission; the Clean Energy Access Network (CLEAN) of hundreds of decentralised clean energy firms; the CEEW Centre for Energy Finance; India's green industrial policy; the USD 125 million India-U.S. Joint Clean Energy R&D Centers; developing the strategy for and supporting activities related to the International Solar Alliance; designing the Common Risk Mitigation Mechanism (CRMM); modelling long-term energy scenarios; energy subsidies reform; energy storage technologies; India's 2030 Renewable Energy Roadmap; energy efficiency measures for MSMEs; clean energy subsidies (for the Rio+20 Summit); Energy Horizons; clean energy innovations for rural economies; community energy; scaling up rooftop solar; and renewable energy jobs, finance and skills.

**The Council's major projects on climate, environment and resource security** include advising and contributing to climate negotiations in Paris (COP-21), especially on the formulating guidelines of the Paris Agreement rule-book; pathways for achieving Nationally Determined Contributions (NDCs) and mid-century strategies for decarbonisation; assessing global climate risks; heat-health action plans for Indian cities; assessing India's adaptation gap; low-carbon rural development; environmental clearances; modelling HFC emissions; the business case for phasing down HFCs; assessing India's critical minerals; geoengineering governance; climate finance; nuclear power and low-carbon pathways; electric rail transport; monitoring air quality; the business case for energy efficiency and emissions reductions; India's first report on global governance, submitted to the National Security Adviser; foreign policy implications for resource security; India's power sector reforms; zero budget natural farming; resource nexus, and strategic industries and technologies; and the Maharashtra-Guangdong partnership on sustainability.

**The Council's major projects on water governance and security** include the 584-page *National Water Resources Framework Study* for India's 12th Five Year Plan; irrigation reform for Bihar; Swachh Bharat; supporting India's National Water Mission; collective action for water security; mapping India's traditional water bodies; modelling water-energy nexus; circular economy of water; participatory irrigation management in South Asia; domestic water conflicts; modelling decision making at the basin-level; rainwater harvesting; and multi-stakeholder initiatives for urban water management.



# Message from NITI Aayog



Energy is a key input towards raising the standard of living of citizens of any country, as is evident from the correlation between per capita electricity consumption and Human Development Index. Access to clean cooking energy, in particular, has a strong impact on alleviating the public health burden posed by household air pollution. It also helps reduce time poverty for women, allowing for time to be invested in education, leisure, and other productive activities. A major initiative taken by the government to improve access to clean cooking energy in recent times is the *Pradhan Mantri Ujjwala Yojana*. As

of August 2019, it has provided credit-linked subsidised LPG connections to over 77 million households and continues to expand the coverage of LPG in India. However, the forthcoming goal would entail plugging of both supply-side as well the demand-side gaps to improve the availability, affordability and sustained use of the fuel. While the stacking of clean fuel with traditional biomass continues to exist across many rural households in India, to address the ill-effects of household air pollution, the entire stack of cooking solutions will have to be clean. Our end aim should be to eliminate the use of traditional biomass combustion for cooking and replacing it with solutions like LPG, PNG, electricity, biogas, improved cookstoves and solar-powered cooking. This requires a multi-fuel and multi-stakeholder approach contextualised for region, appropriateness of the technology, households' income and other factors. The effort of energy ministries needs to be augmented with interventions from other relevant ministries such as Rural Development, Health and Family Welfare, and Agriculture and Farmer's Welfare, to address the challenges in access and affordability of clean cooking energy solutions.

To guide further deliberation towards a national mission on clean cooking energy, NITI Aayog is laying out a 'Roadmap for Access to Clean Cooking Energy in India', in collaboration with the Council on Energy, Environment and Water (CEEW) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. As is evident from the strategies put forward in this document, India is uniquely placed to integrate efforts across various ministries and execute a national mission on clean cooking energy to eliminate the traditional use of biomass for cooking, ensuring a sustained use of clean cooking solutions.

The ideas put forward in this document should provide basis for engaging discussions and dialogues, and for helping India collectively ensure sustainable clean cooking energy access for all.

**Amitabh Kant**  
Chief Executive Officer  
NITI Aayog

# Message from GIZ



Traditional cooking practices, which are largely based on burning biomass to prepare food, and their impact on the environment, climate, and human health have been in the limelight of national and international development organisations for a long time. While the initial focus was more on climate and environment the spotlight has shifted over the past 20 years, more and more to indoor pollution related health concerns. Initially, the public and scientific discourse centered on stove technology using especially woody biomass fuels, and the idea was that improved cookstoves, clean cookstoves or energy efficient cookstoves burn biomass more efficiently thereby emitting less smoke harmful to the climate. The sector received a powerful push by the Clean Development Mechanism (CDM) of the Kyoto Protocol at the beginning of the millennium as many CDM projects homed in on the sector. In contrast, today, the debate is more about clean cooking which connotes a more process-centered approach where the cooking process as such should be clean and less harmful to the members of a household. Thus, Liquefied Petroleum Gas (LPG) and induction stoves where the electricity is largely coming from coal power stations are promoted as they do not or hardly cause any indoor pollution.

The development in India was similar. In 1984, a *National Programme on Improved Chulhas* (NPIC) was launched by the Indian Government for the development and promotion of efficient biomass stove models. In 2009, the Indian Ministry of New and Renewable Energy (MNRE) started a *National Biomass Cookstoves Initiative* (NBCI) which was to foster the use of improved biomass cookstoves. In 2016, the *Pradhan Mantri Ujjwala Yojana* (PMUY) scheme was launched in India to promote the use of LPG as cooking fuel in order to reduce exposure to unhealthy smoke levels especially for women and children. Up to date, several cores of LPG connections have been distributed through the scheme.

However, experiences show that Indian households, depending on circumstances and need, use more than one technology or one source of energy for cooking. Even with an already high LPG penetration, biomass-based cooking or kerosene cookers are still being used concurrently. Electricity grid expansion and an increase in power generation capacity will definitely lead to more electrical stoves being used. Furthermore, MNRE is promoting family biogas digesters through its *National Biogas and Manure Management Programme* (NBMMP).

To better coordinate and bind together the different strands of development and to achieve universal access to clean cooking energy by 2030, MNRE approached GIZ to support the development of a roadmap for clean cooking. I am glad that we could win over CEEW as a knowledgeable, experienced, and resourceful partner in that endeavor. I hope that the principles and strategies outlined in this roadmap will accelerate and support India's efforts in achieving its sustainable development goals.

## **Dr Harald Richter**

Programme Head, Indo-German Energy Programme

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH



# Message from CEEW



Lack of access to clean cooking energy remains a core development challenge in India as it imposes a public health hazard and accentuates time poverty, particularly for women in the household. The *Pradhan Mantri Ujjwala Yojana* has been successful in not only ensuring that the poorest families in the country have an LPG connection, but also in furthering a long-stagnant conversation on access to clean cooking fuels in India.

What is clearer than ever before, though, is that household air pollution cannot be defeated without targeting the continuing use of traditional biomass cookstoves and promoting the sustained use of clean cooking energy alternatives. In order to ease the energy transition for households towards a cleaner stack of fuels, it will be important to offer a suite of clean cooking fuels and technologies from which households could choose, based on socio-cultural, logistical, and economic considerations.

This Roadmap proposes short- and long-term strategies of varying degrees of priority for a range of clean cooking energy alternatives – LPG, improved cookstoves, biogas, PNG, and solar- and electricity-based cooking technologies. In order to do this, our team profiled the challenges faced along the value chain of each cooking fuel and technology by consulting—through semi-structured interviews and group consultations—clean energy practitioners, officials from various ministries, financiers, and civil society organisations.

It has been a valuable exercise for the team to document the most critical bottlenecks that impede growth in the clean cooking energy space in India, and I hope that this Roadmap would lend perspective to the *National Clean Cooking Mission*, as proposed by NITI Aayog.

I would like to thank the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) for having conceptualised and designed the project with our team, and NITI Aayog for taking leadership on the initiative and in convening several ministries in building support for this Roadmap.

## **Dr Arunabha Ghosh**

Chief Executive Officer

Council on Energy, Environment and Water (CEEW)



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The Roadmap was officially guided by a Core Advisory Group with the following members: D. K. Khare, formerly of the Ministry of New and Renewable Energy; Harald Richter, GIZ; Kirk Smith, University of California, Berkeley; Nidhi Sarin, GIZ; Parveen Dhamija, Skill Council for Green Jobs; Santosh Singh, The World Bank; Smita Rakesh, TATA Trusts; and Svati Bhogle, Clean Energy Access Network. We thank all of them for lending their effort and expertise to help ensure that the document and the overall research methodology are as inclusive and well-informed as possible on current realities.

The recommendations in the Roadmap were informed by semi-structured interviews with a diverse group of stakeholders which included clean cooking energy enterprises, donors and non-governmental organisations, government ministries, and financial institutions. We would like to thank them for their valuable insights and inputs. The full list of individuals who were interviewed can be found in Table A1 in the Annexure.

We thank those who participated in our clean cooking energy consultations. They gave invaluable inputs towards strengthening the recommendations proposed under the Roadmap and its analytical framework. The full list of individuals who participated can be found in Table A2 in the Annexure.

We would also like to thank Sara Dethier and Shruti Nagbhusan, our former colleagues at The Council, for their help in the research and analysis phase of this report's preparation and in writing policy notes for the various ministries with whom we engaged during the project.



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*“In our interviews with the practitioners across clean cooking energy solutions, we observed incompatibility between the challenges they deemed most prominent and what the existing policies were looking to address. Some of these challenges were beyond the purview of energy, necessitating a more comprehensive approach to improve access to clean cooking energy for all households. We hope this Roadmap highlights the need for greater congruity between the challenges faced by the practitioners and households, and the policy interventions to address them.”*



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Saurabh Tripathi is a Programme Associate at the Council on Energy, Environment and Water. At The Council, he works on access to electricity and clean cooking energy for households. Previously, Saurabh worked with GIST Advisory, a sustainability consulting firm, where he helped assess the monetary value of corporate externalities and their impact on people, society, and the environment. Saurabh holds an MSc in Economic Development and Policy Analysis, and a BA (Hons) in Economics, both from the University of Nottingham. While at university, he also completed internships with the Grameen Bank in Bangladesh and the United Nations Officer for REDD+ Coordination in Indonesia.

*“Our engagements with government officials uncovered the apparent lack of inter-ministerial coordination on clean cooking energy, in spite of the Government’s considerable efforts through the Ujjwala Yojana. To completely transition households away from polluting fuels, multiple ministries will need to come together to tackle the various administrative, socio-cultural and economic aspects of cooking energy access. Our hope is that this document can lay the roadmap for what strategies such a mammoth exercise should prioritise and pursue.”*



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Abhishek Jain is a Senior Programme Lead at The Council and heads its Energy Access programme. Along with his team, he focuses on provision and use of modern forms of energy for all, especially the deprived. With about eight years of experience, Abhishek has worked on multiple issues at the confluence of energy, economics, and environment. His research (and action) spans energy access for households, communities, and livelihoods. He co-conceptualised and leads CEEW's flagship research efforts on ACCESS – Access to Clean Cooking energy and Electricity – Survey of States, the largest survey of its kind on energy access. Over the years, Abhishek has focused on various issues including renewable energy, decentralised energy access, clean cooking energy, LPG for cooking, fossil fuel subsidies, electricity sector reforms, solar-powered irrigation, and circular economy. He holds an M.Phil. from University of Cambridge and an engineering degree from IIT Roorkee.

*“It is encouraging to see that in recent years the Indian government has focused on clean cooking energy access among its development priorities. I hope this Roadmap will not only nudge but also guide decision-makers towards more comprehensive action in achieving clean cooking energy access for all.”*







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# Abbreviations

<b>AIM</b>	Atal Innovation Mission
<b>ASHA</b>	Accredited Social Health Activist
<b>BDTC</b>	Biogas Development and Training Centre
<b>BEE</b>	Bureau of Energy Efficiency
<b>BGFP</b>	biogas fertiliser plant
<b>BIS</b>	Bureau of Indian Standards
<b>BPL</b>	below poverty line
<b>CFA</b>	central financial assistance
<b>CGD</b>	city gas distribution
<b>CHEST</b>	Clean Household Energy Solutions Toolkit
<b>CLEAN</b>	Clean Energy Access Network
<b>CSIR</b>	Council of Scientific and Industrial Research
<b>CSO</b>	civil society organisation
<b>DBT</b>	direct benefit transfer
<b>DBTL</b>	direct benefit cash transfer for LPG
<b>DDUGJY</b>	Deen Dayal Upadhyaya Gram Jyoti Yojana
<b>DDU-GKY</b>	Deen Dayal Upadhyaya Grameen Kaushalya Yojana
<b>DST</b>	Department of Science and Technology
<b>EDF</b>	Environmental Defense Fund
<b>EMI</b>	equated monthly instalment
<b>FISE</b>	Fondo de Inclusión Social Energético
<b>GERES</b>	Group Energies Renouvelables, Environnement et Solidarité
<b>GLBOMS</b>	Green Loans for Biogas and Organic Manure Service
<b>GLPGP</b>	Global LPG Partnership
<b>GTF</b>	Global Tracking Framework
<b>HAP</b>	household air pollution
<b>ICDS</b>	Integrated Child Development Services
<b>ICMR</b>	Indian Council of Medical Research
<b>ICOPRODAC</b>	Association of Producers and Distributors of Improved Cookstoves in Cambodia
<b>ICS</b>	improved cookstoves
<b>IEA</b>	International Energy Agency
<b>IESS</b>	India Energy Security Scenarios
<b>IIT</b>	Indian Institute of Technology
<b>IOCL</b>	Indian Oil Corporation
<b>IREDA</b>	Indian Renewable Energy Development Agency
<b>IWA</b>	International Workshops Agreement
<b>KCC</b>	Kisan Credit Card
<b>KSK</b>	Kisan Seva Kendra



<b>LNG</b>	liquefied natural gas
<b>LPG</b>	liquefied petroleum gas
<b>M&amp;E</b>	monitoring and evaluation
<b>MGNREGA</b>	Mahatma Gandhi National Rural Employment Guarantee Act
<b>MMSCMD</b>	million standard cubic feet per day
<b>MNRE</b>	Ministry of New and Renewable Energy
<b>MoAFW</b>	Ministry of Agriculture and Farmers' Welfare
<b>MoF</b>	Ministry of Finance
<b>MoHFW</b>	Ministry of Health and Family Welfare
<b>MoP</b>	Ministry of Power
<b>MoPNG</b>	Ministry of Petroleum and Natural Gas
<b>MoPR</b>	Ministry of Panchayati Raj
<b>MoRD</b>	Ministry of Rural Development
<b>MoSPI</b>	Ministry of Statistics and Programme Implementation
<b>MPCE</b>	monthly per capita expenditure
<b>NABARD</b>	National Bank for Agriculture and Rural Development
<b>NBMMP</b>	National Biogas and Manure Management Programme
<b>NCIS</b>	National Programme on Improved Chulhas
<b>NISE</b>	National Institute of Solar Energy
<b>NKS</b>	Neang Kongrey Stove
<b>NLS</b>	New Lao Stove
<b>NNBOMP</b>	New National Biogas and Organic Manure Programme
<b>NRLM</b>	National Rural Livelihood Mission
<b>NSDC</b>	National Skill Development Corporation
<b>NSS</b>	National Sample Survey
<b>NSSO</b>	National Sample Survey Office
<b>O&amp;M</b>	operations and maintenance
<b>OMC</b>	oil marketing company
<b>ONGC</b>	Oil and Natural Corporation Limited
<b>PMAY-G</b>	Pradhan Mantri Awaas Yojana – Gramin
<b>PMMY</b>	Pradhan Mantri MUDRA Yojana
<b>PMUY</b>	Pradhan Mantri Ujjwala Yojana
<b>PNG</b>	piped natural gas
<b>PNGRB</b>	Petroleum and Natural Gas Regulatory Board
<b>PPAC</b>	Petroleum Planning & Analysis Cell
<b>PSU</b>	public sector undertaking
<b>RGGLVY</b>	Rajiv Gandhi Gramin LPG Vitaran Yojana
<b>SAGY</b>	Saansad Adarsh Gram Yojana
<b>Saubhagya</b>	Pradhan Mantri Sahaj Bijli Har Ghar Yojana
<b>SC</b>	Scheduled Caste
<b>SCGJ</b>	Skill Council of Green Jobs

<b>scm</b>	standard cubic metres
<b>SEC</b>	socio-economic classification
<b>SECC</b>	Socio Economic and Caste Census
<b>SETU</b>	Self-Employment and Talent Utilisation
<b>SHG</b>	self-help group
<b>SNA</b>	state nodal agency
<b>SRLM</b>	State Rural Livelihoods Mission
<b>ST</b>	Scheduled Tribe
<b>UCA</b>	Unnat Chulha Abhiyan
<b>UPNRM</b>	Umbrella Programme on Natural Resource Management
<b>VLE</b>	village-level entrepreneur
<b>WDAN</b>	Women's Development Association Network
<b>WHO</b>	World Health Organisation
<b>WSCG</b>	women's savings and credit group
<b>WTP</b>	willingness to pay







Many women continue to use traditional cookstoves to make certain food items, *rotis* in particular.



# Executive summary

Urban India has witnessed greater access to clean cooking energy than its rural counterpart, with a significantly higher proportion of urban households primarily using liquified petroleum gas (LPG). The Government of India has made efforts to enhance access to clean cooking energy by promoting biogas, improved cookstoves (ICS), and LPG through various policies and programmes. It has also envisioned new solutions—including electricity and piped natural gas (PNG)—for meeting the demand for cooking energy in urban India. In recent years, the most prominent effort of the government in terms of improving access to clean cooking energy is the *Pradhan Mantri Ujjwala Yojana* (PMUY) which has provided subsidised LPG connections to over 77 million households (as of August 2019) and consequentially improved the penetration of LPG connections; about 94 per cent of Indian households have an LPG connection as of April 2019. However, a recent study by Jain et. al (2018) in six of the most energy access-deprived states—Bihar, Jharkhand, Madhya Pradesh, Odisha, Uttar Pradesh, and West Bengal—suggests that only about one-third of rural population in these states use LPG as their primary cooking fuel.

As per Census 2011, about 70 per cent of India’s population lives in rural areas. In order to improve access to clean cooking energy for all Indian households, a focused planning is required, targeted at raising awareness and improving the availability and affordability of clean cooking energy in rural areas. The draft National Energy Policy by NITI Aayog proposes a robust strategy for the provision of clean cooking fuel for all in the quickest timeframe, in a mission mode. It emphasises the need to complement the efforts of scaling LPG through PMUY with strategies to deploy agri- and forest-based biomass in a clean and efficient manner.

Clean cooking energy solutions must be appraised from a multidimensional lens that considers the complexity of various effects of cooking energy on people. In such a context, a coherent Roadmap for Access to Clean Cooking Energy is necessary and timely. A multi-fuel, multi-stakeholder approach must be used to design the overall strategy for improving access to clean cooking energy. Such a strategy would need to bring in multiple stakeholders such as government ministries, clean cooking energy enterprises, consumers, donors and financiers, and sector enablers such as non-governmental organisations.

This report is the outcome of a year-long collaboration between CEEW, GIZ and NITI Aayog, which had the aim of building a strong understanding of the multitude of challenges and opportunities across all major clean cooking energy fuels and technologies in the country. Patnaik et al. (2017) document the challenges in the value chain of each major fuel and technology. To inform the Roadmap for Access to Clean Cooking Energy, we held



Only a third of the rural population in six of the most energy access-deprived states use LPG as their primary cooking fuel

consultations with the representatives of key ministries facilitated by NITI Aayog and interviews with key stakeholders in the cooking energy sector. The Roadmap is committed to eliminating the use of cooking arrangements that lead to household air pollution (HAP). This commitment builds on the recognition that accessible, affordable, and convenient alternatives must be made available to all households to meet their entire cooking and heating needs, and to transition away from all arrangements that cause HAP, including the *chulha* (traditional wood/dung stove).

#### The guiding principles of a national roadmap to improve adoption and use of clean cooking energy for all households:

- Consider alternate uses of solid biomass to eliminate negative effects on health
- Measure sustained use of the fuel/technology
- Consider a multi-stakeholder approach to improve adoption
- Develop an ecosystem-based approach
- Ensure that it is inclusive and gender sensitive
- Establish access to clean cooking energy as a developmental goal

## Strategies to improve access, adoption, and use of clean cooking energy

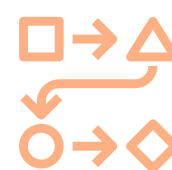
The Roadmap synthesises the discussions that took place among about 30 key stakeholders in the clean cooking energy ecosystem in India. It also includes an extensive literature review of existing challenges in policy and implementation across all fuels and technologies. The document draws from primary research undertaken by the government and non-governmental institutions on the use of different fuels and technologies, expenditure on cooking energy, and barriers to the adoption and sustained use of each fuel or technology. The aim of the document is to lay out strategies for each fuel that can support its value chain and improve the availability and affordability of the fuel and its technologies as well as consumers' awareness of these alternatives. Each strategy was ranked according to key parameters: i) the effort required to implement the strategy; ii) the time taken to implement the strategy; iii) the likelihood of impact; and iv) the scale of impact.

