

Access to Clean Cooking Energy in India

State of the Sector

SASMITA PATNAIK, SAURABH TRIPATHI







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Report on 'Access to Clean Cooking Energy in India: State of the Sector'

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Council on Energy, Environment, and Water (CEEW)

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About the report

This report provides an overview of the clean cooking energy sector in India, including policy and market developments over the last few years. It outlines the key ecosystem-level challenges in creating sustained demand for clean cooking energy products and in building capacity for manufacturers and suppliers of such solutions. The report finally details critical avenues for intervention in policy and through investments to eliminate the inefficient use of traditional biomass by households in India.

The insights are based on an extensive literature review of research papers and reports published by various stakeholders in the sector. The quantitative

analysis on penetration of and barriers to access of clean cooking energy in India, borrows primarily from three publicly available data sources: (a) the 2011 census of India; (b) the 2012-13 round of the household consumer expenditure survey of the National Sample Survey Office (NSSO); and (c) the 2014-15 round of ACCESS, an energy access survey by the Council on Energy, Environment and Water (CEEW) and Columbia University in the six most energy-deprived states of India – Uttar Pradesh, Bihar, Jharkhand, Odisha, Madhya Pradesh, and West Bengal – accounting for 50 per cent of the total households in India reliant on traditional biomass for cooking.

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Contents

1

Overview of access
to clean cooking
energy in India

3

Demand side
constraints

7

Supply side
constraints

10

Fostering an enabling
environment

12

References



1. Overview of access to clean cooking energy in India

819 million

people in India use traditional biomass cookstoves for their cooking needs, according to the World Energy Outlook (2016).



Such cookstoves result in household air pollution (HAP), causing one million premature deaths across the country every year¹.



Women are disproportionately affected, as they spend several hours every week gathering fuelwood. On average, women spend the equivalent of more than two weeks each year collecting firewood in India.²

Access to clean and affordable cooking energy is an important social goal to pursue. The widespread use of traditional cookstoves poses serious risks to health and women's empowerment. It also is a global warming threat, as they emit black carbon, a highly potent short-lived climate pollutant. Access to clean cooking energy has the transformative potential to curb the health risks posed by traditional cookstoves while also reducing the time spent by women on unpaid domestic work. For over three decades, successive central and state governments in India have made efforts to increase the penetration of clean cooking energy solutions like liquefied petroleum gas (LPG), improved biomass cookstoves (ICS), biogas plants and piped natural gas (PNG), among others. Some of the landmark policies undertaken by the government have been summarised below, in Table 1.

Table 1: Summary of government efforts in clean cooking energy in India

Fuel or Technology	Government Policies and Programmes
Liquefied Petroleum Gas	<ul style="list-style-type: none"> Since the 1970s, LPG has been the fuel of choice for the government on policies in the clean cooking energy space. It has been subsidised for large parts of Indian society for decades. Direct transfers and targeted subsidies for families below a specified income threshold are being implemented to plug leakages. Over the last 17 months, the <i>Pradhan Mantri Ujjwala Yojana</i> (PMUY) has distributed about 30 million connections³ to poor households at significantly reduced up-front costs. To expand the network of rural LPG distributors, the government has also relaxed the eligibility and financial criteria to get licenses.
Improved Biomass Cookstoves	<ul style="list-style-type: none"> The first government scheme in support of ICS was the National Programme on Improved Chulhas (NPIC), which distributed 35 million chulhas in 16 years since its launch in 1986.⁴ After its discontinuation in 2002, much of the public investment into ICS has been in research and development to update product design. The government's recent Unnat Chulha Abhiyan (UCA) scheme could meet just one per cent of its ICS deployment target of 2.75 million between 2014 and 2017.⁵
Biogas Plants	<ul style="list-style-type: none"> The nodal scheme for biogas since 1981 has been the National Biogas and Manure Management Programme (NBMMP). It offers financial assistance for family-type biogas plants and training for users and staff on the benefits and maintenance requirements of the plants. In recent years, the annual NBMMP deployment target has not been met, with only 55 per cent of the target met in 2016-17.
Piped Natural Gas	<ul style="list-style-type: none"> The government has also begun allocation of domestically produced natural gas to city gas distributors (CGDs) at uniform prices to meet urban demand for clean energy. Since 2014, CGDs have been prioritised to receive domestic PNG, helping them keep prices low for urban consumers.

