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#ACCESS2018

Access to Clean Cooking Energy and Electricity

Survey of States 2018

Report | November 2018

Abhishek Jain, Saurabh Tripathi,
Sunil Mani, Sasmita Patnaik,
Tauseef Shahidi, and Karthik Ganesan

ACCESS
Access to Clean Cooking Energy and Electricity - Survey of States

Image: Sasmita Patnaik/CEEW

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The Council on Energy, Environment and Water is one of South Asia's leading not-for-profit policy research institutions. The Council uses data, integrated analysis, and strategic outreach to explain and change the use, reuse, and misuse of resources. It prides itself on the independence of its high-quality research, develops partnerships with public and private institutions and engages with the wider public. In 2018, CEEW has once again been featured across nine categories in the '2017 Global Go To Think Tank Index Report'. It has also been consistently ranked among the world's top climate change think tanks. Follow us on Twitter @CEEWIndia for the latest updates.

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Shakti Sustainable Energy Foundation works to strengthen the energy security of the country by aiding the design and implementation of policies that encourage energy efficiency, renewable energy and sustainable transport solutions, with an emphasis on subsectors with the most energy saving potential. Working together with policy makers, civil society, academia, industry and other partners, we take concerted action to help chart out a sustainable energy future for India (www.shaktifoundation.in).

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About CEEW

The Council on Energy, Environment and Water (CEEW) is one of South Asia's leading not-for-profit policy research institutions. The Council uses data, integrated analysis, and strategic outreach to explain – and change – the use, reuse, and misuse of resources. The Council addresses pressing global challenges through an integrated and internationally focused approach. It prides itself on the independence of its high-quality research, develops partnerships with public and private institutions, and engages with the wider public.

In 2018, CEEW once again featured extensively across nine categories in the '2017 Global Go To Think Tank Index Report', including being ranked as South Asia's top think tank (14th globally) with an annual operating budget of less than USD 5 million for the fifth year in a row. In 2016, CEEW was also ranked 2nd in India, 4th outside Europe and North America, and 20th globally out of 240 think tanks as per the ICCG Climate Think Tank's standardised rankings. In 2013 and 2014, CEEW was rated as India's top climate change think-tank as per the ICCG standardised rankings.

In over eight years of operations, The Council has engaged in 200 research projects, published well over 130 peer-reviewed books, policy reports and papers, advised governments around the world nearly 500 times, engaged with industry to encourage investments in clean technologies and improve efficiency in resource use, promoted bilateral and multilateral initiatives between governments on more than 60 occasions, helped state governments with water and irrigation reforms, and organised nearly 250 seminars and conferences.

The Council's major projects on energy policy include India's largest 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; 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; modelling long-term energy scenarios; energy subsidies reform; energy storage technologies; India's 2030 Renewable Energy Roadmap; clean energy subsidies (for the Rio+20 Summit); clean energy innovations for rural economies; community energy; 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 (COP-23) in Bonn, especially on the formulating guidelines of the Paris Agreement rule-book; pathways for achieving INDCs 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; 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.

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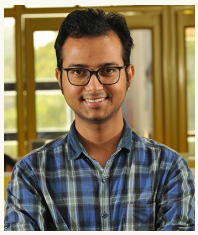

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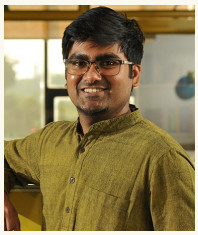

Tauseef Shahidi is a Research Analyst at the Council on Energy, Environment and Water. At The Council, he has co-developed a decision-support tool for the sustainable deployment of solar for irrigation. He is also involved with the data collection and analysis of the household-level survey for six states, as part of India's largest energy access survey called ACCESS undertaken by The Council. He holds a bachelor's degree in Chemical Engineering from the Indian Institute of Technology Guwahati and a post-graduate diploma in Liberal Arts from Ashoka University. His research interest focuses on energy access for households and agriculture.

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AUTHOR CONTRIBUTIONS

Abhishek Jain:	Led the execution of the entire project; provided inputs at every stage; co-authored the executive summary and contributed to all other chapters; and reviewed and edited the entire manuscript.
Saurabh Tripathi:	Contributed to revision of the survey instrument, training of the enumerators, data monitoring and analysis; co-led cleaning of the data; and co-authored chapters 3, 5, and 6.
Sunil Mani:	Contributed to the training of the enumerators and monitoring and analysis of the data; co-led cleaning of the data; and co-authored chapters 4 and 5.
Sasmita Patnaik:	Contributed to revision of the survey instrument, training of the enumerators, and data analysis; and co-authored chapters 2, 4, and 6.
Tauseef Shahidi:	Contributed to the training of the enumerators and analysis of the data; led the data monitoring; and co-authored the chapter 3.
Karthik Ganesan:	Co-authored the executive summary and chapters 1 and 2.

Contents

List of Figures

List of Tables

List of Abbreviations

ACCESS	Access to Clean Cooking Energy and Electricity – Survey of States
ACS	average cost of supply
ARR	annual revenue realised
BLEN	biogas, LPG, electricity, natural gas
BPL	below poverty line
BSPHCL	Bihar State Power Holding Company Limited
CoV	coefficient of variation
DBT	direct benefit transfers
DISCOMS	distribution companies
DDUGJY	Deen Dayal Upadhyaya Gram Jyoti Yojana
DVVNL	Dakshinanchal Vidyut Vitaran Nigam Limited
ESMAP	Energy Sector Management Assistance Program
GED	Global Electrification Database
ICS	improved cook stoves
IEA	International Energy Agency
IHDS	India Human Development Survey
INR	Indian Rupees
JSERC	Jharkhand State Electricity Regulatory Commission
kW	kilowatt
kWh	kilowatt-hour
LPG	liquefied petroleum gas
MPPKVVCL	Madhya Pradesh Paschim Kshetra Vidyut Vitaran Company Limited
MoPNG	Ministry of Petroleum and Natural Gas
MVVNL	Madhyanchal Vidyut Vitaran Nigam Limited
NBPDCL	North Bihar Power Distribution Company Limited
PDS	Public Distribution System
SBPDCL	South Bihar Power Distribution Company Limited
NSSO	National Sample Survey Office
OBC	other backward class
OECD	Organisation for Economic Co-operation and Development
PAHAL	Pratyaksha Hastaantarit Laabh
PMUY	Pradhan Mantri Ujjwala Yojana
PPAC	Petroleum Planning & Analysis Cell
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
SAUBHAGYA	Pradhan Mantri Sahaj Bijli Har Ghar Yojana
SC	Scheduled Caste
SECC	Socio-economic Caste Census
ST	Scheduled Tribe
TV	television
UDAY	Ujwal DISCOM Assurance Yojana
WHO	World Health Organisation
WTP	willingness to pay

Image: Abhishek Jain/CEEW

Executive Summary

To understand energy access and consumption among rural households at a granular level, CEEW undertook the first dedicated energy access survey in India, 'Access to Clean Cooking Energy and Electricity—Survey of States' (ACCESS), between late 2014 and early 2015. The survey was carried out in six of the major energy-access-deprived states of India—Uttar Pradesh, Bihar, Jharkhand, Madhya Pradesh, Odisha, and West Bengal—with support from Shakti Sustainable Energy Foundation, and in association with the Department of Political Science, Columbia University. The framework used to measure access to electricity and cooking energy was inspired by the multi-tier framework (MTF) proposed in 2014 by the World Bank and the Energy Sector Management Assistance Program (ESMAP). The ACCESS framework lends itself to the evaluation of energy access as a multidimensional, multi-tier issue, going beyond unidimensional and binary definitions. On a four-tier scale, ACCESS 2015 showed that between 65 and 97 per cent of rural households in the six states were in the bottom two tiers in terms of electricity access, and between 91 and 97 per cent were in the bottom two tiers in terms of cooking energy access. ACCESS 2015 highlighted the need to look beyond connections and consider the role of affordability and supply-side bottlenecks in improving access to energy. The report, as well as the underlying data, were used from 2015–2018 to provide tailored recommendations to the central and state governments, with the aim of addressing the barriers to energy access faced by rural populations in specific areas and regions.

After a gap of more than three years, CEEW revisited the same households that we surveyed in 2014–15, making ACCESS the largest panel data on energy access in India

In the last three years following ACCESS 2015, a multitude of efforts have been undertaken —both at the central and state levels—to improve access to grid electricity and clean cooking energy. A rejuvenated village electrification scheme, *Deen Dayal Upadhyaya Gram Jyoti Yojana* (DDUGJY), was announced in August 2015 and, as a result, 100 per cent village electrification was achieved by April 2018. In the midst of this village electrification drive, in October 2017, the government raised the bar further by announcing the ambitious *Saubhagya* scheme, with the goal of achieving universal household electrification by early 2019. The *Ujwal DISCOM Assurance Yojana (UDAY)* scheme was launched in 2015 to give discoms more financial breathing room and to help improve their service delivery. In parallel, the government has undertaken efforts to fast-track clean cooking energy provisions for households on a war footing. The Direct Benefit Transfer of LPG (DBTL) scheme in 2014-15 for crediting subsidies directly to consumers, the Give-It-Up campaign in 2015 to rationalise subsidies, and the *Pradhan Mantri Ujjwala Yojana* (PMUY) in 2016 that aims to provide LPG connections to 50 million (later expanded to 80 million) socio-economically weaker households are laudable efforts.

After a gap of more than three years, CEEW revisited the same households that we surveyed in 2014–15, making ACCESS the largest panel data on energy access in India. This second round was undertaken in order to take stock of the current situation on the ground and to assess the effectiveness of these government interventions in improving energy access among rural households in some of the most energy-poor states of India.

Framework used to measure energy access

To assess the energy access situation based on the multidimensional, multi-tier approach, we use the same framework as ACCESS 2015. This framework captures the multidimensional nature of energy access and categorises households' level of access under each dimension into tiers. This approach helps in identifying bottlenecks and targeting policy interventions.

The electricity access framework captures the capacity, duration, quality, reliability, affordability, and legal status of the electricity provision. For cooking energy, the framework covers availability, health and safety, quality of cooking, convenience of cooking, and affordability. Based on these frameworks, each household was assigned a tier for each of the dimensions, and then an overall tier that corresponded to the minimum tier achieved across all the dimensions. Tier 0 is the lowest level of energy access and Tier 3 the highest. Such an approach engenders a conservative estimation, which effectively highlights areas that most require action, making it valuable for decision makers and key stakeholders.[1]

How has energy access in rural India evolved in the last three years?

Electricity access

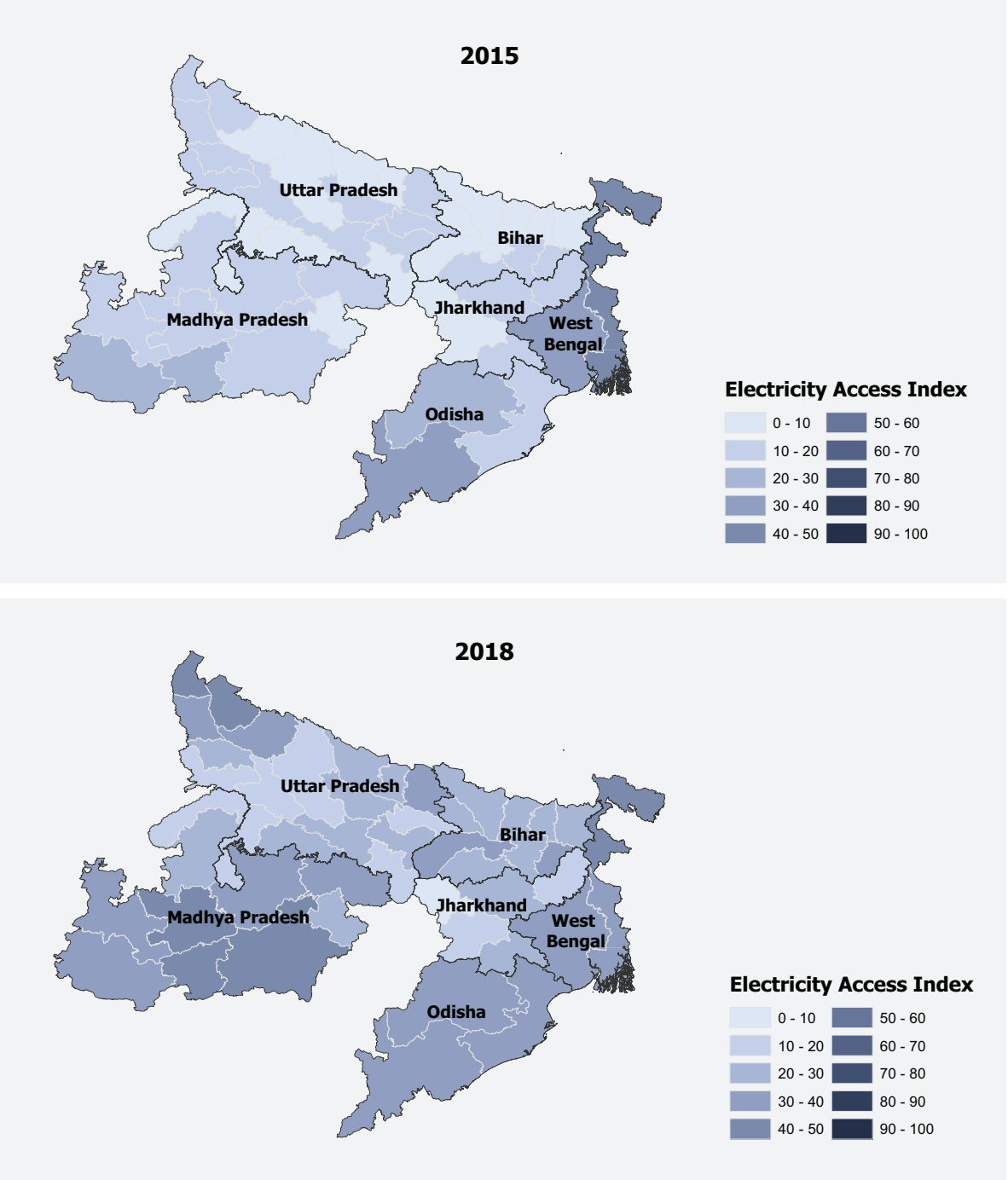
Over the last three years, there has been a significant improvement in electricity access among rural households in the states surveyed. As per ACCESS 2018, 84 per cent of households in these states are already connected to the grid, and this number is increasing rapidly under the *Saubhagya* scheme. More notably, around 80 per cent of rural households depend on grid electricity and solar home systems and/or solar lanterns for their primary lighting needs, up from 44 per cent in 2015. Consequently, the share of rural households who reported that they depend on kerosene as their primarily source for lighting has seen a significant reduction from more than 50 per cent in 2015 to less than 20 per cent in 2018.

Even from a multidimensional, multi-tier perspective, the electricity access situation has significantly improved over the last three years in five of the six states. Looking at the composite electricity access index, we see that West Bengal continues to perform the best among the six states despite having witnessed a decline of about three points in its absolute score since 2015. Odisha has further improved its electricity access situation, reporting an increase in its score from 24.0 to 35.3. Bihar, which has more than tripled its score, is now at 27.8 on this scale. Madhya Pradesh and Uttar Pradesh have more than doubled their scores, from 16 to 33.9 and from 10.7 to 24.4, respectively. The variation in the scores across states has reduced since 2015, indicating a decrease in disparity in electricity access. The variation within states is significant, however, as shown in the map below.

Around 80 per cent of rural households depend on grid electricity and solar home systems and/or solar lanterns for their primary lighting needs, up from 44 per cent in 2015

1 For further details on the framework, please refer to Chapter 2 on Methodology in the full report.

Electricity access indices across six states in 2015 and 2018

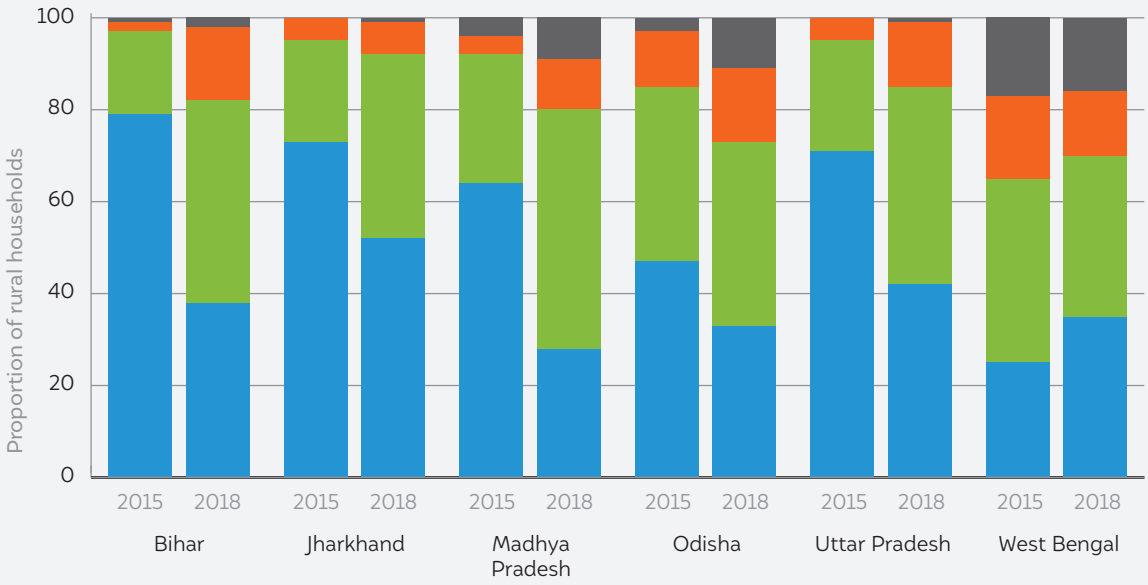


Note: The index is a composite score with range from 0-100, representing the overall electricity access situation in the region by considering the proportion of households in each tier of electricity access. Zero means all households are in Tier 0, and 100 means all households are in Tier 3.

Source: CEEW analysis, 2018

Bihar, Jharkhand, Madhya Pradesh, and Uttar Pradesh have experienced a considerable reduction in the proportion of households in Tier 0, with a commensurate increase in the proportions of households in higher tiers. The decrease in the proportion of households categorised as Tier 0 in Odisha has been accompanied by an increase in the proportions of households in Tiers 2 and 3. A notable percentage of households in West Bengal have actually slipped from higher tiers to lower tiers.

Significant movement of rural households from the lowest tier of electricity access to higher tiers



	Bihar		Jharkhand		Madhya Pradesh		Odisha		Uttar Pradesh		West Bengal	
Tier 3	1%	3%	0%	1%	4%	9%	3%	12%	0%	1%	16%	17%
Tier 2	2%	16%	5%	7%	4%	11%	12%	16%	4%	14%	18%	14%
Tier 1	18%	44%	22%	40%	28%	52%	38%	40%	24%	43%	40%	35%
Tier 0	79%	38%	73%	52%	64%	28%	47%	33%	71%	42%	25%	35%

Source: CEEW analysis, 2018

As of 2018, about 76 per cent of the rural households in Bihar reported using grid electricity as their primary source of lighting, compared to only 21 per cent in 2015. Likewise, rural Jharkhand saw a threefold increase in the number of households that rely on grid electricity as their primary source of lighting, from 20 per cent in 2015 to 60 per cent in 2018, even though the median hours of supply in the state has only marginally improved from eight hours to nine hours a day. The electrification of previously unelectrified households, and an increase in evening hours of supply, from a median value of two to three hours, has primarily led to the increased dependence on electricity for lighting in Jharkhand.

Madhya Pradesh has also witnessed a significant improvement in access to electricity. In fact, about half the households that have moved to tiers 2 and 3 in 2018 were in Tier 0 in 2015. Odisha now also has more than a quarter of its households in the top two tiers of electricity access—a quadruple increase in the proportion of Tier 3 households. But, despite this progress, a third of Odisha's rural households are still in the bottom-most tier because of lack of electricity provision or due to the poor quality and reliability of supply.

Uttar Pradesh, which has a large share of the households that languish from poor levels of electricity access, has also shown significant progress. There has been an almost threefold increase (to nearly 60 per cent) in the share of households that report electricity as their primary source of lighting. A concomitant drop in the use of kerosene for lighting was also seen in the state. However, interestingly, Uttar Pradesh has the highest share of unelectrified households (20 per cent) that do not wish to be connected even if they are provided with a free connection. This could be due to a genuine lack of ability to afford regular consumption of electricity, an inability to pay lumpy and consequently high-value bills, lack of incentive to get formally connected if the electricity is already being

Uttar Pradesh has the highest share of unelectrified households (20 per cent) that do not wish to be connected even if they are provided with a free connection

consumed in unlawful manner, a lack of awareness of how electricity could improve the household's living experience, or a lack of trust in the reliability of supply. The persistence of a significant number of unmetered connections in the state is also an indicator of how even basic electricity consumption could be an expensive proposition for many households. In recent years, the state has more than doubled the fixed tariff for unmetered connections. While this may be a deliberate attempt to incentivise households to adopt metered connections, discoms continue to face challenges in providing reliable metering, regular billing and collection services, to millions of rural households in the state. Even though the median hours of electricity supply in a day has increased from 8 hours to 12 hours, a significant further improvement is required to move households to higher tiers.

Daily supply in all six states combined has increased from a median of 12 hours to 16 hours over the last three years

West Bengal continues to be the best performer among these states but, compared to 2015, there has been a decline in the electricity access situation in the state. While no 24-hour blackouts were reported in 2015 (median value), there are now two such days in a month. Worsening reliability and the deteriorating quality (voltage issues) of supply are the main reasons for a greater proportion of households being consigned in the state to Tier 0 in 2018. There is a clear emphasis in the state on formalising connections and enabling payments to be made to a representative of the electricity department, making it the best-performing state in terms of regularity of billing and collection. Despite having the highest number of hours of supply, households in Tier 2 were unable to progress to the highest tier primarily because of poor reliability and quality, which are common and significant barriers to better electricity access across all tiers in West Bengal.

In most states, households that do not have electricity reported that the upfront cost is a deterrent to getting a connection. Given the provision of free electricity connections under the *Saubhagya* scheme, such reasoning from households suggests that they are either unaware of the scheme, or that they have not yet been offered a connection by the authorities, or that there are gaps in the implementation of the scheme with regard to payment at the local level.

Daily supply in all six states combined has increased from a median of 12 hours to 16 hours over the last three years. In Bihar and Madhya Pradesh, which have shown the most improvement, the supply duration increased from 8 hours to 15 hours, and from 12 hours to 18 hours, respectively.

While the quality and reliability of supply has improved in all states but West Bengal, for a majority of households, they remain the barrier to moving to higher tiers. About 29 per cent of electrified households report that appliance-damaging high voltage occurs at least one day a month (down from 38 per cent in 2015), and about 42 per cent of electrified households report that low voltage—which limits the use of appliances—occurs at least one day in a month (down from 51 per cent in 2015). The median number of 24-hour-long blackouts in a month has decreased from two days to one day at the aggregate level for the six states.

The proportion of electrified households that expressed satisfaction with their electricity provision has more than doubled—from 26 per cent to 57 per cent—over the last three years. Madhya Pradesh witnessed the most significant change, followed by Bihar.

Clean cooking energy access

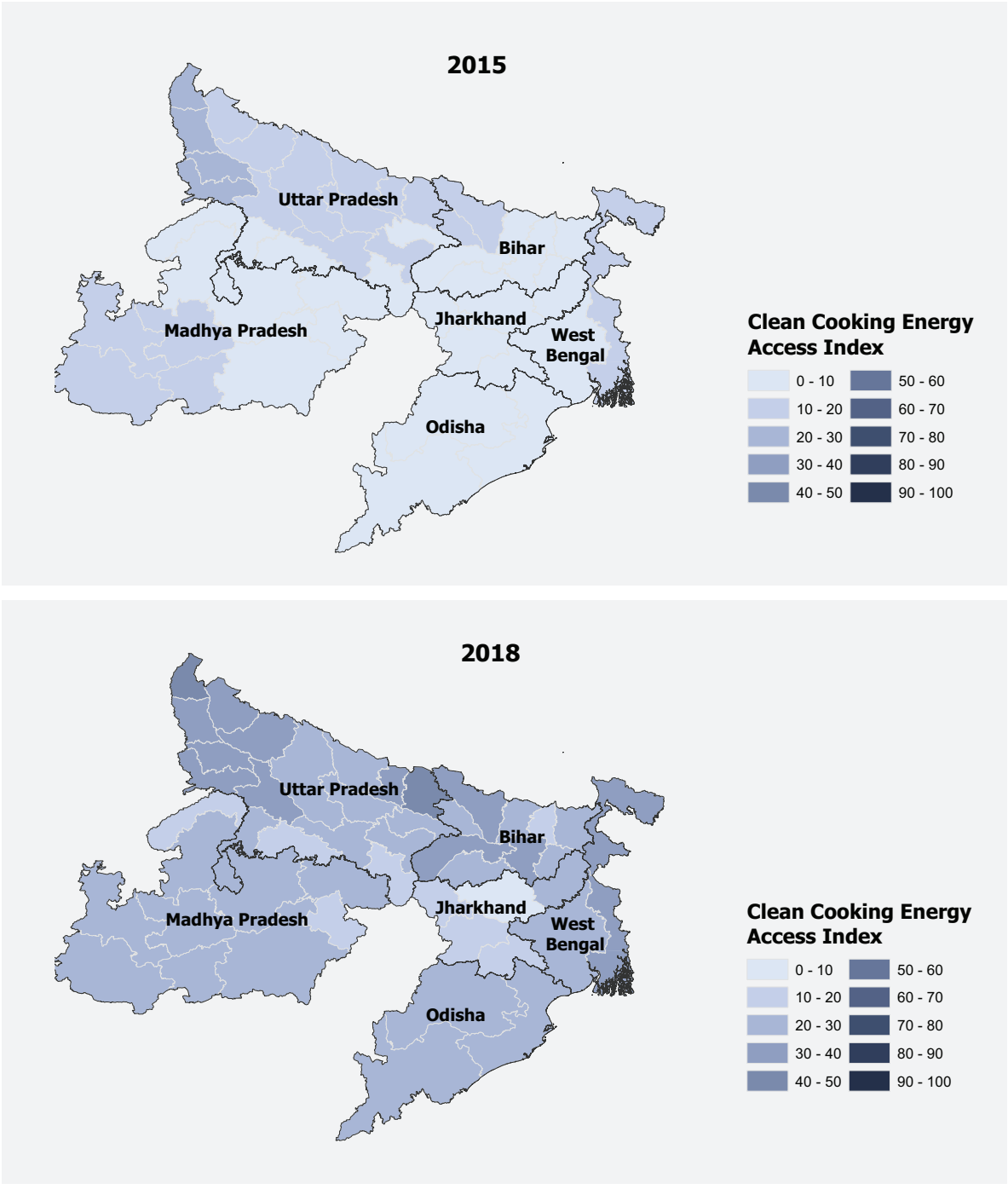
Since 2015, the share of households using LPG in these six states has increased from 22 per cent to 58 per cent, and the share of households using LPG as their primary cooking fuel has increased from 14 to 37 per cent. Its use as the exclusive cooking fuel (eliminating adverse health impacts completely) has also increased from 5 to 19 per cent of rural households.