## Fuel-agnostic strategies to improve access, adoption, and use

These strategies are independent of the clean cooking fuel or technology used by a household, and will apply to all clean cooking energy solutions. Stakeholders across all fuels and technologies will need to understand and work on these strategies before navigating other challenges in the ecosystem.

Proposed strategy	
1. Improve awareness of the health impacts of traditional biomass <i>chulhas</i>	5. Improve data availability for energy access
2. Understand the market and consumers	6. Streamlining of subsidies on cooking energy with better targeting of consumers
3. Understanding the social and cultural factors influencing access to energy	7. Leverage alternate financing solutions
4. Focus on aspects of kitchen design and ventilation	

Source: CEEW analysis, 2018

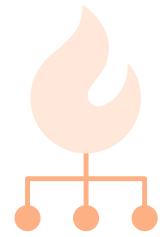


The Roadmap lays out strategies for each fuel/technology that can support growth along its entire value chain

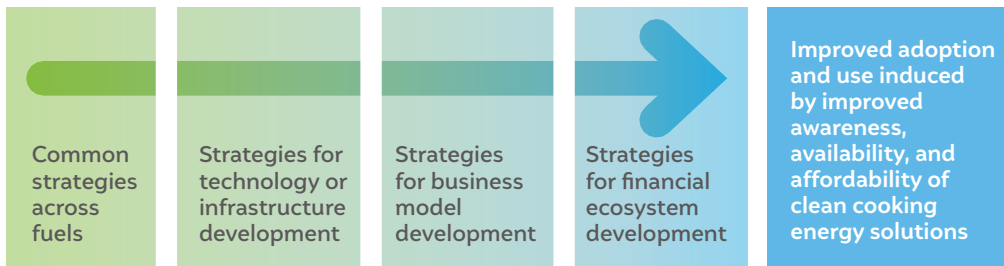
## Fuel-based strategies to improve access, adoption, and use

A detailed set of strategies across fuels have been explained in this Roadmap. The fuel- or technology-specific strategies focus on improving their availability and affordability in order to facilitate sustained use. To that end, all interventions focus on three broad areas: i) the development of technology or infrastructure; ii) business model(s); and iii) the financial ecosystem. These interventions will ensure better availability and affordability of the solutions.

The basket of clean cooking energy solutions considered in this Roadmap, for both urban and rural India, include LPG, biogas, ICS, PNG, electricity, and solar-based cooking. Stacking will be common among households transitioning to clean cooking energy, necessitating a multi-fuel approach with multiple combinations of primary and secondary fuels and technologies. However, different technologies are at different stages of readiness for adoption and scale. While the ecosystem for LPG faces affordability and availability challenges, the ecosystem for electricity needs far more infrastructural investment in order to become a feasible solution for households in rural areas. For newer technologies such as solar-based cooking, it is important to look at the efficiency and durability of the technology itself, to ensure that it meets the cooking needs and diverse food practices of Indian households.



Stacking will be common among households transitioning to clean cooking energy, necessitating a multi-fuel approach

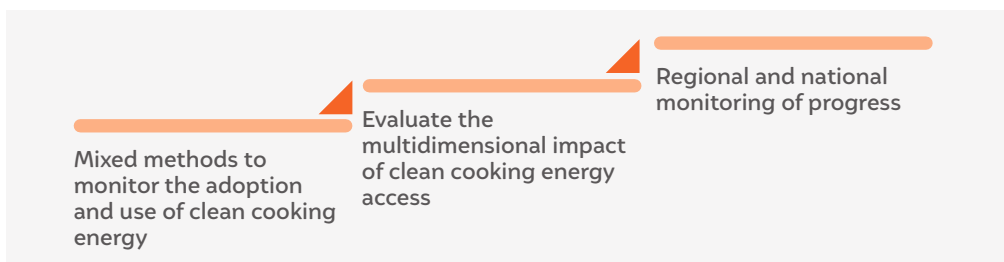


Source: CEEW analysis

The strategies include actionable steps to be taken by the various ministries whose policies and scope of work align with the needs of the clean cooking energy ecosystem. These include recommendations on how existing ministry programmes could be integrated with the value chain of clean cooking energy solutions, identifying possible areas for training and capacity-building of stakeholders in the value chain, and on the new roles and responsibilities of existing ministries in the context of the severity of the issue of public health and energy access.

## Monitoring and evaluation framework

A national roadmap on clean cooking energy would include a rigorous monitoring and evaluation (M&E) component to facilitate the transition from the traditional *chulha* to the sustained access and use of clean cooking energy. The national roadmap should be linked to a third-party baseline, midterm, and endpoint evaluation of access to clean cooking energy. We envisage the following principles for the M&E framework:



Source: CEEW analysis, 2018

The M&E team for this mission should be independent of the programme team, although engaging with them for regular reviews. A combination of quantitative and qualitative research methods should be used to evaluate the roadmap. Administrative data on clean cooking energy providers could also be leveraged to support the programme's M&E. In addition, technology should be leveraged to reduce the reporting bias from survey-based methods. The impact assessment of the use of clean cooking energy should include a focus on health, gender, and livelihoods. A multi-criteria assessment for the initial phase of the mission will help build a stronger case for household adoption of clean cooking energy. The M&E framework should include common review missions that allow multiple ministries to regularly assess the progress in their focus areas. Monitoring should be done at the state, district, and block levels in order to gather specific insights on progress, and accordingly streamline efforts to address gaps.

## Way forward

A multi-fuel, multi-stakeholder, and multipronged national strategy that considers not only the supply side, but also the needs, aspirations, and priorities of consumers will ensure a sustainable transition towards clean and affordable cooking energy access for all. There is a need to prioritise action for each fuel and technology, based on its current level of maturity in terms of penetration, user acceptance, technology development, etc. The promotion of these alternatives should always be planned at a district and state level, but rooted in the local context.

To fully address the development implications of the lack of energy access, it is important to involve all concerned stakeholders in programme ideation and implementation, including the private sector, civil society, government ministries, and consumers. The recommendations in the Roadmap are relevant for all stakeholders in the clean cooking energy space. Given the wide-ranging scope and implications of the strategies, the Roadmap will be most useful if its implementation is overseen by a neutral inter-ministerial commission that fosters an enabling market environment, and coordinates the activities of all the concerned state and non-state actors.



**The M&E framework should include common review missions that allow multiple ministries to regularly assess the progress in their focus areas**





Over 77 million LPG connections have been given out under the *Pradhan Mantri Ujjwala Yojana*.



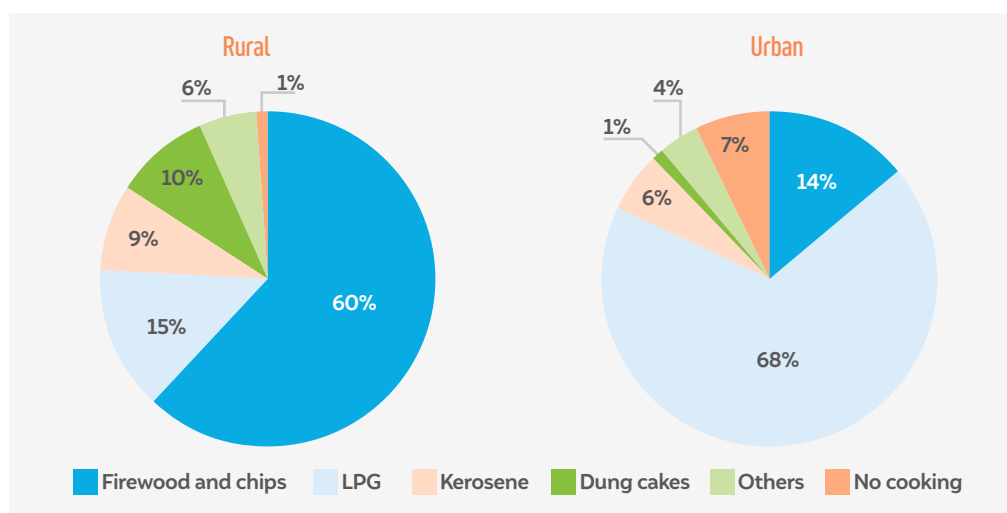


# 1. Introduction

## 1.1. Framing the issue

Urban India has achieved greater access to clean cooking energy than its rural counterpart, with a significantly higher proportion of urban households primarily using liquified petroleum gas (LPG).

**FIGURE 1:** Use of LPG as the primary cooking fuel was four times higher in urban areas than in rural areas in 2012



Source: NSSO (2012)

The 68<sup>th</sup> round of the NSSO (2011–12) revealed that over two-thirds of households in rural India still relied on firewood and cow dung for their primary<sup>1</sup> cooking fuel needs. The Government of India has made efforts to enhance access to clean cooking energy by promoting biogas, improved cookstoves (ICS), and LPG through various policies and programmes. It has also envisioned new solutions—including electricity and piped natural gas (PNG)—for meeting the demand for cooking energy in urban India. In recent years, the most prominent effort of the government in terms of improving access to clean cooking energy is the *Pradhan Mantri Ujjwala Yojana* (PMUY) which has provided subsidised LPG connections to over 77 million households (as of August 2019) and consequentially improved

1 Primary is defined as the cooking fuel or device used by the household to prepare most meals on a regular basis.



Use of LPG as the primary cooking fuel was four times higher in urban areas than in rural areas in 2012



the penetration of LPG connections; about 94 per cent of Indian households have an LPG connection as of April 2019. However, a recent study by Jain et al. (2018) in six of the most energy access-deprived states—Bihar, Jharkhand, Madhya Pradesh, Odisha, Uttar Pradesh, and West Bengal—suggested that only about one-third of the rural population use LPG as their primary cooking fuel.

Clean cooking energy solutions must be appraised from a multidimensional lens that considers the complexities of the impacts of cooking energy. Jain et al. (2015a) use the following dimensions as material aspects of clean cooking energy access, adapted for the Indian context from those of the Global Tracking Framework (GTF).

**Health and safety**, pertaining to the health and safety impacts of HAP for each source of cooking energy

**Availability** of the primary cooking fuel 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**, pertaining to the time taken for cooking and the ease of handling cooking appliances

Studies show that despite having an active LPG connection, households stack LPG with biomass for cooking. Burning biomass for cooking results in HAP, which causes, according to recent estimates, at least 800,000 premature deaths across the country every year (IHME, 2016). Women and children are disproportionately affected as they are exposed to high levels of HAP, and the tedious task of gathering fuelwood is often left to them.

The World Health Organization (WHO) guidelines for household air pollution (HAP) focus on the impact of household fuel combustion on child and adult health. Based on data on exposure to HAP and on solid fuel use in developing countries, the WHO is developing the Clean Household Energy Solutions Toolkit (CHEST) for planning household energy policies and programmes at both the national and local level (WHO 2018). However, 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 no outdoor air pollution in the form of black carbon emissions. Having been subsidised for over three decades, LPG is now the predominant clean cooking fuel in urban India. While the government has taken steps to increase the penetration not only of LPG but also of alternatives like biogas, PNG, and ICS, there is a need to focus further on the sustained use of these options. To mitigate the adverse health impacts of traditional biomass cookstoves (*chulhas*), it is essential to devise policies that encourage stacking between only clean cooking fuels and technologies, and to enable a permanent shift away from cooking arrangements that cause HAP. In order to achieve significant progress in sustained clean cooking energy access, there is a need to develop a coherent strategy that integrates access to clean cooking energy with broader programmes for rural and human development.



About 94 per cent of Indian households now have an LPG connection



## 1.2. What is the Clean Cooking Energy Roadmap?

This report is the outcome of a year-long collaboration between CEEW, GIZ and NITI Aayog that aimed to propose a set of actionable strategies in the form of a “roadmap” to achieve clean cooking energy access for all households in the country. It builds on a comprehensive understanding of the multitude of challenges and opportunities existent across all major clean energy solutions and the sector as a whole. As a precursor to the Roadmap, a policy brief by Patnaik et al. (2017) documented the challenges in the value chain of each clean cooking energy fuel.<sup>2</sup> Readers are encouraged to read this brief as it helps lend necessary context to many of the recommendations that are contained within this report.

We recognise that as each cooking fuel and technology is at a different stage of maturity (due to its inherent characteristics, consumer use preferences, or policy support), there is a need to evaluate the current state, needs, and growth potential of each fuel and technology individually. The private and public support required to scale up biogas to realise its potential nationwide will necessarily differ from that needed to improve the sustained use of LPG in rural households. The Roadmap is committed to eliminating the use of cooking arrangements that lead to HAP. This commitment builds on the recognition that accessible, affordable, and convenient alternatives must be made available to all households in order to meet their entire cooking and heating needs, and thus transition away from all arrangements that cause HAP including traditional biomass cookstoves.

### Vision of the Clean Cooking Energy Roadmap

Eliminate the use of all cooking arrangements that cause household air pollution across all households in India by 2025

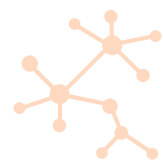
A multi-fuel approach that emphasises the exclusive use of clean cooking energy solutions that complement each other is at the core of this long-term strategy. In the short to medium term, the focus is on improving the availability and affordability of clean cooking energy, and enhancing the awareness of households about the adverse health effects of directly burning solid biomass for cooking.

The recommendations in the Roadmap are relevant for all stakeholders in the clean cooking energy space—enterprises, policymakers, research institutions, and donors. It is written primarily for policymakers, however, as the strategies require action on the part of various government ministries and departments. Given the wide-ranging scope and implications of the recommendations, the Roadmap will perhaps be most useful if its implementation is overseen by a neutral ministerial commission that coordinates the activities of all concerned agencies. While the focus should be multi-fuel and multidimensional, an integrated approach and focus on clean cooking energy rather than on individual fuels or technologies will reduce the duplication of efforts, and will create scope for hybrid solutions through a combination of clean cooking energy fuels and technologies.

The goal of the Roadmap and the methodology used to arrive at, and prioritise, the recommendations are outlined in Chapters 1 and 2. In Chapter 3, we list the guiding principles of the roadmap, based upon which the recommendations have been developed. The common and the fuel-wise strategies for improving access to clean cooking energy are elaborated on in Chapters 4 and 5. We elaborate in some depth on each strategy in these chapters, covering six major fuels and technologies—LPG, ICS, biogas, PNG, solar-based



The Roadmap is committed to eliminating the use of cooking arrangements that lead to household air pollution (HAP)



The Roadmap will be most useful if its implementation is overseen by a neutral ministerial commission that coordinates the activities of all concerned agencies

<sup>2</sup> The policy brief can be found at <https://bit.ly/2ro9l8R>.

cooking, and electricity-based cooking. Chapter 6 documents examples of best practices from around the world, across various clean cooking solutions. It points out where some of the recommendations suggested in this Roadmap have either already been tested or are being implemented. Finally, in Chapter 7, we propose a set of principles and indicators for monitoring and evaluating the implementation and impact of the strategies.



CEEW consulted a diverse set of stakeholders that included energy practitioners, civil society organisations, and government agencies and ministries to inform the Roadmap.









## 2. Methodology

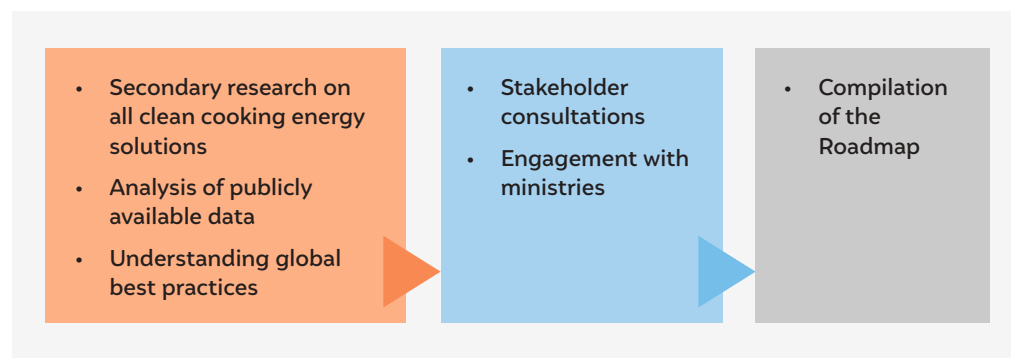
The Roadmap is based on (a) an extensive literature review of existing challenges in policy and practice across all fuels and technologies; (b) semi-structured interviews with over 30 key stakeholders in India's clean cooking energy ecosystem; and (c) group consultations with 40 individuals from government ministries and departments, public sector undertakings, private sector players, and sector enablers such as civil society organisations (CSOs) and financiers. The document also draws from primary research undertaken by the government and non-governmental institutions on the existing use of different fuels and technologies, household expenditure on cooking energy, and the barriers to the adoption and sustained use of these fuels and technologies.



Image: iStock-Vasuki Rao

The document elaborates on strategies for the clean cooking energy sector as a whole and for each clean fuel or technology. In order to prioritise the strategies for implementation, a survey was conducted with experts<sup>3</sup> who rated each strategy across four criteria: (a) effort required to implement the strategy; (b) time required to implement the strategy; (c) likelihood of impact; and (d) scale of impact. We used a framework that combines the parameters according to their relative importance, and then prioritises the strategies for implementation by the government.

**FIGURE 2: Methodology of the Roadmap**

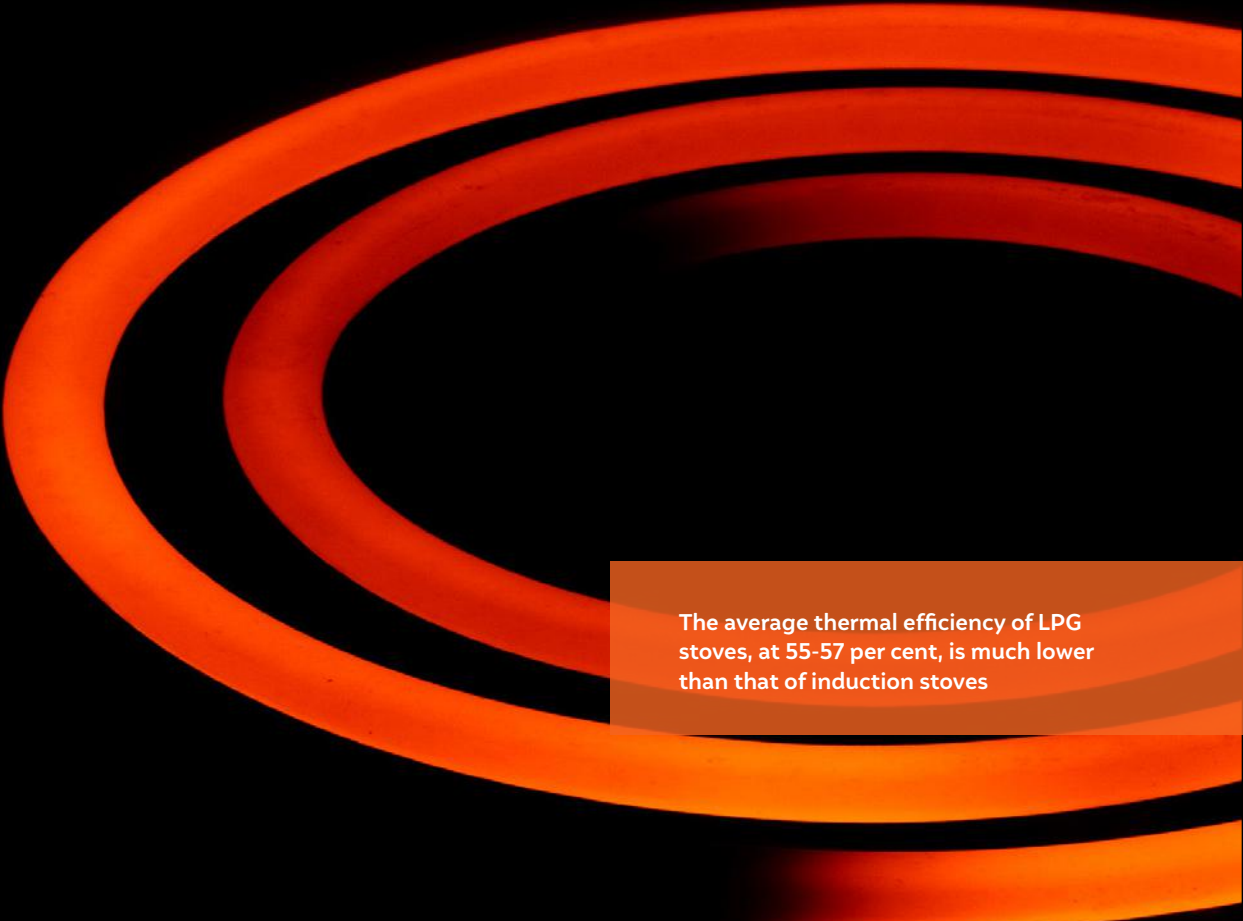


Source: CEEW analysis, 2018

<sup>3</sup> We conducted an online survey with 16 experts across various stakeholder categories, in order to prioritise interventions for LPG, biogas, and improved cookstoves. This exercise did not include PNG, or electricity- or solar-based cooking. The experts rated each strategy across the four parameters (explained in the text). A cumulative score was assigned to each strategy based on the responses by experts. This was used to assign a priority (high/medium/low) and a timeline to each strategy. The details of the survey can be found in the Annexure.