These policies have attempted to improve awareness of the ill-health effects of traditional cookstoves, subsidise clean fuels or technologies to improve affordability, increase the amount of investment in research and development to drive down prevailing market prices, and finally, to improve the penetration of such solutions by tackling the availability of fuels, technologies and after-sales maintenance services. Much of the recent efforts in this space have been in LPG in rural areas and PNG in densely-populated urban centres, with limited investment and policy support for alternatives. Most rural households stack LPG use with traditional cookstoves to circumvent the high lumpsum monthly recurring cost of LPG and long distances travelled to get cylinder refills. It is, therefore, critical to scale other clean cooking energy solutions such as ICS, biogas and induction so that households stack between cleaner options than between LPG and traditional stoves.

Figure 1: Adoption of clean cooking energy in India

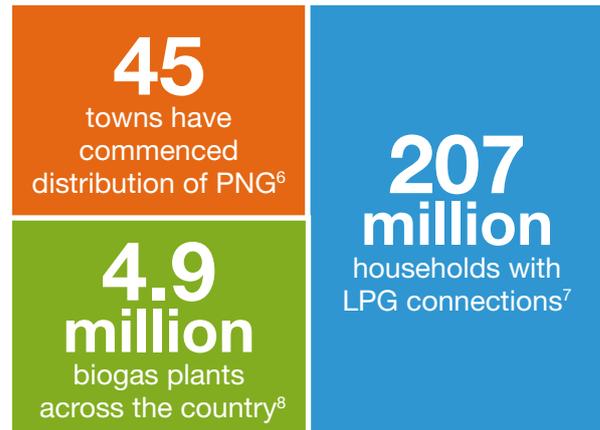


Figure 2: Clean cooking energy and the sustainable development goals (SDGs)⁹

Access to clean cooking energy has often been overlooked in the broader development narrative. The inclusion of access to clean cooking energy for all can deliver gains across 10 of the Sustainable Development Goals (SDGs) and bring about a paradigm shift in the cooking energy space. The SDGs will be decisive in channelling global investments into areas of need, and facilitating dialogue between key stakeholders to foster an enabling environment for growth in the clean energy sector. Four SDGs which benefit directly from investments in clean cooking energy are mentioned below.

7 AFFORDABLE AND CLEAN ENERGY



the traditional use of biomass for cooking.

About 50 per cent of Indian households depend on traditional biomass for cooking. Investments in clean cooking energy will help accelerate progress towards reducing the number of households relying on

Access to clean cooking energy will also contribute in reducing the number of deaths annually attributable to HAP. Many people report difficulty in sight and breathing over long periods of time. Women and children are the most affected owing to the long hours of exposure to HAP.

3 GOOD HEALTH AND WELL-BEING



5 GENDER EQUALITY



lower than the average in fellow developing regions such as China (41 per cent) and Sub-Saharan Africa (39 per cent)¹⁰. Access to clean cooking energy contributes in reducing time poverty - the hours women spend on unpaid domestic work such as gathering fuelwood and cooking for long hours on inefficient stoves.

Globally, women spend three times as much time on unpaid work as men, while in India, women spend ten times as much time. As a result, women are able to contribute only 17 per cent towards the country's GDP, far

Moreover, the complete phasedown of traditional cookstoves will bear positive corollaries for the climate too, as it will sharply reduce black carbon emissions from the incomplete combustion