The share of households using LPG as their primary cooking fuel has increased from 14 to 37 per cent

Even from a multidimensional, multi-tier perspective, significant progress has been observed across all states. Looking at the clean cooking energy access index, we find that West Bengal performs the best

among the six states in 2018, trebling its score from 11.1 to 32.9. Odisha has shown the highest improvement, reporting an increase of 4.5 times in its score—from 4.2 in 2015 to 23 in 2018. As with electricity access, there has also been a reduction in the disparity in cooking energy access across states. With regards to tiers, 44 per cent of households across the six states are in Tier 0 in 2018, as compared to 78 per cent in 2015. The use of LPG by a much higher proportion of households, significantly driven through PMUY, is the primary reason for this drastic movement of households to higher tiers. We find that LPG stands out as the only clean cooking fuel that has enabled households to move to higher tiers of cooking energy access. The cumulative penetration of other nontraditional cooking sources is limited to 0.77 per cent of rural households in these six states.

Clean cooking energy access indices across six states in 2015 and 2018

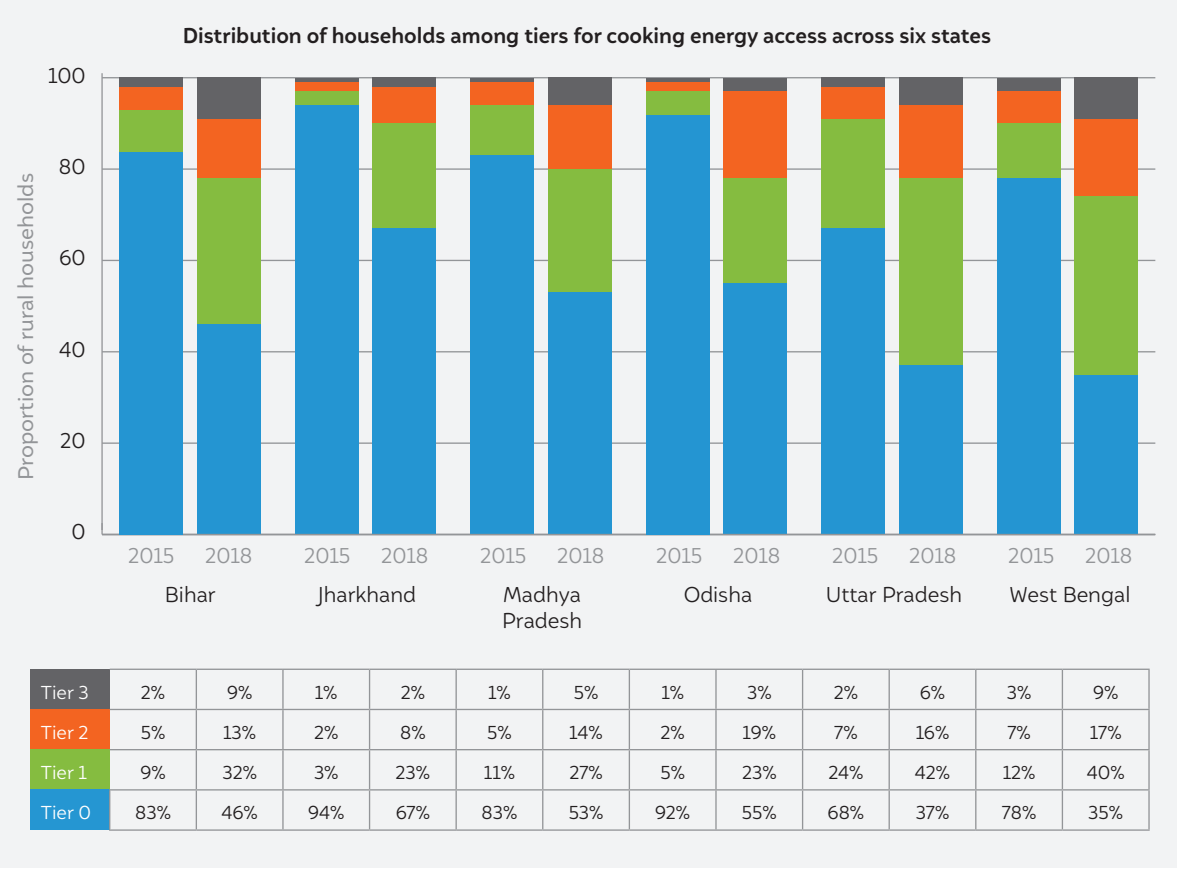


Note: The index is a composite score with range from 0-100, representing the overall clean cooking energy access situation in the region by considering the proportion of households in each tier of clean cooking energy access. Zero means all households are in Tier 0, and 100 means all households are in Tier 3.

Source: CEEW analysis, 2015, 2018

In the six states, of all the rural households that received LPG connections between 2015 and 2018, 43 per cent received them under the *Pradhan Mantri Ujjwala Yojana* (PMUY). Of the households that have moved from Tier 0 to higher tiers, 42 per cent mentioned that they had acquired their connection under PMUY, implying that the scheme has been a critical factor in enabling this transition. However, among these PMUY beneficiaries, a majority (62 per cent) have moved only to Tier 1, and merely six per cent have moved to Tier 3. So, while PMUY has provided the necessary impetus for households to adopt clean cooking energy, there is a need to focus on encouraging its exclusive use, and addressing the barriers to that. A figure comparing the performance of states in 2015 and 2018 is shown below.

West Bengal, Bihar, Odisha, and Uttar Pradesh witness the most significant movement of households from the lowest tier of clean cooking energy access to the higher tiers



	Bihar		Jharkhand		Madhya Pradesh		Odisha		Uttar Pradesh		West Bengal	
	2015	2018	2015	2018	2015	2018	2015	2018	2015	2018	2015	2018
Tier 3	2%	9%	1%	2%	1%	5%	1%	3%	2%	6%	3%	9%
Tier 2	5%	13%	2%	8%	5%	14%	2%	19%	7%	16%	7%	17%
Tier 1	9%	32%	3%	23%	11%	27%	5%	23%	24%	42%	12%	40%
Tier 0	83%	46%	94%	67%	83%	53%	92%	55%	68%	37%	78%	35%

Source: CEEW analysis, 2018

Interestingly, the increasing penetration of LPG in rural areas, through PMUY and otherwise, has fuelled households' aspirations and their interest in adopting LPG. Of the households that do not have an LPG connection, 83 per cent stated that they were interested in acquiring a connection—a significant increase from 2015, when only 48 per cent of LPG-deprived households expressed an interest in getting a connection. Furthermore, households interested in adopting LPG are willing to pay INR 300 per month (median value) for the use of LPG for all their cooking needs.

Among regular (non-PMUY) LPG consumers, usage is strongly correlated with the number of years for which a household has had a connection

Another important development in LPG access in the last three years is the decrease in the disparity of access among different social groups, again largely driven by PMUY. The proportion of Scheduled Castes (SC) and Scheduled Tribes (ST) households who reported using LPG in 2015 and in 2018 has increased from 12 per cent to 45 per cent, and from 8 per cent to 32 per cent, respectively, indicating a significant improvement in LPG penetration among marginalised groups.

While LPG connections have become more ubiquitous in the years between the surveys, the theme that resonates across both surveys is that affordability is still a significant determinant of the extent to which households replace conventional fuels in cooking**.** Second, the availability of free-of-cost biomass is an important reason for households to not use LPG for cooking. Though there has been a drop in the share of households reporting the use of free-of-cost biomass (34 per cent now, compared to 44 per cent in 2015), a significant proportion of households (81 per cent) still continue to rely on such biomass for some, if not all, of their cooking needs. The silver lining is that, among the LPG-using households, almost one-third use it exclusively, i.e., no stacking with traditional biomass.

Among households that have LPG, more than two-third reported that a male member of the household decides when to order a refill

We also find that even among regular (non-PMUY) LPG consumers, usage is strongly correlated with the number of years for which a household has had a connection—potentially indicating that for new LPG connections, consumption evolves over time until it saturates. It is no surprise then, that the median number of cylinders used by PMUY households in a year is five, while non-PMUY households that have been using LPG for two years or less use six cylinders, and non-PMUY households with connections dating back more than two years use about eight cylinders a year. PMUY has been in place for only two years, and it is too early to draw conclusions, based on the consumption patterns of households new to LPG, as to the success of PMUY in weaning households away from traditional biomass. In fact, in just over two years, about 45 per cent of PMUY households report using LPG as their primary fuel for cooking, compared to 73 per cent of all non-PMUY consumers. Such a significant proportion of PMUY households reporting the use of LPG as their primary fuel in a mere span of two years is commendable.

The LPG distribution network has been expanded and strengthened between 2015 and 2018, with a higher proportion of rural households in the six states availing home delivery of LPG cylinders. However, except for West Bengal, in all the other states, less than 50 per cent of rural LPG households have access to home delivery. Also, for those not receiving home-delivery, although the median one-way distance travelled to procure LPG has declined since 2015, it remains high (four kilometres or more) in all states except West Bengal, indicating that there is certainly a need to focus on improving the availability of LPG.

There is a clear difference in the shares of the households that were satisfied with their primary cooking arrangement: 86 per cent for LPG, and 40 per cent for traditional biomass. The most common reasons for dissatisfaction among households using LPG are that LPG is expensive to use and that it is has to be procured from too far away.

While PMUY provides the connection in the name of the adult women of the household, and the linked subsidy is credited to her bank account, the intra-household decision-making with respect to purchasing LPG refills remains dominated by men. Among households that have LPG, more than two-third reported that a male member of the household decides when to order a refill. Women's participation in decision-making was highest in West Bengal, where 59 per cent of households reported that either the women of the household or both spouses made the decision to order the LPG cylinder; it was lowest in Madhya Pradesh (16 per cent). To further the sustained use of LPG, communication and awareness campaigns that are carried out in forums such as LPG panchayats[2] should take into consideration intra-household dynamics in decision-making.

2 LPG panchayats are organised by the Ministry of Petroleum and Natural Gas with an aim to provide a platform for LPG consumers to interact with each other, promote mutual learning, and share experiences.

Understanding policy preferences

As in ACCESS 2015, even in this round we asked households about their policy preferences with regard to energy access. While we see similar preferences emerging in many areas, in a few cases, we observed some interesting trends. Upon asking what should government support if it could support only one type of lighting provision (among grid electricity, solar home systems or lanterns, kerosene, or microgrids), the support for subsidising grid electricity increased from 65 per cent in 2015 to 83 per cent in 2018. The shift in households' preference for subsidised grid electricity could be due to the increased number of connections in 2018 and general improvements in power supply.

More than 60 per cent of the respondents prioritised increasing the subsidy on LPG cylinders, as compared to 47 per cent in 2015

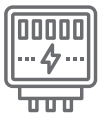
When asked to choose between subsidised kerosene and subsidised solar lanterns, 86 per cent of households (increased from 79 per cent in 2015) were in support of the government providing subsidies on solar lanterns even if it resulted in a reduction in the subsidies on kerosene.

With regard to cooking energy provision, when asked which interventions governments should prioritise (among providing improved biomass cookstoves, increasing the subsidy on LPG, providing biogas plants, or improving the availability of LPG), more than 60 per cent of the respondents prioritised increasing the subsidy on LPG cylinders, as compared to 47 per cent in 2015. The second-most important priority for policy interventions, as identified by respondents, was improving LPG distribution in rural areas. These were the top two priorities in 2015 as well, but there has been a further decrease in the preference for government support for biogas and improved cookstoves. However, those who use these respective technologies do have a higher preference for them, as compared to those who do not, but the former constitute less than one per cent of the rural population in these six states.

Looking at illegal activities associated with energy provision, when asked if there was electricity theft in the village, about 29 per cent of respondents replied in the affirmative, registering a drop from 33 per cent from 2015. Three years ago, our sample showed that in about 14 per cent of villages, more than 75 per cent of the surveyed households reported the occurrence of electricity theft in their village—implying a significant degree of certainty. In 2018, the proportion of such villages has decreased to merely 2.5 per cent. With regard to the reselling of subsidised kerosene, West Bengal observed the most significant decline in the reported reselling of subsidised kerosene in the last three years, from 68 per cent to 30 per cent. Most other states show a minor change on either side.

The share of respondents who reported that they were aware that reselling subsidised LPG is illegal has increased from 36 per cent of respondents to 46 per cent in 2018, but about 11 per cent of households continue to report that reselling of LPG exists in their village. It is important to note that the sharing of LPG cylinders between neighbours and extended families is a regular phenomenon in small town and rural areas owing to availability challenges, and it is not necessarily driven by an intention to siphon off subsidy amounts against the commodity.

Closing remarks



In 2015, when a multidimensional framework to evaluate energy access in India was first used, it shed light on various aspects of energy access that are often overlooked in favour of simplistic measures such as the number of connections deployed. In 2018, the results of this study have re-iterated clearly why it is imperative that we monitor multidimensional aspects of access to energy. Many households that are connected to grid electricity or have LPG connections are satisfied with their energy access situation, but—despite having access to connections—many are not.

Metering of connections, though have improved, needs further improvement particularly in the states of Jharkhand, Uttar Pradesh and Madhya Pradesh

The case for a tier-based analysis is made clear by the sheer scale of households' transitions across tiers in terms of electricity and cooking energy access, both progressive and regressive. For instance, a substantial proportion of households in West Bengal have moved to lower tiers of electricity access since 2015, despite traditional metrics—such as an increased proportion of households with connections and a greater proportion of people using electricity as their primary source of lighting—indicating otherwise. While the use of tiers helps in devising a targeted approach, the use of dimensions helps isolate the main issues afflicting households, thereby assisting in identifying localised recommendations for action.

Thanks to schemes like *Deen Dayal Upadhyaya Gram Jyoti Yojana* (DDUGJY; previously Rajiv Gandhi Grameen Vidyutikaran Yojana - RGGVY), *Saubhagya*, and UDAY, we observed significant improvements in the share of rural households that have electricity connections. In addition, while the duration of supply, metering rates, and the formalisation of previously illegal connections have improved in some states, these aspects need further improvement in others. Day-long blackouts and voltage issues continue to afflict many households, particularly those in Tier 0. It is primarily reflective of poor maintenance services or poor estimation of electricity demand in rural areas. Metering of connections, though have improved, needs further improvement particularly in the states of Jharkhand, Uttar Pradesh and Madhya Pradesh. While all new connections under Saubhagya are mandated to be metered, one does observe metering rates not keeping pace with new electricity connections in a few states. In addition, the billing and collection efficiency certainly needs more on-ground effort as about a third of households had not received a bill in the past one year or ever since they got connected to the grid. Such issues need to be addressed, while improving the quality and reliability of supply to ensure long-term sustainability of high-quality electricity access.

Cooking energy access narratives have remained dominated by PMUY in the last couple of years. The scheme not only expanded the discourse on cooking energy access among policymakers, researchers, and administrators, but it also generated awareness about LPG on the ground, making it an aspirational commodity. However, despite acquiring LPG connections, most households continue to use traditional biomass for some of their cooking due to the high recurring cost of LPG and the availability of free biomass. We find that households take some time to begin using LPG for the majority of their cooking needs, and that the transition cannot be expected to happen in a few months. That being said, affordability (recurring cost of LPG) continues to emerge as a concern across all LPG-using households. This necessitates a targeted approach that includes differentiated support for households considering their ability to pay for the clean cooking fuel.

It is abundantly clear that the policies undertaken by the government since 2015 to promote energy access have yielded encouraging results for rural households, but there remains much scope for policy action in both electricity and cooking energy space if better energy access is to be achieved for all. Such multidimensional and multi-tier assessment assessments are useful to gauge the impact of policies on a wide range of variables over time, offering critical insights that can lead to a more nuanced understanding of the situation, and targeted action that will result in an improvement of access to energy over time.

Image: istock

1. Introduction

In recent years, there has been a renewed sense of urgency among policymakers and researchers alike to identify and remove barriers to the adoption and sustained consumption of modern sources of energy in India. Between 2005 and 2015, before the implementation of *Deen Dayal Upadhyaya Gram Jyoti Yojana* (DDUGJY), the primary focus was on electrifying villages - few electricity poles would be set up within the revenue boundary of the village and easier to connect households would be provided with a connection. Clean cooking energy for the masses was not a priority for nearly seven decades after Independence, and adoption remained skewed, with the wealthier sections of society availing most of the subsidies provided for the consumption of LPG.

Despite the overwhelming evidence that energy is an important factor for improving the incomes of poorer households, data on energy access and the consumption patterns of households has, by and large, been missing in India

The benefits of energy consumption and its causal relationship with poverty alleviation and development have been discussed at great length, both in the global and Indian context. An online search for the keywords 'energy access' throws up more than 5,700 publications focused on the issue (globally), published since the turn of the century.[1] Earlier research focused on traditional electrification needs, the developmental gains from electrification, and the health burden that results from the use of traditional biomass in cooking. More recent research has delved into alternatives to the grid and the role of renewable energy, and has emphasised the inequities in the consumption of clean cooking fuels and the disproportionate impact on the health of women and children in rural areas. Despite the overwhelming evidence that energy is an important factor for improving the incomes of poorer households, data on energy access and the consumption patterns of households has, by and large, been missing in India. For the most part, the discussion had been limited to merely establishing electricity connections or setting up clean cooking energy arrangements.

ACCESS 2015

With the objective of understanding energy access and consumption at a more granular and detailed level, CEEW undertook a dedicated energy access survey titled Access to Clean Cooking Energy and Electricity – Survey of States (ACCESS) between late 2014 and early 2015. The study, which was supported by Shakti Sustainable Energy Foundation and Columbia University, was statistically representative of rural areas in six major Indian states – Uttar Pradesh, Bihar, Jharkhand, Madhya Pradesh, Odisha, and West Bengal. The

1 Only Science Direct was queried to establish the number of publications and not any of the other online databases.

framework that was used to measure electricity and cooking energy access was inspired by the multi-tier framework (MTF) proposed by the World Bank and Energy Sector Management Assistance Program (ESMAP) in 2014.[2] The framework lends itself to the evaluation of energy access as a multidimensional, multi-tier issue, going beyond unidimensional and binary definitions. ACCESS 2015 data showed that between 65 per cent and 97 per cent of rural households in the six states were in the bottom two tiers in terms of electricity access; in terms of cooking energy, between 91 per cent and 97 per cent of the households surveyed were in the bottom two tiers. The report also highlighted the need to look beyond connections and consider the role of affordability and supply-side bottlenecks in order to improve access to energy. The report, as well as the underlying data, were used between 2015 and 2018 to provide tailored recommendations to address the barriers that specific areas or regions experienced. In the intervening years since the first round of ACCESS, the government—both at the central and state level—has made efforts to close the gap on some of the barriers identified in the ACCESS report.

ACCESS 2015 highlighted the need to look beyond connections and consider the role of affordability and supply-side bottlenecks in order to improve the access to energy

Government efforts since 2015

The first major government initiative to improve energy access in recent years was the *Pratyaksha Hastaantarit Laabh* (PAHAL) programme – a massive effort to convert LPG into a commodity sold at market prices to consumers instead of at a subsidised rate, and instead having the subsidy directly transferred to the bank account of the consumer. Within 15 months, more than 12 crore connections were linked to bank accounts. This was followed by the launch of *Pradhan Mantri Ujjwala Yojana* (PMUY) in May 2016, which aimed to provide free LPG connections to below poverty line (BPL) households based on the Socio-economic Caste Census (SECC), and later to other disadvantaged groups as well. The scheme aimed to reduce the upfront financial burden on households, which acted as a barrier to them adopting clean solutions like LPG. As of November 2018, 57 million connections have been provided (MoPNG, 2018), and the overall target has been enhanced to 80 million connections by 2020. If this revised target is achieved, it would represent a two-thirds increase in the customer base in just five years.

To improve electricity access, in August 2015, the government set a target for 100 per cent village electrification within 1,000 days, under the *Deen Dayal Upadhyaya Gram Jyoti Yojana* (DDUGJY), which superseded the *Rajiv Gandhi Gramin Vidyutikaran* Yojana (RGGVY). In April 2018, with the electrification of Leisang, a village in Manipur, the government announced that 100 per cent of the villages in the country had been electrified—implying that at least 10 per cent of households in every recognised and inhabited village in the country had an electricity connection. However, even before this feat was met, the government had announced another ambitious intervention in October 2017 — *Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya)*, which has a target of 100 per cent household electrification by March 2019.

In April 2018, with the electrification of Leisang, a village in Manipur, the government announced that 100 per cent of the villages in the country had been electrified—implying that at least 10 per cent of households in every recognised and inhabited village in the country had an electricity connection

Building on the past interventions, both these flagship schemes, PMUY and *Saubhagya* have pushed the aspirational boundary by promising an electricity and clean cooking energy connection for every household in the country. The pace at which these two schemes have rolled out connections is unprecedented, and in the near future, we will likely witness 100 per cent coverage of electricity and LPG connections.

2 For more details on the approach to the survey and the analysis used in ACCESS 2015, refer to the report at https://www.ceew.in/publication-types/reports.

Continued need for better data on energy access

As India works towards achieving the aforementioned milestones, the discussion must move beyond providing connections, to ensuring reliable supply and promoting sustained use by households, to realise the benefits of modern forms of energy. In such a context, a multidimensional approach to energy access is crucial. In addition, such an approach needs to be complemented with comprehensive monitoring and data collection of the situation on the ground. Talking about data, demand-side surveys are few and far between—no surveys on household energy access, especially one that is representative of large geographies, has been carried out since the first round of ACCESS in 2015. The Household Consumer Expenditure survey conducted by the National Sample Survey Office (NSSO) has remained the primary source of information on household energy consumption—both in quantum and expenditure terms (MoSPI, 2016). This was conducted in 2012 and an intermediate 'smaller-round' should have been conducted by now, but this survey is yet to come through. The data on energy provided in the Household Consumer Expenditure survey is limited—as the instrument is not geared to gather adequate detail on the supply situation and the constraints in demand due to supply bottlenecks. Efforts by the Prayas Energy Group, through real-time monitoring of a few hundred households across the country, has resulted in a better understanding of the supply-side aspects of electricity access in India (Prayas, 2018). However, the study is limited to objective measurements of duration and quality of supply, and it does not capture information on dimensions such as affordability, the legal status of connections, etc. A focus on household energy access and residential energy consumption is vital, with the World Energy Outlook (WEO, 2018) projecting that by 2040, residential electricity consumption will constitute 40 per cent of the total electricity consumption, making households the largest consumer.

Publicly available data is limited in terms of supply-side metrics and is not sufficient to determine the quality, reliability, and affordability of the energy that finally reaches households. With only a handful of distribution companies (discoms) reporting on their supply-side reliability metrics, there is no information in the public domain on the quality of supply experienced by households. Standards of performance are also regularly flouted and the details of such performance are only captured in terms of the number of active complaints at an aggregated level. They do not provide any insight into the number of households impacted. For cooking energy, aggregated data on the number of LPG connections, average consumption, and the number of distributorships is available. However, there is no granular data at the household level, and to make a representative assessment of aspects such as fuel stacking, the affordability of cooking fuels, their local availability, and the associated quality of cooking.

Evolution in international research

Internationally available data and literature has also failed to address the gaps in the data and our understanding of energy access in India. The Energy Progress Report, which is jointly published by the International Energy Agency, World Bank, International Renewable Energy Agency, United Nations (UN) Statistics Division, and the World Health Organization (WHO), is a commonly cited resource for tracking developments in electrification and access to clean cooking energy in countries across the world. The report uses a limited definition of access that focusses only on connections (Tracking SDG7, 2018a). The World Bank's Global Electrification Database (GED) and the WHO Household Energy Database are the primary sources of data, with trends data going back to 1990. The methodology described on the Tracking SDG7 (Tracking SDG7, 2018b) portal clearly suggests that the primary challenge in moving beyond estimations and extrapolations is the lack of representative surveys—either conventional or crowd-sourced. Furthermore, the lack of public household-level data, and the vast resources required to collect primary data, are formidable barriers to addressing these gaps in our understanding of energy access and consumption.