The average thermal efficiency of LPG stoves, at 55-57 per cent, is much lower than that of induction stoves

## 3. The Guiding Principles of the Clean Cooking Energy Roadmap

### 3.1. Consider alternate uses of solid biomass to eliminate its negative effects on health

The provision of clean cooking energy solutions does not in and of itself ensure health benefits if households continue to use solid biomass for other needs such as space heating, water heating, and the preparation of animal fodder. A contextualised approach particular to each region will be necessary to eliminate the use of solid biomass. For instance, in colder regions such as Himachal Pradesh and Uttarakhand, it is important to simultaneously make alternatives for space heating and other heating requirements available, if HAP is to be eliminated. The drudgery of collecting firewood will remain if households continue to rely on biomass to meet their energy needs. Any national strategy that aims to promote clean cooking energy must consider the use of cooking fuels beyond just households. Anganwadi centres, schools, small shops, restaurants, and canteens within workplaces should be included in long-term strategies to improve access to clean cooking energy and in turn to reduce exposure to HAP. Although we have not included interventions to address the burning of solid biomass for other household needs such as heating, we acknowledge the need to conduct thorough research on these aspects if HAP is to be eliminated.



To eliminate household air pollution, it is important to also make alternatives available for space heating and other heating requirements

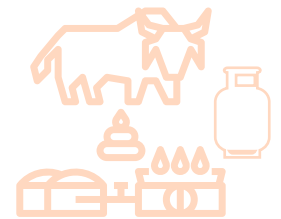
### 3.2. Measure the sustained use of the fuel or technology

All endeavours aimed at improving access to clean cooking energy must measure the consistent use of the fuel or technology as well as the sales, dissemination, and installation numbers. Studies have consistently shown that households often discontinue the use of cookstoves, biogas, and LPG owing to reasons of unaffordability, non-availability, or non-functionality (Jain et al., 2018). Many households limit their use of clean cooking energy alternatives to special occasions, stacking their use with the traditional *chulha*. The mechanism used to monitor access should therefore be nuanced enough to capture the exclusive use of clean cooking energy solutions and should focus on eliminating the use of the *chulha*. The use of solid biomass for space heating in households should also

be measured. National Sample Survey (NSS) and Census data can be leveraged to access information on stacking and/or the exclusive use of clean cooking energy, as well the use of solid biomass for space heating among households in India. In addition, to address the barriers to the sustained use of clean fuels and technologies, a context-based understanding of social, economic, and cultural aspects is necessary. An effort to map areas that are suited to certain fuels or technologies based on fuel availability, as well as agro-climatic and socio-economic conditions, can help in better mapping of solutions. This could be done through in-depth qualitative assessments alongside quantitative surveys. The Ministry of Petroleum and Natural Gas (MoPNG) is best placed to work independently with research institutions, civil society, and other government ministries to design such assessments.

### 3.3. Multidimensional and multi-fuel approach to providing affordable access to clean cooking energy

The national strategy on clean cooking energy should focus on multidimensional aspects of access, including the availability, affordability, convenience, quality, and safety of the cooking fuel or technology. It should therefore be technology agnostic, and should focus on eliminating HAP through a combination of clean cooking energy solutions. This calls for bundling various solutions based on context and geography. For example, in rural areas with an adequate cattle population, the focus should be on complementing LPG with biogas, while in other areas, solar-powered cooking could be one of the solutions. In areas with abundant biomass, improved cookstoves could complement LPG. Even within a certain geographical area, some households will find exclusive use of LPG affordable, while others might find it expensive. Such a targeted approach to understanding and implementing clean cooking solutions will require granular data on household needs and affordability, and a mature ecosystem of deployers and services.

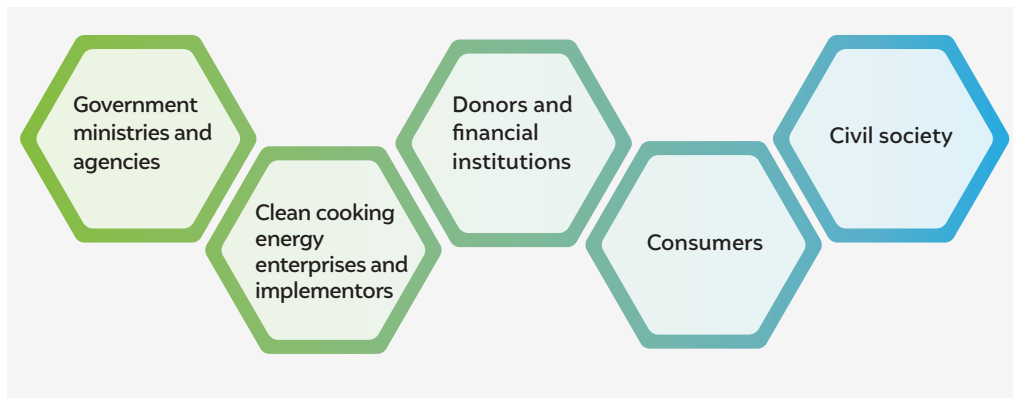


**In rural areas with an adequate cattle population, the focus should be on complementing LPG with biogas**

### 3.4. Multi-stakeholder approach to improve adoption

The collaborative efforts of multiple ministries are critical to addressing the gaps in the value chain for clean cooking energy solutions. Although each ministry has its own mandate, we have identified synergies between their schemes that could be leveraged to implement a coherent strategy. To unify the various socio-economic, cultural, and technological elements of clean cooking energy efforts, it will be important to align the interests and integrate the roles of all the relevant actors in the sector. A detailed assessment of such interests and roles through regular monitoring and feedback will be useful for course correction and immediate action. So far, these various actors have worked in silos and have engaged only occasionally to share their learnings. It is imperative that these learnings be institutionalised and effectively used; hence, it is important to have a collaborative stakeholder platform under the mission.



**FIGURE 3: Stakeholders in the clean cooking energy sector in India**

Source: CEEW analysis, 2018

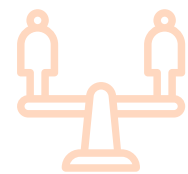
### 3.5. An ecosystem-based approach

To realise affordable access to clean cooking energy for all households in India, it is imperative to take an ecosystem-based approach, in order to comprehensively understand, identify, and address challenges across the value chain. The Roadmap will adopt an ecosystem-based approach focusing simultaneously on first-time access to clean cooking energy, operations, and maintenance; access to affordable finance for entrepreneurs and end users; as well as research and development. Figure 3 outlines the broad categories of ecosystem players who need to be consulted and included in the implementation of solutions. This includes the various ministries that are responsible for multiple elements of clean cooking energy solutions, enterprises that offer clean cooking energy solutions, oil marketing and urban gas distribution companies, donors and financiers, consumers who use these solutions, and other institutions such as NGOs and government labs that support the innovation and adoption of solutions.

### 3.6. Inclusive and gender sensitive

The Roadmap is rooted in a rights-based framework that seeks to promote the right to development, without discrimination, of women, children, and all marginalised groups. Current socio-political structures compound the poor access of vulnerable groups to clean cooking energy—the low opportunity cost of women’s labour leads to the undervaluation of the time they spend collecting firewood, preparing dung cakes and fuelwood, and cooking. Due to pre-existing patriarchal social conditioning and their lack of ownership rights or access to incomes, women have limited influence on household expenditure decisions.

According to Jain et al. (2018), although 58 per cent of rural households use LPG, access is skewed towards upper classes, with 69 per cent of General households using LPG against just 38 per cent of Scheduled Tribe households. Similarly, access to clean cooking energy is limited for the urban poor owing to the lack of affordability and documentation. Hence, the strategy for access must ensure social inclusion of all marginalised groups regardless of caste, gender, and age. This necessitates a targeted context-based approach, region by region, to ensure equitable access across social groups.



The Roadmap is rooted in a rights-based framework that promotes the right to development, without discrimination, of all marginalised groups

### 3.7. Access to clean cooking energy as a developmental goal

Access to modern energy services is fundamental to fulfilling basic social needs, driving economic growth, and supporting human development. As an enabler of human development, access to clean cooking energy will allow millions—particularly women and children—to escape HAP and drudgery, and will reduce time poverty. It will allow families to benefit from better health and the increased productivity of their members. To this end, we need to evolve our understanding of access to clean cooking energy, not for energy access alone, but also for human development.

This can be achieved by integrating access to clean cooking energy into existing government schemes in the various ministries. For instance, the *Saansad Adarsh Gram Yojana* (SAGY), under the Ministry of Rural Development (MoRD), aims at empowering citizens to transform villages into successful models through inclusive and holistic development in a time-bound manner. As nodal officers for the implementation of the programme, district collectors can be encouraged to include access to clean cooking energy in the strategy for SAGY. The adoption and adaptation of technologies and the introduction of innovations are critical to this programme. Hence, improved versions of clean cookstoves and biogas plants (in addition to LPG) could be introduced under this programme in order to eliminate stacking of LPG with *chulhas*. The scheme envisages holding *mahila sabhas* and *bal sabhas* to discuss women- and children-specific issues and concerns. This could become an effective platform for increasing women’s awareness of the negative health effects of burning firewood, and could help enable them to voice any complaints they may have about the availability of clean cooking energy solutions.







Household air pollution from the incomplete combustion of solid fuels disproportionately affects women and children

## 4. Sectoral Strategies to Improve Access to All Clean Cooking Energy Solutions

### 4.1. Improve awareness of the health impacts of traditional biomass *chulhas*

Both, limited awareness of the impact of burning solid fuels on health, and ignorance of the benefits of cleaner cooking fuels, influence bottom-up demand. According to Jain et al. (2015a), 72 per cent of households that use solid biomass are aware that it has adverse impacts on their health. Despite that, only 59 per cent believe that LPG has positive health benefits over traditional cooking fuels. In 2015, a Steering Committee on Indoor Air Pollution constituted by the Ministry of Health and Family Welfare acknowledged the impact of burning solid biomass in *chulhas* on women's health, and emphasised the need for government interventions to ensure the ubiquitous availability of clean cooking fuels (Rao, 2016). The health department seeks to include village health and sanitation committees in efforts, campaigns, programmes, and policies aimed at bringing about a behavioural change towards using clean cooking energy solutions and a move away from solid biomass.

The Ministry of Health and Family Welfare (MoHFW) could play an important role as a neutral party, not promoting a particular technology, but educating households about HAP. In public awareness efforts, along with the message, it is equally important for users to trust the carrier of the message or information. Villagers are understandably reluctant to believe statements from institutions about the health impact of using biomass in traditional *chulhas*, suspecting them of having an agenda such as, for example, promoting LPG or biogas. It is important that the message comes from an authoritative independent source such as the MoHFW. Sub-centres and primary health centres are the closest access points to healthcare for the rural population, and thus could be effective venues for communication. Through posters and other kinds of visual representation, people could be made aware of the negative effects of using solid biomass as a cooking fuel. Communication instruments such as radio announcements and community-based broadcasting could be used to disseminate information about indoor air pollution and its effect on perinatal health (still births, low birth weight, etc.), as part of announcements on reproductive health. Accredited social health activists (ASHAs) are the primary interface between the public health system and the community, and hail from the very communities they serve. They regularly engage with rural households on aspects of maternal and child health, and thus are a reliable and effective medium for the dissemination of information about the negative health effects of using solid biomass.



Sub-centres and primary health centres are the closest access points to healthcare for the rural population, and thus could be effective venues for communication

The Indian Council of Medical Research (ICMR) can play an instrumental role in assessing the health effects of exposure to emissions from solid biomass on women and children. Research leading to a database of such information will aid health and energy professionals to design effective solutions for affected populations. The Roadmap for Access to Clean Cooking Energy should budget for such data collection and assessment activities.

The Ministry of Women and Child Development could also support awareness campaigns through its network of Integrated Child Development Services (ICDS). Anganwadi workers could be trained to handle queries on HAP and its impact on children’s health and well-being. Building the message around the health of children could encourage more parents to take note of the issue and seek affordable clean cooking energy solutions.

The Ministry of Panchayati Raj can support the institutionalisation of affordable clean cooking energy access as an essential element of development for villages. Similar to LPG *panchayats*, biogas *panchayats* hosted by *gram sabhas* can offer people the opportunity to improve their awareness by interacting with various stakeholders in the biogas ecosystem—including manufacturers, distributors, and servicemen—and have their queries addressed.

## 4.2. Understanding the market and consumers

The sector could benefit from detailed studies that offer context-based consumer segmentation with respect to food habits, willingness to pay, fuel mix, frequency of cooking, current stoves, etc. A recent study conducted by Nielsen classified rural and peri-urban consumers into four segments in order to identify early adopters of clean fuels and stoves. Though the study focused on Rajasthan and Kerala, it provides a framework for classifying consumers across India. The segments identified for Rajasthan are elaborated below as an illustrative example (Nielsen, 2016). Focused studies of a similar nature can help multiple players in the sector.

**TABLE 1: Consumer segments for adoption of clean fuels and stoves**

Consumer segment	Description	Approach
Discerning affluent	This segment is in the highest socio-economic classification (SEC) and bases its decisions on convenience and traditional beliefs. This segment does not lack purchasing power but continues using solid fuel due to traditional and cultural rigidity and taste preferences. Predominantly mixed fuel users, they use solid fuel stoves primarily for cooking rotis and other traditional food items, and use LPG for cooking all other items.	A focus on increasing the awareness of household members, and especially educating decision makers, is necessary.
Struggling maximisers	The segment is at a medium-level SEC, trying to balance both ends. The large size of families as well as convenience factors play a key role in the selection of fuels, while a traditional orientation plays a small role. A good proportion of these households reported having access to LPG; however, usage of LPG remains limited. Although these households understand the negative health effects of using solid biomass, they consider LPG usage to be a costly alternative and so continue to use solid fuel.	Complementary solutions (biogas, cookstoves, solar-powered cooking, and electric stoves) should be encouraged, and affordability should be improved by enabling payment through instalments.



Consumer segment	Description	Approach
Wishful	This segment has a low SEC profile and affordability is the key issue; however, there is a strong desire to escape this condition. The households in this segment predominantly use solid fuel but emphatically report its inconvenience.	Clean cooking energy enterprises should provide affordable biogas, solar-powered cooking, and improved cookstoves for enabling households to transition to a clean and convenient fuel or technology.
Strapped	This segment falls in the lowest SEC profile and does not have the disposable income to pay for cooking fuel. They continue to use solid fuel in the absence of affordable alternative fuels, and purchasing power remains the key constraint.	Improved cookstoves (with or without subsidy) should be provided, coupled with instalment schemes, in order to encourage a shift away from <i>chulhas</i> . Ventilation of the kitchen should be improved through chimneys.

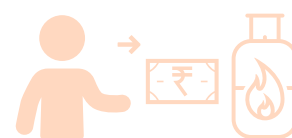
Source: Nielsen, 2016

Most government efforts to promote clean cooking energy in the last few decades have focused on improving the availability of fuels and the deployment of solutions, with a limited understanding of consumer needs. While there have been isolated attempts by civil society actors to gauge consumer satisfaction with small-scale biogas plants or improved biomass cookstoves, government policies have continued to focus on technical specifications such as efficiency and emissions, while giving limited consideration to convenience of use and after-sales service support. Often, the small sample size and low external validity of these studies have limited their integration into any national strategy.

A key knowledge gap is the lack of reliable estimates of consumers' willingness to pay (WTP) for either the upfront cost or the recurring cost of fuel. These estimates should be sensitive to the different types of consumers, including their cooking habits and needs and how much they are willing to pay. Such market segmentation will be useful for entrepreneurs to better understand the consumer base, and thereby to more effectively tailor their marketing strategy.

There is also a need for qualitative assessments that span various cultural contexts in order to adequately appreciate the operational challenges associated with the proper use of the solution. Documenting the challenges and remedies at the household level will help distributors adopt more personable and practical methods of generating demand.

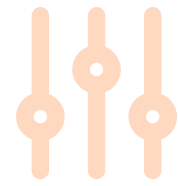
For widescale communications—given the characteristics of the typical rural household—outreach should primarily be carried out through community radio stations and, in certain pockets, television advertisements and WhatsApp. It might be useful to have popular local personalities advocating clean cooking fuels. For more targeted dissemination, local community institutions could be leveraged to carry out sensitisation and awareness drives. The people in these institutions are likely to be well known and understood in the community and, as such, hearing about new technologies from such trusted sources would increase the likelihood of their adoption and of positive word-of-mouth dissemination.



**A key knowledge gap is the lack of reliable estimates of consumers' willingness to pay for access to clean cooking energy**

### 4.3. Understanding the social and cultural factors influencing access to energy

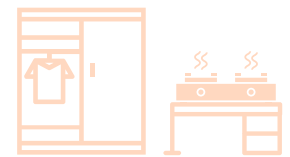
As explained earlier, we understand access to clean cooking energy as being more than just the adoption of the technology; increasing access includes supporting its primary and sustained use in a manner that is affordable and convenient. While improving the availability and affordability of the technology are essential, that does not necessarily lead to its adoption and use. In fact, access itself is influenced by factors such as political will, local networks and influencers, and consumers' perceptions. Further, household and community socio-economic structures influence the priority assigned to cooking as an activity and to the health of the women engaged in it. A national roadmap for access to clean cooking energy must be cognisant of the socio-economic disparity in India, and must, therefore, refrain from a one-solution-fits-all approach. Understanding geographic, social, and economic contexts is essential to identifying barriers to access and to designing appropriate solutions. Most importantly, any programme on access to clean cooking energy must be gender inclusive and must understand the implication of policies for the inclusion and exclusion of women. Enhancing women's agency to navigate social structures around gender norms, and improving their capacity to negotiate with the men of the household, the community, the state, and the market (Kelkar et al., 2016), is of utmost importance if the transition to clean cooking energy is to be sustained. Access to clean cooking energy should therefore be analysed in terms of a broader context, one that spans beyond access to energy and intersects with socio-political structures within and outside a household.



The roadmap must be cognisant of the socio-economic disparity in India, and must refrain from a one-solution-fits-all approach

### 4.4. Focus on aspects of kitchen design and ventilation

There should be a focus on improving kitchen design to allow for ventilation, especially in households that use biomass for cooking. According to Census 2011, about 40 per cent of houses in India did not have a separate kitchen. Designs for better ventilation could be promoted under the MoRD's housing scheme, *Pradhan Mantri Awaas Yojana – Gramin* (PMAY-G). For the safe use of LPG, cooking must take place on an elevated platform. This could also be incorporated into the design for the kitchens being constructed under PMAY-G. For those living in houses built without PMAY-G support, a programme designed to increase their awareness of the importance of ventilation could be helpful. The contractors who undertake the construction work could be trained by the MoRD to focus on these aspects when constructing houses in rural areas.



As of 2011, about 40 per cent of houses in India did not have a separate kitchen

### 4.5. Improving data availability for energy access

The most widely cited data sources on energy access in India are the Census and the National Sample Survey Office (NSSO). While they are nationally representative surveys, their frequency is rather limited, with Census data being made available once in 10 years, and NSSO data on consumer expenditure available every five years. There is a need to collect granular data on energy access more frequently. Data on cooking energy must capture its multidimensionality by going beyond just the instalment of a connection, and documenting the lived experience of using cooking energy fuels and technologies.

Although many CSOs across the country have made attempts to measure varying aspects of clean cooking energy access in different states and at different times, they have often done so in silos. A national strategy on clean cooking energy could unify these uncoordinated data

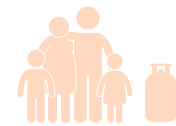
gathering efforts, and could leverage the local expertise of CSOs to improve the frequency of energy access data collection. At relatively little extra cost, it could also engage the Ministry of Statistics and Programme Implementation (MoSPI) to collect nationally representative data on energy access as part of its many existing surveys on consumer expenditure and health. This would enable immediate course correction in the implementation of government schemes, especially considering the fast-evolving nature of energy access.



**There is a need to collect granular data on energy access more frequently**

#### 4.6. Streamlining of subsidies on cooking energy with better targeting of consumers

The subsidy for direct benefit transfer for LPG (DBTL) has increased from INR 12,000 Crore in 2016-17 to about INR 21,000 Crore in 2017-18 (PPAC, 2018). However, the distribution of LPG subsidies has been inequitable, with subsidy transfers disproportionately accruing to consumers and businesses in most-developed states and union territories (Clarke 2014). A prime reason for this inequity has also been the lack of LPG connections among low-income citizens. The PMUY has addressed this barrier, allowing below poverty line (BPL) households to avail a new subsidised LPG connection. However, whether the benefit actually translates into gains for the beneficiaries will be highly dependent on their ability to afford refills. There is also a scheme through which the government provides subsidies to households for the construction of biogas plants and for the purchase of improved cookstoves. However, an integrated fuel subsidy reform that focuses on the subsidisation of clean cooking energy (purchase or use)—as opposed to the subsidisation of each fuel or technology—could benefit households better, allowing them a choice and ensuring sustained use. It would also allow the government to plan for the country’s overall cooking energy needs instead of planning individually for each fuel or technology.