13 CLIMATE ACTION

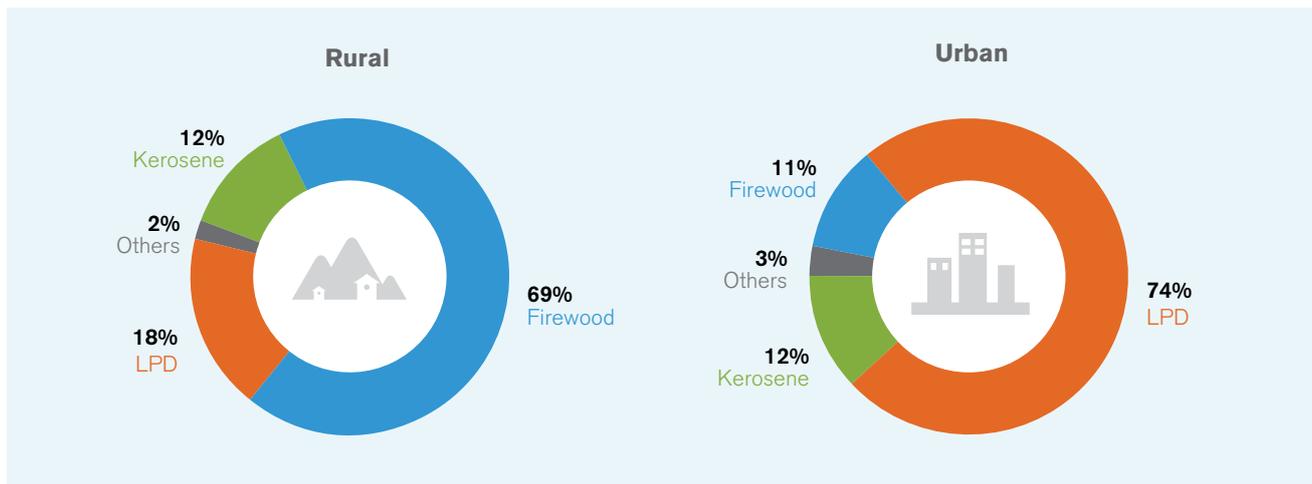


of biomass. India contributes 12 per cent of global anthropogenic black carbon emissions, with over 60 per cent of it emitted from the residential sector¹¹. Sustained effort in the clean cooking energy space has the potential to transform the lives of hundreds of millions while also accelerating progress along several indicators under the SDGs due to the multi-dimensional nature of cooking energy access.

2. Demand side constraints

Demand-side factors such as affordability, awareness and accessibility are key to understanding why access to clean cooking energy remains low in India.

Figure 3: Households in rural India predominantly use biomass for cooking, while urban India uses LPG



*Others include biogas, agro residue, coal/charcoal and cow dung cakes

Source: Census, 2011¹²

Affordability of clean energy solutions is a challenge for adoption and sustained use of clean cooking solutions.



Biogas

Less than one per cent of households in India use biogas for cooking.¹² The upfront cost of INR 20,000 (USD 307) under NBMMP makes biogas plants unaffordable for low-income households.⁸ The subsidies are provided in instalments, and range between INR 9000 and 17,000 (USD 138 – 261).⁸



LPG

88 per cent of households not using LPG report high recurring costs as one of the bottlenecks to adoption of LPG.¹³



Traditional biomass

About 43 per cent of households across the most energy deprived states do not spend any real money to procure their cooking fuel,¹³ and more than 70 percent of the rural households in the lowest seven percentile classes use firewood & chips for cooking, indicating a higher use of traditional biomass among low-income households.¹⁴



Electricity-based cooking

Given the current wattage of induction cookstoves, with three hours of cooking per day,¹³ a household's monthly expenditure on cooking energy will be INR 540 (USD 8), comparable to the price of an LPG cylinder. Access to reliable electricity supply in rural areas remains a major barrier to the penetration of electricity-based cooking. Although just over one per cent of rural households used an electric or induction stove in 2015, only 0.01 per cent of households used it as primary cooking energy.¹³



PNG

As of 2013, only three per cent of urban households in India had PNG connections.¹⁵ The cost of a PNG connection at INR 5000 (USD 77) makes it unaffordable for low-income urban households.

Affordability concerns lead to stacking of cooking fuels

In 2011, despite paying for the connection, almost half of the households in India having LPG were not using it as their primary cooking fuel.¹² 29 per cent of the rural households and 34 per cent of the urban households in India were stacking traditional fuels with LPG.¹⁴ The level of fuel stacking has increased over the years, as households transition to LPG but continue using traditional biomass.¹⁶

Households that pay for traditional biomass and use it as the primary fuel for cooking actually spend more than households using LPG as primary fuel

57 per cent of the rural households spend some amount to procure their cooking fuel.¹³ The median expenditure per month is INR 432 (USD 7) for households using LPG as primary fuel, and INR 455 (USD 7) for households using traditional biomass. The average price of a subsidised LPG cylinder is INR 453 (USD 7)¹⁷ a month, implying that many households already incur a similar expenditure.