Aklin, Harish, and Urpelainen (2018), in their recent paper on a new compendium of data sources from over 124 non-OECD countries, have also not cited any new data sources for India in recent years. They have also found that the GED estimates were inconsistent with the actual data points from representative surveys from a few countries, indicating the importance of primary data. Palit and Bandyopadhyay (2017), in their paper on the evolution of electrification policies and India's approach to electrification, also limit themselves

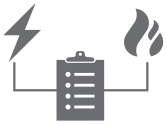
to discussing the quantum of electricity connections and conclude that a reliable and adequate supply of electricity is still not a reality in many parts of the country. Malakar, Greig, and Fliert (2018a; 2018b), in their assessment of the resistance to rejecting solid fuels for cooking in India, conclude that the supply of modern fuels and stoves alone is not sufficient to enable a transition to cleaner cooking. They go on to argue that a deeper understanding of the social context, such as entrenched traditions, income-generating practices, and gender norms are essential to effectively address the poor adoption of cleaner fuels. The Indian government aims to provide LPG to every Indian household that relies only on traditional fuels for cooking. However, Patnaik and Tripathi (2017) have argued that given the poor resource endowment and the financial considerations of rural households, a mix of cleaner cooking options needs to be promoted under a potential National Mission on Clean Cooking Energy Access. In a critical review of the role of improved cook stoves (ICS) and why they have failed, Khandelwal, et al. (2017) suggest that efforts to replace the lowly *chulha* (traditional stove) will have profound implications "that cannot be reduced to energy consumption or environmental hazards" (pg. 13). For all the shortcomings of traditional cookstoves, they are a remarkably "successful technology" that satisfy many of the requirements of rural households. In a similar vein, Aklin, Chao-YoCheng, and Urpelainen (2018) suggest that for lighting and electricity needs, the social acceptance of new and sustainable energy technologies cannot be taken for granted, as households perceive these options as more expensive and inequitable compared to the services enjoyed by their urban counterparts. Despite the challenges in promoting alternative technologies for cooking and electricity provision (i.e., non-grid-connected), the literature has also discussed the role of alternative technologies in bridging the demand–supply gap in household energy needs (Banerjee, Prasad, Rehman, & Gill, 2016; Rathore, Chauhan, & Singh, 2018; Yaqoot, Diwan, & C.Kandpal, 2017; Sandwell, et al., 2016; Numminen, Lund, Yoon, & Urpelainen, 2018; Ulsrud, Rohracher, Winther, Muchunku, & Palit, 2018).

A mix of cleaner cooking options needs to be promoted under a potential National Mission on Clean Cooking Energy Access

Motivations and objectives

Given this context of policy interventions since 2015, to improve energy access as well as the evolution of the research and literature, our main motivation to conduct a second round of the ACCESS survey is to shed light on the progress (or regression) along all dimensions of energy access and fill the persistent gaps in high quality, large-scale energy access data within the country. In addition, as several studies have identified, the barriers to the adoption and sustained use of modern energy sources are diverse, and they can be only addressed after assessing how households and users interact with modern sources of energy. These data are captured through the multidimensional, multi-tier approach that we used for the ACCESS survey, actualised by its elaborate questionnaires. We are cognisant of the rapidly changing energy landscape and the pace at which energy access is evolving across the country. However, some of the deep-rooted challenges pertaining to affordability, reliability, fuel stacking, and quality still remain.

While undertaking this round of the survey, we were faced with two options— a fresh cross-section or a panel data set. Despite the challenges (arising from the potential loss of the original respondents), we opted for the panel data approach. Panel data capture both inter-household differences and intra-household movement and have several advantages over simple cross-sectional data. Panel data also help to control the impact of omitted variables. For these reasons, a panel data approach was chosen.



The main motivation to conduct ACCESS 2018 is to shed light on the progress (or regression) along all dimensions of energy access

The objectives of this study, which in a way unveils and presents the second round of the ACCESS survey data, are as follows:

1. To empirically test the multi-tier framework used in the first round to see if the framework lends itself to studying the evolving realities of

energy access on the ground, and the extent to which it captures the nuances, otherwise lost, of changes over time.

2. Given the rapidly evolving circumstances on the ground, to track the evolution of the challenges or reasons that limit the transition of households from lower to higher experiences of energy access, i.e. across energy access tiers.

3. To assess the impact of the ongoing policy interventions of the Government of India to further energy access.

Organisation of the report

The report is organised as follows:

Chapter 2 details the methodology—details pertaining to the survey, such as the sampling methodology, the questionnaire used, and variations from the first version are covered. The multidimensional framework for evaluating access to electricity and cooking energy remains the same as in the first report.

Chapters 3 and 4 cover results pertaining to electricity access and clean cooking energy access, respectively. The chapters describe the results of the second round of ACCESS and compare the findings across the two cross-sections—2015 and 2018. The significant role of the state in driving electricity outcomes explains the variations within the states. The central government runs broad support policies and schemes to promote clean cooking energy, and thus more cross-cutting themes are explored with regards this sector.

Chapter 5 examines the respondents' policy preferences on a variety of electricity and cooking energy-related topics. This includes peoples' attitudes towards government support for specific fuels and technologies, and their perception of corruption and legal status in the context of energy provision.

Chapter 6 concludes by summarising the key highlights from the survey results and the analysis of major energy access policy initiatives undertaken in the last three years. It ultimately calls for continued multidimensional and multi-tier assessments of energy access in India.


Image: Sasmita Patnaik/CEEW


Image: Morsel Research and Development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2. Methodology

The methodology for this fundamentally follows from ACCESS 2015. In 2018, we conducted a longitudinal panel study, where we interviewed the households we surveyed in 2015 to understand the changes in their access to electricity and cooking energy. This report presents cross-sectional descriptive analyses of evolution of energy access among rural households and uses panel-level information only to understand the movement of households across energy access tiers between 2015 and 2018. However, we recognise the strength of the panel dataset and its potential to provide an even deeper understanding of the subject; thus, we intend to conduct rigorous panel analyses in the coming months, to gain further insights that the dataset may provide. In this section, we explain the methodology adopted in ACCESS 2015 and elaborate on the modifications undertaken in 2018.

This report presents cross-sectional descriptive analyses of evolution of energy access among rural households and uses panel-level information only to understand the movement of households across energy access tiers between 2015 and 2018

In 2015, we developed a measurement framework that would capture the multidimensional nature of energy access while also serving to categorise the level of access (under each dimension) in tiers. This approach helped in identifying bottlenecks and targeting policy interventions. We used a modified version of MTF to contextualise and effectively capture the energy access scenario in rural India.

Two separate multidimensional, multi-tier frameworks were used to analyse electricity access and cooking energy access. The multi-tier approach was used as it allows for multiple levels of energy access and not just the binary states of 'having' and 'not having' access. Under the proposed framework, a tier is assigned to each household for each of the dimensions. Finally, we assigned an overall tier to the household that corresponds to the minimum tier achieved across all the dimensions. Apart from leading to a conservative estimation, such an approach effectively highlights areas that most require action, making the framework valuable for decision makers and key stakeholders.

While the basic approach of our framework and even some of the dimensions are similar to the MTF, it differs in the definitions used for indicators and in the formulation of the tiers. One major difference is in the number of tiers used to measure energy access. Unlike the six tiers used in the MTF, our proposed framework has only four tiers. Being a global framework, the number of tiers defined in the MTF may be more relevant in the energy contexts of other countries, where a finer differentiation may be possible or necessitated.[3]

3 ACCESS 2015 report provides a detailed section on comparing our framework with MTF.

Electricity access

For electricity access, we captured information across six dimensions and four tiers. The six dimensions are capacity, duration, reliability, quality, affordability, and Legal status. We excluded health and safety, an indicator included in the MTF framework, primarily because the information could not be captured comprehensively in the survey. Table 1 provides a snapshot view of the framework that will be used to measure electricity access.

TABLE 1: Multidimensional, multi-tier framework to assess electricity access

	Tier 0	Tier 1	Tier 2	Tier 3
Capacity	No electricity	Lighting (~1-50 W)	Lighting + air circulation + entertainment/communication (TV/computer) (~50-500 W)	Tier 2 services + medium to heavy loads (>500 W)
Duration	<4 hrs	>4 hrs and <8 hrs	>8 hrs and <20 hrs	>20 hrs
Reliability (Blackout days)	5 or more days	2-4 days	1 day	0
Quality*	$N_H > 3$; $N_L > 6$	$N_H = 0$-3; $N_L = 0$-6	$N_H = 0$-1; $N_L = 0$-3	$N_H + N_L = 0$
Affordability	Unaffordable		Affordable	
Legal status	Illegal		Legal	

*N_H is the number of high-voltage days in a month causing appliance damage; N_L is the number of low-voltage days in a month limiting appliance usage.

NOTE: For dimensions where the categories span multiple tiers, only the higher tier values apply. For example, affordability can only be categorised as Tier 1 or Tier 3. The same is the case for legal status.

Source: CEEW analysis, 2015

1. **Capacity** is defined as the maximum power that can be drawn from a given electricity connection. The supply capacity is the primary dimension that determines the quantum of services a household can use, provided that it can afford the corresponding appliances to derive those services. The capacity tiers are designed to correspond to a set of incremental energy services. The watt ratings were determined by aggregating the loads of the devices or appliances that would be used to provide these services.

    a. Tier 0 includes households without a grid connection or any off-grid solution (microgrids, solar home systems, and solar lanterns); the households in this tier are referred to as unelectrified households.

    b. Tier 1 includes households that have access to only lighting and mobile charging services, either through a solar lantern, solar home system, or a microgrid. Given the efficiency of the most commonly used appliances in India, rudimentary calculations suggest that the power requirements of this service level are 0–50 W.

    c. Tier 2 includes houses with capacities that allow for air circulation (fans), advanced communication, and entertainment (TV or computer). Households connected to microgrids having the capacity to support at least a fan or a TV, and households with solar home systems having a fan or a TV or both, get included this tier. The power requirements for this service level is estimated to be about 50–500 W.

    d. Tier 3 (>500 W) includes households with power capacity that can support medium to heavy loads like refrigerators, irons, air conditioners, etc. All grid-connected households are assumed to be in this tier.[4] We understand that there can be few households categorised as 'lifeline consumers' or '*Kutir Jyoti*', whose sanction load could be of the order of 100 W or so. But, it is very difficult to identify

4 The actual appliance ownership data of households were not used to determine the capacity tiers, because appliance ownership is strongly influenced by affordability. Moreover, the quality and reliability of supply also influence the appliance ownership rate. In this multidimensional framework, where we are trying to disaggregate barriers to energy access, using appliance ownership to determine capacity would not truly reflect the system's capacity to provide electricity to a household.

the sanctioned load levels during a survey, and even from utilities perspective, it is practically very challenging for utilities to limit load for such households. Thus, considering these practical constraints and on-ground realities, we assume all grid-connected households practically availing a capacity level of 500W+.

The threshold of electricity consumption of 1kWh per household per day emerges from an energy service perspective, and was computed based on a household's typical usage of basic electricity services in a day

2. **Duration** is defined as the average number of hours electricity supply is available in a day. The definition of tier boundaries for the duration reflects the limitation that limited hours of supply impose on households for utilising electricity services. Households with less than four hours of supply in a day are assigned to Tier 0. This is equivalent to almost not having any electricity. The subsequent tiers are defined as 4 to 8 hours (Tier 1), 8 to 20 hours (Tier 2), and beyond 20 hours of supply (Tier 3) in a day.

3. **Reliability** is another important factor that affects electricity consumption and which influences the need for alternative provisions. MTF defines reliability as a binary measure, based on the occurrence or absence of unscheduled outages. As unscheduled outages are a common phenomenon in rural India (as in urban India), this approach would lead to an overestimation of the lack of electricity access. Short-term power outages are often used as a demand control or grid-balancing measure in India. In addition, momentary interruptions (less than five minutes) do not even figure in the reliability measurements used by utilities in India.[5] Therefore, we have estimated the reliability of electricity supply by enumerating the number of days in a month the household had no power supply (i.e., complete blackout for 24 hours), which usually results due to reasons other than intentional demand management by load dispatch centres. The lowest tier includes households that experience five or more blackout days in a month, resulting in an 'extremely unreliable supply'. Tier 1 includes those households that witness two to four blackout days in a month. Households experiencing one blackout day in a month were assigned to Tier 2, and those without any blackout days were categorised as Tier 3.

4. **Quality** or the voltage level of the electricity supply can be assessed using multiple attributes, depending upon the context and end use. For the purpose of household access, we used voltage fluctuations—power surges and low-voltage instances—as key indicators of quality. Two measures were used—the number of days in a month the household experienced a voltage surge causing appliance damage (N_H), and the number of days in a month the household experienced low-voltage instances limiting appliance use (N_L). The threshold for these across tier levels were defined as below:

   a. Tier 3: $N_H = 0$ & $N_L = 0$
   b. Tier 2: $N_H = 0\text{-}1$ or $N_L = 0\text{-}3$
   c. Tier 1: $N_H = 0\text{-}3$ or $N_L = 0\text{-}6$
   d. Tier 0: $N_H > 3$ or $N_L > 6$

5. **Affordability** is measured using a binary tier structure (Tier 1: unaffordable; Tier 3: affordable). Households are categorised as having an affordable electricity supply if less than four per cent of their monthly expenditure is spent on a threshold level of electricity consumption. This threshold level was defined as the consumption of 1 kWh per household per day. This definition of the *threshold level* emerges from an energy service perspective, and was computed based on a household's typical usage of basic energy services (lighting, fans, television, and mobile charging) in a day.[6]

5 Based on grid reliability numbers, even in states such as Karnataka that exhibit higher levels of development, the average rural area experienced more than eight outages a week, with the total outages exceeding 300 minutes a week (CEA, 2014).

6 1kWh of electricity would be equivalent to 6–8 hours of lighting (2–3 units), 8–10 hours of fan use (1 unit), 2–3 hours of TV use (1 unit), and mobile/radio charging. Essentially, the expenditure on such energy services should be within the affordability limit. Over 90 per cent of the households in our 2015 survey indicated that lighting, fans, and TV (in that order) and mobile charging were the top priority services they would consume if given an electricity connection. This also helped us validate the minimum set of energy services to be considered for determining affordability thresholds.

While discussing affordability, it is difficult to define a normative threshold for the affordability ratio below which the energy would be termed as affordable. However, there exists a precedent in the literature, where governments and international agencies have tried to establish such normative limits for different energy expenditures in order to design policies for safeguarding vulnerable or low-income groups (Bartl, 2010; Fankhauser & Tepic, 2007). A meta-analysis of these cases indicates that such a limit is about 10 per cent of the total household expenses for the overall energy expenditure.

The limit of four per cent of monthly expenditure on basic consumption of electricity was arrived at by analysing two empirical observations regarding household expenditure patterns. The first was the affordability ratio as defined above. The second was the spending on electricity as a share of the household's total energy expenditure (~40 per cent), which was the mean value from the consumer expenditure data in the National Sample Survey (Jain, Agrawal, & Ganesan, 2014). Combining these two factors, four per cent of household expenditure was used as affordability limit for consuming threshold (basic) level of electricity.

MTF defines the affordability of energy expenditure on the basis of its ratio to the household's monthly income, rather than as a share of the household's monthly expenditure. Given the lack of data, and the difficulties associated in seeking income information in surveys, we opted to use monthly expenditure figures for our estimation. Households are much less reluctant to share expenditure figure than to share income figures. Also, for certain professions which are prevalent in rural India, such as farming, the income cycles are not monthly, making it difficult to impute.

The recurring monthly expenditure (not capital expenses) on electricity for various households was estimated based on the type of connections as follows:

a. **Grid-connected households:** Information about connection status (metered or unmetered) from our survey, along with the published tariff structures (corresponding to metered and unmetered connections, and applicable slab rates for 30.5 kWh/month), were used to calculate expenditure towards electricity. This value along with household's over monthly expenditure were used and to determine the affordability tier.

b. **Off-grid households:**
    i. Households that did not have a regular monthly outlay, such as those that owned solar home systems or solar lanterns, were categorised into the 'affordable' tier.
    ii. For households using off-grid electricity services (i.e., either connected to a microgrid, or rented or pay-as-you-go solar home system or solar lantern), their reported monthly outlay was used to estimate their electricity affordability level.

6. **Legal status** pertains to whether the payment for electricity consumption is made to the legal entity that supplies the electricity (directly or indirectly). In terms of this dimension, the household electricity connections were classified as being legal or illegal (binary). This was done on the basis of their response to a specific question which identifies the entity to which the periodic payments (if at all) are made, against the metered/unmetered consumption. An illegal connection could refer to the unauthorised tapping of electricity from the mains as well as the non-payment of bills for a legal connection. Legal status may not affect the electricity consumption of an individual household directly, but due to the shared nature of the electricity grid, it does indirectly influence system reliability, quality, and affordability of electricity. Hence, it is important to capture this dimension while measuring energy access.

Clean cooking energy access

Literature on access to cooking energy is significantly limited compared to electricity access. Based on our past work on clean cooking energy (Jain, Choudhary, & Ganesan, 2015), as well as our discussions with multiple experts and stakeholders, we identified five pertinent dimensions to capture access to cooking energy: health and safety, availability, quality, affordability, and convenience.

TABLE 2: Multidimensional, multi-tier framework to assess cooking energy access

	Tier 0	Tier 1	Tier 2	Tier 3
Health and safety	Only traditional fuels are used (firewood, dung-cakes, agricultural residue)	A mix of traditional fuel and BLEN (biogas, LPG, electric, natural gas) is used		Only source of cooking fuel is BLEN
Availability	Cooking less because of lack of availability	Unsatisfied with availability	Neutral to availability	Satisfied with availability
Quality	Quality of cooking is not adequate		Quality of cooking is adequate	
Affordability	Not affordable		Affordable	
Convenience	Both difficult to use and time-consuming		Either difficult to use or time-consuming	Neither difficult nor time-consuming

NOTE: For dimensions where the categories span multiple tiers, only the higher tier values apply. For example, households can only be ranked Tier 1 or Tier 3 for the quality and affordability dimensions, or Tier 0, Tier 2, or Tier 3 for the health and safety dimension.

Source: CEEW analysis, 2015

1. **Health and safety** pertains to the impact on health due to the indoor air pollution that results from the use of the cooking arrangement. It is one of the most significant dimensions to consider, as indoor air pollution associated with the use of traditional fuels, is a major public health burden leading to millions of pre-mature deaths annually. There are two components—the cookstove and the fuel—that determine the level of indoor air pollution. Apart from this, the environment—i.e., the openness and size of the cooking area, extent of ventilation, and proximity of the person to the cookstove—also determines the exposure of individuals to emissions. Continued exposure over time also influences the extent of the health impact. Ideally, to determine the exact levels of exposure and to categorise households into tiers, a multi-seasonal emission exposure profile must be created for each household. However, such an exercise is well beyond the scope of this work. Instead, conservative estimates were made regarding the performance of households in this dimension using the following approach.

    a. Households that use only traditional fuels were assigned to the bottom-most tier, irrespective of the type of cooking device and the surrounding environment. We opted to take this conservative approach for three main reasons. First, in India, the device most commonly used to burn traditional biomass is still the traditional *chulha*. Second, the penetration and use of improved cookstoves is very low. Third, there is a significant gap between the on-field performance and theoretical performance of improved cookstoves. All of these together lend support to this conservative estimation of tiers.

    b. Households that stack traditional fuels with cleaner fuels (biogas, LPG, and electricity) were categorised as Tier 2. The impact of transition to cleaner fuels varies based on the extent to which traditional fuels are replaced. Those who cook mostly using cleaner fuels are more likely to reap greater health benefits compared to others who use them to a lesser extent. However, since the exposure to emissions also depends on other factors such as the ventilation of the cooking area, the individual's proximity to cookstove, and the type and quality of the biomass, we categorised all households that use any amount of traditional fuel along with cleaner fuels into Tier 2. Moreover, the challenge of all these households is the same—stacking. So, we put them in a common tier for the health and safety dimension.

c. Households using only clean fuel for cooking were ranked in the top tier, i.e., Tier 3.

This is a significant departure from the criteria used in the MTF for assessing households in terms of health and safety. The MTF uses information on the type of cookstove owned to compute this indicator; however, as discussed, only the type of cookstove cannot effectively determine the health impact associated with the cooking arrangements in a household.

To estimate cooking energy expenditure, we considered the market price of the fuel and used this in conjunction with the total quantity of fuel that was procured (from a vendor/local market)

2. **Availability** captures the availability of the primary cooking fuel for a particular household. A reduced availability of the primary fuel could either lead to stacking of other (often inferior) fuel types, or worse, to the curtailment of cooking itself. It is assessed on the basis of the household's satisfaction with the availability of their primary cooking fuel.[7] Households that face availability issues, to the extent that it limits their cooking, were assigned to Tier 0. Those who were unsatisfied with the availability of their primary cooking fuel were assigned Tier 1. Tier 2 captures the households that are neutral about cooking energy availability. Finally, those who are satisfied with the availability of their cooking fuel were assigned to Tier 3.

3. **Quality** primarily covers the quality of the cooking that can be achieved using the primary cooking arrangement. This binary dimension is assessed by analysing the household's view on whether its primary cooking energy arrangement cooks food adequately or not. Use of cookstoves that are unsuitable for particular utensils or cooking needs (local dishes), or fuel adulteration leading to improper combustion, could result in poor-quality cooking.

4. **Affordability** was measured by calculating the household's expenditure on all types of cooking fuels. If this amount was less than six per cent of the household's total monthly expenditure, then the household was classified in the affordable tier (Tier 3). We used six per cent as the threshold amount spent on procuring cooking energy based on an analysis carried out by Jain, Agrawal, & Ganesan (2014). The MTF considers only the affordability of the primary fuel used for cooking. In a significant departure from this assumption, this framework considered the overall expenditure on all cooking fuels in order to effectively capture the fuel stacking that is prevalent in many rural Indian households. To estimate this expenditure, we considered the market price of the fuel and used this in conjunction with the total quantity of fuel that was procured (from a vendor/local market) to calculate the expenditure. For the purposes of the affordability analysis, no monetary value was assigned to biomass that was collected free of cost.

5. **Convenience** of cooking could be attributed to multiple factors like the time taken for cooking, ease of handling cooking appliances, ease of flame control or heat intensity, quick start-stop operation etc. Some of these attributes are desirable while others are necessary – each is given a different importance by individual households. For the purpose of energy access determination, we have used two basic criteria—an ordinal estimate of the time consumed for cooking and the ease of cooking with the primary cooking arrangement. Households that reported that their primary cooking arrangement was both time-consuming and difficult to use were assigned Tier 1 status. Those who reported any one of the two criteria as a problem with their primary cooking arrangement were classified into Tier 2. Households that reported that they faced neither of these issues were categorised as Tier 3.

We used the same approach as the one adopted for analysing electricity access to determine the overall cooking energy access tier of a household (minimum across all dimensions). To address the subjectivity in defining the thresholds for various tiers, we undertook a sensitivity analysis by studying two alternative scenarios with each having varying cut-off points for each dimension. We found that the current tier structures and their cut-off points were fairly robust across the six states that were surveyed. The details of the same are available in ACCESS 2015 report.

7 Due to the lumped nature of cooking fuel (except in case of piped gas supply or electricity, both of which are virtually non- existent in rural India), the availability of fuel in itself captures the reliability of fuel supply. An unreliable supply would lead to lower levels of satisfaction with fuel availability.

Aggregation of household results

Once the overall tiers for each household were determined (separately for both electricity and cooking energy), we aggregated the results to create two indices (electricity and cooking) at the state and division levels through a population-adjusted weighted average approach. In mathematical form, this can be understood as:

$$E = k \sum_{i=0}^{3} f_i . i$$

Where E is the electricity index at the state/division level, k is a constant with value 100/3 used to normalise the index to a scale of 100, f_i is the fraction of households in i^{th} tier for electricity access, and i is the tier level. For example, at the state level, if the proportion of households falling into Tier 1 and Tier 3 was 40 per cent and 60 per cent respectively, then the overall access index for the state would be $(0.4 \times 1 + 0.6 \times 3)100/3 = 73.33$. As a result of this formulation, the aggregated index value can take values from 0 to 100 (100 being the best possible index that can be achieved). The same approach as described above is used to calculate the cooking energy access index (C) as well.

Survey and data gathering

Given the level of details and data points required to assess the energy access situation as per the proposed framework, none of the existing datasets such as the Census, National Sample Survey (NSS), or India Human Development Survey (IHDS) could be used. In order to understand the true state of energy access and its barrier and drivers, and to empirically test our proposed energy access measurement framework, we conducted a large-scale primary survey exercise. In 2015, we surveyed 8,568 households across six states—Bihar, Jharkhand, Madhya Pradesh, Odisha, Uttar Pradesh, and West Bengal. Together, these states house approximately 500 million people (almost 40 per cent of the Indian population) and exhibit some of the lowest levels of energy access in the country. In 2018, we surveyed 9,072 households, as opposed to 8,568 households surveyed in 2015. The increase in the number of households surveyed was due to the expansion of the study to three additional districts in Odisha in 2018, to increase the sample size for the state. We surveyed 504 additional households across three new districts (one in each administrative division) in Odisha. In addition to the household survey, we also conducted a village-level survey with a representative such as a village head, Gram Sabha member, primary school teacher, or any person who has knowledge about the village to gather information on the energy access situation at the village level. In total, we interviewed 756 village representatives, one in each village.

A brief summary of the survey design and its implementation, including the various stages, is provided below.

Questionnaire design

We started with the rigorously piloted, tested and utilised questionnaire of 2015, which had 155 questions in all. While we removed some of the old questions given the evolution of the context on the ground, we added 27 new questions to cover three broad components—i) the identifiers to categorise households according to Socio-economic Caste Census (SECC) deprivation criteria; ii) LPG refills, fuel stacking, and intra-household decision-making regarding the purchase on LPG cylinders; and iii) willingness to pay for electricity and LPG using an experiment approach. The final questionnaire was designed to be completed in 40–45 minutes, while the median time taken per interview was 37 minutes. The questionnaire encompassed the following broad sub-sections:[8]

1. Socioe-conomic information of the household
2. State of electricity access
3. Electricity access-related satisfaction

8 The complete survey instrument, both at the household and village level, is available at http://ceew.in.

4. State of cooking energy access
5. Cooking energy-related satisfaction
6. Policy preferences of the household
7. Willingness to pay for electricity and LPG

Sampling

In 2018, we interviewed the same households that were surveyed in 2015. For ACCESS 2015, we used the random sampling approach with multiple levels of stratification. The same is explained in this paragraph. States in India are geographically divided into administrative divisions. Given logistical and resource constraints, we sampled one district from each division, while ensuring a geographically representative sample. Both West Bengal and Odisha has only three large administrative divisions, each. Each such division has a significant population. While, we had two districts from each division for West Bengal in 2015, and one district from each division in Odisha. In 2018, we added three new districts in Odisha, one from each division.