**A subsidy regime that differentiates entitlements on the basis of socioeconomic characteristics will improve affordability of LPG among households**

Jain et. al (2016) argue for better targeting of LPG consumers and move towards a differentiated subsidy regime reflective of the economic situation of the household to enable affordability of LPG. A flat subsidy for all households may not lend to an optimal outcome, given the limited resources available to any government. A subsidy regime that is able to differentiate the entitlements for different socioeconomic groups would be essential to improving affordability of LPG among households. DBTL provides a path to set a common market price for LPG and enable subsidy targeting and differential subsidy. While the government has already announced the exclusion of households based on their reported annual income, the population covered under this method is limited. A better targeting method – one that uses proxies to ascertain economic wellbeing - would allow for an accurate assessment of the subsidy needs of the households using LPG.

#### 4.7. Leverage alternate financing solutions

Given the scale of development challenges such as the lack of access to clean cooking energy, they often require system-scale investments to streamline supply-side bottlenecks. Seeing as public funds alone may not be able to address these problems, they should be leveraged strategically to unlock private investments in the clean cooking energy sector. The use of public funds as capital guarantee for private investments will help in reducing the rate of lending, and in boosting investor confidence.

Private investors should look to lend to rural energy enterprises through results-based financing, where funding is tied to verifiable, pre-determined outcomes and outputs. This can improve the performance and long-term impacts of energy access projects, as households will be incentivised to use the products regularly, reducing exposure to HAP.



Further, given the emissions-reducing potential of clean cooking energy solutions, it is also important to explore carbon finance—which has been used to scale up ICS in several countries—as an alternative to incentivise households to use them. According to MNRE, the offsets generated from cookstoves are reportedly the most sought-after among voluntary offset purchases (MNRE, 2014a). The integration of efforts to facilitate voluntary carbon credits across enterprises that offer renewable energy-based cooking solutions can help improve the availability of finance for both consumers and enterprises. However, given the sensitivity of this mode of finance to global markets and politics, it should be used cautiously and in appropriate conditions that are likely to render positive outcomes.



Households in India use a range of clean cooking energy alternatives: LPG, improved cookstoves, biogas, PNG, and electricity- and solar-based cooking technologies







Images: iStock



# 5. Fuel-specific Strategies for Improving Access to Clean Cooking Energy

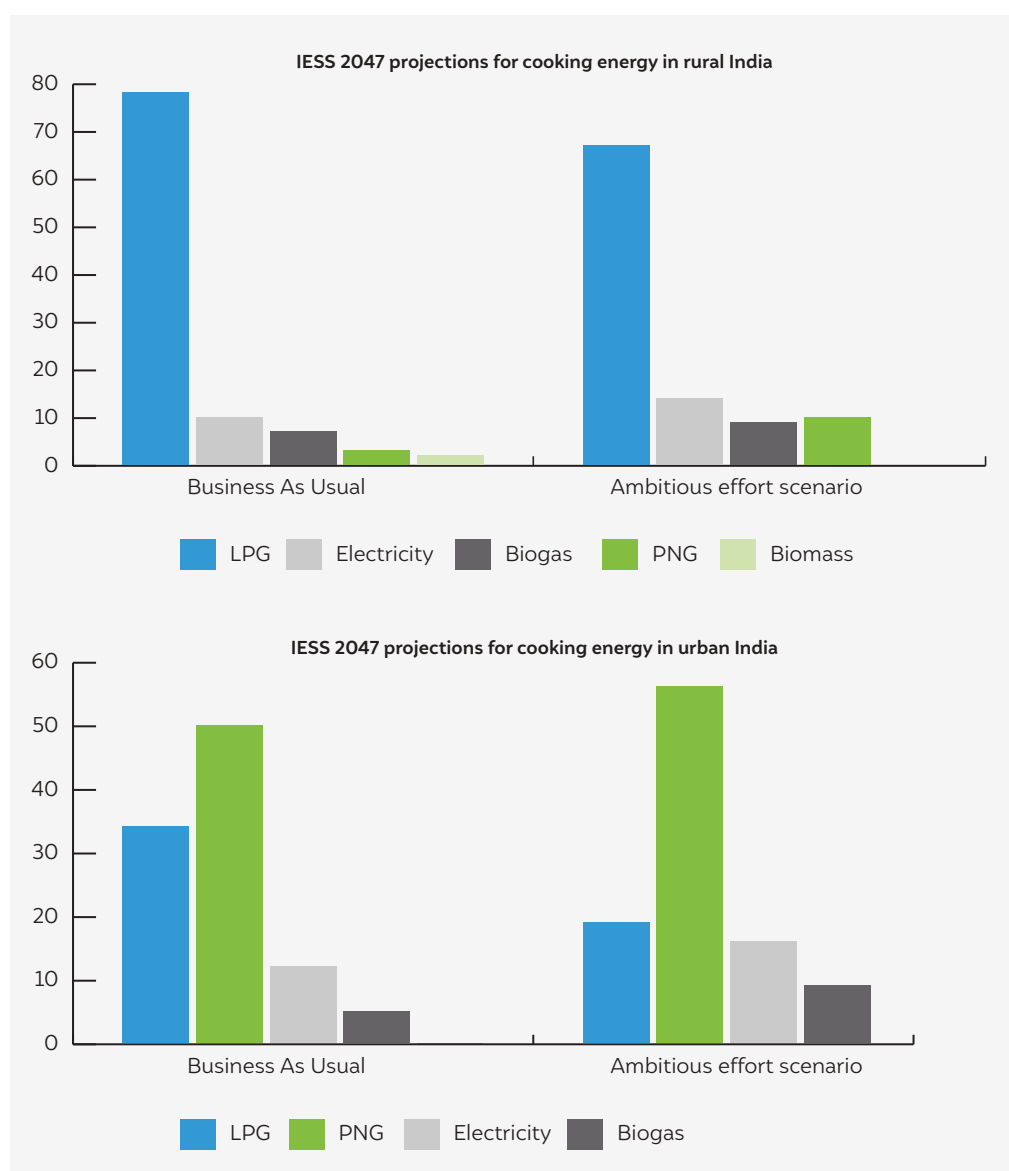
## 5.1. Convergence and stacking of fuels

No one fuel or technology would be able to meet all the cooking energy needs of a diverse country like India. Differences in food patterns, income levels, the availability of fuels, and cultural norms must be considered in order to gain a holistic understanding of cooking needs and cooking energy in the country. While stacking is a reality, the focus of a multi-fuel-based approach should be to ensure a clean stack, based on the availability and affordability of all options. With 31 per cent urbanisation and a per capita income of INR 39,143, approximately 1,104 TWh of energy is used for domestic cooking in India (NITI Aayog, n.d.). On average, every year, a household uses about 7 to 8 LPG cylinders, or 170 standard cubic metres (scm) of PNG, or 1,022 kWh of electricity for cooking. After accounting for stove efficiencies using modern fuels, the average useful energy needed for cooking per day per household is estimated at ~7 MJ/day (NITI Aayog, n.d.). The long-term energy scenarios estimated by NITI Aayog (Indian Energy Security Scenarios, IESS) consider the exclusive use of only one fuel at the household level. However, these scenarios do not consider household stacking of cooking energy solutions, whereas the reality remains that urban as well as rural households continue to stack various cooking energy arrangements. Any demand projection exercise, as well as government strategy stemming from them, need to account for stacking, and need to take action towards ensuring a clean cooking energy stack.



Any demand projection exercise, as well as government strategy must account for stacking

**FIGURE 4A AND 4B: IESS 2047 projections of the use of LPG and electricity in rural India; PNG and LPG in urban India**



Source: NITI Aayog, forthcoming

Stacking will remain a key aspect of the transition towards clean cooking energy access for all, allowing for a multi-fuel approach with multiple combinations of primary and secondary fuels and technologies. Key strategies across fuels have been summarised below, with details in the following sections. These strategies have been prioritised as low, medium, or high by experts, where each strategy was rated across four criteria: (a) effort required to implement the strategy; (b) time required to implement the strategy; (c) likelihood of impact; and (d) scale of impact. We used a framework that combines the parameters according to their relative importance, and then prioritises strategies for implementation by the government. A time frame has been assigned for the implementation of each of the strategies (2020, 2021-2022, 2023-2025) based on its priority.

**TABLE 2: List of identified strategies to improve access to clean cooking energy in India, by source of cooking energy, including degree of urgency and priority**

LIQUEFIED PETROLEUM GAS				
S.No.	Strategy	Stakeholder	Priority	Timeline
<b>5.2.1 Technology development</b>				
#LPG01	Invest in R&D to improve the thermal efficiency of LPG stoves	MoPNG <sup>4</sup> ; DST <sup>5</sup>	High	2020
#LPG02	Make energy-efficiency labelling for LPG stoves mandatory industry-wide	MoPNG; MoP <sup>6</sup>	High	2020
#LPG03	Promote innovation in, and bulk procurement of, composite fibreglass LPG cylinders	MoPNG	Low	2023-2025
<b>5.2.2 Improve availability and accessibility of LPG</b>				
#LPG04	Enable self-help groups (SHGs) and other local outlets to become extension counters for rural distributors	MoPNG; MoRD <sup>7</sup> ; SRLMs <sup>8</sup>	High	2020
#LPG05	Stock small LPG cylinders with <i>Kisan Seva Kendras</i> and local shops in rural areas	MoPNG; OMCs <sup>9</sup>	Medium	2020
#LPG06	Increase rural LPG coverage, and improve safety/security of warehousing and retailing by enhancing skilling support for entrepreneurs and workers interested in LPG distributorships	MoPNG; NSDC <sup>10</sup> ; MoRD	High	2020
<b>5.2.3 Improve affordability for sustained use</b>				
#LPG07	Provide low-interest loans to households for LPG refills through SHGs, to allow flexible payment plans and to promote the sustained use of LPG	MoPNG; MoRD; SRLMs	Medium	2020
#LPG08	Promote innovation and bulk procurement of pay-as-you-go smart valves for LPG cylinders	MoPNG; Donors	Medium	2021-2022

IMPROVED COOKSTOVES				
S.No.	Strategy	Stakeholder	Priority	Timeline
<b>5.3.1 Research and development</b>				
#ICS01	Invest in R&D of ICS to improve their resilience/longevity, efficiency, safety, and user convenience to bring their on-field emissions within WHO safe limits (Tier 4)	MNRE <sup>11</sup> ; DST	Medium	2021-2022
#ICS02	Invest in R&D infrastructure, including laboratories for the testing of various models	MNRE; DST; IITs <sup>12</sup>	Medium	2021-2022

4 Ministry of Petroleum and Natural Gas

5 Department of Science and Technology

6 Ministry of Power

7 Ministry of Rural Development

8 State Rural Livelihoods Missions

9 Oil marketing companies

10 National Skill Development Corporation

11 Ministry of New and Renewable Energy

12 Indian Institutes of Technology



IMPROVED COOKSTOVES				
S.No.	Strategy	Stakeholder	Priority	Timeline
#ICS03	Mandate that testing centres provide detailed lab reports on ICS to manufacturers instead of the current 'pass/fail' report	MNRE	Medium	2021-2022
#ICS04	Mandate on-field testing in the certification process of cookstoves	MNRE	Medium	2020
#ICS05	Make the labelling of energy efficiency and emissions on ICS mandatory; push the industry to improve their efficiency	MNRE	Medium	2021-2022
#ICS06	Mandate empanelled enterprises to provide warranties on ICS for at least as long as the loan repayment period	MNRE	Medium	2020
<b>5.3.2 Improve the capacity of national and local agencies</b>				
#ICS07	Create scope in policy for better capacity-building of state- and national-level implementation agencies	MNRE	Medium	2021-2022
<b>5.3.3 Create and support a market for pellets</b>				
#ICS08	Support rural entrepreneurs/self-help groups (SHGs) through preferential loans and capital subsidies for the production and distribution of pellets/briquettes	MNRE; MoRD	Medium	2023-2025
#ICS09	Pilot various business models of pelletisation	MNRE	Low	2023-2025
#ICS10	Provide subsidised training in pellet manufacturing and ICS manufacturing, assembling, and marketing to local entrepreneurs and workers	MNRE; SCGJ <sup>13</sup> ; MoRD	Medium	2021-2022
<b>5.3.4 Improve the financial ecosystem</b>				
#ICS11	Sensitise bank professionals to lend to empanelled ICS enterprises to ease their working capital requirements	MNRE; MoF <sup>14</sup>	High	2020

BIOGAS				
S.No.	Strategy	Stakeholder	Priority	Timeline
<b>5.4.1 Research and development</b>				
#BGS01	Provide grants for the promotion of new technologies that are less effort intensive and/or more efficient	MNRE; DST	High	2021-2022
#BGS02	Invest in R&D to develop double-burner stoves that can use LPG and biogas	MNRE; MoPNG; DST	Medium	2021-2022
<b>5.4.2 Testing business models</b>				
#BGS03	Allow subsidies for prefabricated biogas plants	MNRE	High	2020
#BGS04	Pilot enterprise-based models for biogas-as-a-service, and offer incentives, such as cheaper loans, to rural biogas entrepreneurs	MNRE	Medium	2020

13 Skill Council for Green Jobs

14 Ministry of Finance

15 Ministry of Health and Family Welfare

16 Ministry of Panchayati Raj

BIOGAS				
S.No.	Strategy	Stakeholder	Priority	Timeline
#BGS05	Invest in R&D to reduce the cost of biogas bottling and packaging	MNRE; DST	High	2020
<b>5.4.3 Generating awareness</b>				
#BGS06	Organise demonstrations that illustrate the experience of using biogas by outlining the differences between modern biogas plants and traditional <i>chulhas</i> , as well as older models of biogas	MNRE; Mo-HFW <sup>15</sup> ; MoRD; MoPR <sup>16</sup>	Medium	2020
<b>5.4.4 Strengthen the skill-development ecosystem for better installations and after-sales service</b>				
#BGS07	Provide subsidised training in manufacturing, marketing, and maintenance to local entrepreneurs and workers; and in plant operation to users	MNRE; SCGJ; MoRD	High	2021-2022
<b>5.4.5 Streamline easy operation and maintenance for existing biogas plants</b>				
#BGS08	Start a helpline for households to report breakdowns and guarantee the time frame for the repair	MNRE	High	2020
<b>5.4.6 Ecosystem for finance</b>				
#BGS09	Sensitise financial institutions and other investors to the newest business models in biogas and related technologies	MNRE; MoF	Medium	2020
#BGS10	Improve ease of access to consumer finance for biogas	MNRE	High	2020
#BGS11	Involve agricultural finance institutions in supporting biogas plants	MoAFW <sup>17</sup> ; MNRE	Medium	2021-2022

PIPED NATURAL GAS				
S.No.	Strategy	Stakeholder	Priority	Timeline
#PNG01	Credit-linked instalments for PNG connections	MoPNG; PNGRB <sup>18</sup> ; CGDs <sup>19</sup>	High	2020
#PNG02	Adoption of prepaid metres that allow recurring payments of smaller amounts	MoPNG; PNGRB; CGDs	Medium	2021-2022
#PNG03	Prevent households from having both LPG and PNG connections	MoPNG; CGDs	Medium	2021-2022
#PNG04	Decentralise the supply and distribution of LNG	MoPNG; PNGRB; CGDs	Medium	2021-2022
#PNG05	Manage the profitability of CGDs through a healthy balance of import and domestic LNG	MoPNG; PNGRB; CGDs	Medium	2021-2022

17 Ministry of Agriculture and Farmers' Welfare

18 Petroleum and Natural Gas Regulatory Board

19 City Gas Distributors

20 National Institute of Solar Energy

SOLAR-BASED COOKING				
S.No.	Strategy	Stakeholder	Priority	Timeline
#SOL01	R&D to improve the efficiency and affordability of solar thermal/electric cooking	DST; MNRE; NISE <sup>20</sup>	High	2020
#SOL02	Improve terms of patents and prizes in competitions to allow serious entrepreneurs to apply	DST; MNRE; PSUs <sup>21</sup>	Medium	2020
#SOL03	Pilot enterprise-based business models and facilitate access to affordable credit for entrepreneurs and households	MNRE; MoPNG	Medium	2021-2022

ELECTRICITY-BASED COOKING				
S.No.	Strategy	Stakeholder	Priority	Timeline
#ELC01	Improve the quality of electricity access	MoP; PMO <sup>22</sup>	High	2020
#ELC02	Ensure that the connection and peak loads can support induction stoves legally	MoP	High	2021-2022
#ELC03	Map the willingness and ability to pay for electricity in order to identify priority areas that can use electricity as cooking energy	MoP	Medium	2021-2022
#ELC04	Improve the energy efficiency of induction cookstoves	Donors; Private enterprises; DST; MoP	Medium	2020
#ELC05	Improve consumer awareness of electric cooking and stove efficiency	MoP	Medium	2021-2022

Source: CEEW analysis, 2018; Survey with experts

21 Prime Minister's Office

22 Based on interviews with a limited number of clean cooking enterprises in the sector.



## 5.2. LPG



The diversity across and within states requires that policy makers understand these geographic and cultural differences or similarities, and design solutions to improve access to cooking energy accordingly. As of April 2019, India's LPG coverage based on the active connections is about 94 per cent (PPAC, 2019a). Despite this high coverage, use of LPG varies widely across states, across rural and urban areas, and across different income and social groups. In 2015-16, as per NFHS, only 23 per cent of rural households used LPG for their primary cooking needs, as opposed to 78 per cent of urban households (IIPS and ICF, 2017). In 2011-12, as per NSSO, 4.25 per cent of households in the lowest wealth quintile used LPG as their primary source of cooking energy, in comparison to about 75 per cent in the highest wealth quintile.<sup>23</sup> In rural India, the use of LPG as a primary cooking fuel is limited by the lack of availability, the steep cost of acquiring a connection, the unaffordability of refills, and the availability of free-of-cost biomass (Jain et al., 2018). Below we discuss strategies that could improve access to LPG and increase sustained use of the fuel.

<sup>23</sup> NSSO 68<sup>th</sup> Round offers the most recent nationally representative data on cooking energy. While the information is dated, it provides us an indicative trend on adoption and the use of various fuels in India. However, we have used more recent data from MoPNG and other surveys such as Jain et al. (2015a; 2018), wherever possible.

## 5.2.1. Technology development

### #LPG01 Invest in R&D to improve the thermal efficiency of LPG stoves

The thermal efficiency of the LPG stoves used in India is about 55–57 per cent, which is much lower than the 84 per cent efficiency of induction stoves (Jain et al., 2015b). Improving stove efficiency will reduce the consumption of gas and improve the experience of cooking. Some oil marketing companies (OMCs) are trying to introduce more efficient stoves for their new customers. Indian Oil Corporation (IOCL) is, for instance, providing its customers with stoves that have an efficiency of 68 per cent and are certified by the Bureau of Indian Standards (BIS). The Bureau of Energy Efficiency (BEE) also has a voluntary energy-star labelling system to rate the efficiency of domestic LPG stoves. The lowest star rating comprises efficiency between 68–72 per cent, and the highest is above 81 per cent (BEE 2016).

Radiant burners are an alternative to conventional burners in terms of improved efficiency. Radiant burners use a porous material to mix fuel and air and to house the flame, producing both convective and radiant heat. Studies have shown that radiant burners can provide an efficiency rate of up to 71 per cent (Muthukumar, 2014).

### #LPG02 Make energy-efficiency labelling for LPG stoves mandatory industry-wide

Making energy-efficiency labelling mandatory will help push the industry to make better burners and will also help in educating customers on energy efficiency. A few practitioners have been working on improving the efficiency of stoves, in partnership with OMCs. For example, in a joint undertaking of oil majors in India, *Agnisumukh* has strategically tied up with the LPG Equipment Research Centre for joint research programmes.

### #LPG03 Promote innovation in, and bulk procurement of, composite fibreglass LPG cylinders

Composite fibre cylinders are much lighter than metal cylinders and safer to use. As they are transparent, users can ascertain the level of gas in the cylinder at any given time. However, the reported cost of such cylinders (for 14.2 kg) is about INR 3,000, which is more than double the cost of a metal cylinder (Airy, 2016). OMCs believe that with higher rates of adoption, the cost of the cylinder will decrease due to economies of scale (*ibid.*). The improved quality and weight of cylinders can also have positive implications for distribution. Lighter cylinders will be easier and cheaper to transport, and as a result, they could help improve service delivery and reduce transportation costs for distributors. In areas where road access is poor or seasonal, lighter cylinders can be more easily transported by two-wheelers and by other locally available modes of transport. In hilly terrains, it could help reduce the drudgery of physically carrying cylinders.



The thermal efficiency of the LPG stoves is about 55–57 per cent; much lower than the 84 per cent efficiency of induction stoves

**FIGURE 5: Composite LPG cylinders**

Image: Aburi Composites, 2015

## 5.2.2. Improve availability and accessibility of LPG

Several concerns around LPG distribution are yet to be addressed. First, although the number of rural distributors has increased considerably in recent years—by 3,591 in 2018-19, 1,360 in 2017-18, and by 870 in 2016-17—the growth has not been even across states. For instance, between 2016 and 2019, in Uttar Pradesh, connections increased by 51 per cent and distributorships increased by 44 per cent, whereas in Madhya Pradesh, these numbers were further apart at 65 per cent and 20 per cent, respectively. Second, due to the affordability constraints of newly connected households, rural distributors also face a risk of encountering a low demand for refills (Jha, 2017). This adversely affects their ability to deliver cylinders to the doorstep of consumers, as is mandated under the Unified Distribution Guidelines for LPG (2016). Only 41 per cent of rural households receive home-delivery of LPG cylinders, while the median one-way distance to procure an LPG cylinder ranges from 2 km in West Bengal to 7 km in Madhya Pradesh, indicative of the hardship associated with accessing the fuel.