Awareness about health benefits of clean energy, coupled with the knowledge of available clean energy alternatives

Bottom-up demand is influenced by limited awareness about the benefits of cleaner cooking fuels.

Seventy two per cent of households using traditional biomass were aware that it has adverse impacts on their health. However, only 59 per cent believe that LPG has positive health benefits over traditional biomass based cooking,¹³ implying that not all households consider the need to transition to cleaner energy for cooking as the solution to the adverse health impacts of traditional biomass. Clean cooking energy enterprises believe aspects of fuel savings, and convenience of cooking are equally important concerns for households and should be communicated effectively. Many households are also not aware of the clean cooking energy solutions available to them, with only 16 per cent of rural households having heard of ICS, and 36 per cent having heard of biogas.¹³ Enterprises have limited resources for marketing, but partner with local non-government organisations to conduct demonstrations in villages.

Building awareness and addressing affordability concerns for ICS and biogas will be necessary to increase adoption

- Only **five per cent of the budget of UCA** was dedicated to awareness generation around the positive aspects of using improved cookstoves and ill-health effects of traditional stoves.¹⁸
- **47 per cent of ICS users** find their stoves too costly.¹³
- Households using ICS report an average saving of **10 kgs of fuel per week** in an ICS as compared to traditional chulha.¹³
- A third of unsatisfied biogas plant users reported **capital cost as an issue**.¹³
- Over **50 per cent of households** that acknowledged the impact of traditional cookstoves on their health were interested in getting an LPG.¹³

Availability of the clean cooking energy solutions – last mile distribution and accessibility

Feasible business models to enable availability are critical for better access to clean cooking energy solutions. The existing infrastructure struggles to provide last mile connectivity at affordable prices.



Biogas

Budgetary expenditure on NBMMP has increased from INR 55 crores (USD 8 million) in 2015-16 to INR 134 crores (USD 21 million) in 2017-18.¹⁹ Even then, this is less than one per cent of the outlay for LPG subsidies.²⁰ The targets set by the Ministry of New and Renewable Energy (MNRE) for biogas plants has been falling over the years, with only 65,180 targeted for 2017-18. While only 85 per cent of the target for 2012-13 was achieved, the achievement rate fell further to 77 per cent in 2014-15.¹⁹ The scale achieved by private enterprises in the sector has been limited, owing to lack of capacity for last mile service delivery and consumer finance. Subsidy based business models are cumbersome and time consuming.⁵



LPG

Data from the Petroleum, Planning & Analysis Cell (PPAC)²¹ shows that over 55 per cent of the addition of distributors in 2016-17 has been skewed towards urban and urban/rural. For households using LPG, the median one-way distance to procure an LPG cylinder ranged from 3 km in West Bengal to about 11 km in Madhya Pradesh.¹³ Of the 10,000 new distributorships planned under PMUY in 2016-17, the process was initiated for only 3500.²² Rural LPG distributors also face the risk of encountering low demand for refills, due to affordability constraints of newly connected rural households.²³



Electricity-based cooking

The draft National Energy Policy (NEP) by NITI Aayog emphasises on investment in induction stoves for electricity based cooking. Induction stoves, can reach fuel efficiency levels of 90 per cent (fuel efficiency of LPG is 60-70 per cent). Over 621,000 induction stoves were sold in 2015 by a leading company in India.²⁴ However, the cost of electric stoves and electricity are the biggest barriers to the adoption of induction stoves. The cost of single-burner induction cookstoves (1400 W - 2100 W) ranges from INR 2,500 (USD 38) to INR 5,000 (USD 77).²⁵ Lack of access to reliable electricity supply also limits the use of electricity for cooking.



PNG

There are regional imbalances in the pipeline infrastructure for PNG. Few states like Gujarat, Maharashtra, and Uttar Pradesh account for 65 per cent of consumption, while a large number of states have no access to PNG.¹⁴



ICS

There is a dearth of ICS manufacturers that meet required quality standards on efficiency and durability of the stoves. Very few have achieved profitability and scale.²⁶ MNRE has an approved list of 26 natural and forced draft biomass cookstove manufactures, of which only 5-6 have achieved scale at the national level. Most manufacturers are concentrated in Maharashtra, Tamil Nadu, Gujarat, Karnataka and Kerala, instead of the most energy deprived states.²⁷ Over 245,000 ICS were manufactured and distributed across the country in 2016-17^{27,28}, in comparison to subsidized LPG connections for 30 million households under PMUY. The newly introduced Goods and Services Tax (GST) has further reduced the accessibility of the technology to low income households, by levying a tax rate of 12 per cent on manufacturers.