Using 2011 Census data, we first split villages in each district into two groups: small and large villages, based on their population size. Each group consisted of 50 per cent of all the rural households in the district. Next, seven villages from each group were chosen at random in every district. This categorisation into large and small villages was necessary to ensure that the specific challenges faced by small and big villages would be captured adequately. Finally, 12 households were randomly selected from each village. Even within the villages, we tried to ensure a representative sample across different habitations/hamlets within the village. In 2018, we retained the same sample size for all states, except Odisha, where we added three new districts across the three administrative divisions.

The number of districts, villages, and households surveyed in each state in 2018 are shown in Table 3.

TABLE 3: Sampling strategy for the six states

State	Divisions	Districts	Villages	Responses
Bihar	9	9	126	1,512
Jharkhand	5	5	70	840
Madhya Pradesh	10	10	140	1,680
Odisha	3	6	84	1,008
Uttar Pradesh	18	18	252	3,024
West Bengal	3	6	84	1,008
Total	48	54	756	9,072

Source: CEEW analysis, 2018

To interview the previously surveyed households, the enumerators identified them based on identifier information including name of the household head, its address, and phone numbers, which had been recorded during ACCESS 2015. We ensured that we interview the head of the household as was done in 2015. If the head of the household was not available, then the enumerators interviewed any other willing adult member of the household. If the entire household was not available or unwilling to participate, it was replaced by the fifth household on the right of the original household. In all, we were able to interview 86 per cent of the households surveyed in 2015. For the new households, we used the same protocol of looking for the head of household or a willing adult member. To answer the questions in the cooking energy section, we requested the primary cook of the household to be present during that section of the survey.

We were able to interview 86 per cent of the households surveyed in 2015

The retention rate of original households by state is shown in the table below.

TABLE 4: Retention rate of households by state

State	Responses	Proportion of old households interviewed
Bihar	1,512	82%
Jharkhand	840	84%
Madhya Pradesh	1,680	77%
Odisha*	1,008	82%
Uttar Pradesh	3,024	92%
West Bengal	1,008	88%
Total	9,072	86%

*In Odisha, the retention rate only pertains to the sample of 2015, which is 504.

Source: CEEW analysis, 2018

Data collection and cleaning

For the data collection, we trained and selected enumerators through role-playing exercises. We also conducted in-person training sessions for each team of enumerators. Further, as far as possible, we tried to design a self-contained questionnaire that included clear instructions so as to avoid any confusion. The enumerators who did not meet expectations were re-trained or dropped from the survey. Prior to the analyses, we also carried out a thorough quality check of the data for any incorrect recording of observations, missing values, and outliers.

As an evolution from 2015, where we had used paper-based surveys, we used digital devices (tablets) for data recording in 2018. We used the application SurveyCTO to collect the data electronically and to ensure better monitoring and control in real time. The application allowed us to set up automated quality checks, conduct random audio audits, and get standardised reports as per the research needs. We could also track the time taken to answer each question in the survey and request re-collection of data whenever the quality was unsatisfactory.

To ensure that the research meets ethics standards, we communicated the objective of the survey to every respondent, the approximate time of the interview, and the nature of the questions to be asked. We also took written or verbal consent, depending on the comfort level of the respondent. In case of written consent, we collected the signature of the respondent. In case of verbal consent, the enumerator confirmed the approval of the respondent and signed on the form.

Limitations

While the framework has been developed keeping in mind the nuances associated with the state of energy access in India and has tried to be capture of the ground realities of energy, it does have certain limitations. Listed below are the points that must be noted while using this framework.

The actual survey was conducted in three different languages, Hindi, Odiya, and Bengali

1. First and foremost, evaluation of the framework is based on the stated responses of respondents in a face-to-face survey. Many of the questions on energy consumption levels rely on the ability of the respondents to recall their energy consumption over the past month (or an average level over a longer period). To this end, all the information may not be entirely accurate. But given the lack of a better alternative to gather this kind of detailed data from households, this limitation appears to be a necessary evil.
2. Further, there were a few questions for which a few households were not able to respond. For some such questions that were not perception-based, we imputed values for the missing data points. These include data points for questions such as "What is the market price at which wood is sold in your locality/village?" We input the data based on the media value of the habitation and village.
3. One main change in the method to estimate household expenditure on LPG is worth noting. In 2015, before direct benefit transfer for LPG, we had used respondent reported value for the cost of LPG cylinder from a distributor to estimate household expenditure on LPG. However, given the regular fluctuation in price and corresponding subsidy into the bank account after the implementation of DBTL, it is difficult to obtain this value from the households in a reliable manner. Hence, we used district-wise price of subsidised cylinder as listed at the website of Indian Oil Corporation Limited (Indane).[9] The real price (after adjusted for subsidy) that a household is paying in that district could be different from the listed price on the website.
4. The previous round of ACCESS (2015) survey was conducted primarily in the winter months, from December 2014 to March 2015. The re-survey for Odisha was conducted in May 2015. In 2018, the survey was conducted in the spring and summer months—from March to June. This seasonal variation in the time of the survey could have influenced responses pertaining to the demand and supply of electricity, quality of electricity supply, and the satisfaction of households with existing services.
5. The questionnaire was carefully designed, and the enumerators were rigorously trained to minimise bias and avoiding leading the respondents. Wherever discrepancies were observed (in the data), the survey agency was asked to either cross-verify the information or redo the survey. Re-surveys were done for households where the quality of the data was doubtful. Despite these efforts, it is likely that some responses could reflect the enumerators' bias or their interpretation of the context for a question.
6. Assumptions had to be made in places where specific questions to elicit the required response were difficult to administer. For instance, we assumed that all the houses connected to the grid were connected at a capacity of more than 1 kW. Establishing the connected load in each household is a tedious task and beyond the scope of the survey. The same capacity assumption is used to estimate electricity expenditure charges towards threshold electricity consumption. Further, tariff orders for Uttar Pradesh and West Bengal could not be found for 2018–19. Earlier tariff orders from 2016–17 and 2017–18 were used for West Bengal and Uttar Pradesh, respectively, to estimate the affordability metrics.
7. Talking about affordability, this measure strongly depends on the monthly household expenditure as reported by the respondent. While the NSS estimates monthly household expenditure in an itemised manner, we use only a single direct question to gather the same information, thus introducing the possibility of recall bias. Moreover, the fact that a portion of rural expenditure could be in kind or from home-grown sources could further complicate the actual estimation of monthly expenditure values.

9 Extracted from https://indane.co.in/tarrifs_price.php?mode=Search&txtMarket.

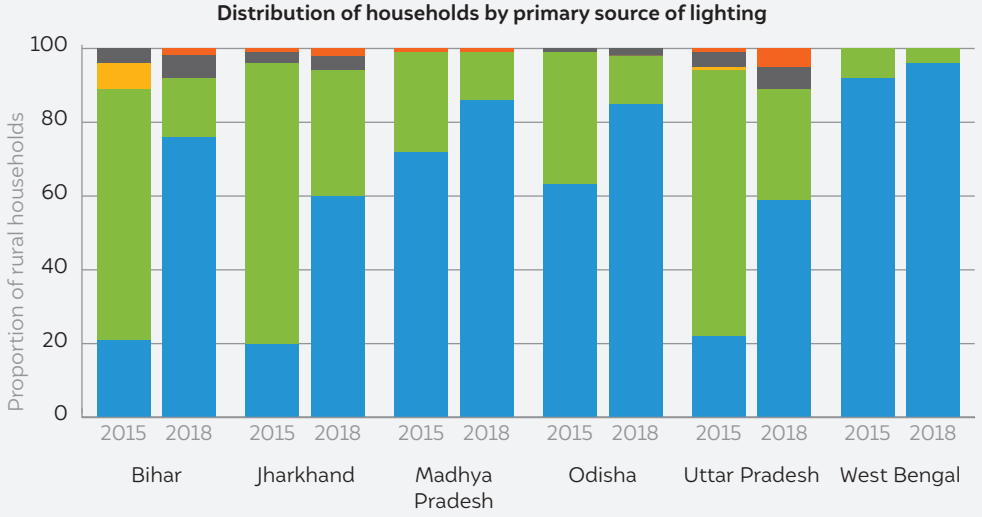
8. The actual survey was conducted in three different languages, Hindi, Odiya and Bengali. Significant effort was made to control (and prevent) translation and interpretation errors. Our team had researchers who could read, write, and understand Hindi, Odia, and Bengali. However, given the nature of the survey, the level of comprehension of the respondents, and the differences in dialect across regions in every state, there is a likelihood that some questions may not have been administered as expected for some households.
9. The threshold levels for the tiers have been constructed using the best-available knowledge and information. The interpretation of the results from the multi-tier framework is contingent on the definition of the tiers. However, given the absence of published literature on this topic, the threshold levels for the tiers can be a point of contention. We hope that in subsequent rounds of this exercise, academic research catches up and provides us with more a concrete basis for defining the tiers.
10. It is also worth acknowledging the possibility that the tier-specific analyses may carry some bias as a result of reporting bias in the questions that inform which tiers households are assigned to for each dimension of cooking energy and electricity access. Although much of the movement of households across tiers since 2015 is perhaps due to actual changes in access to energy, some of it may well be the result of reporting errors by households in 2015, or in 2018, or in both .

Image: Sasmita Patnaik/CEEW

3. State of Electricity Access

Since ACCESS 2015, we witnessed many milestone achievements and the setting of new targets to improve the state of electricity access in India. As per ACCESS 2018, 84 per cent of households in six states are already connected to the grid, and around 80 per cent depend on grid electricity and solar home systems and/or lanterns for their primary lighting needs. This presents a brighter picture than 2015. Three years ago, more than 50 per cent of these households were relying on kerosene to meet their lighting needs.

FIGURE 1: The use of grid electricity has increased in every state



	Bihar		Jharkhand		Madhya Pradesh		Odisha		Uttar Pradesh		West Bengal	
Others	0%	2%	1%	2%	1%	1%	0%	0%	1%	5%	0%	0%
Solar home system/ lantern	4%	6%	3%	4%	0%	0%	1%	2%	4%	6%	0%	0%
Microgrid	7%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%
Kerosene lamp/ lantern	68%	16%	76%	34%	27%	13%	36%	13%	72%	30%	8%	4%
Grid	21%	76%	20%	60%	72%	86%	63%	85%	22%	59%	92%	96%

Source: CEEW analysis, 2018

As of 4 October 2018, nine per cent of rural households across India are yet to be electrified; the ambitious *Saubhagya* scheme aims to achieve 100 per cent household electrification by March 2019. It is worth noting that the pace at which the scheme is implemented has shot up tremendously in the last few months. If it is realised this year—or even a few months into the next—we are not far from witnessing 100 per cent household electrification across the country. It will, however, remain a challenge to ensure a reliable, affordable, and quality 24-hour power supply to each household—another target set by the government—and to ensure its sustained use by consumers. In this regard, we present our findings and analyses of electricity access in six of the most energy-deprived states from a multi-tiered and multidimensional perspective.

The pace at which the *Saubhagya* scheme is being implemented has shot up tremendously in the last few months

Over the last three years, we have observed a significant improvement in the electricity access situation in five of the six states studied. Looking at the electricity access index, a multidimensional multi-tier measure, on a scale of 0 to 100, West Bengal continues to perform the best among the six states despite having witnessed a decline of about three points in its absolute score since 2015. Odisha has further improved its electricity access situation with an increase in its score from 24.0 to 35.3. Bihar, which has more than tripled its score, is now at 27.8 on this scale. Madhya Pradesh and Uttar Pradesh have more than doubled their scores, from 16 to 33.9 and 10.7 to 24.4, respectively. The variation in the scores of these states has reduced since 2015, indicating a decrease in electricity access disparity. However, such a reduction in disparity can only be celebrated if all states progress in absolute terms, which is the case for all but West Bengal.

TABLE 5: Aggregate electricity access indices in 2015 and 2018

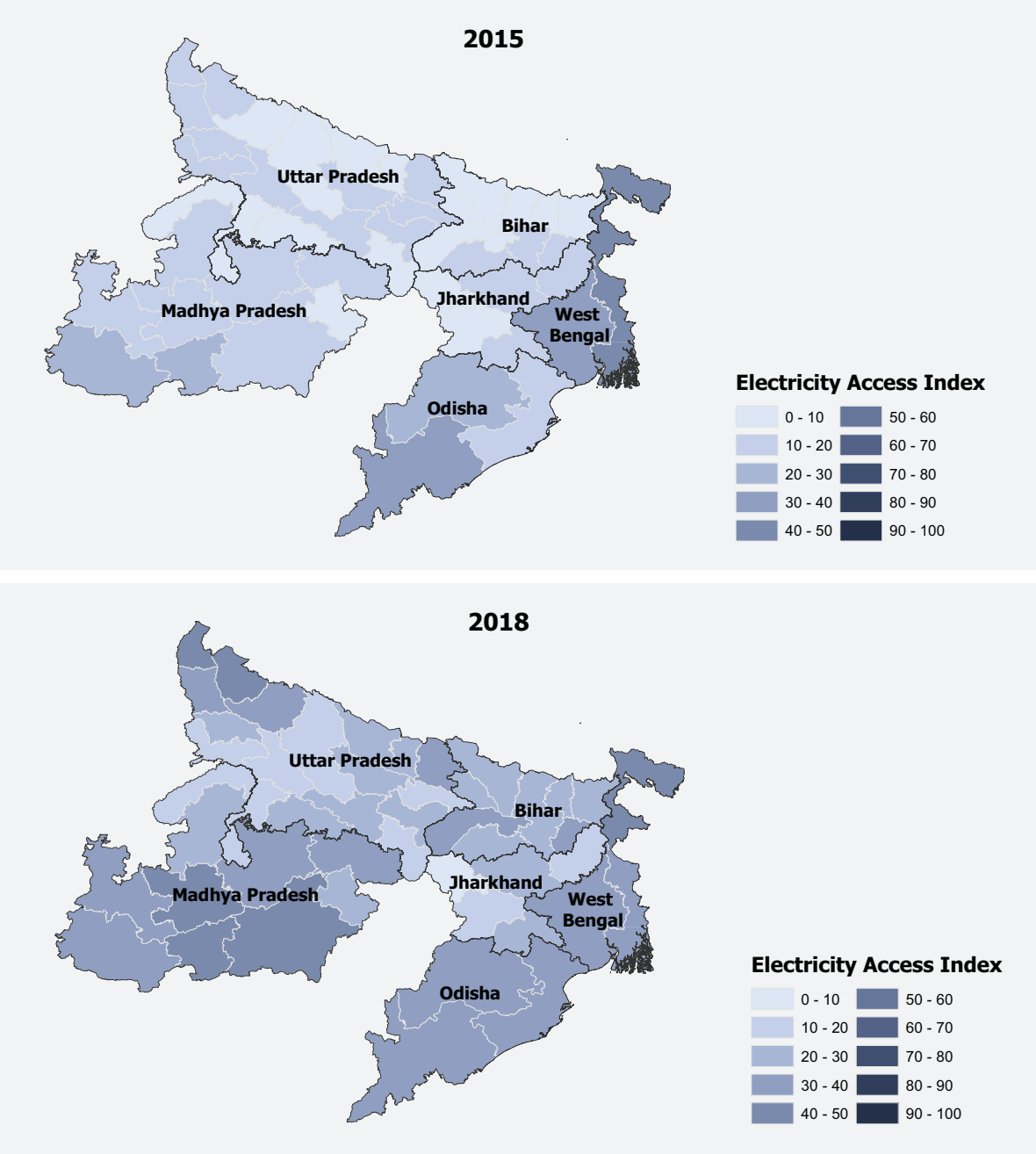
State	Aggregate electricity access index		Percentage increase in index value
	2015	2018	
Bihar	8.3	27.8	242%
Jharkhand	10.7	19.0	72%
Madhya Pradesh	16.0	33.9	109%
Odisha	24.0	35.3	50%
Uttar Pradesh	10.7	24.4	118%
West Bengal	41.3	38	-8%
Mean	**18.5**	**29.7**	
Coefficient of variation (CoV)	**0.62**	**0.24**	

Source: CEEW analysis, 2018

The map below indicates the electricity access situation in each administrative division across the six states. Darker shades represent better access to electricity. Most areas across these states are still represented by lighter shades, revealing the vast gap that needs to be closed in order to provide the best-quality electricity to all. No state has achieved an electricity index score beyond 60. There is also a fair degree of variation in the shades assigned to different divisions within a state. For instance, within Jharkhand, the Palamu division features the lightest shade with a score of four, while the North Chotanagpur division is two shades darker, and its score is six times higher.

Most areas across these states are still represented by lighter shades, revealing the vast gap that needs to be closed in order to provide the best-quality electricity to all

FIGURE 2: Electricity access indices across six states in 2015 and 2018



Note: The index is a composite score with range from 0-100, representing the overall electricity access situation in the region by considering the proportion of households in each tier of electricity access. Zero means all households are in Tier 0, and 100 means all households are in Tier 3.

Source: CEEW analysis, 2015, 2018

In order to understand the issue at a granular level and identify key areas of action, the subsequent sections of this chapter shall provide in-depth analyses of the issues in each state.

3.1. Bihar

Darkness no longer looms over Bihar; rural areas in the state have gained substantial access to electricity over the last three years. In ACCESS 2018, about 75 per cent of the respondents in the state reported using grid electricity as their primary source of lighting, compared to only 20 per cent in 2015—an increase of over 250 per cent. This dramatic rise in the dependence on grid electricity has happened along with, and largely due

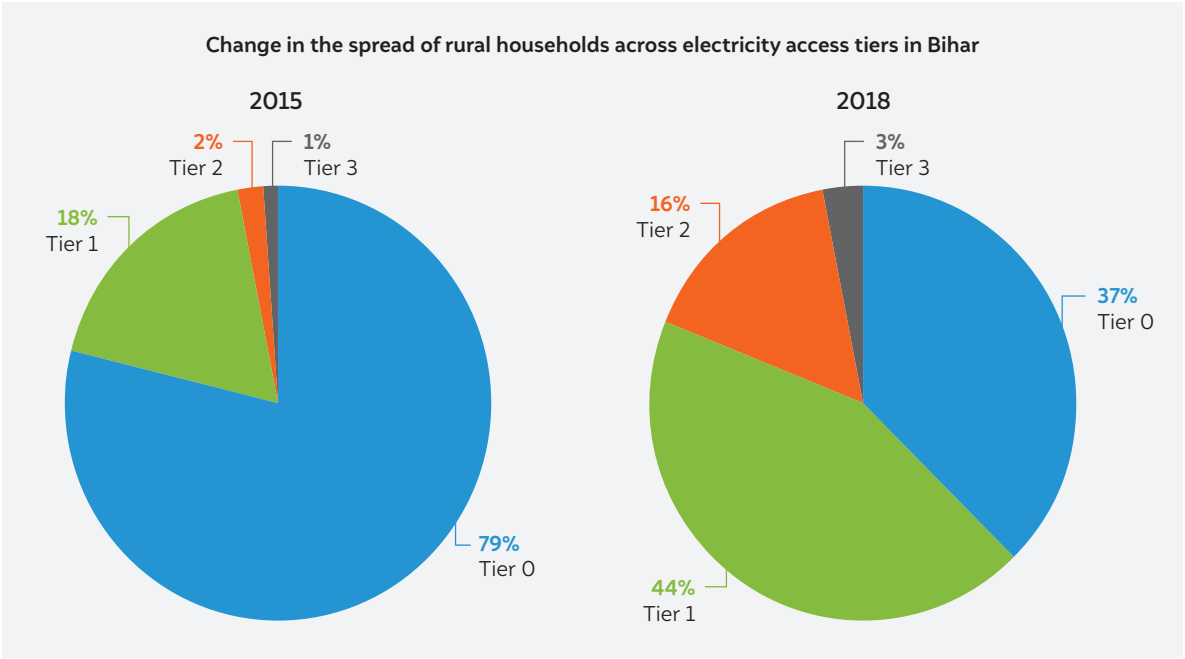
to, the massive jump in the proportion of electrified households—from 41 per cent to 88 per cent. It is also important to note the reducing gap between electrified households and those using the grid as their primary source of lighting. This is testimony to the overall improvement in the state of power supply in Bihar, at least from the perspective of consumers.

As expected, the increased use of grid electricity has led to a massive decrease in the proportion of households using kerosene as the primary source of lighting across the state—from 68 per cent in 2015 to 16 per cent in 2018. In addition, the use of diesel microgrids, or diesel-powered gensets, has become negligible, having reduced from 13 per cent of households reporting its use in 2015 to 0.3 per cent in 2018. The use of solar home systems and solar lanterns for lighting has increased from 7 to 16 per cent.

About 75 per cent of the respondents in the state reported using grid electricity as their primary source of lighting, compared to only 20 per cent in 2015

Even on a multi-tiered, multidimensional metric, a massive proportion of rural households–42 percentage points–in Bihar have moved up from Tier 0 to higher tiers over the last three years. Despite these positive shifts, there is still much to achieve, as over 81 per cent of rural households remain in Tiers 0 and 1. Also, while there has been a significant upward movement among households across tiers, downward movements have also happened. For instance, one-third of the erstwhile Tier 1 households have slipped to Tier 0, mainly on grounds of deteriorating quality and reliability of supply experienced by such households.

FIGURE 3: A reduction by more than half of Tier 0 households in Bihar

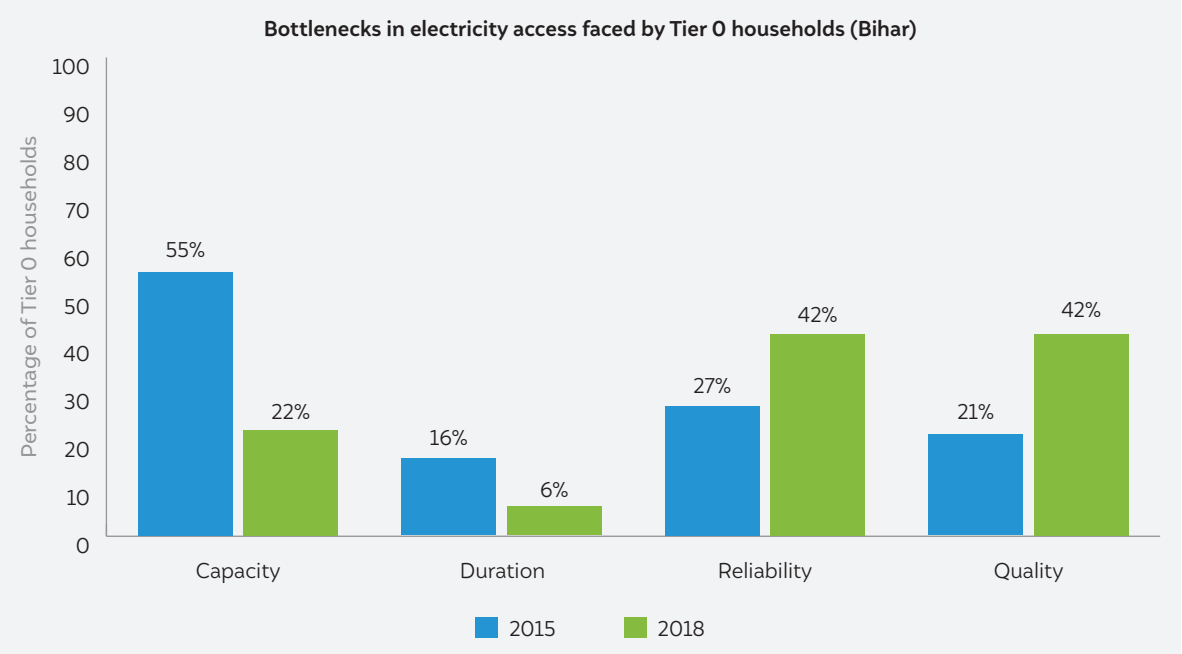


Source: CEEW analysis, 2018

Tier 0 households in Bihar

With improved electrification, lack of capacity has become less of a concern, whereas reliability and quality are now the major challenges at Tier 0. A majority of Tier 0 households suffered five or more day-long blackouts in a month indicating poor reliability. An almost equal number suffered at least four days with instances of voltage fluctuation, which caused damage to appliances, or at least seven days with instances of low voltage, which restricted appliance usage, indicating quality concerns. This implies that increased access to electricity has not necessarily translated into reliable and quality power for many. The issue of supply being available only for short durations is now a bottleneck for only six per cent of Tier 0 households—a reduced proportion.