### #LPG04 Enable self-help groups (SHGs) and other local outlets to become extension counters for rural distributors

Although home delivery has been mandated by the Unified Distributorship Guidelines, discussions with LPG distributors reveal that in most rural areas, it is difficult to home deliver LPG cylinders. Many customers have to pick up the cylinder from the distributor or must incur additional expenses to have the cylinder delivered home. To improve availability in villages, sub-distributorships could be allowed within safety limits and with verifiable background and infrastructural checks. The current guidelines allow the storage of up to 100 kgs of gas—6 large cylinders or 20 small (5-kg) cylinders. The potential sub-distributors could be SHGs with an existing track record of operating commercially viable businesses, or *Kisan Seva Kendras* (KSKs) operated by IOCL. Such alternative models are encouraged by the Draft National Energy Policy (NITI Aayog, 2017), which calls for alternative payment terms and retail practices that will be more suitable for rural markets.

Leveraging local institutions to stock LPG cylinders and supply households directly will very likely reduce the distance travelled by users to procure cylinders. In addition, the sub-distributorships may provide other services such as selling and repairing gas stoves and selling cooking vessels (including pressure cookers). Moreover, the prevalent social network



Only 41 per cent of rural households received LPG cylinders at their doorstep in 2018



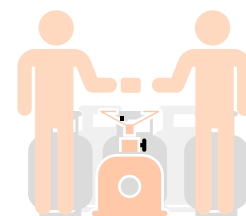
Leveraging local institutions to stock LPG and to supply directly to households will reduce the distance travelled by users to procure cylinders



and the trust between households and SHG members could be leveraged to allow for the payment of LPG refills in instalments. This will help align households' cash flows with their outlay on cooking fuel, overcoming the lumped cost associated with LPG refills. For households that are unable to afford LPG even on an instalment basis, SHG members could sensitise women to the time-saving potential of LPG and connect them with opportunities to use the saved time for income-generating activities.

The Ministry of Rural Development implements programmes focused on livelihood enhancement and skill development that can be integrated with the value chain of LPG to improve access, affordability, and awareness of the fuel. One of its key programmes—the *National Rural Livelihoods Mission*—aims to create efficient and effective institutional platforms to enable the rural poor to increase their household income through sustainable livelihood enhancements and improved access to financial services. NRLM's support for self-employed individuals and entrepreneurs can be integrated with clean energy interventions.

In order to integrate local institutions with the LPG distribution network, it will be crucial to make provisions for competitive financial incentives. At present, the commission per cylinder is the same for all categories of distributors. While the urban distributor benefits from high volumes, the rural distributor grapples with the low demand for refills (Jha 2017). The Ministry of Petroleum and Natural Gas (MoPNG) is working with agencies to use data intelligence to monitor distributor performance and adherence to safety guidelines across districts in India. It is equally important to design incentive structures that allow distributors to cater to the needs of rural areas. The current distribution terms may not be adequate to service households in remote parts of the country.



The typical rural LPG distributor grapples with low demand for LPG refills

#### How SHGs can add value to LPG distribution?

**Awareness:** SHG members can engage with individuals in their local area to improve awareness of the negative health effects of household air pollution from the use of the traditional *chulha*, and of the safety procedures and use practices of LPG. These interactions will complement and reinforce the messages disseminated at LPG panchayats; they will also encourage those with LPG connections to use the fuel on a regular basis, and those without connections to consider taking one and using it. SHG members can also build a case for sustained use, by explaining how the time saved can be used for income generation. They can reach out to households with LPG connections to discuss and understand the nature and extent of the time saved as a result of LPG use, and can connect women with appropriate income-generating possibilities that could be leveraged during the time saved.

**Availability:** LPG distributors that currently deliver LPG cylinders to a local community point (from where households usually access them), could instead deliver the cylinders to the SHG member running the sub-distributorship. The distributor can deliver cylinders—based on the sales at the SHG—once or twice in a fortnight. There will be a predetermined commission for the SHG member for stocking the cylinders, interacting with households, and collecting payments from them. This can be provided by the distributorship from the commission that it receives for each cylinder. The commission would be mutually finalised between the SHG and the distributor at the time of the contract.

**Affordability:** Households should be able to make staggered payments through the SHG sub-distributorship. The SHG could accept payments on an ad hoc basis from the households. SHGs' microsavings and microcredit facilities would help to streamline cash flows for the household and overcome the lumped cost issue with LPG refills.

### #LPG05 Stock small LPG cylinders with *Kisan Seva Kendras* and local shops in rural areas

KSKs are low-cost retail outlets started by IOCL to cater to the needs of rural customers. They also sell pesticides, vegetables, banking products, and stationery items. They could stock up to twenty 5-kg cylinders, or several 2-kg cylinders, to facilitate better access to customers. This would improve the visibility of LPG among customers who visit KSKs to purchase agricultural inputs and equipment, and would improve the ease of purchase when required. It could displace small cylinders that are sold and refilled by informal vendors.

### #LPG06 Increase rural LPG coverage, and improve safety/security of warehousing and retailing by enhancing skilling support for entrepreneurs and workers interested in LPG distributorships

Promoting the sustained use of LPG requires the expansion of distribution networks, especially in remote and rural areas. This in turn increases the demand for storage warehousing related to distribution. Most of the players in the storage warehousing industry are micro-, small-, and medium-scale entrepreneurs. Specialised warehousing skill requirements for picking and stacking, and inventory management using warehouse management systems, are also applicable to rural entrepreneurs involved in LPG distribution. The National Skill Development Corporation under the Ministry of Skill Development and Entrepreneurship is working with the MoPNG to improve skilling in LPG distribution. Based on what has been learned from the existing work, this initiative could be tested in rural areas.

## 5.2.3. Improve affordability for sustained use

Rural consumers are not a homogeneous group, and therefore the affordability of LPG varies across and within states. For instance, in 2011–12, within the “top 30 per cent” category of monthly per capita expenditure (MPCE) in rural Tamil Nadu, over 53 per cent of households used LPG as their primary source of cooking energy, in comparison to a mere 12.6 per cent of households in the same MPCE category in rural Odisha (Manjula and Gopi, 2017). In urban Tamil Nadu and Odisha, however, similar proportions of urban households<sup>24</sup> in the top 30 per cent MPCE category used LPG as their primary fuel for cooking, whereas the figures vary widely between Tamil Nadu’s middle 40 per cent and bottom 30 per cent MPCE categories.<sup>25</sup>

A study conducted by CRISIL and the Petroleum Planning and Analysis Cell of MoPNG across 120 districts in 13 states revealed a strong correlation between median monthly household income and expenditure on cooking fuel (CRISIL, 2016). As the monthly household income increases, the propensity to collect cooking fuel decreases. At the highest level of monthly income (more than INR 5,000), 74 per cent of rural households pay for their fuel, spending about INR 391 per month. At the lowest level of monthly income (less than INR 2,500), 59 per cent of households purchased fuel. However, irrespective of income level, over 80 per cent of households that did not use LPG reported high recurring costs as a barrier. Of the households not using LPG in 2018, 83 per cent expressed interest in getting it. Over 60 per cent of these interested households are willing to spend INR 300 or more a month (INR 450 or more in six weeks) to use LPG for all cooking needs (Jain et al., 2018).



In 2016, over 80 per cent of households that did not use LPG reported high recurring costs as a barrier

<sup>24</sup> 72.5 per cent and 73.3 per cent respectively

<sup>25</sup> Among the bottom 30 per cent MPCE category in urban areas, 60 per cent of Tamil Nadu households used LPG as primary source of cooking energy, and only 12.8 per cent did so in Odisha.

The upfront cost of getting a connection is also a critical bottleneck to the widespread adoption of LPG. Although PMUY has addressed this to a great degree by making subsidised connections available to the poorest households, it is important to appreciate that there will still be many non-BPL households that will need support to obtain a connection. Such households will benefit immensely from an equated monthly instalment (EMI)-based connection fee.

### **#LPG07 Provide low-interest loans to households for LPG refills through SHGs, to allow flexible payment plans and to promote the sustained use of LPG**

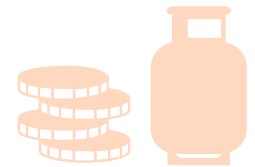
To improve the affordability of LPG refills, a few donors have provided revolving loans at low interest rates to support women in SHGs in paying for refills, with the goal of achieving access to clean cooking energy for all. SHGs under the NRLM could support the purchase of LPG cylinders by facilitating smaller pay-outs through group lending.

Similar models have been successful in various settings. For instance, Jagriti, an NGO from Himachal Pradesh, employed a consumer finance approach through its women's savings and credit groups (WSCGs), to enable low-income households to use LPG and other improved cooking technologies (Chandar and Tandon, 2004). In Cameroon, microfinance institutions provide loans to support the purchase and initial refilling of LPG cylinders. In Sudan, Practical Action established a revolving loan with start-up financing from Carbon Clear, to provide carbon-financed loans that enable low-income and internally displaced families in North Darfur to purchase efficient cookstoves and LPG. Managed by the Women's Development Association Network (WDAN), the fund allows local women to receive a loan that covers the upfront costs of the LPG cylinder and cooking equipment, which can be repaid in instalments over time. WDAN's representatives are local community members who are able to develop flexible payment plans that meet the specific circumstances of each grantee. As the loans are repaid the money is invested back into the fund and can be loaned to other women. The loan fund has revolved 20 times in this manner since 2008, enabling long-term benefits (GACC, 2016).

Prepaid subsidy vouchers that can be cashed in during the purchase of cylinders could also help in easing payments for households. Many may find it convenient to pay a smaller amount in cash to buy a cylinder, and would benefit from vouchers that reduce their out-of-pocket cash expenditure. Most rural households in India continue to find it difficult to pay INR 700-800 in one instalment for LPG.

### **#LPG08 Promote innovation and bulk procurement of pay-as-you-go smart valves for LPG cylinders**

Pay-as-you-go technologies for LPG, where cylinders are fitted with smart valves, are being tried with some success in Africa largely due to the wide penetration of mobile money. The Indian Government's push towards digital payments could be leveraged to enable discrete payments for LPG consumption. However, the cost of the smart valve to support this technology is prohibitive. Reducing the cost of this technology in order to improve its scalability is essential.



**SHGs could support the purchase of LPG cylinders by facilitating smaller pay-outs through group lending**

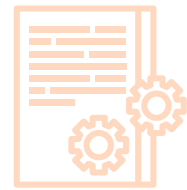


## 5.3. Improved biomass cookstoves

NITI Aayog (2014) projects that in 2047, under the rather optimistic ‘Determined Effort Scenario’, 20 per cent of rural households will still be reliant on biomass for cooking. Historical evidence suggests that households continue to use traditional biomass despite access to LPG; it is clear that it takes households a considerable amount of time to shift from the exclusive use of the traditional *chulha* to the exclusive use of LPG for cooking. Therefore, it is important to find approaches that enable the safe use of traditional biomass in order to reduce the public health burden of HAP. The use of improved biomass cookstoves (ICS) is one such approach—it could complement LPG in meeting the rural household’s need for cleaner cooking energy.

However, less than one per cent of rural households surveyed by Jain et al. (2018) reported using ICS. Only 14 per cent of households were aware of their existence, indicating low awareness among non-users. The sustained use of ICS will depend on user satisfaction (GIZ, 2014; Lambe and Atteridge, 2012). The *National Programme on Improved Chulhas* (NPIC), the first policy to support ICS, introduced 35 million *chulhas* between 1986 and 2002 (MNES, 2004). *Unnat Chulha Abhiyan* (UCA) was initiated to provide subsidies ranging from INR 300–800 per ICS. The UCA was launched in 2014 with the aim of deploying 2.75 million ICS by March 2017 and a budget of INR 294 crore (MNRE, 2014b). However, an official at the Ministry of New and Renewable Energy (MNRE) and associated with UCA confirmed that the scheme had met only 1.3 per cent of its target by March 2017, with much of the budget having lapsed unutilised. Without a subsidy, an ICS costs between INR 1,200 (natural-draft) and INR 4,500 (forced-draft). Locally manufactured, cheaper models are also available for less than INR 1,000, but are not as efficient or durable.

In recent years, the government’s policies on clean cooking energy have favoured increased penetration of LPG in rural areas over other alternatives. This could perhaps stem from people’s aspirations and preference for LPG as well the lack of a robust alternative (like biogas or ICS) that is not only convenient for the consumer, but also affordable and durable. However, owing to the mismatch between the requirements of rural families and the availability and affordability of modern clean energy solutions, fuel stacking, fuel stacking is predominant among rural households. Thus, alternative, complementary clean cooking solutions are necessary to eliminate the use of solid biomass. With the launch of PMUY, households are more likely to transition towards a cleaner suite of cooking solutions. However, for this to happen, policy planning must give other solutions due support, not just within the concerned ministry, but also in the national discourse on clean cooking energy. Government schemes on LPG, cookstoves, and biogas should be communicated as complementary and non-competing. A supportive policy environment will include a greater focus on technology development, stricter quality standards, and awareness drives to increase usage; it can nurture an ecosystem that supports entrepreneurs who provide quality services to the user.



Supportive policies will include a greater focus on technology development, stricter quality standards, and awareness drives to increase usage

### 5.3.1. Research and development

**#ICS01 Invest in R&D of ICS to improve their resilience/longevity, efficiency, safety, and user convenience to bring their on-field emissions within WHO safe limits (Tier 4)**

The primary focus of the sector should be on improving the design and quality of cookstoves for greater efficiency and convenience. This requires government grants to improve infrastructure such as labs to test new technologies. While practitioners have made efforts to

improve the efficiency and affordability of cookstoves, the design and convenience aspects have been ignored. The International Workshops Agreement (IWA) framework by ISO rates cookstoves on four indicators—efficiency, indoor emissions, total emissions, and safety, each along five tiers. To meet the WHO guidelines for indoor air quality, a cookstove must at least fulfil the requirements for Tier 4 in emissions and efficiency. Most stoves sold in India are Tier 2 or 3—they offer efficiency of 25–30 per cent, while Tier 4 stoves offer efficiency greater than 45 per cent. Therefore, significant investment in R&D is necessary in order to improve the quality of ICS. However, Tier 4 cookstoves also face challenges in fuel supply and standardisation. Some Tier 4 stoves need standardised pellets. In India, the biomass available through the year varies in quality; standardising pellets manufactured through a decentralised production system is a challenge. Therefore, the government must also encourage the use of Tier 3 stoves equipped with chimneys for adequate ventilation. Studies have shown that various forms of ventilation reduce exposure to indoor smoke and the particulate matter concentration in households (Majdan et al., 2015).

The MNRE's allocation under the UCA for establishing test centres, R&D capacity-building, and after-sales service was only INR 12 crores. Furthermore, there are only five testing facilities for the certification of any new cookstoves, some of which are not perennially functional, resulting in undue delays for manufacturers. Thus far, enterprises have relied on grants from donors and the government to support R&D to improve the design and efficiency of cookstoves while reducing their cost.

Investments in R&D for ICS could be championed by the *Atal Innovation Mission* (AIM) and *Self-Employment and Talent Utilisation* (SETU) programmes, as they provide platforms that incubate and support innovators to become entrepreneurs. Incubation centres under the AIM could be used to nurture start-up businesses looking to manufacture efficient and affordable cookstoves. Collaborations with global and Indian companies skilled at designing efficient combustion systems could add significant value to the design thinking required to address the challenge of engineering an efficient cookstove that meets WHO standards on indoor air quality.

### **#ICS02 Invest in R&D infrastructure, including laboratories for the testing of various models**

The Ministry of Science and Technology could facilitate cross-learning across countries through partnerships with cookstove manufacturers in countries that have built successful designs. The Council of Scientific and Industrial Research (CSIR) has developed a multi-fuel cookstove, albeit with limited commercialisation (CSIR, 2017). A collaboration between government labs and the private sector could help integrate R&D costs and create a bigger pool of shared resources for developing a better cookstove. The private sector could also leverage this opportunity to commercialise existing technology at government labs. Some successful designs can be made available in the public domain and promoted to encourage entrepreneurs to replicate and scale the product while maintaining affordability.

### **#ICS03 Mandate that testing centres provide detailed lab reports on ICS to manufacturers instead of the current “pass/fail” report**

To better support innovations in the sector, testing centres need to be more efficient and have shorter turnarounds. Delays in acquiring certification is expensive for businesses, most of whom operate with limited operating budgets and cannot afford any delays in the delivery of their products to the market. The testing centres should provide a detailed report on how the cookstove can be improved, instead of just a pass or fail statement. In addition, all cookstoves must be checked to ensure that they meet a minimum standard before reaching the market.



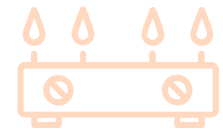
**The government must also encourage the use of Tier 3 ICS equipped with chimneys for adequate ventilation**

#### #ICS04 Mandate on-field testing in the certification process of cookstoves

Many cookstoves perform adequately in laboratory conditions but fail to meet consumer needs in practice. Therefore, field-based testing is necessary to ensure that the cookstoves are reliable and durable outside of laboratory conditions. The testing protocol should enforce the same standards for quality and durability for cookstoves as any other consumer durable in the market.

#### #ICS05 Make the labelling of energy efficiency and emissions on ICS mandatory; push the industry to improve their efficiency

In addition to increasing the number of test centres, the MNRE should lay down simpler yet higher standards for the testing and certification of cookstoves. Labelling cookstoves with their efficiency and emission rating, as with LPG stoves and other consumer durables, will aid customer awareness and help them pick stoves of the right quality. ICS manufacturers should be encouraged to make known the uses that the stove is best suited for, such as making *rotis*, heating water, etc. This will help the consumer decide on whether to purchase the product based on its utility. If a household has had a bad experience with a poor-quality cookstove or due to uncommunicated expectations, such clear labelling could change their perception of the product entirely. These efforts would bolster the sales of genuine players who provide better quality ICS.



Labelling cookstoves with their efficiency and emissions rating will aid customer awareness

#### #ICS06 Mandate empanelled enterprises to provide warranties on ICS for at least as long as the loan repayment period

A product warranty is a strong factor that could influence the acquisition and retention of customers. However, if the warranty period is lesser than the loan period, defaults in payments are more likely, following the breakdown of the product. If the cost of repairing the product is high, then customers will shy away from incurring the additional expenditure and may even discontinue using the stove. If cookstove manufacturers offer extended replacement and repair warranties, at least to cover the loan repayment period, there will be increased trust in the product and in the ecosystem. The manufacturers empanelled under the MNRE could be mandated to extend their warranties to cover the loan tenure.

### 5.3.2. Improve the capacity of national and local agencies

#### #ICS07 Create scope in policy for better capacity-building of state- and national-level implementation agencies

The technology and business landscapes are evolving at such a rapid pace that there is increased pressure on the state to leverage evolving technologies for use in governance. While some ministries have adapted to such changes well, others are yet to make the transition. Key decision makers need to be regularly updated on improvements in ICS technology and business models so they can promote the latest models in rural markets. The state nodal agencies (SNAs) should be provided the requisite training and incentives in conjunction with the support and funds they need to contract services such as monitoring and evaluation, complementary their efforts. This is already encouraged by the newer policies such as the *New National Biogas and Organic Manure Management Programme* (NNBOMP). The servicing and maintenance of cookstoves is extremely vital to their sustained use—it is therefore essential to improve the abilities of the concerned state- and district-level agencies. When cookstoves are sourced under government schemes, it is important that the procuring agency has the capacity to vet the technical quality of the



stoves and educate users of the protocol to be followed for their operation and maintenance. This calls for larger budgets for capacity-building and more focused policy attention—as is the case of LPG. Currently, the cookstoves disseminated under various schemes are not monitored for sustained use or guaranteed maintenance services. SNAs need to be trained to approach clean cooking solutions holistically, so that they can establish the complementary role of cookstoves in the movement towards access to clean cooking energy for all.

### 5.3.3. Create and support a market for pellets

Tier 4 cookstoves need standardised fuels, such as pellets, to optimise efficiency and reduce emissions. For these cookstoves to be viable, a reliable supply of pellets and briquettes at affordable prices is needed. The draft NEP has emphasised R&D to improve the efficiency of biomass cookstoves and gas stoves, coupled with investment in the manufacture of pelletised biomass as fuels. Biomass pellets can offer about 30–50 per cent greater efficiency than solid biomass. However, biomass pellets have an expensive supply chain. The cost of a pellet-manufacturing machine alone is around INR 7 lakhs, which is a high upfront cost for small-scale manufacturers, who suggest that decentralised pellet manufacturing can reduce pellet costs by a third<sup>26</sup>. Agro and forest residue surplus is estimated to increase by 16 per cent by 2030, creating opportunities to expand pellet production for cooking energy and electricity (Purohit and Chaturvedi, 2016). About 2 kg of pellets per day are required to meet the cooking needs of a household of four to five members. The cost of pellets ranges from INR 10–15 per kilogram, translating to a monthly expenditure of INR 600–900. An established supply chain with regular customers is essential to bring down the cost of pellets. We discuss below some strategies to improve the availability of pellets and make them affordable.