Operations and maintenance (O&M) of systems in rural areas is a strong determinant of the sustainability of a fuel or technology.



Biogas

O&M constraints prevail due to unreliable feedstock availability, water, and usage requirements. Sixty per cent of the unsatisfied users of biogas plants find them difficult to use and 82 per cent mentioned maintenance as an issue to the sustained use of their plant. MNRE's budget for repair of broken plants under NBMMP has been capped at five per cent of the overall budget, and there is no information on the status of repairs undertaken.²⁹ Fifty per cent of the expenditure of the repair is to be borne by the beneficiary households. Enterprises in the sector have started providing on-ground O&M services, for a fee, to ensure continued use.⁵



LPG

The federation of LPG distributors of India has raised concerns of safety suggesting more than 90 per cent of economically backward beneficiaries do not meet the safety parameters required for installation of a connection.³⁰



ICS

80 per cent of ICS users reported poor maintenance as an issue.¹³ Repair for ICS includes fixing of wires, and replacing batteries of the fan, etc.⁵ To ensure continued use of ICS, sellers should extend maintenance services beyond the three years mandated in the policy UCA.



Electricity-based Cooking

The lack of universal electricity access is a major deterrent to electricity-based cooking. However, given the government's plans of providing 24x7 power for all by 2022, there is a need to plan for the additional capacity that would be required to substitute other cooking fuels with electricity. 62 per cent of households with no electricity connection find it too expensive and 86 per cent find the monthly cost too high.¹³

Way forward

- Build awareness through communication and behaviour change campaigns to influence adoption of clean cooking energy solutions, the role of the government and donors remain critical in this regard.
- Integrated approach for communications to include other ministries such as health, rural development, environment and women and child development will be equally important for mass awareness.
- Enhance affordability of solutions by reducing the cost of the fuel and cooking devices; providing consumer finance; and through interventions that strengthen livelihoods.
- Reduce the upfront cost for households through innovative payment mechanisms such as pay-as-you-go and rental models.
- Leverage local institutions and groups for efficient and faster delivery mechanisms.
- Set-up local manufacturing and servicing facilities to sustain prolonged use of clean cooking energy solutions, through improved accessibility and affordability.
- Evaluation of adoption and use of clean fuels and technologies to provide the much-needed evidence to inform future interventions.

3. Supply side constraints

Research and technology development



Biogas

Between 2007 and 2011, MNRE sanctioned about INR 8 crores (USD 1.2 million) for R&D in biogas.³¹ However over 50 per cent of this outlay was for production of biofuels.



Electricity-based
cooking

Few companies have set up government approved R&D centres to improve the efficiency of induction cookstoves. The Prime Minister of India recently called upon the oil marketing companies to use their INR 100 crore (USD 15 million) start-up fund to develop user friendly electric cooking appliances.³²



ICS

Significant investment in R&D is required to improve the efficiency of ICS from the current Tier 2/3 to Tier 4 for indoor emissions. Although the budget for UCA includes outlay on R&D for ICS, it is less than 2 per cent of the total funds.¹⁸ Issues of R&D, fiscal support for manufacturing and after sales service have limited the expansion of the market for ICS.²⁶ Enterprises have relied on grants from the donors and the government to support R&D on improving the design and efficiency of cookstove, while reducing its cost.

Pelletised biomass as fuel for ICS

The draft NEP has emphasized on R&D to improve the efficiency of biomass cookstoves and gas stoves, coupled with investment in manufacturing for pelletised biomass as fuels. Biomass pellets can offer about 30-50 per cent greater efficiency than traditional biomass. However, biomass pellets have an expensive supply chain. The cost of a pellet manufacturing machine alone is around INR 7 lakhs (USD 11,000)⁵ which is a high upfront cost for small scale manufacturers. Manufacturers suggest decentralised pellet manufacturing facilities can reduce the pellet costs by a third.⁵ Agro and forest residue surplus is estimated to increase by 16% by 2030, creating opportunities to expand pellet production for cooking energy and electricity.³³ About 2 kgs of pellets are required per day to meet the cooking needs of a household with 4-5 members. Existing cost of pellets range from Rs 10-15 per kg⁵, translating to a monthly expenditure of INR 600-900 (USD 9-14).