FIGURE 4: Poor reliability and quality are major reasons limiting households at Tier 0 of electricity access

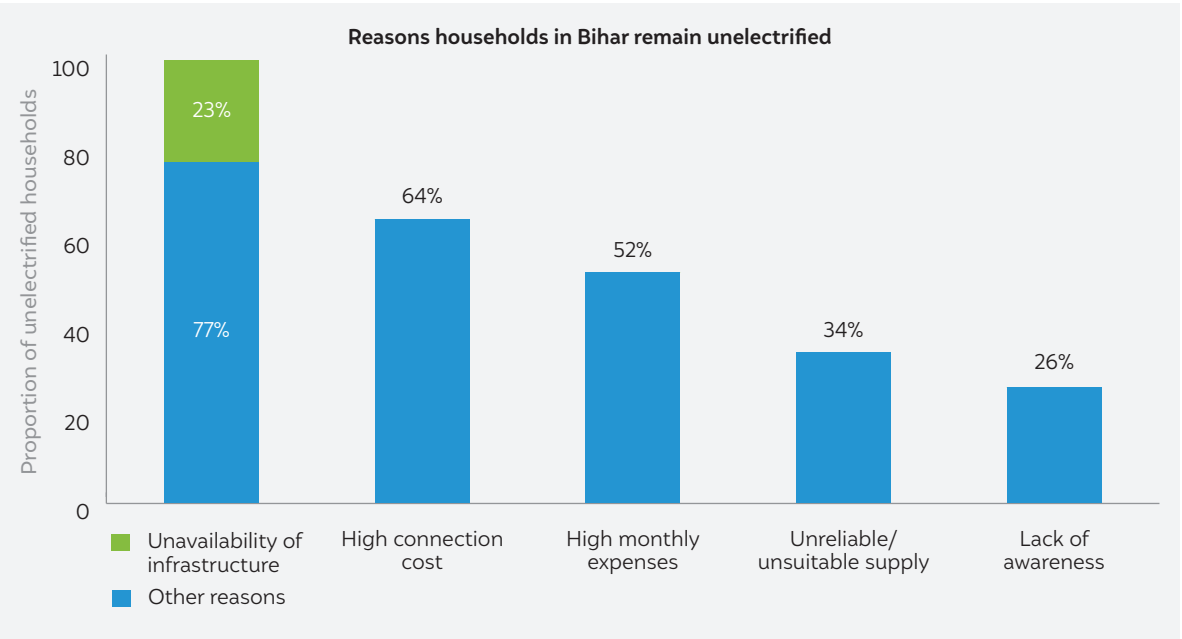


Source: CEEW analysis, 2018

Unelectrified households in Tier 0

Around 23 per cent of unelectrified households lack electrical infrastructure in their vicinity. The large number of households that do not have electricity despite the existence of the necessary infrastructure reported that high connection costs and monthly expenses limited their ability to obtain a connection. This is surprising, given that under the Saubhagya scheme, households can avail connections either free of charge or on instalments. It is possible that there is a lack of awareness of the free connection, or that consumers end up making some payment due to lax in implementation of the scheme at local level. In addition, a third of unelectrified households find the current electricity supply unreliable or unsuitable for their needs, and a quarter do not know how to acquire a connection.

FIGURE 5: High connection cost and monthly expenses limit households to get electricity connection in Bihar

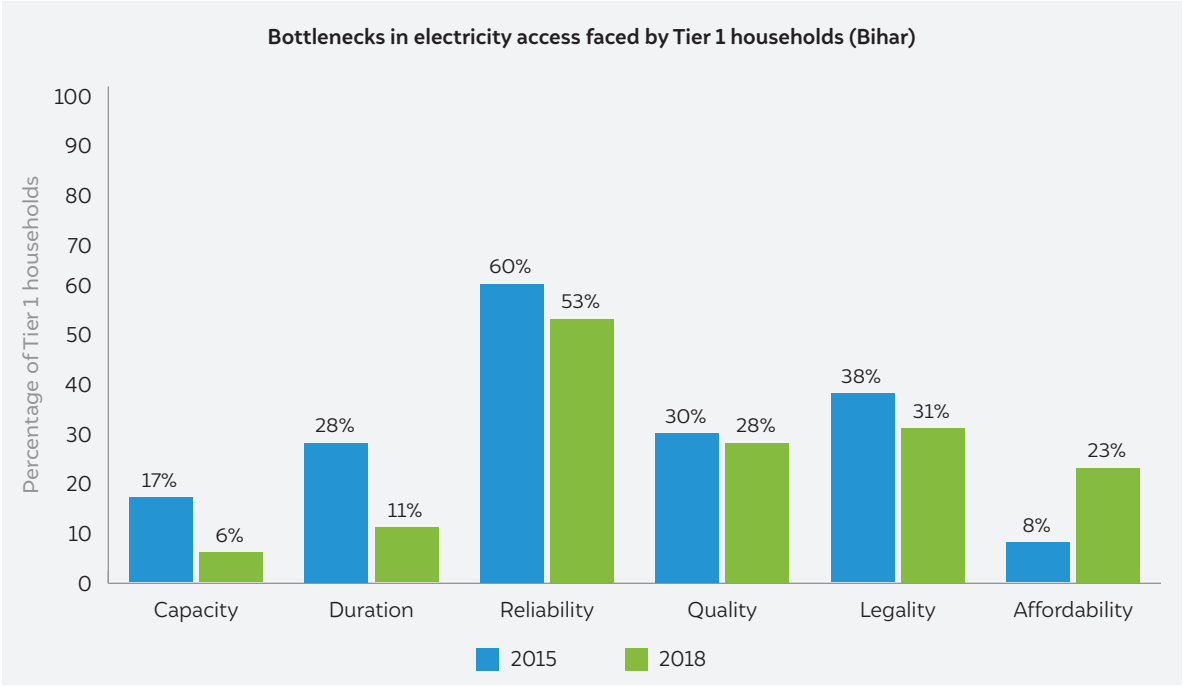


Source: CEEW analysis, 2018

Tier 1 households in Bihar

Tier 1, which includes maximum proportion of the rural households of the state, dominates the Bihar story. Despite a considerable improvement since 2015, the poor reliability of the power supply is still an impediment for 45 per cent of households in this tier. About a quarter of these households also reported receiving poor-quality supply. Further, almost one-third of households do not have legal electricity connections—this needs to be addressed to ensure that the service remains a viable proposition for discoms. Affordability, which was a barrier to only eight per cent of households in 2015, has emerged as a critical bottleneck for 23 per cent of households in 2018 because of the revision in monthly supply rates by both the discoms in Bihar over the last three years (BSPHCL, 2018; NBPDCL, 2014; SBPDCL, 2014). It is important to note that the rates for unmetered households in FY 2018-19 were significantly higher as compared to FY 2014-15 even after the generous subsidy from the state government. This gets testified by the fact that basic electricity is unaffordable for 55 per cent of unmetered rural households in Bihar as compared to merely five per cent of metered households. Higher level of tariffs for unmetered connections could be a deliberate effort by the state government to nudge households to get their connections metered. Now that electricity connections have been provided to households over a large section of Bihar, a focus on improving reliability, quality, legality, and affordability can ensure that households are able to adequately utilise and reap the benefits of electricity.

FIGURE 6: Unreliable supply remains the dominant challenge limiting households at Tier 1 in Bihar

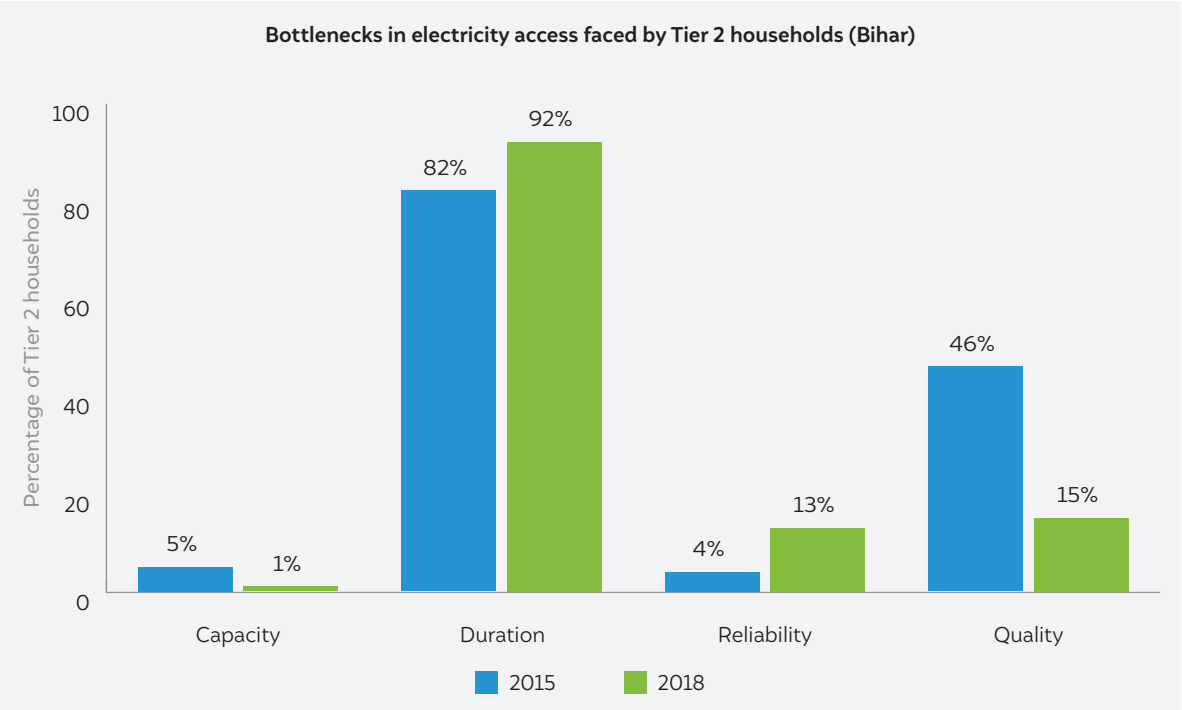


Source: CEEW analysis, 2018

Tier 2 households in Bihar

In Bihar, 16 per cent of households are categorised as Tier 2. Limited-duration supply is the main problem for Tier 2 households, evident from the fact that there has been almost no increment in the percentage of households receiving more than 20 daily supply hours since 2015. The quality and reliability of power supply are concerns for a much smaller proportion of Tier 2 households.

FIGURE 7: Duration is the key barrier for Tier 2 households in Bihar



Source: CEEW analysis, 2018

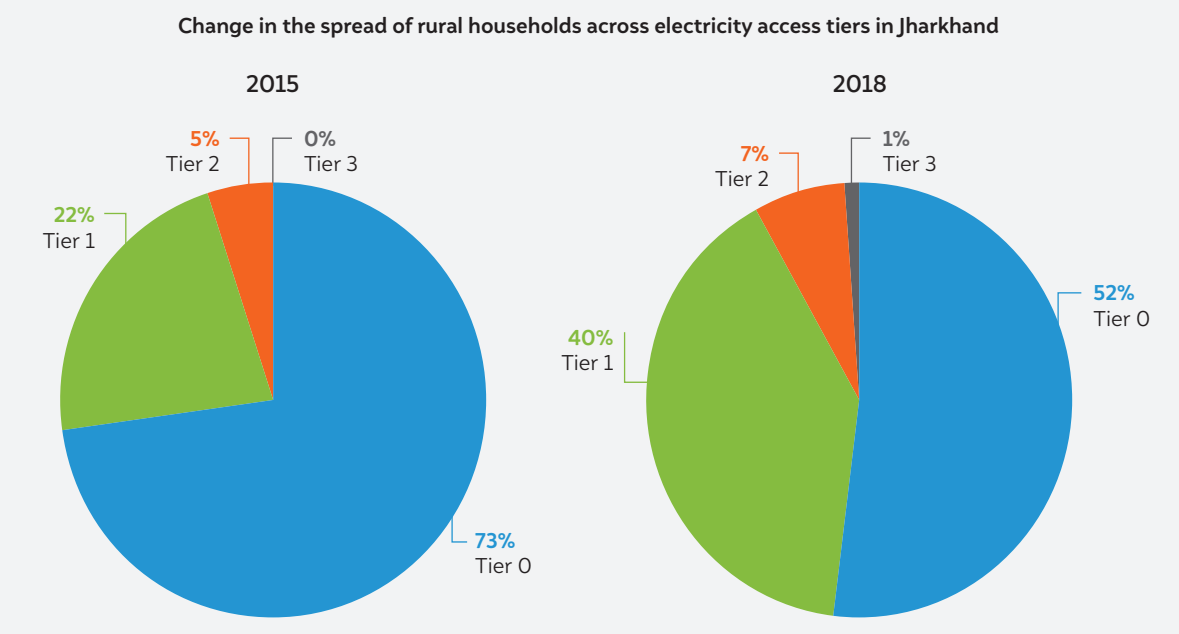
3.2. Jharkhand

Rural Jharkhand has seen a threefold increase in the number of households that rely on grid electricity as their primary source of lighting, from 20 per cent in 2015 to 60 per cent in 2018. In comparison, the household electrification rate has only increased from 64 per cent to 83 per cent. This indicates that the improvement in electricity supply has been good enough to meet most household lighting needs. There has been an extraordinary change in the use of kerosene over the last three years. The proportion of households relying on kerosene for their primary lighting needs has reduced by a whopping 42 percentage points, from 76 per cent in 2015 to about 34 per cent in 2018.

We observed a significant variation in the rate of household electrification among the five surveyed districts of Jharkhand, with Garhwa and Sahibganj reporting 65 per cent or less; and Bokaro, Ranchi, and Saraikela-Kharsawan reporting well over 90 per cent. It is important to note that given the pace of electrification under the *Saubhagya* scheme, the rate of rural household electrification across India is increasing rapidly, though unevenly.

Rural Jharkhand has seen a threefold increase in the number of households that rely on grid electricity as their primary source of lighting, from 20 per cent in 2015 to 60 per cent in 2018

FIGURE 8: The proportion of Tier 1 households in Jharkhand has almost doubled since 2015



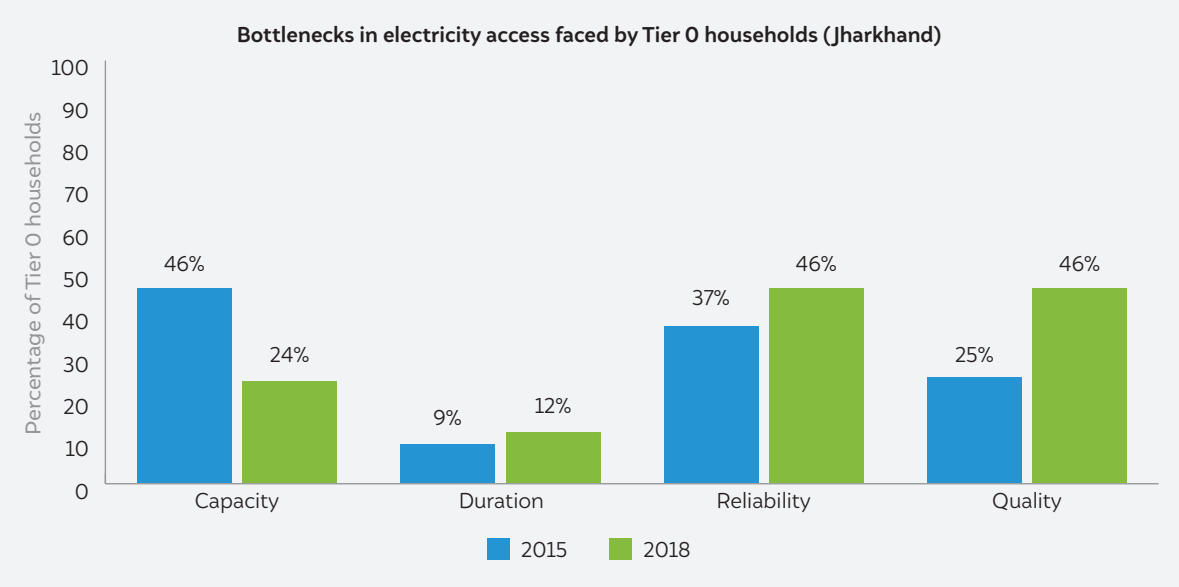
Source: CEEW analysis, 2018

On the multidimensional multi-tier metric, about one-fifth of rural households in the state have moved from Tier 0 of electricity access to higher tiers between 2015 and 2018. However, majority of them have moved to Tier 1 only. Despite some progress, more than half of the rural households in Jharkhand remain in the bottommost tier of electricity access—highest among the six state.

Tier 0 households in Jharkhand

The quality and reliability of power supply are the two biggest reasons why the remaining 76 per cent of Tier 0 households have not moved to Tier 1. Problems such as high voltage leading to equipment damage, and low voltage leading to low appliance usage persist; however, there has been a reduction in the overall number of days lost to voltage fluctuation. However, the issue seems more pronounced for Tier 0 households in 2018, as the absolute number of Tier 0 households has reduced and fewer households face the issue of capacity; instead, they experience other issues around electricity access, such as quality, reliability, and supply duration.

FIGURE 9: Reliability and quality-the biggest bottlenecks for Tier 0 households in 2018

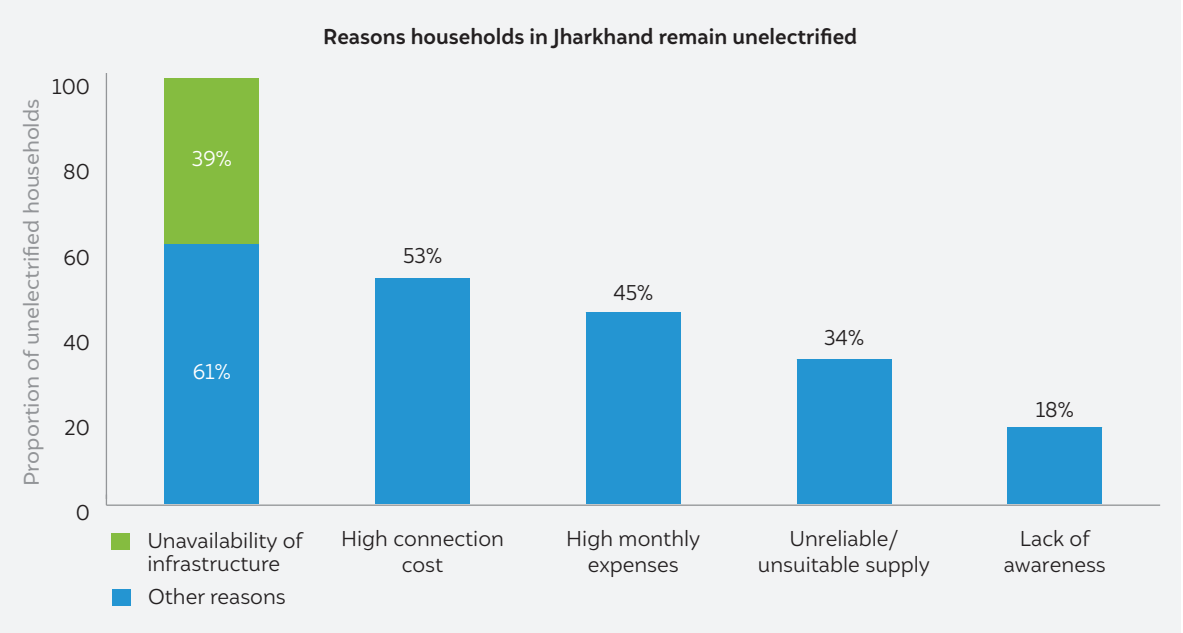


Source: CEEW analysis, 2018

Unelectrified households in Tier 0

At the time of conducting the survey, about 12 per cent of rural households in Jharkhand were not electrified, although this figure is reducing rapidly. About 40 per cent of the unelectrified households did not have grid infrastructure in their habitation. Even when grid infrastructure was available, a significant proportion cited steep connection costs and the high recurring expenses as reasons for not availing a connection. Unelectrified households viewing the high upfront cost as a barrier to electrification is somewhat surprising, as the *Saubhagya* scheme provides free connections to BPL households and accepts nominal payment in monthly instalments from non-BPL households. This could be the result of a lack of awareness or may reflect an implementation gap—despite the mandate to provide subsidised connections, local authorities or representatives may (illegally) charge households for installing connections.

FIGURE 10: The unavailability of grid infrastructure at the hamlet level is still a barrier for nearly 40 per cent of unelectrified households in Jharkhand



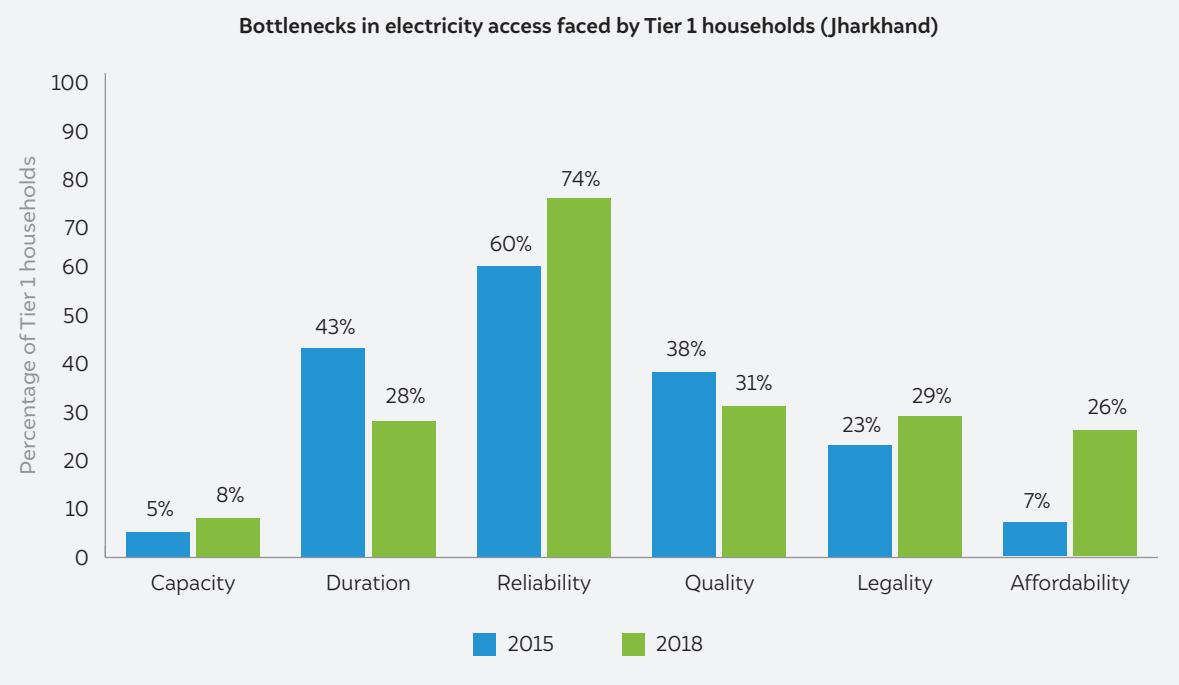
Source: CEEW analysis, 2018

A third of all unelectrified households in Jharkhand do not have a grid connection as they believe the electricity supply in their area is poor. Such households may not see any value in being connected to the grid and bearing recurring costs if their power supply is unreliable. This holds true for some even if the connection is provided free of charge. Nearly 10 per cent of unelectrified households (i.e. ~1.2 per cent of rural households) in the state said they would prefer to remain unelectrified even if they were offered a connection for free.

Tier 1 households in Jharkhand

As the proportion of Tier 1 households with electricity access has doubled over the last three years, the nature of the bottlenecks in their progress to higher tiers has also changed. In 2018, a smaller proportion of Tier 1 households reported issues related to short duration of supply and poor quality. While the supply duration in Jharkhand has improved marginally in the last three years, it remains the lowest among the six states, with a median power supply of nine hours per day.

FIGURE 11: Reliability of electricity is the main challenge limiting majority of households at Tier 1 in Jharkhand



Source: CEEW analysis, 2018

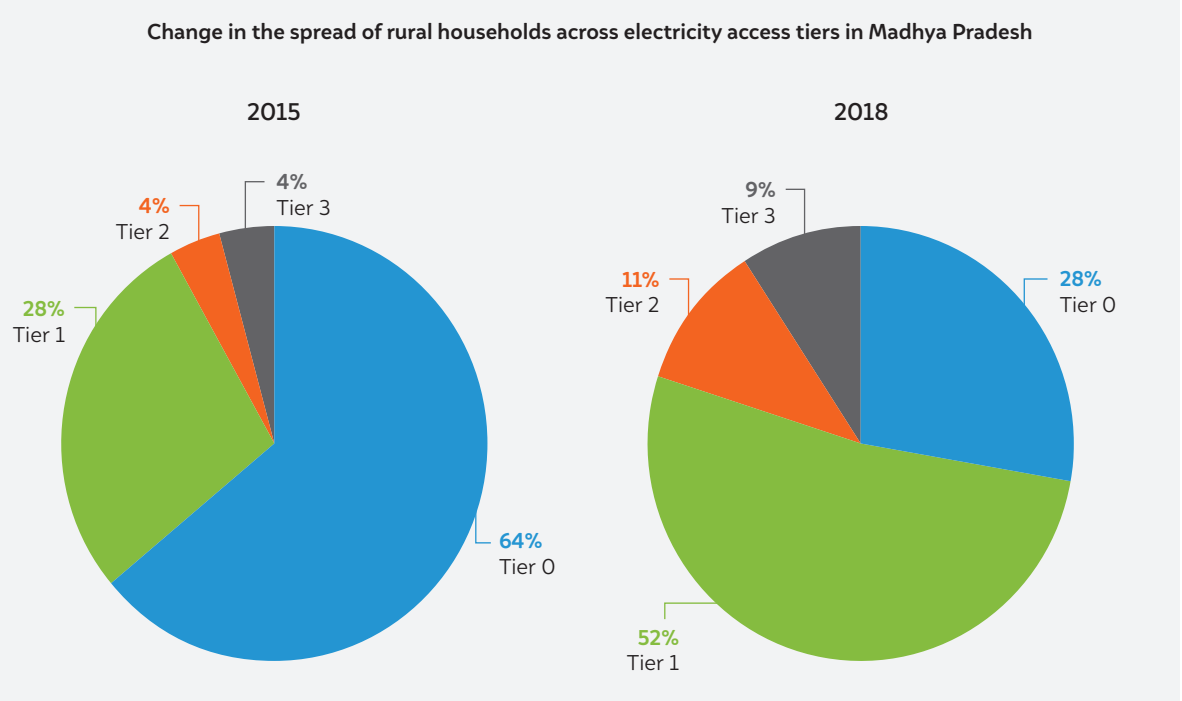
Poor reliability of electricity is the primary issue faced by Tier 1 households in Jharkhand. Almost three quarters of Tier 1 households in the state suffer between two to four blackout days in a typical month. Unaffordability as a bottleneck for progression to higher tiers has increased from seven per cent to 26 per cent. This is primarily driven by the wedge between the percentage increase in the tariff of metered connections, and the increase in monthly household expenditure over the last three years.