**FIGURE 6:** Biomass pellets for cooking



**#ICS08 Support rural entrepreneurs/self-help groups (SHGs) through preferential loans and capital subsidies for the production and distribution of pellets/briquettes**

The MoRD could involve SHGs in the production and distribution of pellets as a means of generating a livelihood. Pellet manufacturing and distribution could be a regular, revenue-

<sup>26</sup> Primary interviews with stakeholders.

based model for women that will improve both availability and affordability. SHGs in many parts of India have been running successful businesses for several years. Funds from the *National Rural Livelihood Mission* (NRLM) and SHG lending could help finance the initial costs of setting up the manufacturing facility. In addition, the integration of women into the value chain of clean cooking energy solutions could improve the awareness—and hence the demand—for these solutions. The Skill Council of Green Jobs (SCGJ) could also train SHG members in the production and distribution of pellets, the MNRE and MoRD could subsidise training costs for SHGs.

### #ICS09 Pilot various business models of pelletisation

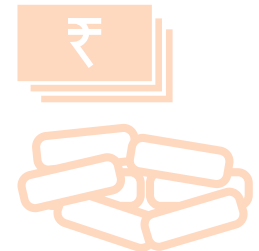
While the affordability of pellets is a challenge, mass manufacture with the intention of selling to local industries and restaurants has helped reduce costs by leveraging economies of scale. Businesses have paid a marginal premium for the product and thus subsidise the cost for households. MNRE could support such business models by providing cheap capital to local entrepreneurs who wish to enter the sector. In addition, they could explore a barter model for households that cannot afford to pay for fuel. Such households can trade their firewood for pellets—still better in thermal efficiency than the firewood—and use them for cooking. The local pellet manufacturer can collect the wood from each household and, in return, provide them with pellets. Such a model does not reduce the drudgery of collection, but it could considerably reduce indoor air pollution. Other public schemes, such as the *Mahatma Gandhi National Rural Employment Guarantee Act* (MGNREGA), could also be leveraged to collect discarded biomass for a price.

The policy should allocate funds towards a few such pilots. These pilots could be conducted at the village or district level to test and modify the business model as needed. This would allow pellet manufacturers and cookstove manufacturers and distributors to work together and strengthen the ecosystem for both cookstoves and biomass pellets.

### #ICS10 Provide subsidised training in pellet manufacturing and ICS manufacturing, assembling, and marketing to local entrepreneurs and workers

The Ministry of Skill Development and Entrepreneurship can play a crucial role in enabling rural youth to become entrepreneurs who manufacture and sell pellets locally. The SCGJ is the nodal agency for skilling; it prepares occupational maps for each sector to identify job roles along the value chain as well as qualification packages with details on the training material needed for the specified job role.

It has four qualification packs on biomass cookstoves, including the assembly, distribution, and maintenance of ICS. The SCGJ could also train local youth to run manufacturing units for pellets. The two parts of the value chain—the collection of firewood from households and the industrial production, and the sale of pellets—open up opportunities for job creation, even in remote areas. It will also be necessary for entrepreneurs to collaborate with regional rural banks to facilitate loans under *Pradhan Mantri MUDRA Yojana* (PMMY). The MNRE and MoRD could subsidise training costs for these village-level entrepreneurs (VLEs).



Businesses could pay a premium for pellets and help cross-subsidise the cost for households

FIGURE 7: A Biomass pellet-manufacturing machine



Image: IFDC Photography, flickr~

### 5.3.4. Improve the financial ecosystem

#### **#ICS11 Sensitise bank professionals to lend to empanelled ICS enterprises to ease their working capital requirements**

It is important to sensitise bank professionals to lend to empanelled ICS enterprises to ease their working capital requirements. Entrepreneurs who have acquired working capital loans from commercial banks emphasise the need to sensitise banks to improve access to credit. A study by the Clean Energy Access Network (CLEAN) highlights that “inadequate balance sheet data” and an “insufficient company track record” are the most common criteria for the rejection of loan applications by clean energy enterprises (CLEAN 2017). However, bank officials’ lack of knowledge on the technical and quality aspects of ICS also limits their ability to make accurate lending decisions, in case of companies who are able to show the necessary data and track record. Training institutes such as the Bankers Institute of Rural Development (BIRD) could be leveraged to inform relevant loan officers on a regular basis.

## 5.4. Biogas

There were about five million individual and community-level biogas plants in India as of 2016, against an estimated potential of 12.3 million (MNRE, 2017). Many of them were installed as part of the *National Biogas and Manure Management Programme* (NBMMP) launched in 2002–03, earlier known as National Project on Biogas Development. Beginning 2018–19, the *New National Biogas and Organic Manure Programme* has succeeded the NBMMP as the primary biogas scheme in the country, albeit with a scaled down target of installing at least 0.25 million plants by 2019-20 (MNRE, 2018a). The MNRE sets annual targets for SNAs to deploy biogas plants through pre-approved vendors across the country.

Biogas has additional value in comparison to most clean energy alternatives because it is also a method of waste management, be it animal, human, or food waste. It allows communities to be energy independent, as the quantity and quality of the output is entirely dependent on the use and maintenance practices of the plant users. Despite having had government support by way of central government schemes for almost four decades, the entire value chain of biogas faces several critical challenges. Each of these is detailed below along with strategies to alleviate them.

### 5.4.1. Research and development

#### **#BGS01 Provide grants for the promotion of new technologies that are less effort intensive and/or more efficient**

Between 2007 and 2011, the MNRE sanctioned about INR 8 crores for R&D in biogas, of which 50 per cent was allotted for the production of biofuels (MNRE 2018). The government should consider increasing its allocations to new entrepreneurs who seek to improve process efficiency and biogas packaging. The Department of Science and Technology (DST) and the Ministry of Petroleum and Natural Gas (MoPNG) could assist the MNRE in supporting entrepreneurs’ research in this area.



**#BGS02 Invest in R&D to develop double-burner stoves that can use LPG and biogas**

There is a need for R&D on the possibility of developing a single-burner stove that can burn using both biogas and LPG. Perhaps the construction could include an outer ring that supplies one fuel while the inner ring supplies the other. Research efforts to this end should also consider whether such a stove will be compatible with existing utensils. An alternative to this two-ring burner could be stove burners that can mix gaseous fuels before ignition. The development and lab and field testing of these models requires government support as well as the help of technical institutes.

**FIGURE 8: Single-burner biogas stove**



Image: Saurabh Tripathi/CEEW

**5.4.2. Testing business models**

**#BGS03 Allow subsidies for prefabricated biogas plants**

The dominant model of procuring state-subsidised biogas plants is to get them from one of the MNRE’s approved vendors. This affects the pace of deployment because vendors have to install the pre-approved fixed dome “*deenbandhu*”, a family-type plant, through a labour-intensive process. Prefabricated plants, on the other hand, are far quicker to assemble, as they require very little on-site preparation and labour. However, in order to scale up their use, the operational and economic viability of these plants need to be assessed, support by appropriate access to subsidies. The inclusion of prefabricated biogas plants in the new scheme (MNRE, 2018a) may unlock the potential of biogas by standardising conditions for scalability.

**FIGURE 9: A Pre-fabricated biogas plant**



Image: Saurabh Tripathi/CEEW

**#BGS04 Pilot enterprise-based models for biogas-as-a-service, and offer incentives, such as cheaper loans, to rural biogas entrepreneurs**

The new scheme on biogas – NNBOMP - has emphasised on the entrepreneurship model and involvement of SHGs to allow for comprehensive biogas services, including installation to maintenance services. In addition, there is also a need to explore models in which biogas plants are owned and operated by entrepreneurs, and households pay a monthly fee for the biogas supply. The entrepreneur manages the upfront payment for the construction and the hassle of cleaning and maintaining the plant with regular feedstock. Since these are the predominant reasons for non-adoption and dissatisfaction with biogas, such a biogas-as-a-service model may help alleviate these issues to position it as an attractive clean energy alternative. The biogas-as-a-service model must also explore piped supply to households, who can then pay for the gas they use for cooking. NNBOMP also provides an additional subsidy for farmers/ dairy farmers for setting up plants of bigger size from 10 m<sup>3</sup> to 25 m<sup>3</sup>, to save their diesel and electricity bills. An extension of such a model could allow *gaushalas* (cow shelters) to own and operate biogas plants that would provide cooking gas for a consumption-based fee to nearby households.



When biogas is provided as a service by an entrepreneur, households need not take on the hassle of operating, cleaning and maintaining the plant

FIGURE 10: Community biogas plant



Image: Saurabh Tripathi/CEEW

Enterprise-run biogas models further stand to benefit from the use of slurry as an organic enriched bio-manure in agriculture; the sale of bio-slurry in the market can provide an additional source of revenue to households. Market research should be conducted to estimate the demand for slurry and to design appropriate business models and communication strategies for farmers. The MNRE should provide more incentives to Biogas Development and Training Centres (BDTCs) for research on biogas slurry utilisation, given its potential for commercialisation. BDTCs should lead the pilot demonstrations of the new models as envisaged under the new scheme. The Ministry of Agriculture and Farmer's Welfare could support the energy ministries in drafting a credible business model around the utilisation of biogas slurry in farms.

#### **#BGS05 Invest in R&D to reduce the cost of biogas bottling and packaging**

Bottled biogas is yet another potential means of improving adoption. Like LPG, biogas can be generated, packaged, and supplied locally to households at a fixed price. As part of its Research, Design, Development, and Demonstration policy, since 2007–08, MNRE has taken initiative in demonstrating medium-size, mixed-feed biogas fertiliser plants (BGFP) for the generation, purification, enrichment, bottling, and piped distribution of biogas. In the demonstration phase, the ministry has sanctioned central financial assistance (CFA) of up to 50 per cent of the cost (excluding that of land) for the implementation of a limited number of such entrepreneurial projects on a reimbursement basis. So far, the MNRE has sanctioned over INR 14 crore across 14 projects, half of which are under trial (MNRE, 2018b). While the technology is yet to be vetted, some enterprises in India are exploring bottling biogas for household use as a business model. Owing to the cost of bottling, this has so far been limited to bottling bio-CNG for commercial use.

### 5.4.3. Generating awareness

There is a twofold need for consumer awareness of biogas: first, some households have never heard of biogas being used as a cooking energy technology; second, others have a negative perception of the technology. Despite the MNRE allocating funds towards raising awareness of biogas under NBMMP, Jain et al. (2018) estimate that about 62 per cent of households had never heard of biogas for cooking. The messaging around household-level biogas must be strengthened, so that the technology appears as aspirational as LPG to the typical rural household.

**#BGS06 Organise demonstrations that illustrate the experience of using biogas by outlining the differences between modern biogas plants and traditional *chulhas*, as well as older models of biogas**

The communications and publicity strategy should highlight specific aspects of the technology: energy independence and security, low recurring costs in comparison to other gas-based solutions, and household and animal waste management. Comparing it with traditional *chulhas* could highlight the ease of use. Biogas could also be promoted by linking it with income-generating activities such as food preservation, drying, and other such household-level food processing—if their economics works out better than other clean cooking fuels.

Many households that have heard of biogas hold a negative perception of the technology primarily because they believe that biogas “does not work” or that it “breaks down easily”. These narratives stem from the high rate of non-functionality among biogas plants constructed during the 1990s and early 2000s under NBMMP (CAG, 2015). For such households, awareness campaigns must include a technology demonstration to visually differentiate modern biogas plants from the kind that were installed previously.



**Demonstration of modern biogas plants is required to visually differentiate them from the earlier ones that had a high rate of non-functionality**

### 5.4.4. Strengthen the skill-development ecosystem for better installations and after-sales service

It is imperative that there be a skilled workforce primed to aid the development of the biogas sector. There is a need to formally skill people at different stages of the biogas value chain—from R&D and manufacturing to distribution and awareness generation. This could be improved through the biogas-as-a-service model that incentivises entrepreneurs to provide continued after-sales services. The current scheme allows BDTs to upgrade the existing training programmes based on feedback from implementing agencies. The ‘Biogas *Mitras*’ trained by the BDTs should be connected to the biogas enterprises that are looking for skilled employees to improve the job opportunities for trainees and reduce the cost of training and recruitment for the enterprises. This could also improve the local availability of services, if the selection of trainees is customised by region and the incentives are aligned appropriately.

**#BGS07 Provide subsidised training in manufacturing, marketing, and maintenance to local entrepreneurs and workers; and in plant operation to users**

While SCGJ has helped in formalising the training ecosystem, it is crucial to initiate and sustain the demand for formal job roles along the value chain of the fuel. Under the NBMMP, the incentives for turnkey workers to carry out regular operations and maintenance (O&M) were not lucrative. In the NNBMMP, although the turnkey fee has been increased from



INR 1,500 to INR 2,500 for fixed-dome plants, and extended to larger plants of 15–25m<sup>3</sup> size, there is a need for assessments to ascertain if the new fee is lucrative enough (MNRE, 2014b; MNRE, 2018b). It is important that critical nodes in the value chain, such as turnkey workers, be incentivised adequately under the SNA approach or the enterprise model to take up roles within the business ecosystem of biogas. In addition to providing appropriate economic incentives, training centres could look to subsidise training for rural clean cooking entrepreneurs and workers under the *Deen Dayal Upadhyaya Grameen Kaushalya Yojana* (DDU-GKY). DDU-GKY is a key skills-training programme by the MoRD that focuses on rural youth, aged 15 to 35 years, from poor families. It supports DDU-GKY partners through investments, capacity-building, strategies for retention, linkages for placement, and technology assistance for training purposes. Under DDU-GKY, State Skill Development Missions can train rural youth to become clean energy entrepreneurs. The lower training fees will encourage greater participation in the sector's activities. Village-level entrepreneurs can provide installation and repair services for biogas plants. The skilling of workers alone would not suffice, as it is important to build capacity through entrepreneurs who would absorb the skilled workforce.

To ensure that biogas plants run smoothly, it is important to train users to operate them in a manner that minimises the need for maintenance. Biogas distributors should ensure that the main user of the plant is trained thoroughly on the kind of feedstock to use and how and when to clean the plant. In some cases, while the training is given to the men in the household, it is often the women who are responsible for maintaining the plant (Raha, Mahanta, and Clarke, 2014). Hence, the primary operators of the plants should be trained.

#### 5.4.5. Streamline easy operation and maintenance for existing biogas plants

Almost all stakeholders articulated O&M as the single biggest challenge in the scaling of biogas across the country. So far, even though five million plants have been installed, a significant proportion are non-functional, in many cases due to construction-related problems and poor maintenance. A biogas plant can be a long-term cooking energy investment for households if it is operated well and maintained regularly.

##### **#BGS08 Start a helpline for households to report breakdowns and guarantee the time frame for the repair**

There needs to be an emphasis on after-sales services. Many plant owners are not aware of whom they should approach if the plant were to break down, and they are not trained to fix the problem themselves. In such cases, the plant becomes defunct due to negligence. A centralised toll-free helpline could be useful for people to lodge complaints regarding their biogas plants. It would help in tracking reports of faults and breakdowns, and the rate at which complaints are being answered and addressed. The data on breakdowns collected by such a system would help SNAs devise appropriate strategies to resolve O&M issues in biogas systems.



It is important to train users to operate biogas plants in a manner that minimises the need for O&M



A centralised toll-free helpline could be useful for people to lodge complaints

### Where best to deploy biogas

For biogas use to be sustainable, it is important to ensure the regular availability of feedstock and maintenance. Ideally, these plants should be deployed in areas where feedstock is readily available. One method would be to map the cattle population using the livestock census. Where biogas is concerned, entrepreneurs should prioritise consumers in areas with a large cattle population. Other requirements, such as the availability of water and labour to feed the plant on a regular basis, should also be considered. Ultimately, it would be useful to assess the requirement for biogas against several use-case scenarios—such as hours spent cooking, number of meals, and proportion of households using biogas—at the village level, and map it against the daily availability of wet dung in the village.

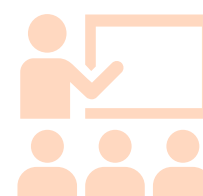
It is worth noting that biogas from food waste can be used for cooking in urban areas, either as piped or bottled gas. This can help solve the urban waste management problem, reduce urban demand for LPG and PNG, and make biogas use aspirational in rural areas. In urban areas, many large restaurants are already using biogas generated from food waste as an additional source of income (PTI, 2017). This can be scaled to larger restaurants across all cities and towns. Where appropriate, residential welfare associations can supply piped biogas from food waste to their localities. However, adequate incentives must be introduced for biogas to compete with LPG and PNG in urban areas, keeping in view their degree of import dependence. The incentives should also focus on both convenience of use and economic viability. For instance, lightweight bag digesters,<sup>27</sup> which are easy to install and use, will have a higher likelihood of adoption than plants, which need construction.

## 5.4.6. Ecosystem for finance

There are two main gaps in the financing ecosystem for biogas. First, entrepreneurs must have easy access to private capital for business needs. Second, the poorest households must be able to secure loans to finance the upfront cost of the plants.

### #BGS09 Sensitise financial institutions and other investors to the newest business models in biogas and related technologies

Most of the entrepreneurs we spoke to stated that while they receive grants and donations for their businesses from foundations and multilateral agencies, they are unable to secure debt or equity from larger private players, investors, and banks; this stifles their growth severely due to investors' lack of faith in the long-term sustainability of the technology, perhaps owing to the high rate of non-functionality of existing plants. As newer models emerge, it will be important to gain the confidence of financiers. NNBOMP now directs scheduled/public sector banks, the National Bank for Agriculture and Rural Development (NABARD), and the Indian Renewable Energy Development Agency (IREDA) to set certain minimum targets for their branches to disburse loans under Green Loans for Biogas and Organic Manure Service (GLBOMS). However, to fully enable this transition for financiers, it would be useful to have a communications strategy that can sensitise financiers to the newest business models and technologies in biogas. Loans towards biogas must be accommodated under priority sector lending to benefit a greater number of entrepreneurs. It is important to sensitise both bankers and households to the possibilities of end-user financing.



There is a need to sensitise financiers to the newest business models and technologies in biogas

<sup>27</sup> Lightweight bag digesters are flexi-biogas systems that use balloon or tube digesters constructed from polyethylene or plastic bags. They are cheaper, use less material, can be set up in a single day, require less manure to start up, and convert waste into energy more quickly.

**#BGS10 Improve ease of access to consumer finance for biogas**

Plugging the gap in end-user financing will help generate sustainable demand for biogas. The cost of setting up a household biogas plant is steep (approximately INR 20,000 for 1m<sup>3</sup>), despite the state subsidy of INR 7,500–17,000 (MNRE, 2018b). Despite the availability of loans for households who are unable to afford the upfront cost, bank officers and households are often unaware that they can secure a loan. Moreover, commercial banks charge interest rates at 12% and above and require collateral that can only be provided by high-income households, thereby limiting access.<sup>28</sup> It is then in the interest of the SNAs to sensitise both parties to the possibilities of end-user financing.

Even in the absence of loans for end users, the MNRE could consider introducing EMIs for poor households who may prefer to pay in small instalments instead of one steep lump sum. Likewise, it would be more useful to disburse subsidies for biogas plants in instalments over the period of construction, as opposed to one pay-out at the end of the construction period, since the latter might limit access for many financially weak families.

**#BGS11 Involve agricultural finance institutions in supporting biogas plants**

Cooperative dairies could provide loans to their members—small and marginal farmers. These dairies can secure loans or funds from banks to install the plants at the premises of interested members; they can adjust the instalments for the setting up cost against milk bills on a regular basis. Further, other interlinked schemes under MoAFW such as the ‘*Organic Farming Mission*’ and now *Dairy Entrepreneurship Development Scheme* could be leveraged to improve the affordability of biogas plants (MNRE, 2018a). Access to loans for biogas could also be improved by allocating a fixed amount on the *Kisan Credit Card* (KCC), as proposed to the MoAFW and NABARD in the new scheme. In the past, NABARD has explored synergies in their existing programmes for such loans. For instance, it supported mini dairy units between 2013 and 2016 under the Umbrella Programme on Natural Resource Management (UPNRM) for livelihood enhancement. It facilitated term loans (INR 18.6 million) and grants (INR 1.3 million) for about 600 on-farm biogas plants to provide energy for cooking and mobilised subsidies for biogas and cattle insurance (NABARD, 2016).