Standards and testing

As part of the National Biomass Cookstove Initiative (NBCI), the government set up test centres for biomass cookstoves as per standards set by the Bureau of Indian Standards (BIS). The cookstoves are tested on three parameters - thermal efficiency, emission ratio of CO/CO₂ and total suspended particulate matter.³⁴ However, challenges remain in the implementation of standards and testing for ICS.

- The number of such centres is limited (3 old and 2 new as per the UCA), while testing facilities also need upgradation. Only 4 per cent of the entire UCA budget has been allocated to test centres, R&D capacity building and after-sales.¹⁸
- The testing standards do not cater to multiple types of cookstoves available in the market.³⁴
- These standards are not well communicated to the end-users.

Capacity building of clean cooking energy enterprises

Enterprises operating in rural areas face difficulties such as complicated procedures for setting up businesses and complex regulatory procedures such as taxation and construction permits.¹³ Lack of market intelligence, strong data management systems and limited ability to evaluate the impact of their products are leading challenges for the sector.²⁷ Further, distribution capacity of the enterprises is limited by the availability of networks, finance and technically skilled people in the sector.

Access to commercial finance is limited for last mile energy enterprises owing to lack of a strong track record of profitability.²⁷ Finance is essential to meet enterprise needs for R&D, marketing, distribution, training and after-sale services, and scaling up of operations. Entrepreneurs also seek partners for consumer finance, but face barriers such as high interest rates, high transaction costs, and complex collateral requirements.³⁵ In India, some of the largest enterprises in the sector have received a total of about INR 2 crores (USD 320,000) in debt, INR 11 crores (USD 1.7 million) in equity and INR 6 crores (USD 950,000) in grants so far.²⁷ Some examples of financial support available for clean cooking energy solutions are discussed in Table 2.

Table 2: Financial ecosystem for clean cooking energy solutions

Type of institution	Form of finance	Type of support provided
Microfinance institutions (MFIs)	Loans (for end-user finance)	ICS manufacturers collaborate with MFIs for aggregating demand and providing consumer finance. Consumer defaults are a serious concern for MFIs. The small size of the loans also inhibits MFIs from investing at scale in this space. ⁵ Nevertheless, MFIs and clean energy solutions find synergy in the type of customers they primarily serve. MFIs offer not only the financial support but also play the role of distributors and provide after-sales services for many manufacturers of ICS.
Government	Subsidy, Grants	Ministry of Petroleum and Natural Gas (MoPNG) and MNRE have supported clean energy solutions through subsidies, and by investing in the infrastructure. <ul style="list-style-type: none"> • INR 294 crores (USD 45 million) was allocated for dissemination of biomass cookstoves under UCA.¹⁸ • Subsidy of INR 9000-17000 (USD 138 – 260) is provided for biogas plants of 2-6 cm³.³⁷ Outlay for family type plants in 2015-16 was INR 130 crores (USD 20 million). • INR 8000 crore (USD 1.2 billion) has been budgeted under PMUY, for providing subsidised LPG connections to 5 crore households below poverty line by 2019. The under recovery reported for subsidised domestic LPG in 2014-15 was INR 36, 580 crores.³⁸
Banks	Loans (for enterprise finance)	Entrepreneurs that have acquired working capital loans from commercial banks, emphasise on the need to sensitise banks to improve access to credit. Lack of knowledge on the technical and quality aspects of clean cooking energy solutions limits banks' ability to make accurate lending decisions. Commercial banks charge interest rates at 12 per cent and above ⁵ , and require collateral that can only be provided by high-income households, thereby limiting access to clean cooking energy. Inadequate balance sheet size and insufficient company track record are the most common criteria for rejection of loan applications for clean energy enterprises. ²⁷ The conventional terms of lending inhibit investment in this sector.
Multilateral agencies/ Donors	Grants, Seed-funding, Interest subsidy on loans	Multilateral agencies and donors support the ecosystem through capacity building and integrating resources to augment the growth of clean cooking energy solutions. Notable organisations include GACC that work with a network of global partners to support the ecosystem to enable production and distribution of efficient clean cooking energy solutions to households in developing countries. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) has also supported the government's policies on ICS and biogas, by providing technical assistance, generating awareness and building stakeholder capacities. Tata Trusts has invested in the ecosystem for ICS to enable entrepreneurs generate better awareness, provide institutional support, and offer consumer finance for the sector to grow. Almost 50 per cent of the trust's project budget was allocated for awareness and marketing. ⁵