3.3. Madhya Pradesh

After Bihar, Madhya Pradesh reported the second highest decline in the proportion of rural households in Tier 0—from 64 per cent in 2015 to 28 per cent in 2018. This transformation has come about without a significant improvement in the rate of household electrification, which has increased by six percentage points in three years to about 92 per cent. The proportion of households using kerosene as their primary source of lighting has reduced from 27 per cent in 2015 to 13 per cent in 2018. However, it is worrying to note that five per cent of households that previously depended on grid electricity for their primary lighting needs now rely on kerosene lamps and lanterns. Only about half of such households still have grid connections, and receive fewer hours of power in 2018 than they did in 2015. The daily duration of supply and particularly supply available during evening hours, could be key drivers for households to switch to or away from using grid electricity.

About half the households that have moved to Tier 2 and 3 in 2018 were in Tier 0 in 2015

FIGURE 12: Electricity access in Madhya Pradesh has improved significantly, with 20 per cent of households now in Tier 2 and 3



Source: CEEW analysis, 2018

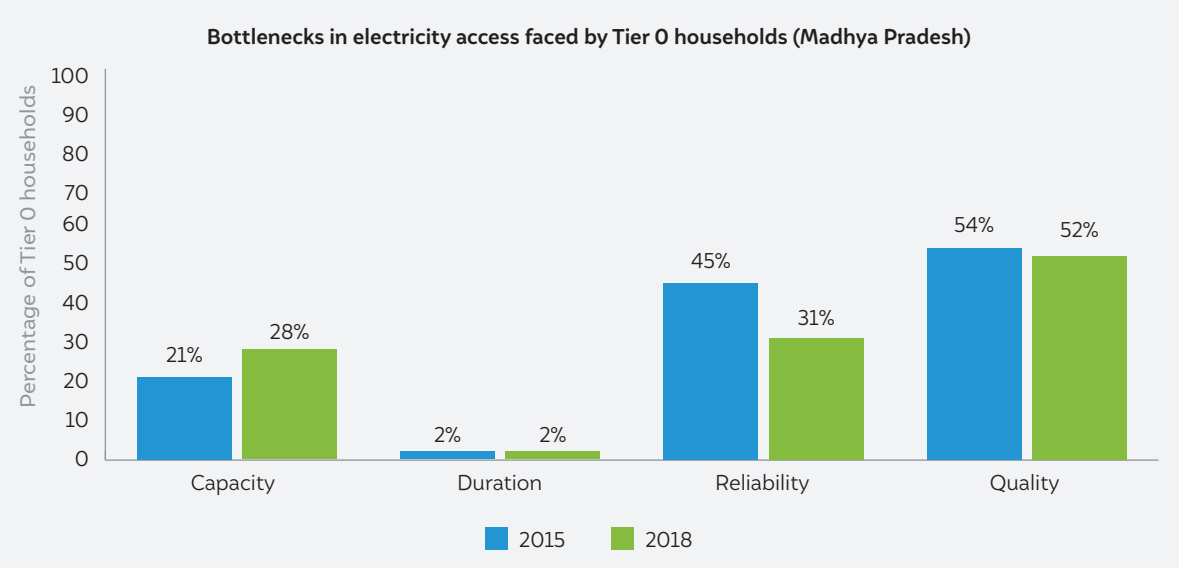
It is important to highlight the increase in the percentage of Tier 2 and 3 households in the state, and it is encouraging to note that about half the households that have moved to these tiers in 2018 were in Tier 0 in 2015. This shows that many households leapt from an almost negligible level of access in 2015 to a very high level of access in just three years. However, it should also be noted that not all households made progress. About half of Tier 2 households and three-quarters of Tier 3 households in 2015 slipped to lower tiers in 2018. Such findings highlight the need for continuous monitoring of electricity access, even in areas that are considered 'electrified', as it is possible for the state of affairs to evolve in either direction over time.

Tier 0 households in Madhya Pradesh

Even though the proportion of households in Tier 0 has reduced by 36 percentage points, their reasons for not progressing to higher tiers have not changed as much. In 2018, about half of Tier 0 households are categorised in this tier as they suffered at least four high-voltage days or seven low-voltage days in a month, leading to either appliance damage or sub-optimal usage. The lack of reliability, that is, experiencing five or more blackout days in a month, remains a challenge for 31 per cent of Tier 0 households.

Although it might appear that capacity is a graver issue in 2018 than it was previously, it must be noted that the overall percentage of households in Tier 0 has reduced by more than half.

FIGURE 13: Electrification of remaining households and improving the quality and reliability are necessary to move Tier 0 households to higher tiers



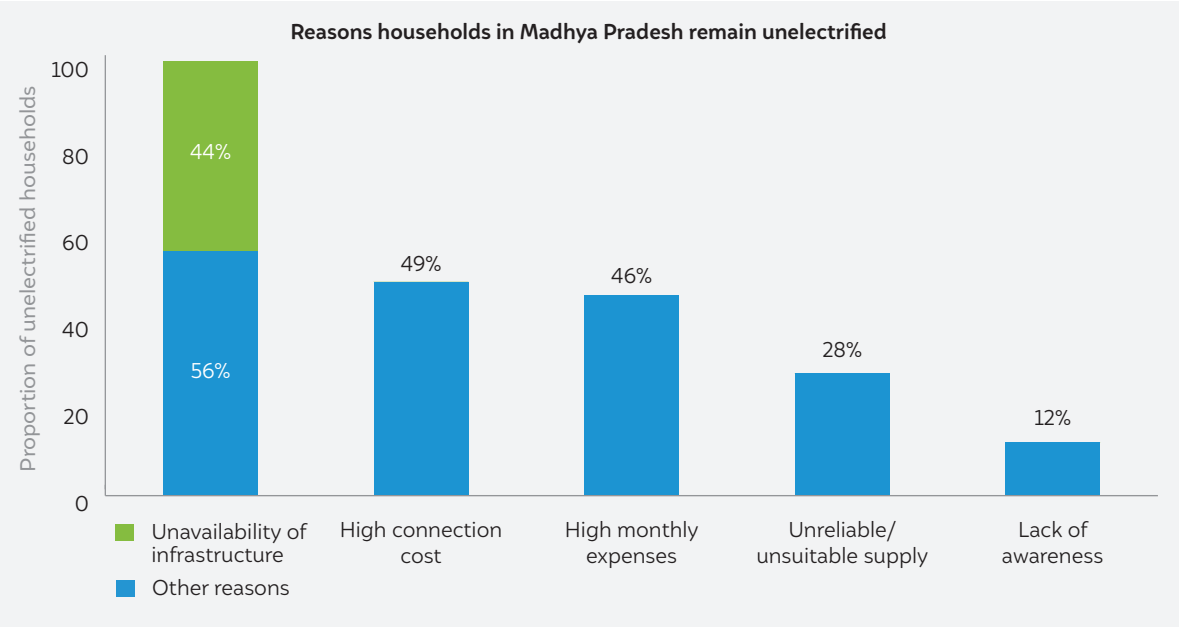
Source: CEEW analysis, 2018

Unelectrified households in Tier 0

Although less than eight per cent of rural households in the state remain unelectrified, it is imperative to provide them electricity access through grid extension or decentralised means. More than two-fifths of unelectrified households in Madhya Pradesh remain so due to the lack of power infrastructure in their locales, potentially indicating grid accessibility as a challenge.

Of the 56 per cent of unelectrified households that did have electricity in their locales, a vast majority were unelectrified because they could not afford the steep upfront cost of obtaining an electricity connection or the high recurring expense that accompanies being connected to the grid. Perhaps the latter helps explain why about 10 per cent of unelectrified households in the state said they would prefer to not have an electricity connection, even if offered one for free.

FIGURE 14: The unavailability of grid infrastructure at the hamlet level is still a barrier for almost half of the unelectrified households in Madhya Pradesh



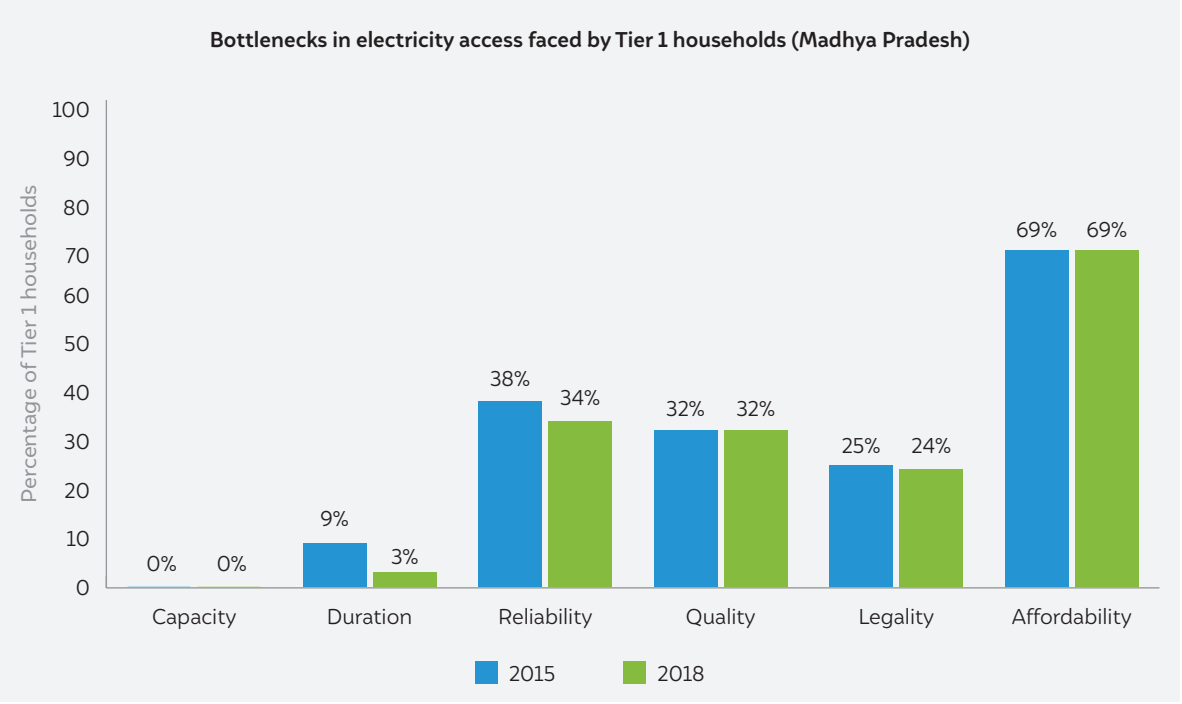
Source: CEEW analysis, 2018

Tier 1 households in Madhya Pradesh

The barrier of limited-duration supply among Tier 1 households has reduced, owing to an increase in the power supply hours available throughout the state. The median number of hours supplied to Tier 1 households in Madhya Pradesh is now reported to be 19 hours per day, compared to 15 supply hours in 2015.

Although affordability is the main obstacle in the progress of Tier 1 households in the state to higher tiers of electricity access, this is no different from the situation in 2015. Unlike in Bihar, Jharkhand, and Uttar Pradesh, where the problem of affordability has aggravated, in Madhya Pradesh, the electricity tariff has not altered dramatically. Both, the fixed and variable costs of metered and unmetered one-kilowatt (kW) connections, have increased, albeit marginally. Since the cost of basic electricity consumption is much higher in unmetered connections than metered ones, it is perhaps unsurprising that 64 per cent of households dealing with the challenge of affordability had unmetered connections. Higher monthly charges for unmetered connections could also be a deliberate way for electricity commission and discoms to nudge households to get their connection metered.

FIGURE 15: Affordability is the single largest challenge that Tier 1 households face in Madhya Pradesh

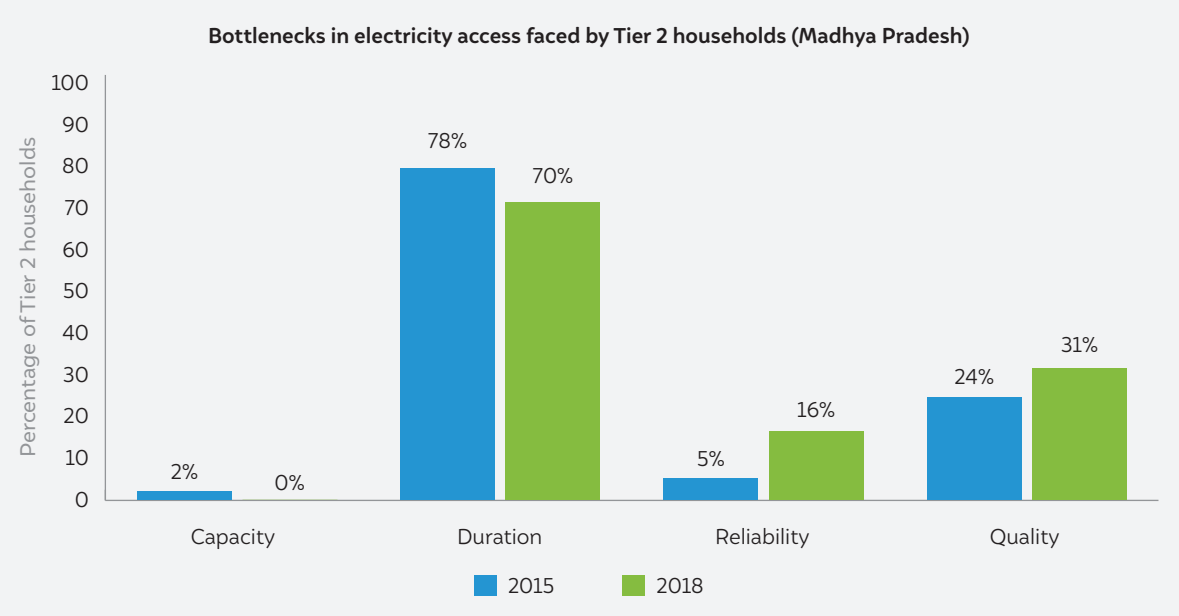


Source: CEEW analysis, 2018

Tier 2 households in Madhya Pradesh

The proportion of Tier 2 households in Madhya Pradesh has increased multifold over the last three years. Consequently, even as duration has become less of an issue, the sheer number of households unable to move to Tier 3 owing to poor durational supply has increased considerably. At the time of the survey, 70 per cent of households in Tier 2 received between 8 and 19 hours of power supply on a typical day.

FIGURE 16: Less than 20-hours of supply is the reason for majority of households limiting them to Tier 2



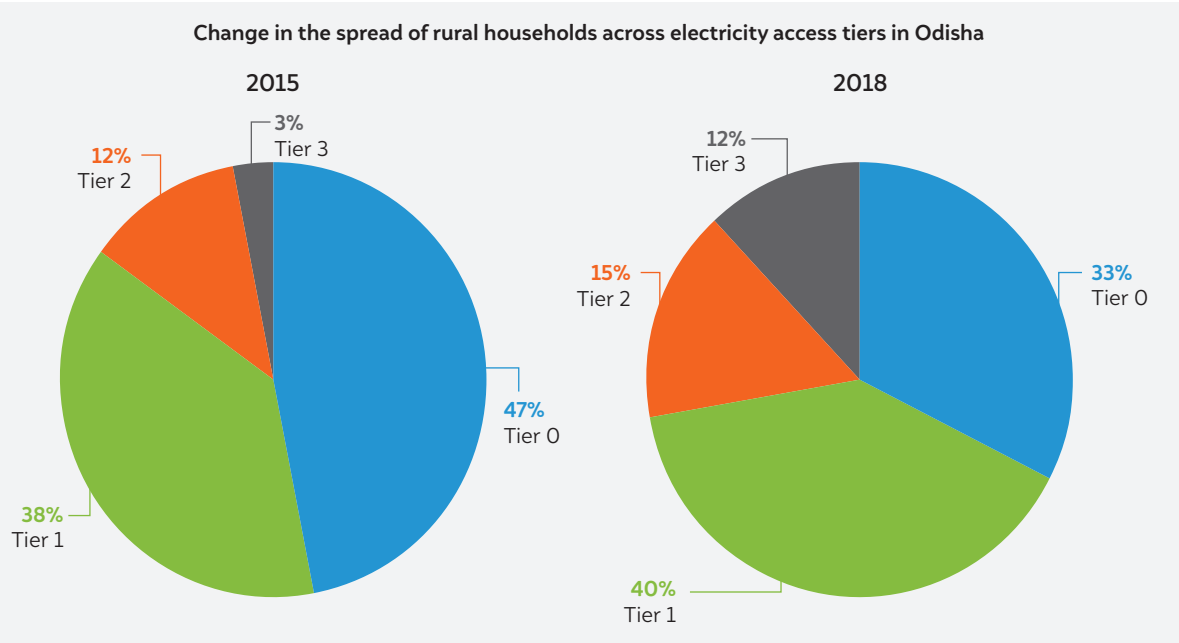
Source: CEEW analysis, 2018

Finally, it must be noted that both reliability and quality are now hindering larger number of households at Tier 2 than in 2015. About 16 per cent of Tier 2 households face at least one 24-hour blackout day in a typical month, compared to five per cent in 2015, when there were fewer Tier 2 households.

3.4. Odisha

Like other states, Odisha has also shown considerable progress in its rate of electrification. As of June 2018, 86 per cent of households reported being connected to grid electricity as opposed to 70 per cent in 2015. In what seems to be an encouraging trend, almost all households connected to the grid use grid electricity as their primary source of lighting. The use of solar home systems and lanterns as the primary source of lighting has also increased, from 0.6 per cent in 2015 to 1.6 per cent households in 2018.

FIGURE 17: The proportion of households in top two tiers has increased by almost 80 per cent in Odisha



Source: CEEW analysis, 2018

There has been an improvement of over 15 percentage points in the use of grid electricity as the primary source of lighting across all three districts surveyed during ACCESS 2015.[10] The proportion of households reporting the use of kerosene as their primary source of lighting has reduced from 36 per cent to 13 per cent across the state over three years. We have also observed an inverse correlation between the pace of grid electricity improvement and the use of solar home systems and lanterns across the districts of Odisha. In Bargarh, which reported the highest use of the grid as its primary lighting source (93 per cent) and the maximum improvement in its use over the three years, the use of solar home systems and lanterns has decreased over this period. In Mayurbhanj, on the other hand, where the use of grid electricity is lowest (73 per cent) and has shown the least improvement among the surveyed districts, the use of solar home systems and lanterns has increased over last three years.

Odisha has also experienced a spurt of growth in its proportion of Tier 3 households, from 3 to 12 per cent—the highest among all the states

With regards multidimensional electricity access, Odisha presents a slightly more peculiar picture than the other five states. The decrease in the proportion of Tier 0 households has been accompanied by a simultaneous increase in the share of Tier 1 households in every state but Odisha. Though the overall proportion has remained almost unchanged for Tier 1, around half of them have moved up from Tier 0. Odisha has also experienced a spurt of growth in its proportion of Tier 3 households, from 3 to 12 per cent—the highest among all the states. A glance at the tier distribution suggests progress in Odisha, but not all shifts have been from lower to higher tiers. While it is true that overall, a higher number of households have moved up the tiers, a significant proportion have also slipped down to lower tiers. For instance, three-quarters of households currently in Tier 2 had been categorised as Tiers 1 and 0 households in 2015, whereas 47 per cent of the current Tier 0 households have slipped from higher tiers to the lowest one.[11] This highlights the need for a multidimensional, multi-tiered approach to monitoring energy access over time, as households not only progress, but could also regress, depending on the electricity supply situation and their own context.

Tier 0 households in Odisha

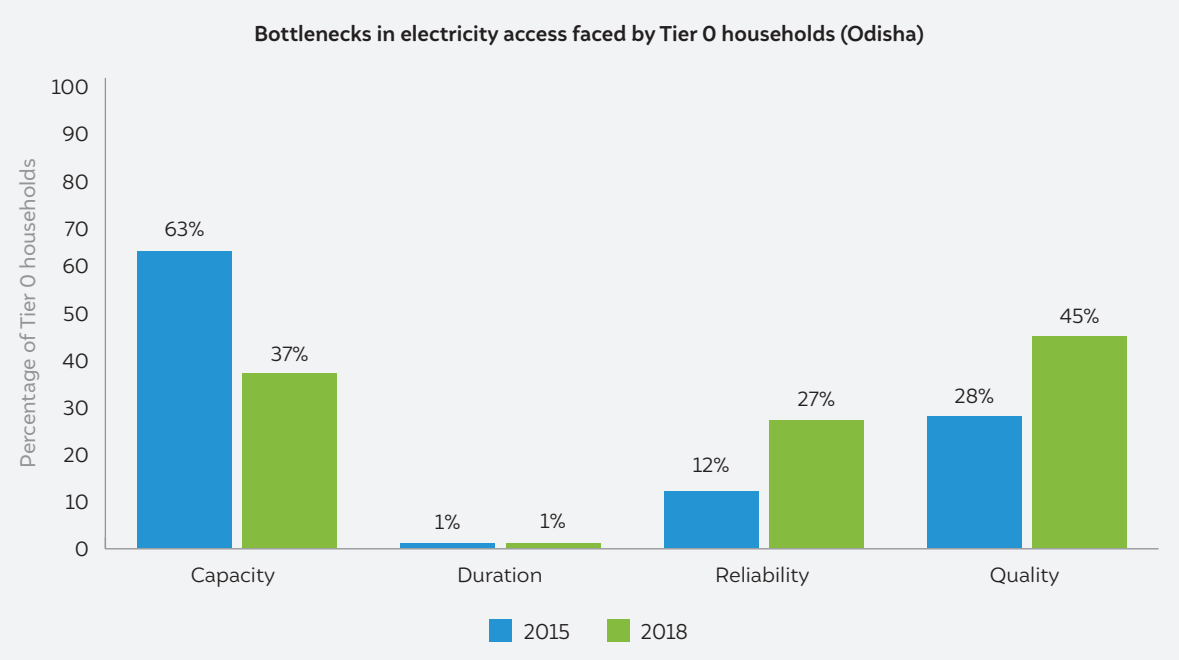
Despite progress in the electricity access situation in Odisha, a third of rural households are still classified as Tier 0. They face a variety of bottlenecks that restrict them from achieving better electricity access. A substantial proportion of Tier 0 households (37 per cent) still lack access to electrification, limiting movement to higher tiers. Quality is also a major bottleneck for Tier 0 households, and the issue has worsened over the last three years. About 45 per cent of electrified households in Tier 0 either face appliance damage or are unable to use their appliances optimally because of at least four days of high-voltage instances or seven or more days of low-voltage instances in a month, respectively. Reliability is another barrier; the lack of it impedes a higher proportion of households in 2018 than it did in 2015. The situation is particularly poor in Mayurbhanj, where more than three-quarters of electrified Tier 0 households are plagued by the problem of reliability. Supply duration is a negligible bottleneck for Tier 0 households in Odisha. If quality and reliability are addressed, almost all electrified households in Tier 0 would be able to move up to higher tiers.

Despite progress in the electricity access situation in Odisha, a third of rural households are still classified as Tier 0

10 Three more districts were added to the survey sample of Odisha for ACCESS 2018.

11 As Odisha sample was revised for ACCESS 2018, it should be noted that the above analysis of tier-level movement was only performed for the households surveyed both times.

FIGURE 18: Improving quality and reliability of supply and electrification of remaining households should be the focus at Tier 0

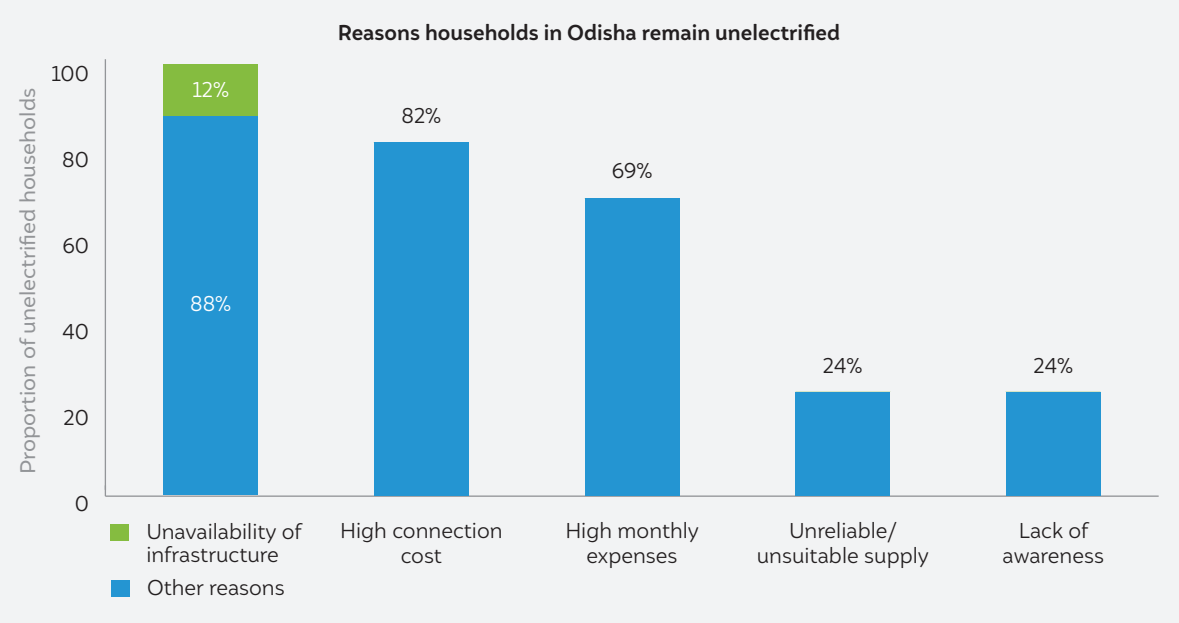


Source: CEEW analysis, 2018

Unelectrified households in Tier 0

Of the unelectrified households in Odisha, only 12 per cent are without electricity due to the lack of necessary infrastructure. Many households whose hamlets are equipped with infrastructure are unable to access electricity due to high connection costs and monthly expenses. As previously mentioned, it is particularly discouraging to note that despite the roll-out of *Saubhagya*, under which connections are to be extended at no cost or on an instalment basis, households continue to cite high connection costs as a barrier to electrification. In addition, a quarter find the existing supply either unsuitable or unreliable, or are simply unaware of how to get a connection.