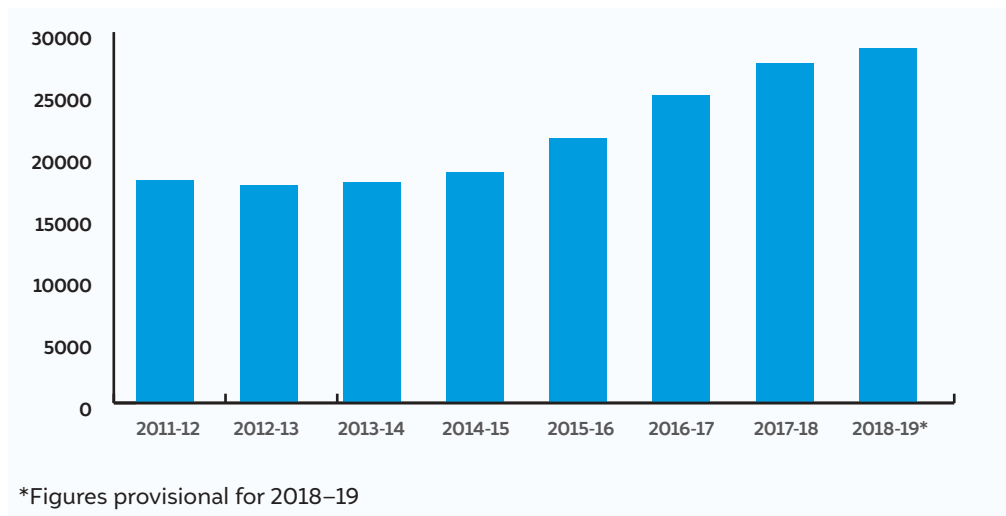
## 5.5. Piped Natural Gas

Towns across 400 districts of the country now implement or plan to launch piped natural gas (PNG). The government aims to scale up PNG to make it the predominant source of cooking energy in urban areas. As India moves towards a gas-based economy, aiming to meet 15 per cent of its primary energy demands through natural gas by 2030, PNG has emerged an important component of this plan. The projected demand for PNG in 2030, as estimated by the Petroleum and Natural Gas Regulatory Board (PNGRB), is 44.67 million standard cubic feet per day (MMSCMD) up from the existing sales and supply of 8.57 MMSCMD in 2016–17<sup>29</sup>. This will entail investment in additional capacities for pipelines and distribution networks, and in gas infrastructure, including the addition of cities to the existing city gas distribution (CGD) network. Liquefied natural gas (LNG) imports in India have more than doubled between 2007–08 and 2017–18. As of 2018, there are about 4 million domestic customers of LNG, with the majority in Delhi, Maharashtra, and Gujarat. The target is to reach 10 million customers by 2020 (Pathak, 2018a). While the power sector drives the maximum demand for LNG, CGD is expected to register the fastest growth and contribute 11 per cent of the total demand for natural gas by 2030 (Enincon, 2017).

28 Primary interviews with stakeholders.

29 Derived from the overall projection for city gas, using the existing proportion of 52.25% (2016–17 sales) for PNG.

**FIGURE 11: Imports of LNG in India increased by 241% between 2011-12 and 2018-19**



Source: PPAC, 2019b

**#PNG01 Credited-linked instalments for PNG connections**

One of the challenges that restricts the expansion of PNG is the prohibitively high connection cost—INR 5,000—that makes it unaffordable for the urban poor. Credit-linked instalment mechanisms can allow for a more inclusive customer base. The Government of Gujarat offers subsidised PNG to BPL households—it pays INR 1,600 as a one-time subsidy per connection and provides INR 1,725 as a loan to customers who opt for a new connection. The beneficiary then pays INR 118 for a new connection and a refundable security deposit of INR 50 per month for a period of 100 months (Pathak, 2018b)(Pathak 2018). Other parts of the country can also experiment with such a scheme to increase access to PNG.



Credit-linked instalment mechanisms can allow for a more inclusive customer base

**#PNG02 Adoption of prepaid metres that allow recurring payments of smaller amounts**

The recurring cost of the gas might also be a challenge for BPL households. Hence, there is a need to explore different payment plans whereby the urban poor can make smaller payments at a specified frequency. Adopting prepaid meters that allow recurring payments of smaller amounts can improve the affordability of PNG for low-income urban and peri-urban households.

**#PNG03 Prevent households from having both LPG and PNG connections**

It is equally important to prevent leakages in the ecosystem by ensuring that households with PNG connections give up their existing LPG connections. This would also help improve the availability of LPG in rural areas.

**#PNG04 Decentralise the supply and distribution of LNG**

The cost of pipeline construction can be significant in hilly terrain. CGD companies also face challenges in finding clear land to lay distribution pipelines (Sircar, Sahajpal, and Yadav 2017). This could be resolved by exploring decentralised distribution models for peri-urban and rural areas along the same lines as microgrids for electricity.



### **#PNG05 Manage the profitability of CGDs through a healthy balance of import and domestic LNG**

The pricing of PNG is currently regulated by the pricing formula<sup>30</sup> adopted by the government in 2014. Its supply is controlled through the Gas Utilisation Policy, which prioritises sectors that produce gas domestically—one of which is CGD. However, companies have expressed concern that the financial incentives provided under this policy are insufficient for meeting investments in exploration and production. Imported LNG is available at significantly higher prices than domestically produced LNG, and has implications on the profitability of CGD companies. Furthermore, the global shift in LNG prices could adversely affect the affordability of PNG if the government were to stop prioritised access to domestically produced gas.

## **5.6. Solar-based cooking**

The MNRE has supported solar-based cooking solutions—such as solar steam cooking systems, dish-type solar cookers, and parabolic solar cookers—for households through capital subsidies. Approximately 3,737 solar cookers were sanctioned for sale and distribution in 2016–17 (MNRE, 2017). They can attain temperatures of about 350 to 400 degrees Celsius, which can support roasting, frying, and boiling. However, the challenges associated with solar cookers include the limited duration of cooking, intermittency of sunlight, and the need to place the cooker outside the household. Solar thermal cookers, therefore, do not offer the convenience and reliability of other clean cooking energy solutions; they can only play a supportive role owing to the intermittency of sunlight and the other limitations of the technology.

### **#SOL01 R&D to improve the efficiency and affordability of solar thermal/electric cooking**

Solar-based cooking offers higher thermal efficiency and convenience to households that are dependent on the traditional *chulha*. The technology is at a nascent stage and requires significant investment in research and development. The DST and the National Institute of Solar Energy (NISE), an autonomous institute under the MNRE, could play an important role in the development of solar-powered thermal and electric cooking solutions. While the ministry has been supporting upstream research on solar applications including storage devices, solar thermal technologies, and solar energy materials under the Clean Energy Research Initiative, there is potential to focus on solar-powered cooking technologies that can be efficiently designed to suit cooking conditions in India. Through the Mission Innovation challenges, the DST has encouraged innovation in off-grid access to electricity, carbon capture, sustainable biofuels, and affordable heating and cooling of buildings. It could launch similar challenges for solar-powered cooking solutions. NISE could look to expand its solar thermal research to include cooking applications and, specifically, their efficiency and affordability.

### **#SOL02 Improve terms of patents and prizes in competitions to allow serious entrepreneurs to apply**

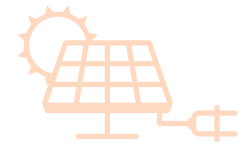
Prizes at energy innovation-themed competitions can be very rewarding for entrepreneurs. In a recent effort, the Oil and Natural Corporation Limited (ONGC) launched an innovation

<sup>30</sup> The new formula calculates the prices using the weighted average rates of Henry Hub of the US, National Balancing Point of the UK, and rates in Alberta (Canada) and Russia, with a lag of one quarter.

challenge to design a solar *chulha*. The winner was awarded prize money of INR 10 lakhs along with financial support for the fabrication of 1,000 units that would be procured for demonstration in different regions. However, while such competitions can help disruptive technologies emerge, they often tend not to attract the best innovators, at times because the terms of the patent and remuneration are not negotiable. Depending on the maturity of the technology, the innovator should be rewarded adequately. The reward could include the strategic involvement of the concerned ministries in the form of shared patent rights or financial support to start a business. This will help source rather mature and developed solar-based cooking solutions.

### #SOLO3 Pilot enterprise-based business models and facilitate access to affordable credit for entrepreneurs and households

The solar-based cooking sector also needs innovative business models and financing mechanisms to improve the availability and affordability of its products. MNRE and MoPNG can help pilot business models driven by entrepreneurs and make affordable credit accessible to entrepreneurs and households. Business models for solar-powered cooking should also account for the cost of replacing batteries for households across income groups. The technology will also need adequate field testing for quality, reliability, and durability. A key initiative to further the technology can include collaborations between public labs and private enterprises, which will ensure that infrastructural facilities, such as labs, are made available to a larger group of entrepreneurs.



Business models for solar-powered cooking should account for the cost of replacing batteries

## 5.7. Electricity-based cooking

As the country makes progress towards achieving universal household electrification, the use of electricity for cooking and heating is only likely to increase. Under the ambitious scenario of IESS, 14 per cent of rural households will use electricity for cooking by 2047. In 2018, only about one per cent of rural households used an electric or induction stove (Jain et al., 2018). It thus becomes clear that a major policy push is required to wean households off fossil fuels and other traditional sources of cooking fuel and transition towards a clean energy stack through electricity.

### #ELC01 Improve the quality of electricity access

Rural electrification schemes such as *Deen Dayal Upadhyaya Gram Jyoti Yojana* (DDUGJY) and *Saubhagya* have focused on the electrification of villages and households, but not on the reliability or quality of supply. Without assured quality (consistency in voltage), reliability (occurrence of black-outs), and sustained duration of electricity supply, households are unlikely to invest in induction cookstoves and other such electric devices, given that they currently have the flexibility of cooking at any time of the day with the traditional *chulha* and LPG. The government's ambition to provide all households with power 24x7 by 2022 (PTI, 2015) will be instrumental in unlocking the potential of electricity-based cooking in rural areas.

### #ELC02 Ensure that the connection and peak loads can support induction stoves legally

Given the wattage of such cookstoves—1400W to 2100W—many newly electrified households will not be able to make use of them, as they are likely to have received 500W connections under *Saubhagya*. The easy availability of such appliances, coupled with the low connection loads available, might create perverse incentives to illegally tap electricity to access higher



In 2018, only about one per cent of rural households used an electric or induction stove

loads for cooking energy. There is thus a need to plan for the additional capacity that will be required through investments to augment the power distribution infrastructure—such as upgrading the 500W connections, providing three-phase connections, and reducing the length of trunk lines to improve the quality of supply, etc.

### #ELC03 Map the willingness and ability to pay for electricity in order to identify priority areas that can use electricity as cooking energy

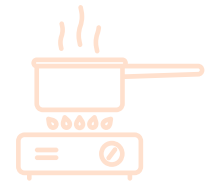
When households without electricity were asked why they were not electrified despite the electrification of their neighbourhood, almost 80 per cent stated that they found it too expensive (Jain et al., 2018). After adding cooking energy to the mix, the increased cost of electricity will be predictably steep for many households. However, a careful mapping of the willingness and ability to pay for electricity is necessary to identify and prioritise clusters of households that will be able to use electricity as clean cooking energy. Since many rural households will be new consumers of electricity, it will be important to study their attitude towards the use and payment of electricity, and to improve their understanding of how electricity can further the convenience of cooking vis-à-vis the traditional *chulha*.

### #ELC04 Improve the energy efficiency of induction cookstoves

On average, with three hours of cooking in a day, a household's monthly expenditure on electric cooking energy will be INR 540 (USD 8), which is comparable to the monthly outlay required for LPG.<sup>31</sup> However, if households are to rely entirely on electricity-based cooking, it is important to improve the energy efficiency of induction cookstoves and other commonly used electric devices. This would help households minimise their energy consumption and lower their recurring expenditure on electricity. A few companies have set up government-approved R&D centres to improve the efficiency of induction cookstoves. Although oil marketing companies and ONGC have begun start-up funds to support the development of user-friendly electric cooking appliances (IANS, 2017), entrepreneurs in the sector still need more direction to innovate affordable energy-efficient appliances for the rural segment.

### #ELC05 Improve consumer awareness of electric cooking and stove efficiency

In addition to improving households' understanding of how electricity can improve cooking, there is also a need to make them aware of alternative energy-efficient appliances and practices. This will help in the provision of quality electricity supply and in reducing household expenditure on electricity. They will also need to be made aware of the importance of factoring in energy-efficiency ratings when making decisions around the purchase of electric consumer durables for cooking.



A mapping of the willingness to pay for electricity could help identify clusters of households that can possibly use electricity for cooking



On average, a household's monthly expenditure on electric cooking energy will be INR 540, comparable to the average outlay on LPG

31 Primary interviews with stakeholders.





Two-thirds of rural households with LPG continue to use traditional biomass cookstoves (CEEW ACCESS 2018 survey).





## 6. Best Practices for Improving Access to Clean Cooking Energy Solutions

### Targeted subsidies

In 2007, Indonesia started a fuel substitution scheme designed to substitute household consumption of subsidised kerosene with subsidised LPG. Every household across six provinces in Indonesia received a free starter package containing a 3-kg LPG cylinder, the first LPG fill, one burner stove, a hose, and a regulator. The financing for the programme came from the roll back of subsidies on kerosene. The share of LPG in household consumption has increased from 1.9 per cent in 2005 to 13.5 per cent in 2013, while the share of kerosene has dropped considerably from 18 per cent in 2005 to 1.8 per cent in 2013 (Toft, Beaton, and Lontoh, 2016).

In 2012, the Government of Thailand announced its intention to develop a system to provide subsidised LPG only to low-income households and small businesses. Since its inception, the policy has provided LPG at a fixed price of THB 18.13 (less than 60 US cents) per kg (IMF, 2015). Households are eligible for benefits if they have a power connection of no more than 5 amperes and consume an average of less than 90 kWh of electricity per month. Their consumption is limited to 18 kg every three months (EPPO, 2015).

### Complementary policies

In order to expand LPG use, Senegal set up three different price structures, with price revisions every three months: one for 2.75-kg bottles, another for 6-kg bottles, and a third for large 12.5-kg cylinders. Only the first two sizes were subsidised. The policy of encouraging LPG consumption was complemented with measures to rationalise wood resource management. This included an increase in wood-cutting license fees, tighter production quotas, the creation of a land allocation system for charcoal production, and a progressive increase in the official sales price of charcoal (GIZ, 2007).



Cameroon adopted its first national LPG master plan in 2016 to increase the share of households cooking with LPG from about 12 per cent in 2014 to 58 per cent by 2030 (Van Leeuwen, 2017). The government partnered with the Global LPG Partnership (GLPGP) to craft policies and reforms and define investments and interventions. The approach is government-led, inter-ministerial, and multi-stakeholder, drawing on the best international practices and facilitated by GLPGP experts. Over the next 15 years, about EUR 400 million will be invested in cylinders, importation facilities, refilling plants, and distribution, including by small and medium-size enterprises. In February 2017, GLPGP, together with Cameroonian partners and the Department of Public Health and Policy at the University of Liverpool, launched a new microfinance pilot to expand the adoption of LPG for clean cooking to previously unserved communities (World Bank, 2017).

## Awareness campaign to increase adoption

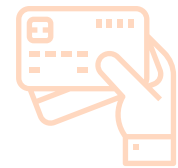
In order to support gradual price rises and the introduction of targeted LPG subsidies, the Government of Thailand developed a two-stage public relations plan aligned with the stages of its own planning process. This involved interviews with Ministry of Energy officials, seminars, public hearings, leaflets, posters, TV media, print media, radio media, and online news (Toft, Beaton, and Lontoh, 2016).

In Lag Valley in India, the NGO Jagriti employed volunteers from villages to disseminate information on LPG and the available subsidy. Volunteers from low-caste and low-income households were chosen, so that the knowledge would be disseminated uniformly across various social categories.

## Leveraging technology

In El Salvador, LPG retailers have been provided with a mobile phone connected to a central database that is updated in real time. LPG consumers register for the subsidy using their single identification document and enter an individual password into the retailer's mobile phone to check their eligibility. The vendor then receives confirmation from the central database and can sell LPG at a fixed below-market price to the consumer (Toft, Beaton, and Lontoh, 2016).

Envirofit, a social enterprise that manufactures clean cookstoves, offers a new, technology-based, pay-as-you-go service called SmartGas that allows households to pay for LPG as they use the fuel. The technology—a smart valve—monitors the use of gas and allows the company to schedule the delivery of a new tank before the customer runs out of LPG, thus assuring consistent supply. The company has started implementing SmartGas in Kenya and plans to expand to other regions soon (Envirofit, 2017).



Envirofit offers a pay-as-you-go service called SmartGas that allows households to pay for LPG as they use the fuel

## Linking with social protection and livelihood intervention programmes

To improve energy access, the Peruvian government created the *Fondo de Inclusión Social Energético* (FISE) in 2012. Under the FISE scheme, recipient households receive a monthly voucher worth PEN 16 (roughly USD 5.70) and financial support for the first LPG refill every month. The voucher is provided to recipients through a numeric code on their electricity bill that they can redeem via their own mobile phones. Subsidy recipients can redeem their allowances for up to two months, and the LPG must be purchased through an “authorised LPG agent”—a distribution network that has expanded since the inception of the programme (Toft, Beaton, and Lontoh, 2016; FISE, 2018).

The Bihar Livelihoods Promotion Society, JEEViKA, with the support of The Energy and Research Institute, introduced solar home lighting systems and forced SHGs to use draft smokeless cookstoves. Some women in Madhubani district have found the smokeless cookstoves useful and have experienced reduced smoke and begun to consume less firewood. The extent of firewood use has reduced from 10 kg per month to 3 kg per month.

## Local entrepreneurs for maximising impact

Kenya, Uganda, Tanzania, and Rwanda are witnessing a growing briquetting industry focused on coal and biomass. At the micro-entrepreneur end of the market, organisations like Energy 4 Impact (formerly, GVEP), Harvest Fuel, and the Legacy Foundation are supporting the migration of micro- and small-scale entrepreneurs from manual extruders to low-cost, locally fabricated, motorised briquette machines (ESMAP, 2015).

TIDE, based in Karnataka, engages semi-literate rural women as VLEs. These VLEs have constructed over 7,500 cookstoves using local materials. The VLEs, selected through women's SHGs, are provided with a five-day training conducted by women who are proven leaders.

## Product differentiation for markets

Group Energies Renouvelables, Environnement et Solidarité (GERES) started the *Cambodian Fuelwood Saving Project* in urban areas of Cambodia and developed and distributed the New Lao Stove (NLS). However, GERES recognised the need to develop an improved cookstove for rural users and engaged women potters to develop the Neang Kongrey Stove (NKS). The production methods of these two cookstoves differ widely. Women potters produce the NKS in their homes. Its prototype, originally produced by women clay potters who were trained by GERES, was validated in 2004. The production process involves skills that traditional potters already have. The NKS is made from coarse clay, a material already used for the production of traditional *chulhas*. It lasts between one and two years and costs approximately USD 1.50 (GACC, n.d.). These trained producers become part of a collaborative enterprise called the Association of Producers and Distributors of Improved Cookstoves in Cambodia (ICOPRODAC), which consists of approximately 250 members. Before accepting women into the training, GERES communicates with the husbands to ensure that they have their support to participate in the programme. GERES has also been experimenting with providing loans for producers to invest in equipment through a savings-cum-credit cooperative scheme.

## Behaviour change communication

In Kenya, the Global Alliance for Clean Cookstoves supported the launch of a television programme named *Samba Chef* (GACC, 2017). The objective of the show was to demonstrate the use of cookstoves and inspire people to switch to cleaner cookstoves and fuels. According to research, 80 per cent of the targeted population regularly watches television and listens to the radio. *Samba Chef* is complemented by a community outreach intervention in 17 counties in Central and Western Kenya. Community-based organisations conduct door-to-door and small group communication sessions on the benefits of clean cooking, as well as market events and cooking demonstrations.



The show *Samba Chef* demonstrates clean cookstoves and inspires people to use them



## Financial collaboration

Sistema Biobolsa, a biogas enterprise based out of Mexico and Kenya, has collaborated with Kiva<sup>32</sup> since 2012 to fundraise about USD 718,000 for installing affordable biodigester systems for households (Kiva, 2015). Savings from the use of the organic fertiliser has allowed farmers to repay the loans in time.

## Biogas as waste management

In several European countries, regulations have pushed for a scaled biogas sector to manage the animal waste generated from dairy husbandry and slaughterhouses. These plants, run by agricultural cooperatives, also generate electricity. In Central Hungary, since 2007, a 1.7 MW plant produces 6 billion m<sup>3</sup> of biogas annually, meeting the electricity needs of about 4,000 households. This has reduced the demand for natural gas in the region. The plant received private funding for operations and state support for infrastructure (Intelligent Energy, n.d.).

## Network-based approach to construction, maintenance, and monitoring

Over the last seven years, the Environmental Defense Fund (EDF) has created a network of 30 partner NGOs and set up about 100,000 biogas plants in India. Their approach includes the construction, maintenance, and monitoring of plants managed by a network of NGO partners. Local entrepreneurs are trained to construct the plants in-situ, while local women, who are paid INR 4,000 a month for looking after 100 units, provide maintenance services. To monitor the maintenance and use of plants, users provide feedback to a local volunteer—such as the school teacher—who records all the information on tablets that EDF can access. EDF has also used carbon finance to reduce the upfront cost of setting up biogas plants for households.<sup>33</sup>



**EDF has used carbon finance to reduce the upfront cost of setting up biogas plants for households**

32 Kiva is an international fundraising non-profit based in San Francisco, with a mission to connect people through lending to alleviate poverty.

33 Primary interviews with stakeholders.

Handwritten Thai text in white ink on a dark background, featuring stylized characters.