Type of institution	Form of finance	Type of support provided
Impact investors	Equity, Debt	Impact investors have stepped in to fund enterprises that have attained a stable business model and are looking to grow. Clean Cooking Working Fund, started by Deutsche Bank and GACC, invested in Envirofit and Biolite in 2016, to support them in expansion of production, distribution and customer support in existing and new markets. ³⁹ Envirofit has also been supported by Shell Foundation since 2007 to find the right business model to scale-up globally.

Way forward

- Encourage field-based tests to demonstrate performance of ICS with local cooks, foods, practices, and fuels.
- Better communication of ICS standards to the consumers, to enable sale of good quality products.
- Modified norms for rural LPG distributorships to accommodate the higher transaction cost of operating in rural areas will be crucial to improving availability of LPG.
- New business models for biogas operated by entrepreneurs at local and regional level will enable greater adoption of the fuel.
- Local manufacturing of ICS fuels – pellets and briquettes, for economic viability and local availability.
- After sale services for sustained use of clean cooking products.
- Raise patient capital support for early stage clean cooking energy enterprises for R&D and large-scale pilots.

4. Fostering an enabling environment

To achieve access to clean cooking energy for all by 2022, as envisioned by the NITI Aayog's draft NEP, it will be essential to plug the existing gaps on both the demand and supply side of cooking technologies and fuels. An enabling policy, market and financial ecosystem, working in tandem, will be critical to address the challenges of the sector as discussed in the earlier sections.

4.1 Policy and market ecosystem

Technology agnostic policies supporting all clean cooking energy options such as LPG, PNG, electricity, biogas, and ICS will be key to universal clean energy access. The increased use of LPG is reflected in the rise in LPG consumption by 9.8 per cent in 2016-17 to 21.5 million metric tonnes.²³ Over half of the demand for LPG in 2016-17 was met by LPG imports, which have been increasing.⁴⁰ For a complete transition to clean cooking energy for all, there is a need to look beyond LPG as the only solution, and emphasise on extending clean energy coverage through multiple fuels and technologies. The National Mission on Clean Cooking (NMCC) – proposed by NITI Aayog – will help coordinate efforts on all cooking fuels, efficient cookstoves and related R&D.²⁶

Raising awareness of the ill-health impacts, and increasing the availability of clean energy options in rural areas will be crucial to stimulating demand. UCA had budgeted 5 per cent of the total outlay for awareness and marketing, amounting to just INR 14 crores (USD 2 million). The five-year budget for communication and publicity of biogas under NBMMP is INR 12 lakh (USD 18,462).⁴¹ In contrast, the Swachh Bharat Abhiyan (Clean India Mission) had spent INR 100 crores (USD 15 million) in 2014- 2015, within a year of its launch, on advertisements for awareness generation and health education.⁴² The allocated budget for Information, Education and Communication (IEC) for the mission is about INR 1828 crores (USD 280 million).⁴³ Behaviour change communication (BCC) campaigns implemented by GACC in Bangladesh to increase the use of cleaner cooking solutions, have received major support from the government, owing to its effectiveness in reaching out to a wider, traditionally underserved population.⁴⁴ For the promotion of LPG, the government of India has run nation-wide campaigns on awareness of PMUY. It also plans to start LPG Panchayats, leveraging on the network of oil marketing companies, ASHA workers and social workers, to popularise usage of cleaner fuel for cooking, and increase the uptake of LPG refills.⁴⁵ Given the scale of the problem, significantly more needs to be invested in awareness and BCC for access to clean cooking energy in India. Further, innovative means of communication such as the LPG Panchayats will be essential to reach a wider audience, based in rural and remote regions of the country.