FIGURE 19: High upfront and recurring expenses remain the main reasons for the absence of electricity connections

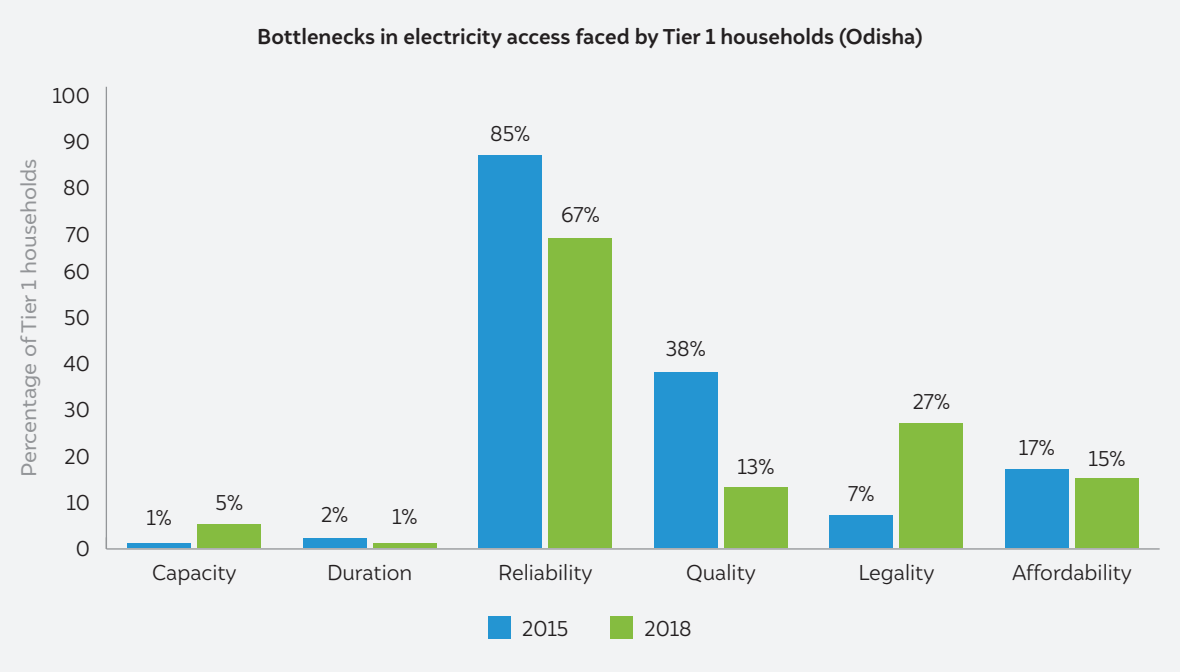


Source: CEEW analysis, 2018

Tier 1 households in Odisha

A significant proportion of households are still in Tier 1, facing a variety of bottlenecks that inhibit their upward movement. Though fewer households in Tier 1 reported unreliability in power supply as a crucial problem, it still remains a critical challenge for the vast majority (67 per cent). The percentage of households with illegal connections has increased almost fourfold in the last three years. While, the incidence has increased in old surveyed districts, in particular we observe greater incidence of potentially unlawful payment behaviour. Affordability is less of a roadblock in Odisha. In fact, the proportion of those who find electricity unaffordable has declined over three years owing to an unchanged electricity tariff, and increasing household overall expenditure over the same period.

FIGURE 20: Despite improvement, reliability is a persistent bottleneck for Tier 1 households in Odisha



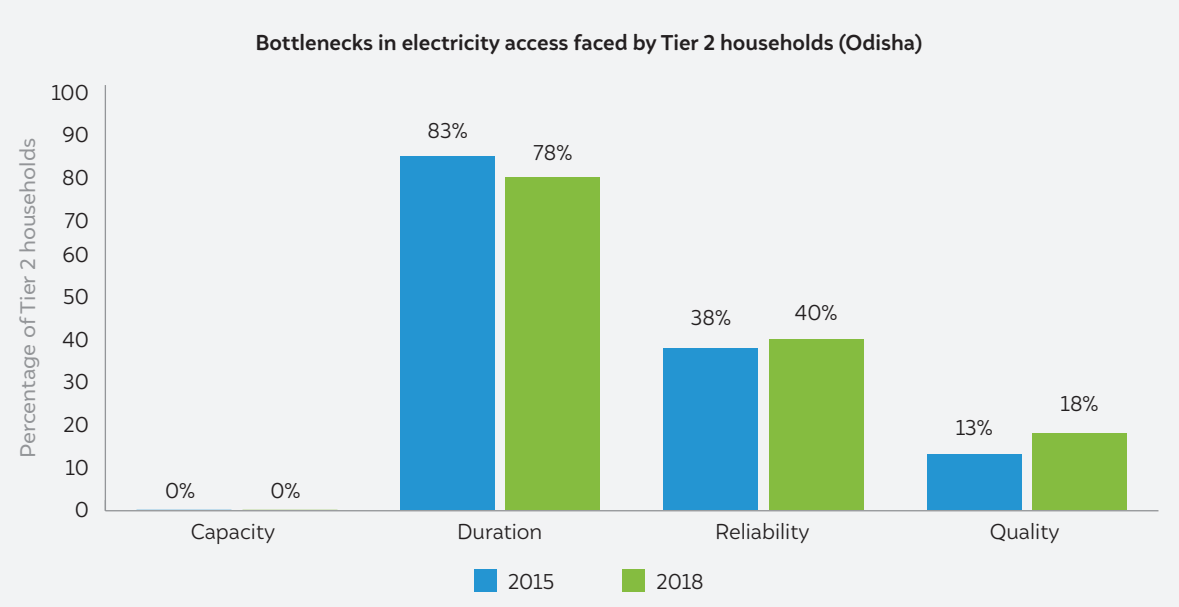
Source: CEEW analysis, 2018

Tier 2 households in Odisha

About 15 per cent of rural households in Odisha are categorised as Tier 2. Poor supply duration is still the biggest problem that the Tier 2 households face, preventing more than three-quarters of them from moving to the highest tier. In fact, the median supply hours in the state have only increased marginally—from 18 to 19 hours.

A point to highlight here is that there exists a wide disparity in the share of households that are in Tier 2 across the six districts of Odisha. For instance, 34 per cent of Jajpur households are in Tier 2, compared to merely five per cent in Mayurbhanj.

FIGURE 21: Less than 20-hours of supply-duration greatly limits Tier 2 households



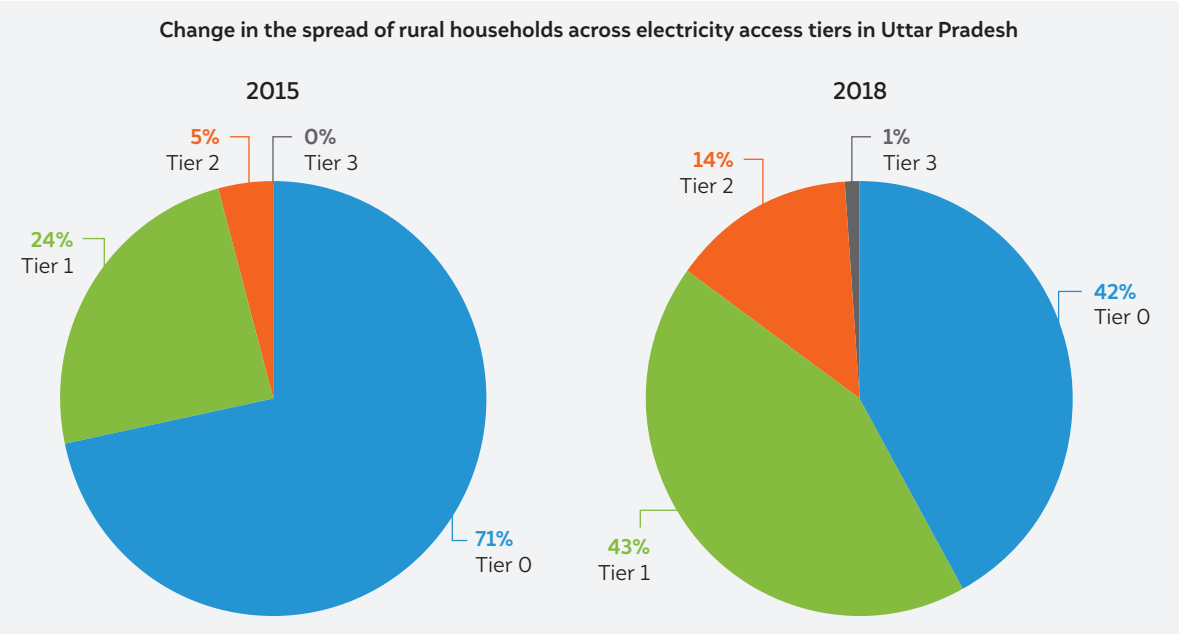
Source: CEEW analysis, 2018

As in other tiers, one sees district-level variations in the percentages of Tier 3 households and an improvement in their respective percentages since 2015. For instance, 22 per cent of Bargarh's households are now in Tier 3 as compared to four per cent in 2015; in Mayurbhanj, which had no Tier 3 households in 2015, about four per cent of households are in the highest tier in 2018.

3.5. Uttar Pradesh

In Uttar Pradesh, 59 per cent of households reported that grid electricity was their primary source of lighting—registering an almost threefold increase since 2015. This happened along with an acute reduction in the use of kerosene as a primary source for lighting—72 to 30 per cent—over three years. Overall, six per cent of respondents in the state reported using solar home systems and/or solar lanterns as their primary source of lighting.

FIGURE 22: Significant progression of households in Uttar Pradesh from Tier 0 to Tier 1 and 2



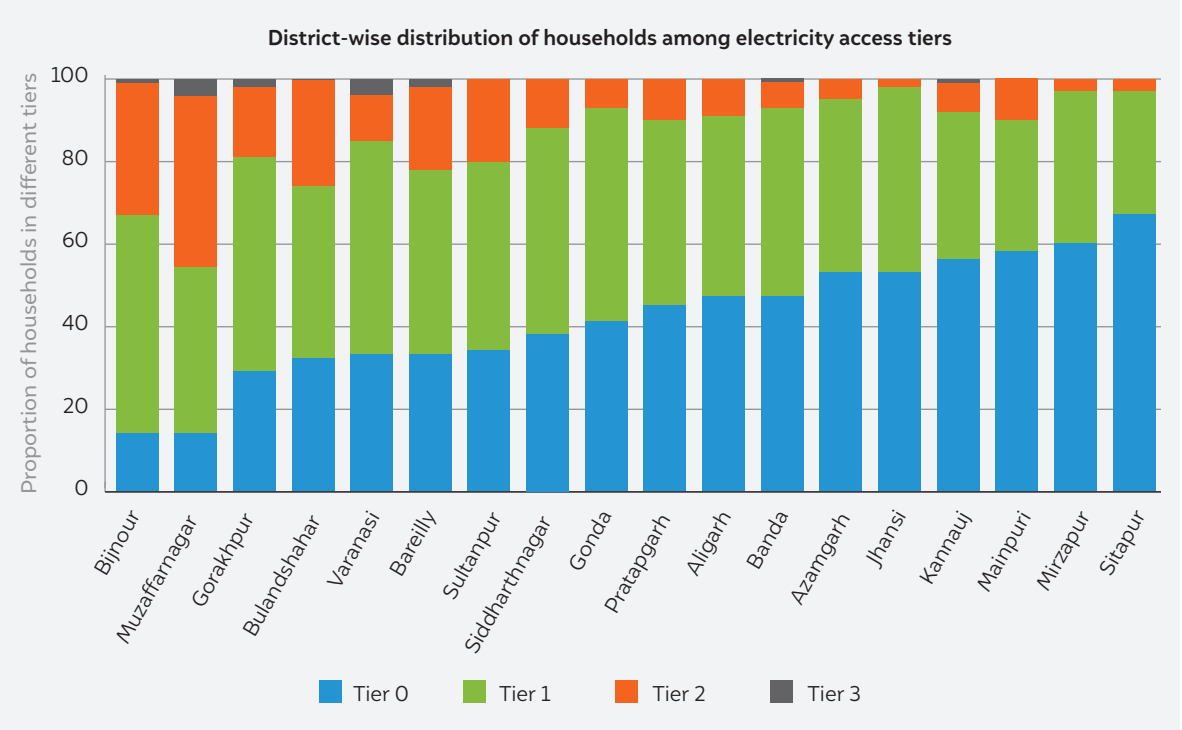
Source: CEEW analysis, 2018

Given the vastness of Uttar Pradesh, both in geography and population size, we observe significant variations within the state. For instance, only 20 per cent of households in Banda reported that grid electricity was their primary source of lighting as compared to 95 per cent in Muzaffarnagar. Similarly, the disparity in the use of solar home systems and lanterns is equally stark, as only two per cent of households in Muzaffarnagar reported using them, as opposed to 30 per cent in Sitapur.

Given the vastness of Uttar Pradesh, both in geography and population size, we observe significant variations within the state

Even in terms of its electricity access tiers, Uttar Pradesh has shown significant improvement. The proportion of households in Tier 1 and Tier 2 has increased by about 20 and 10 percentage points, respectively, over the last three years, with a commensurate decline in Tier 0. But the proportion of households in the top tier remains marginal. As with households' primary lighting source, we observed wide regional variations in the case of tier distribution as well (Figure 23). For instance, only 3 per cent of households in Sitapur have been included in Tier 2 as compared to 41 per cent in Muzaffarnagar.

FIGURE 23: Electricity access varies significantly among districts in Uttar Pradesh

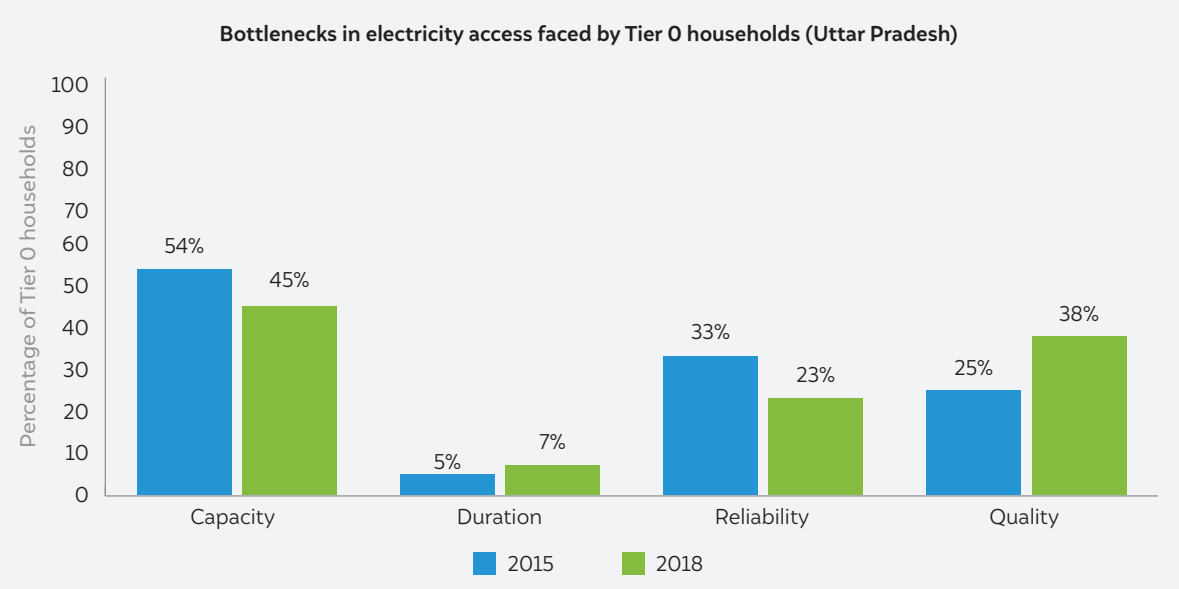


Source: CEEW analysis, 2018

Tier 0 households in Uttar Pradesh

Despite the increase in the electrification rate in the state, the lack of electricity connections still remains a key challenge for almost half the Tier 0 households in Uttar Pradesh—but with a great degree of regional disparity, as illustrated earlier. About 38 per cent of Tier 0 households endure poor-quality supply, a lower but still rather significant proportion of households—23 per cent—are constrained by the unreliable power supply.

FIGURE 24: Lack of electricity provision limits the majority of rural households in Uttar Pradesh at Tier 0

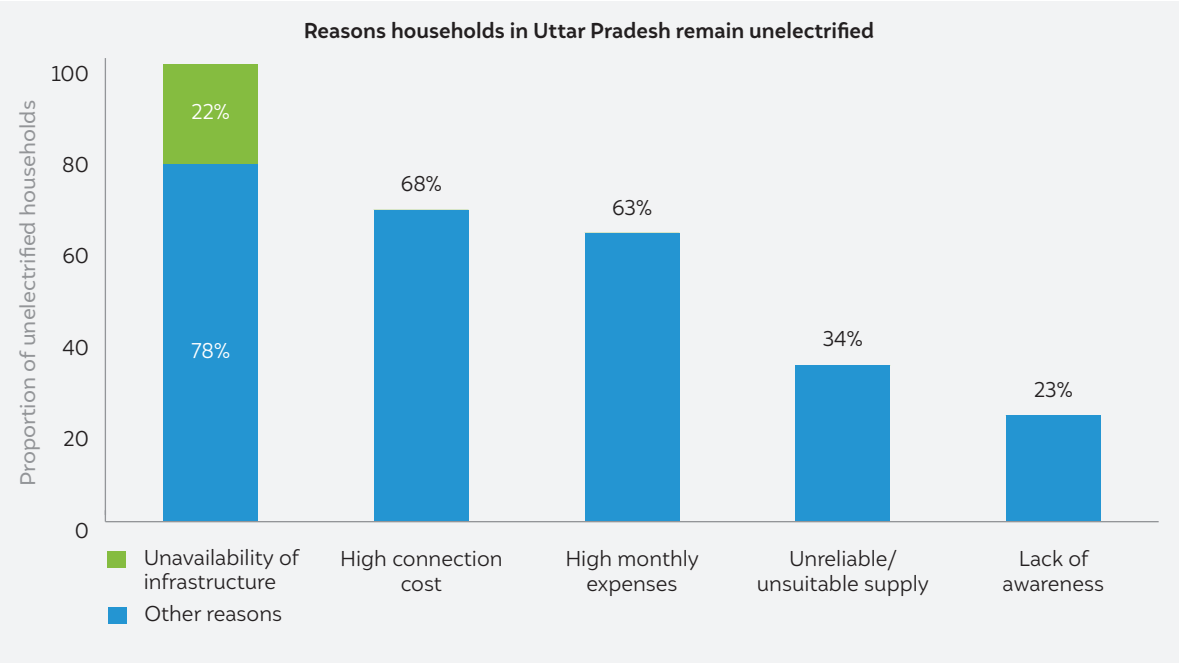


Source: CEEW analysis, 2018

Unelectrified households in Tier 0

About 22 per cent of unelectrified households in Uttar Pradesh lack the necessary infrastructure to connect to the grid in their locality. More than two-thirds of unelectrified households cannot access grid electricity due to high connection costs. As previously mentioned, it is surprising to note that such challenges or perception exist despite the provisions of the *Saubhagya* scheme. It indicates either a lack of awareness among consumers, or an implementation gap at the last mile. Additionally, about a third expressed unreliable or unsuitable supply as their reason for not availing a connection, and about a quarter cited a lack of awareness of the process of setting up a connection. It is significant that nearly 20 per cent of unelectrified households in the state reported that they would prefer to remain unelectrified even if the connections were extended to them for free, making the proportion of households to refuse electrification in Uttar Pradesh the highest among the six surveyed states.

FIGURE 25: High connection costs and recurring expenses prevent a majority of unelectrified households in Uttar Pradesh from availing electricity connections



Source: CEEW analysis, 2018

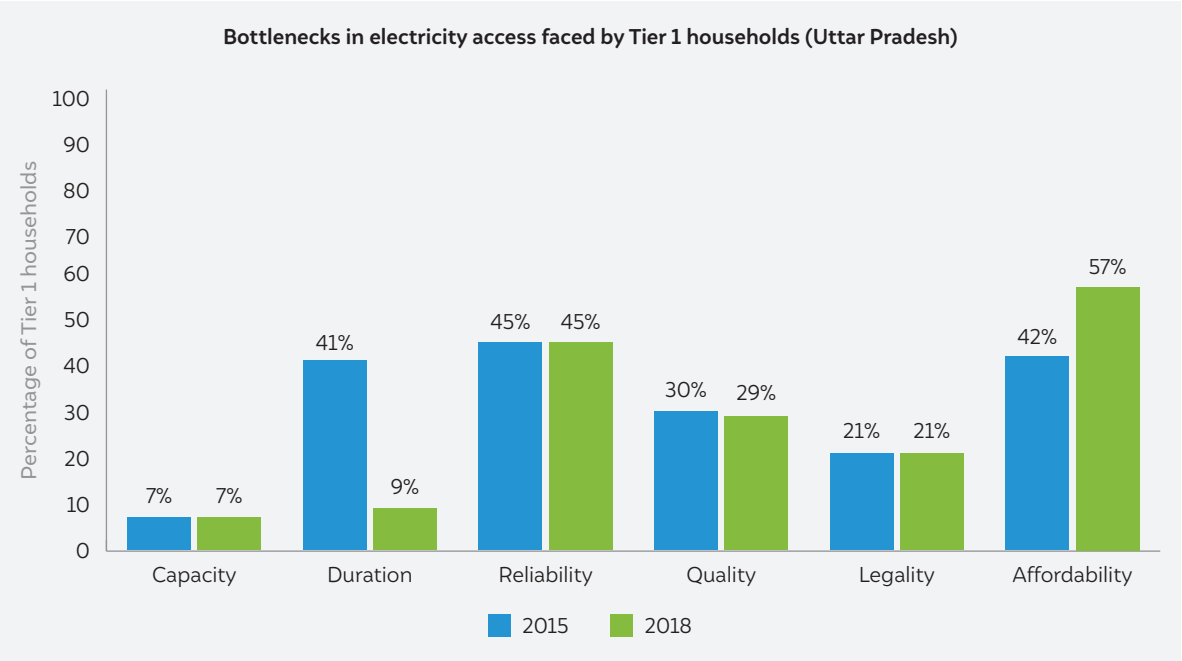
Tier 1 households in Uttar Pradesh

Affordability features as a bottleneck for three-quarter of unmetered rural households as against only 15 per cent of metered ones

Maximum proportion of rural households in Uttar Pradesh are currently categorised as Tier 1. Affordability appears to be the biggest bottleneck for the majority of households in Tier 1. It is important to highlight that the monthly charge for basic electricity consumption (30.5 units per month) for unmetered rural households is almost three times than that for metered connections in the state (UPPCL, 2017). Consequently, affordability features as a bottleneck for three-quarter of unmetered rural households as against only 15 per cent of metered ones. Thus, a part of this issue of affordability could be addressed by merely shifting households from unmetered to metered connections. It could very well be the case that the state has deliberately kept such high tariff for unmetered consumers to nudge them to get their connections metered. We have also observed a wide disparity in affordability at the district level. Electricity is unaffordable for almost 77 per cent of Tier 1 households in Mainpuri, as compared to only 31 per cent in Sitapur. The differences in the metering rates in the two districts and the differences in the economic status of the households (ascertained through monthly household expenditure) are the main drivers for this variation.

Limited daily supply hours, which was a concern for a significant proportion (41 per cent) of households in 2015, is now a bottleneck for only nine per cent of Tier 1 households. The substantial increase in the median supply hours, from 8 to 12 hours, explains this evolution.

FIGURE 26: Affordability is a significant barrier to electricity access for Tier 1 households in Uttar Pradesh

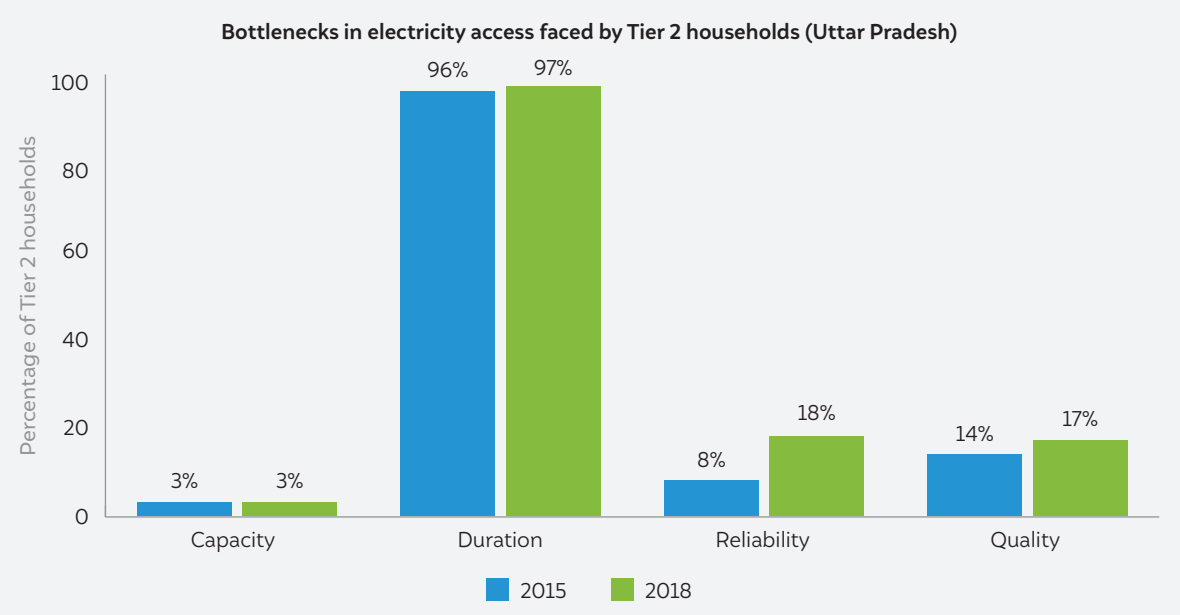


Source: CEEW analysis, 2018

Tier 2 households in Uttar Pradesh

Uttar Pradesh has managed to make electricity accessible to many more households at the Tier 2 level over the last three years. The factor that limits almost all Tier 2 households from moving to Tier 3 is the limited duration of supply. Although the median hours of daily supply have increased from 10 to 15 hours for these households, it is still well below 20 hours—the threshold for these households to move to the highest tier.