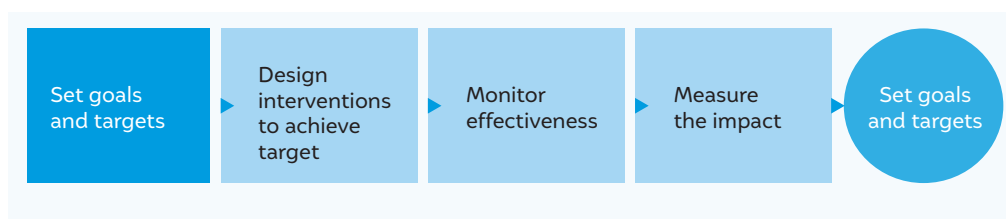
Programme evaluation must go beyond connections to assess the sustained use of clean energy technologies.



## 7. Monitoring and Evaluation Framework

A national mission on clean cooking energy will need rigorous monitoring and evaluation (M&E) to facilitate the transition from the traditional *chulha* to sustained access to, and use of, clean cooking energy. The M&E team under the mission should be independent of the programme team, while engaging with it for regular reviews. The evaluation of this national roadmap should be linked to a third-party baseline, midterm, and endpoint evaluation of access to clean cooking energy. This section lays down some mechanisms for designing a tracking and evaluation framework that can help with course correction at regular intervals.

**FIGURE 12:** The arc of programme design, monitoring, and evaluation



Source: CEEW analysis, 2018

### Monitoring effective use of clean cooking energy

The M&E framework should be designed to monitor the change in exposure to HAP resulting from discontinuing use of the *chulha* and initiating sustained use of a single fuel or stacked clean cooking energy solutions. The sale or dissemination of technologies should be tracked, and this data should be used to generate feedback with regard to adoption. The national roadmap should have interim targets by which to measure achievements, and which should also be used to benchmark the various policies and programmes. There should be a comprehensive evaluation to assess the effectiveness of the programme design and strategic interventions, implementation efficiency, as well the overall impact of those interventions on the outcome indicators.



## Mixed methods to monitor

Sensor-based technologies could be used to remotely monitor changes in the exposure to HAP that result from discontinuing use of the *chulha*. This will help reduce the reporting bias from survey-based methods. In addition to sensors and surveys, qualitative community-level and stakeholder-level assessments must be conducted to gain a deeper understanding of the issues faced across regions, social groups, and cooking energy solutions. Administrative data of oil marketing companies and other clean cooking energy providers can be leveraged to evaluate adoption and sustained use. While some data is already available publicly, more can be procured to inform programmes on clean cooking energy. The M&E should be done through independent third parties and be supervised by the mission's M&E team.

## Evaluate multidimensional impact

The impact assessment should include a focus on health, gender, and livelihoods. A multi-criteria assessment at the start of the mission will help in building a stronger case for the adoption of clean cooking energy among households. In order to facilitate this, the M&E team should include members who have experience in the fields of energy access, health, gender, environment, etc. As discussed before, the lack of access to clean cooking energy should be monitored across social groups, income deciles, regions, and other context-specific variables that could contribute to reduced access.

## Regional and national monitoring

The M&E framework should include common review missions that allow multiple ministries to assess progress regularly with regard to their particular focus areas. The monitoring should be done at the state, district, and block levels in order to gather specific insights on progress, and to accordingly streamline efforts to address gaps. For instance, state-specific challenges with regard to awareness should lead to a focus on awareness campaigns in that state. Hence, granular information on gaps in the sector become essential. Further, the team should learn from best practices across districts and states, and should replicate these best practices in context-specific situations to improve the effectiveness of interventions in terms of availability, affordability, and awareness of clean cooking energy.



Access should be monitored across social groups, income deciles, regions, and other similar context-specific variables



Image: iStock-Patpitchaya

**TABLE 3: Indicative list of metrics for M&E of the national mission on clean cooking energy**

Theme	Indicator
Energy	<ul style="list-style-type: none"> <li>• Percentage of households using clean cooking energy</li> <li>• Percentage of households using stacking only among clean cooking energy</li> <li>• Kind of stack used in the household</li> <li>• Percentage of households using traditional <i>chulhas</i> for uses other than cooking meals (space heating, boiling water, etc.)</li> <li>• Average household monthly expenditure on cooking energy (by income level, by caste, by region, by sex of the head of the household)</li> </ul>
Gender and Livelihoods	<ul style="list-style-type: none"> <li>• Percentage of households where women reported time saved in cooking and cleaning due to the use of clean cooking energy</li> <li>• Percentage of households where women reported greater involvement of men in the kitchen due to ease of cooking</li> <li>• Percentage of households where women or girls reported reduction in drudgery due to the use of clean cooking energy</li> <li>• Percentage of households where women reported an increase in income due to the use of clean cooking energy</li> <li>• Percentage of households where women decided what fuel to buy for cooking and when</li> <li>• Other benefits articulated by men and women</li> </ul>
Health	<ul style="list-style-type: none"> <li>• Percentage of households with reduced incidence of sore eyes, and cough during cooking</li> <li>• Percentage of households where expectant mothers were not exposed to burning of solid fuels during cooking</li> <li>• Percentage of households where children under five years were not exposed to burning of solid fuels during cooking</li> </ul>

Source: CEEW analysis, 2018

## 8. Conclusion

Enabling access to clean cooking energy is crucial to reducing the public health burden imposed by household air pollution. Through LPG subsidies and various programmes in support of improved cookstoves and biogas, the Government of India has been promoting access to clean cooking fuels and technologies for about five decades. Despite such efforts, a large section of the Indian population, particularly rural households, remains dependent on traditional biomass cookstoves for most of their cooking needs.

Over the last two years, through its flagship programme, PMUY, the government has taken an important step forward in enabling clean cooking energy access by making LPG connections available to millions of low-income households. It has also brought the issue into mainstream discussions, promoting an understanding of clean cooking energy among the masses that had perhaps till then only existed in the echo chambers of development professionals and policymakers.

However, as access to clean cooking energy is a multidimensional issue, it is not enough to merely adopt a countrywide strategy that focuses on a single fuel or benefit-transfer mechanism. The lack of energy access manifests in a variety of practical forms, including poor public health, high time poverty, inferior development opportunities for women and children, unequal rural development, and loss of critical biodiversity and natural resources. As a result, to fully address the issue in a manner that covers all potential threats arising from the lack of access, it is important to involve all concerned stakeholders in programme ideation and implementation, including the private sector, civil society, relevant government ministries and, above all, the households that are at the heart of the issue.

Energy access is multidimensional not just in its implications but also in its characteristics. Stakeholders who are working towards improving access to clean cooking energy must consider the health and safety, fuel availability, convenience, affordability, and quality associated with the use of the fuel or technology. To ensure that all these aspects are dealt with and that fuel stacking with traditional cookstoves is eliminated, we need a national



**It is not enough to adopt a countrywide strategy that focuses on a single fuel or benefit-transfer mechanism**

strategy that is open to multiple fuels and is delivered by multiple stakeholders at the local, state, and national levels.

Since the vision of the Roadmap is to eliminate the use of cooking arrangements that cause HAP, the primary focus must be to ensure that the fuel stack of households is clean from an air-pollution perspective. Exposure to HAP must be brought within WHO-prescribed safe limits by increasing access to modern fuels and technologies and simultaneously improving ventilation in the cooking area of households. To ensure that the stack of fuels is entirely clean, there must be a focus on measuring and monitoring the sustained use of clean cooking energy solutions and on monitoring the discontinuation of traditional cookstoves. To fully eliminate exposure to HAP, it is important as well to address the practice of heating homes using traditional biomass.

It is also important to consider and communicate the complementary roles that these solutions play in unlocking access to clean cooking energy. Furthermore, there is a need to prioritise action for each fuel and technology, based on its current level of maturity (in terms of penetration, user acceptance, technology development, etc.). For instance, before it is deployed widely, the ICS ecosystem needs support in terms of technology innovations to improve its durability, convenience, and emissions performance. Additionally, in order to scale up biogas, there is a need to pilot and strengthen business models to reduce the effort required of households in operating and maintaining the plants, and to offer training in effective plant-management practices. In stark contrast to both ICS and biogas, the strategies for LPG need to focus more on improving availability in rural areas and allowing for flexible payment schedules. There is also a need to leverage the DBT platform to transition from the current uniform subsidy model to one that is context based and is tailored to households' affordability. Emerging alternatives such as solar- and electricity-based cooking need investments in technology development as well as ecosystem-building support. Finally, the promotion of these solutions should be based on the local context, planned at the district and state level, and should consider local needs, geographical factors, available natural resources, and prevailing socio-economic and cultural conditions.

A multi-fuel, multi-stakeholder, and multipronged national strategy that considers not only the supply side, but also the needs, aspirations, and priorities of consumers will ensure a sustainable transition towards clean and affordable cooking energy access for all.



**To fully eliminate household air pollution, it is important to address space heating of homes using traditional biomass**



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# 10. Annexures

**TABLE A1: List of stakeholders interviewed**

S.No.	Name	Institution
<b>Clean cooking energy enterprises</b>		
1	Amar Patil	Urja Bio Systems
2	Chandru Kalro	Prestige
3	Devang Joshi	Rudra Solar Energy
4	Dharmendra Gor	Taylormade Solar Solutions
5	Harish Anchan	Envirofit
6	Mateen Abdul	Grassroots Energy
7	Partha Talukder	Prakti Design
8	Piyush Sohani	SustainEarth Energy
9	Prasad Kokil	Ecosense Appliances
10	Sameer Kanabargi	Phoenix Products
11	Sucheta Baliga	Greenway Grameen
<b>Donors and financiers</b>		
12	Anuradha Bhavnani	Shell Foundation
13	Jayshree Vyas	SEWA Bank
14	Jugal Kishore Pattnayak	Mahashakti Foundation
15	Smita Rakesh	TATA Trusts
16	Supriya Kumar	Global Alliance for Clean Cookstoves
<b>Civil society organisations</b>		
17	Richie Ahuja	Environmental Defense Fund
18	Helle Lund	Humana People to People
19	Upmanyu Patil	Swayam Shikshan Prayog
20	Patil Balachandra	Indian Institute of Science
21	Asim Mirza	The Energy and Resources Institute
22	Manish Pandey	The Energy and Resources Institute
23	V. K. Vijay	Indian Institute of Technology, Delhi
24	S. Kamaraj	Non-Conventional Energy and Rural Development Society
<b>Government ministries and agencies</b>		
25	D. K. Khare	Ministry of New and Renewable Energy (Retd.)
26	G. L. Meena	Ministry of New and Renewable Energy
27	Inder Parkash	Directorate General of Health Services
28	Jyotsna Gola	National Skill Development Corporation
29	Parveen Dhamija	Skill Council for Green Jobs
30	Praveen Saxena	Skill Council for Green Jobs
31	Sarika Dhawan	Deen Dayal Upadhyaya Grameen Kaushalya Yojana
32	Subodh Kumar	Indian Oil Corporation
33	Suresh S. Honnappagol	Department of Animal Husbandry, Dairying and Fisheries

Source: CEEW compilation

**TABLE A2: List of participants at the consultation on Roadmap for Access to Clean Cooking Energy**

S.No.	Name	Institution
<b>Consultation with clean cooking energy practitioners</b>		
1	A.R. Shukla	Indian Biogas Association
2	Dhaval Thakkar	Sahastra Urja Private Limited
3	Loitongbam Bidhan	Synergy
4	Mateen Abdul	Grassroots Energy
5	Meenakshi Verma	Indian Oil Corporation
6	Priyadarshini Karve	Samuchit Enviro Tech
7	Rachna Yadav	Vardaan Indane Gas
8	Rajesh Joshi	Rupak Enterprises
9	Rohit Lohia	Envirofit International
10	Rumana Qidwai	Indian Oil Corporation
11	Saurabh Dubey	Greenway Grameen
<b>Consultation with sector enablers (CSOs and donors)</b>		
12	Akanksha Rai	Global Alliance for Clean Cookstoves
13	Supriya Kumar	Global Alliance for Clean Cookstoves
14	Ashwini Dabadge	Prayas (Energy Group)
15	Asim Mirza	The Energy and Resources Institute
16	Debajit Palit	The Energy and Resources Institute
17	Manish Pandey	The Energy and Resources Institute
18	Chandrashekhar	Integrated Research and Action for Development
19	Govind Kelkar	M. S. Swaminathan Research Foundation
20	Kapil Goel	Centers for Disease Control and Prevention
21	Madhura Joshi	Independent Consultant
22	Meenakshi Goel	National Bank for Agriculture and Rural Development
23	Pooja Arora	The Energy and Resources Institute
24	Rekha Krishnan	WEFT Research
25	Rishika Jerath	Environmental Defense Fund
26	Sarabjit Singh Sooch	Punjab Agricultural University
27	S. N. Srinivas	Clean Energy Access Network
28	Soma Dutta	Independent Consultant
29	Chandra Shekhar Sinha	World Bank
<b>Consultation with government ministries and agencies</b>		
30	Aravindh M. A.	Ministry of New and Renewable Energy
31	Avantika Garg	Indian Oil Corporation
32	Ayush Kumar	Indian Oil Corporation
32	Bijay Kumar	Indian Oil Corporation
33	G. L. Meena	Ministry of New and Renewable Energy
34	H. R. Khan	Ministry of New and Renewable Energy
35	Ashutosh Jindal	Ministry of Petroleum and Natural Gas

S.No.	Name	Institution
36	Harald Richter	Deutsche Gesellschaft für Internationale Zusammenarbeit
37	Praveen Saxena	Skill Council for Green Jobs
38	Preeti Kaur	Ministry of New and Renewable Energy
39	Rajnath Ram	NITI Aayog
40	Subodh Kumar	Indian Oil Corporation
41	Vineet Saini	Department of Science and Technology
42	Virendra Kumar Vijay	Indian Institute of Technology, Delhi

Source: CEEW compilation

## Guidelines for survey and for prioritisation of strategy

We are proposing the following strategies under the Clean Cooking Energy Roadmap, for improving access to LPG/biogas/ICS in India, to the extent of its suitable potential. Please rate each strategy as 'low', 'medium', or 'high', across the four parameters described herewith:

**Effort involved in implementation:** Please consider (jointly) the political and administrative effort and the financial resources required to implement the strategy nationally.

**Time to implement:** Please consider the time that will be required to implement the strategy nationally. For this parameter, please select 'low' if the time required is less than one year, 'medium' for one to three years, and 'high' for more than three years.

**Likelihood of impact:** Please rate how likely the strategy is to lead to its intended impact.

**Scale of impact:** Please rate the magnitude of impact likely to result from the implementation of the strategy. This should take into consideration both the number of households benefitted and the average quantum of impact for each affected household. Please use:

- 'Low' for a limited impact on a small proportion of households,
- 'Medium' for either a limited impact on a large proportion of households or a significant impact on a small proportion of households,
- 'High' for a significant impact on a large proportion of households.

## Proposed strategies, by ministry

Relevant ministry	Proposed strategy	
Ministry of Petroleum and Natural Gas	#LPG01	Invest in R&D to improve the thermal efficiency of LPG stoves
	#LPG02	Make energy-efficiency labelling for LPG stoves mandatory industry-wide
	#LPG03	Promote innovation in, and bulk procurement of, composite fibreglass LPG cylinders
	#LPG04	Enable self-help groups (SHGs) and other local outlets to become extension counters for rural distributors
	#LPG05	Stock small LPG cylinders with <i>Kisan Seva Kendras</i> and local shops in rural areas

Relevant ministry	Proposed strategy
	#LPG06 Increase rural LPG coverage, and improve safety/security of warehousing and retailing by enhancing skilling support for entrepreneurs and workers interested in LPG distributorships
	#LPG07 Provide low-interest loans to households for LPG refills through SHGs, to allow flexible payment plans and to promote the sustained use of LPG
	#LPG08 Promote innovation and bulk procurement of pay-as-you-go smart valves for LPG cylinders
	#BGS02 Invest in R&D to develop double-burner stoves that can use LPG and biogas
	#PNG01 Credit-linked instalments for PNG connections
	#PNG02 Adoption of prepaid metres that allow recurring payments of smaller amounts
	#PNG03 Prevent households from having both LPG and PNG connections
	#PNG04 Decentralise the supply and distribution of LNG
	#PNG05 Manage the profitability of CGDs through a healthy balance of import and domestic LNG
	#SOL03 Pilot enterprise-based business models and facilitate access to affordable credit for entrepreneurs and households
Ministry of New and Renewable Energy	#ICS01 Invest in R&D of ICS to improve their resilience/longevity, efficiency, safety, and user convenience to bring their on-field emissions within WHO safe limits (Tier 4)
	#ICS02 Invest in R&D infrastructure, including laboratories for the testing of various models
	#ICS03 Mandate that testing centres provide detailed lab reports on ICS to manufacturers instead of the current "pass/fail" report
	#ICS04 Mandate on-field testing in the certification process of cookstoves
	#ICS05 Make the labelling of energy efficiency and emissions on ICS mandatory; push the industry to improve their efficiency
	#ICS06 Mandate empanelled enterprises to provide warranties on ICS for at least as long as the loan repayment period
	#ICS07 Create scope in policy for better capacity-building of state- and national-level implementation agencies
	#ICS08 Support rural entrepreneurs/self-help groups (SHGs) through preferential loans and capital subsidies for the production and distribution of pellets/briquettes
	#ICS09 Pilot various business models of pelletisation
	#ICS10 Provide subsidised training in pellet manufacturing and ICS manufacturing, assembling, and marketing to local entrepreneurs and workers
	#ICS11 Sensitise bank professionals to lend to empanelled ICS enterprises to ease their working capital requirements
	#BGS01 Provide grants for the promotion of new technologies that are less effort intensive and/or more efficient
	#BGS02 Invest in R&D to develop double-burner stoves that can use LPG and biogas
	#BGS03 Allow subsidies for prefabricated biogas plants



Relevant ministry	Proposed strategy	
	#BGS04	Pilot enterprise-based models for biogas-as-a-service, and offer incentives, such as cheaper loans, to rural biogas entrepreneurs
	#BGS05	Invest in R&D to reduce the cost of biogas bottling and packaging
	#BGS06	Organise demonstrations that illustrate the experience of using biogas by outlining the differences between modern biogas plants and traditional <i>chulhas</i> , as well as older models of biogas
	#BGS07	Provide subsidised training in manufacturing, marketing, and maintenance to local entrepreneurs and workers; and in plant operation to users
	#BGS08	Start a helpline for households to report breakdowns and guarantee the time frame for the repair
	#BGS09	Sensitise financial institutions and other investors to the newest business models in biogas and related technologies
	#BGS10	Improve ease of access to consumer finance for biogas
	#BGS11	Involve agricultural finance institutions in supporting biogas plants
	#SOL01	R&D to improve the efficiency and affordability of solar thermal/ electric cooking
	#SOL02	Improve terms of patents and prizes in competitions to allow serious entrepreneurs to apply
	#SOL03	Pilot enterprise-based business models and facilitate access to affordable credit for entrepreneurs and households
Department of Science and Technology	#LPG01	Invest in R&D to improve the thermal efficiency of LPG stoves
	#ICS01	Invest in R&D of ICS to improve their resilience/longevity, efficiency, safety, and user convenience to bring their on-field emissions within WHO safe limits (Tier 4)
	#ICS02	Invest in R&D infrastructure, including laboratories for the testing of various models
	#BGS01	Provide grants for the promotion of new technologies that are less effort intensive and/or more efficient
	#BGS02	Invest in R&D to develop double-burner stoves that can use LPG and biogas
	#BGS05	Invest in R&D to reduce the cost of biogas bottling and packaging
	#SOL01	R&D to improve the efficiency and affordability of solar thermal/ electric cooking
	#SOL02	Improve terms of patents and prizes in competitions to allow serious entrepreneurs to apply
	#ELC04	Improve the energy efficiency of induction cookstoves
Ministry of Power	#LPG02	Make energy-efficiency labelling for LPG stoves mandatory industry-wide
	#ELC01	Improve the quality of electricity access
	#ELC02	Ensure that the connection and peak loads can support induction stoves legally
	#ELC03	Map the willingness and ability to pay for electricity in order to identify priority areas that can use electricity as cooking energy
	#ELC04	Improve the energy efficiency of induction cookstoves
	#ELC05	Improve consumer awareness of electric cooking and stove efficiency
Ministry of Rural Development	#LPG04	Enable self-help groups (SHGs) and other local outlets to become extension counters for rural distributors

Relevant ministry	Proposed strategy
#LPG06	Increase rural LPG coverage, and improve safety/security of warehousing and retailing by enhancing skilling support for entrepreneurs and workers interested in LPG distributorships
#LPG07	Provide low-interest loans to households for LPG refills through SHGs, to allow flexible payment plans and to promote the sustained use of LPG
#ICS08	Support rural entrepreneurs/self-help groups (SHGs) through preferential loans and capital subsidies for the production and distribution of pellets/briquettes
#ICS10	Provide subsidised training in pellet manufacturing and ICS manufacturing, assembling, and marketing to local entrepreneurs and workers
#BGS06	Organise demonstrations that illustrate the experience of using biogas by outlining the differences between modern biogas plants and traditional <i>chulhas</i> , as well as older models of biogas
#BGS07	Provide subsidised training in manufacturing, marketing, and maintenance to local entrepreneurs and workers; and in plant operation to users

Source: CEEW analysis



Although 58 per cent of rural households have LPG connections, only 37 per cent use it for most of their cooking needs (CEEW ACCESS Survey 2018).



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