Demand for clean cooking energy needs to be coupled with sustainable, affordable and accessible supply of the products. Bringing clean cooking energy to millions of households presents a considerable opportunity for entrepreneurs. However, the sector needs support for R&D, cost effective manufacturing and distribution, reliable after sale services, standardised testing and quality standards, and innovative end-user financing options. Policy support through reduced taxes on the products would go a long way in making solutions affordable for households. Existing institutional apparatus such as the extensive network of public distribution system (PDS) and self-help groups can be leveraged to improve last mile distribution and servicing. A coherent roadmap, focusing on multiple clean cooking energy solutions, laying out a strategy to address both demand and supply constraints will be strategic to achieving access to clean cooking energy for all.

For improved access to clean cooking energy for all Indians, the government must also implement robust monitoring mechanisms that are based on a multi-dimensional and multi-tier evaluation framework. This would allow policymakers and entrepreneurs alike to intervene directly in areas of critical need.

4.2 Financial ecosystem

According to SE4ALL,⁴⁶ the financial commitments for residential clean cooking in the high-impact countries averaged USD 32 million per year over 2013 and 2014, falling well short of the USD 4.4 billion of annual investment needed as a minimum to achieve universal access to clean fuels and technologies for cooking by 2030. Public funding accounted for the largest share of commitments for residential clean cooking, amounting to an annual average of USD 26 million. Global funding for clean cooking energy remains low, only three per cent of the total investment in energy access was for cooking in 2013.⁴⁷ **India received USD 2.5 million in 2013-14 for residential clean cooking energy access from both public and private sources.**⁴⁶

Table 3: Planned and estimated investment by fuel or technology in India

Fuel or Technology	Estimated investment
 <p>LPG</p>	<p>The government aims to provide LPG connections to 95 per cent of the households in India by 2019 and foresees an investment of INR 30,000 crore (USD 4.6 billion) in LPG infrastructure including import terminals, pipelines and bottling plants.⁴⁸ PMUY has expanded the LPG penetration to 86 per cent of the households.⁴⁹ State owned oil companies plan to add 47 new LPG bottling plants over the next two years, expanding the total capacity to 21 million tonnes to 2018-19.⁴⁸ The budget allocation for LPG subsidies in 2016-17 was 18,700 crores (USD 2.9 billion).⁵⁰</p>
 <p>Electricity</p>	<p>The Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) with a budget of INR 76,000 crores (USD 12 billion) aims to ensure 100 per cent rural village electrification by 2019.⁵¹ A newly launched scheme Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA), is to invest INR 16,300 crores (USD 2.5 billion) to ensure universal household electrification by 2018.⁵²</p>
 <p>ICS</p>	<p>Based on the India Energy Security Scenarios (IESS), 2047⁵³, about 20% of all rural households in India will continue to rely on traditional biomass for cooking in 2047. Assuming these households use ICS for cooking, the investment in manufacturing and assembly of ICS alone (at current average prices of natural draft cookstoves ~INR 1200 / USD 18) would be USD 1.2 billion.</p> <p>CLEAN estimates the largest enterprises in the sector will require INR 10 crores in debt (USD 1.5 million), INR 58 crores in equity (USD 9 million) and INR 5 crores (USD 761,500) in grants between 2017 and 2020.²⁷</p>
 <p>Biogas</p>	<p>Over INR 58 crores (USD 9 million) will be required for subsidy payments alone if MNRE were to meet all its biogas targets (65,180 plants) in 2017-18.</p>
 <p>PNG</p>	<p>Projected demand for PNG in 2030 as estimated by Petroleum and Natural Gas Regulatory Board (PNGRB) is 44.67⁵⁴ Million standard cubic feet per day (MMSCMD) from the existing sales/supply of 8.57 MMSCMD in 2016-17. This will entail investment in additional capacity for pipelines and distribution. The government plans to connect 10 million households to PNG network by 2020⁵⁵, from the existing 3.3 million⁵⁶. India is targeting USD 100 billion worth of investments in the natural gas sector by 2022. This will include investment in gas infrastructure including an addition of 228 cities to the existing CGD network.</p>

The need to provide access to clean cooking energy for the largest population in the world deprived of access to modern energy services, is challenging yet critical. While the challenges might seem daunting, there is increasing evidence of transition towards a transformative decade that lies ahead. Access to clean cooking energy is not solely an issue of energy access, and therefore various stakeholders must adopt a multi-dimensional approach to address the challenges that face the sector today in India, and around the globe. To achieve sustained clean cooking energy access, there remains a need to integrate access to clean cooking energy with the broader programmes for rural and human development.

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