FIGURE 27: Duration limits the progress of an overwhelming proportion of Tier 2 households in Uttar Pradesh

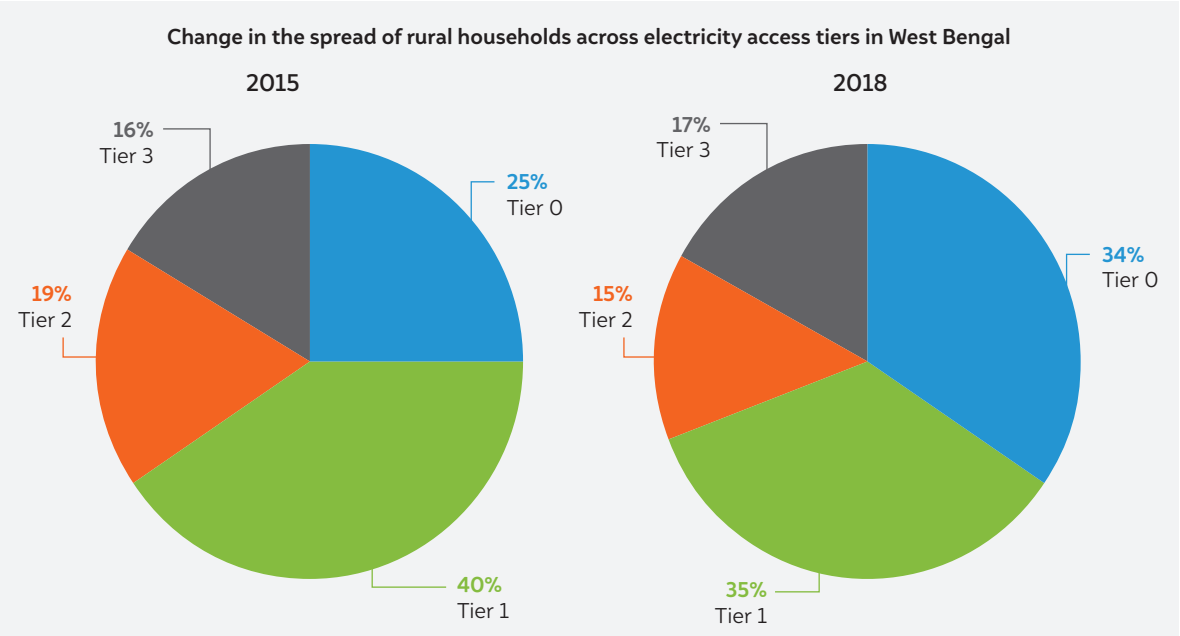


Source: CEEW analysis, 2018

3.6. West Bengal

Almost all households in West Bengal that use grid electricity employ it as their primary source of lighting. The reliance on kerosene lamps and lanterns for primary lighting dropped from eight to four per cent. Despite this, West Bengal is the only state in our survey whose proportion of Tier 0 households has increased over the last three years. Even as the rate of rural household electrification has improved from 93 to 96 per cent, a notable fraction of households has regressed from higher tiers to the lowest tier since 2015, indicating a potential deterioration in electricity situation in the state. The story of access in West Bengal necessitates careful analysis and nuanced discussion, and reinforces the utility of a multidimensional approach.

FIGURE 28: The proportion of households in West Bengal in Tier 0 has increased substantially since 2015



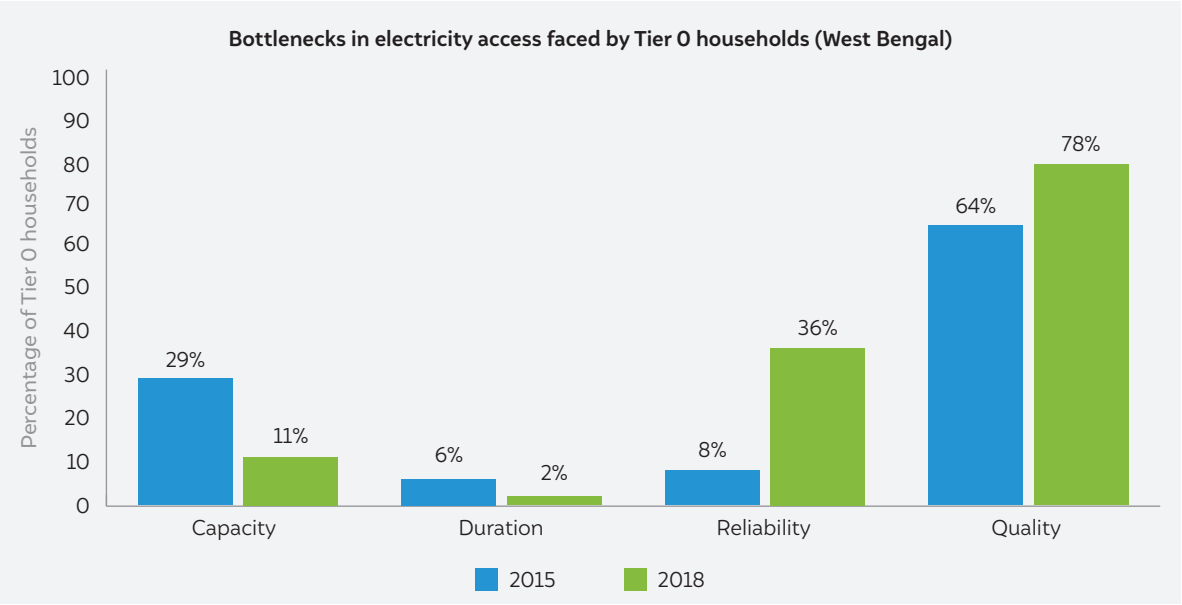
Source: CEEW analysis, 2018

One hypothesis for somewhat deteriorating picture of electricity situation in West Bengal as represented in our survey data could be because of the seasonality difference between our last round and this round of survey.[12] However, the metrics, which have particularly worsened in the state are reliability and quality—greater number of 24-hour long blackouts and higher number of days with instances of low voltage—are less likely to be affected by seasonality. Also, one could argue that the same seasonality effect, if any, should have played out in other states too. Having said that, even if seasonality has played a role, the state should take a notice of the same, as worsening performance of electricity situation in parts of the year still means poorer lived experience of electricity by households in those times.

Tier 0 households in West Bengal

Given the high rate of electrification in the state, capacity is no longer a major bottleneck for Tier 0 households, and while poor quality and unreliable power supply are prime barriers for these households, unreliability, in particular, has increased in the last three years. Tier 0 households have regressed from experiencing a median value of zero days of 24-hour blackouts in a typical month in 2015 to three such days in a typical month in 2018. Day-long blackouts are symptomatic of gaps in maintenance services—more so than load-shedding by the discoms, given the long duration of the blackouts. It is then crucial to identify areas afflicted by such poor maintenance and rectify the situation by increasing manpower to these services. Among Tier 0 households, power supply was particularly unreliable in the districts of Nadia and Purulia, where households typically experienced five days of 24-hour blackouts in a month in 2018.

FIGURE 29: Reliability stands out as the most evolved bottleneck, but quality remains the biggest challenge for Tier 0 households in West Bengal



Source: CEEW analysis, 2018

The bottleneck of poor-quality power supply has also increased over the last few years, and remains the biggest challenge for Tier 0 households. Tier 0 households in West Bengal reported that while the number of days with high-voltage instances resulting in equipment damage has reduced considerably, the number of low-voltage supply days that resulted in the sub-optimal use of appliances has risen significantly, from six to nine days a month.

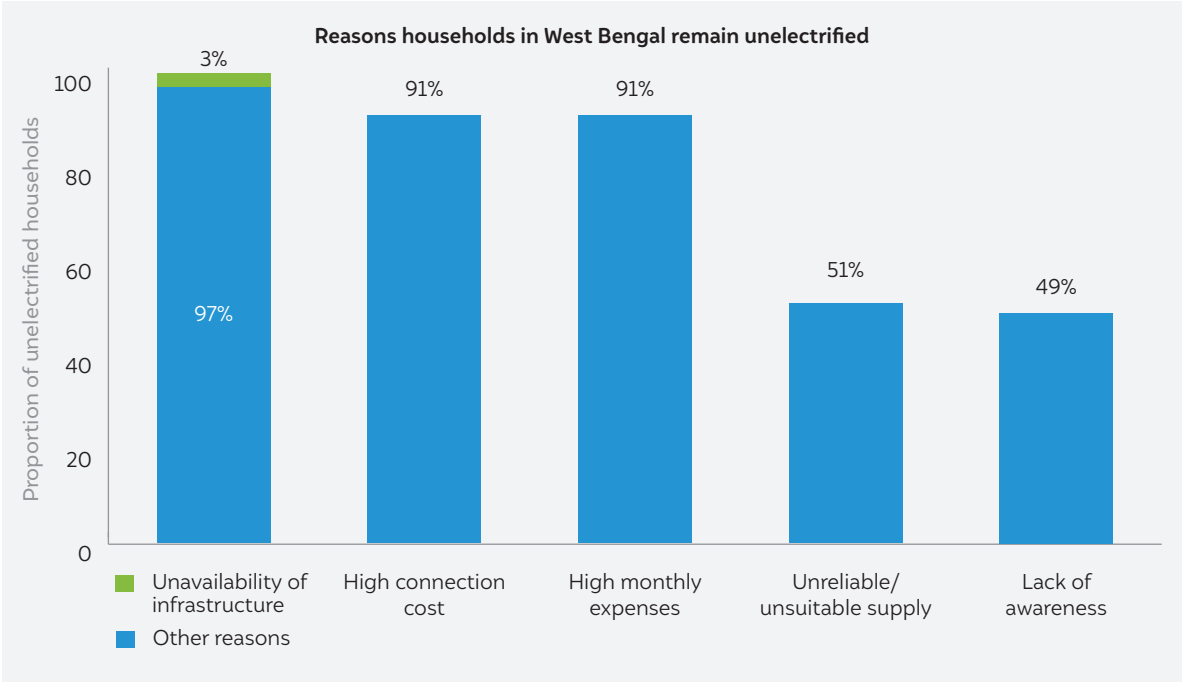
Unelectrified households in Tier 0

Almost all of West Bengal's unelectrified rural households live in habitations that already have access to grid electricity, indicating that the lack of distribution infrastructure is no longer a major bottleneck for

12 ACCESS 2015 happened between November 2014 and February 2015 and ACCESS 2018 happened between May – June 2018.

unelectrified households in the state. Instead, the issue of affordability continues to afflict these households, which, like many households in other states, find the upfront connection cost and recurring expenses a barrier to electricity access.

FIGURE 30: Upfront and recurring expenses are the main barriers for unelectrified households in West Bengal

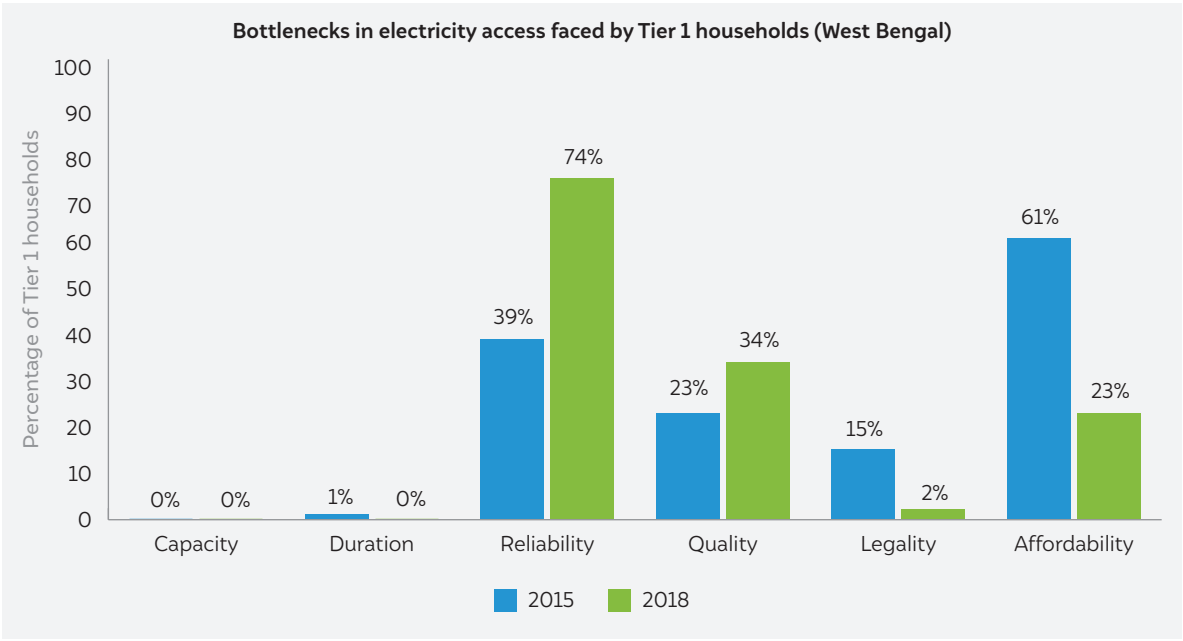


Source: CEEW analysis, 2018

Tier 1 households in West Bengal

The proportion of households categorised as Tier 1 has decreased perceptibly between 2015 and 2018. It is worth noting that around two-fifths of households in this category have regressed to this level from Tiers 2 and 3 over the last three years. Furthermore, although reliability remains the prime barrier for households in Tier 1, the most unique change is in the legality of connections.

FIGURE 31: Reliability of electricity has worsened even for Tier 1 households in West Bengal



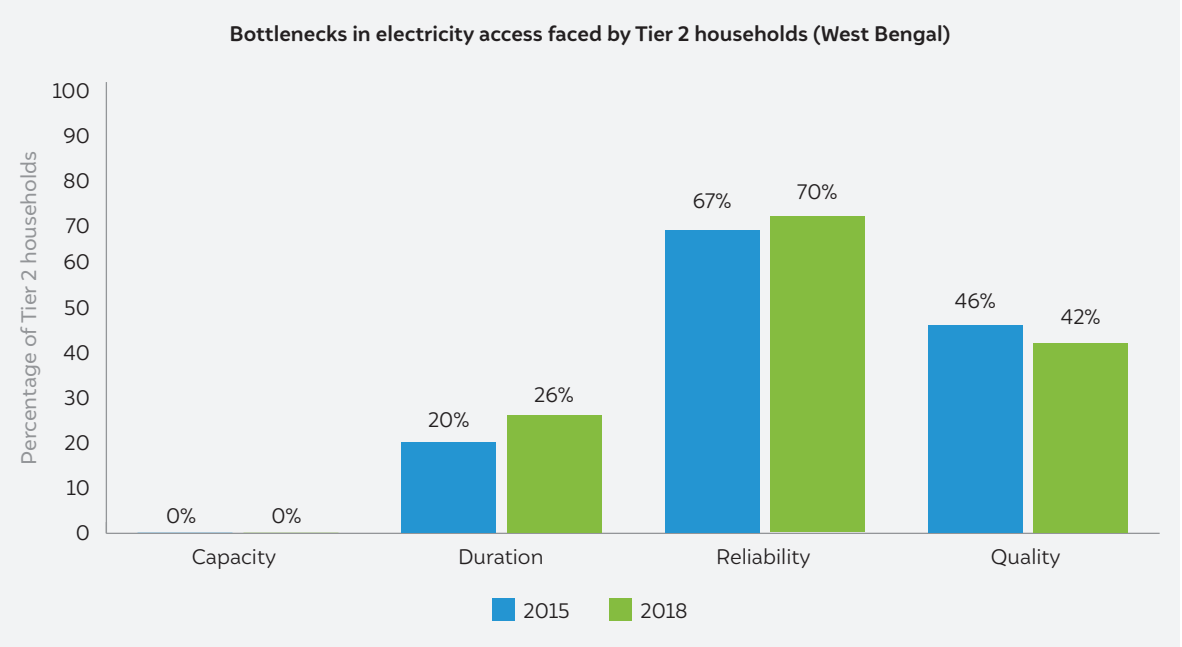
Source: CEEW analysis, 2018

n West Bengal, more so than in other states, there seems to have been an emphasis on formalising payments from existing electricity consumers. The proportion of households in Tier 1 that did not pay (or did not feel the need to pay) for electricity dropped rather dramatically, from 15 per cent in 2015 to less than two per cent in 2018. Almost all households now pay for electricity to a representative of the electricity department.

Tier 2 households in West Bengal

Households in Tier 2 were unable to progress to Tier 3, primarily because of issues relating to reliability and quality—common and significant barriers to better electricity access across all tiers in West Bengal. Although a higher proportion of Tier 2 households reported that they face the problem of reliability in 2018, it is important to note that the proportion of households in Tier 2 has decreased by five percentage points since ACCESS 2015. Even so, 70 per cent of households in this category reported that they experience one 24-hour blackout day in a typical month, and 42 per cent said that they face up to one day of high-voltage supply in a month, resulting in equipment damage, or up to three days of instances of low-voltage supply, leading to the poor utilisation of existing household appliances. It is interesting to note that quality issues in West Bengal are now primarily due to low voltage instances, in fact, high voltage instances have reduced significantly in the state over last three years.

FIGURE 32: Much like Tier 1, unreliability of supply limits majority of households in Tier 2 as well

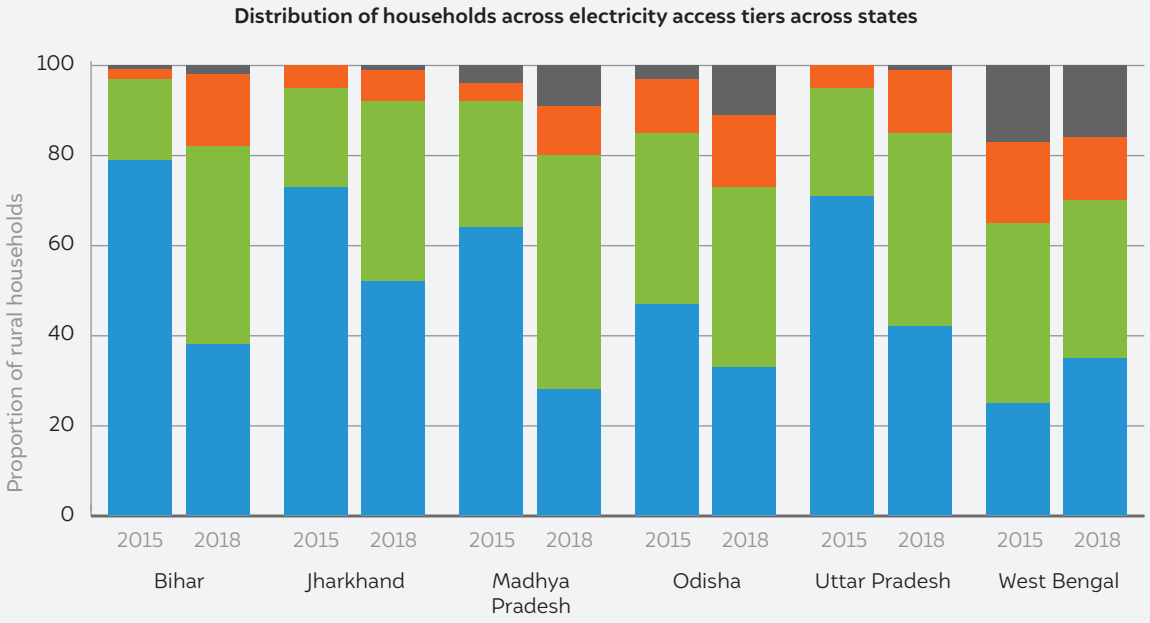


Source: CEEW analysis, 2018

3.7. Electricity access: summarising key insights

When viewed from a multidimensional perspective, the electricity access situation has significantly improved over the last three years. Bihar, Jharkhand, Madhya Pradesh, and Uttar Pradesh have experienced a considerable reduction in the proportion of households in Tier 0, with a commensurate increase in the proportions of households in higher tiers. The steep decrease in the proportion of households categorised as Tier 0 in Odisha has been accompanied by an increase in the proportions of households in Tiers 2 and 3. A significant share of households in West Bengal have actually slipped from higher tiers to lower tiers.

FIGURE 33: Electricity access has improved everywhere except West Bengal, but it still remains the best performing among the six states



	Bihar 2015	Bihar 2018	Jharkhand 2015	Jharkhand 2018	Madhya Pradesh 2015	Madhya Pradesh 2018	Odisha 2015	Odisha 2018	Uttar Pradesh 2015	Uttar Pradesh 2018	West Bengal 2015	West Bengal 2018
Tier 3	1%	3%	0%	1%	4%	9%	3%	12%	0%	1%	16%	17%
Tier 2	2%	16%	5%	7%	4%	11%	12%	16%	4%	14%	18%	14%
Tier 1	18%	44%	22%	40%	28%	52%	38%	40%	24%	43%	40%	35%
Tier 0	79%	38%	73%	52%	64%	28%	47%	33%	71%	42%	25%	35%

Source: CEEW analysis, 2018

A summary table highlighting the key challenges across the different tiers in each state has been provided below. A quick look at this table suggests that there is an overlap in the challenges that all states face at each tier level. Quality emerges as the most common issue among all six states at Tier 0, highlighting the need to supply domestic consumers with power at improved and stable voltages. Affordability is a major bottleneck for households stuck at Tier 1, owing to the revision of tariff schedules by the discoms in each state. Most states suffer from short-duration supply—less than 20 hours—limiting many households to the Tier 2 level.

TABLE 6: Key challenges that households face in different tiers and states

Tiers	Bihar	Jharkhand	Madhya Pradesh	Odisha	Uttar Pradesh	West Bengal
Tier 0	Reliability and quality	Reliability and quality	Quality and reliability	Quality	Capacity	Quality
Tier 1	Reliability	Reliability	Affordability	Reliability	Affordability and reliability	Reliability
Tier 2	Duration	Duration	Duration	Duration	Duration	Reliability
Key insights and recom-mendations	Reliability of power should be dealt with along with improving the duration of supply.	Similar to Bihar, reliability of power supply should be improved.	A tier-specific strategy is required as the problem varies with the tier	A tier-specific strategy is required as the problem varies with the tier	Reliability and duration of supply should be enhanced along with providing electricity access to the unelectrified	The deteriorating quality and reliability of electricity in the state should be addressed.

Source: CEEW analysis, 2018

Overall, the six states have witnessed considerable advancement in households' use of grid electricity as the primary source of lighting, but variations remain across states. Bihar has shown the maximum progress over the last three years. Uttar Pradesh and Jharkhand have both shown a threefold improvement in the proportion of households using electricity as their primary source of lighting. However, there is a need for greater improvement, given that over a quarter of the households in these states still depend on kerosene for lighting. From the multidimensional perspective, the three most common bottlenecks which have emerged from various tiers are discussed below.

Duration

The total number of supply hours per day has increased in most states, although the increase has been greater in some cases than others. The median hours of daily supply in all six states together has increased from 12 to 16 hours over the last three years. In Bihar and Madhya Pradesh, which have shown the most improvement, the supply duration has increased from 8 to 15 hours and 12 to 18 hours, respectively. Uttar Pradesh also witnessed a considerable improvement, from 8 to 12 hours. Jharkhand recorded only a modest increase in its median hours of power supply, from eight to nine hours per day. The median supply duration has remained more or less constant in Odisha and West Bengal, where they were already relatively higher (18 hours and 20 hours) than in other states.

Quality

On average, the supply quality has improved in all six states. The percentage of households that reported zero days with high voltage (which damages equipment) in the 30 days before the survey increased from 61 to 71 per cent; the proportion of households that reported zero days with low voltage (which limits the use of appliances) during the aforementioned period also increased—from 48 to 57 per cent—at an aggregate level for each state except West Bengal. In West Bengal, the proportion of such households has decreased from 62 to 44 per cent, indicating a decline in the supply quality on the latter parameter—low voltage days.

Reliability

The median number of blackout days in a month has decreased from two days to one day at the aggregate level for the six states, indicating an overall improvement in the reliability of power supply. While this number has reduced in five states, it has increased from zero to two in West Bengal. Also, the proportion of households reporting zero blackout days has decreased in the state, from 53 to 30 per cent, indicating a deteriorated state of reliability in West Bengal.

3.8. Spotlight: affordability

For a significant proportion of electrified households, affordability is one major bottleneck in their upward mobility in access to electricity. As more household transition from being unelectrified to electrified, the issue has aggravated in Uttar Pradesh, Bihar, and Jharkhand despite subsidy support from the respective state governments to rural domestic consumers. A vast majority continues to suffer from it in Madhya Pradesh. The challenge of affordability of basic electricity consumption (up to 30.5 units per month) in these states is due to rise in electricity rates, particularly for unmetered connections, over the last three years. Whereas, the economic status (ascertained by the overall monthly expenditure) of households has not increased by the similar proportion in the same period.

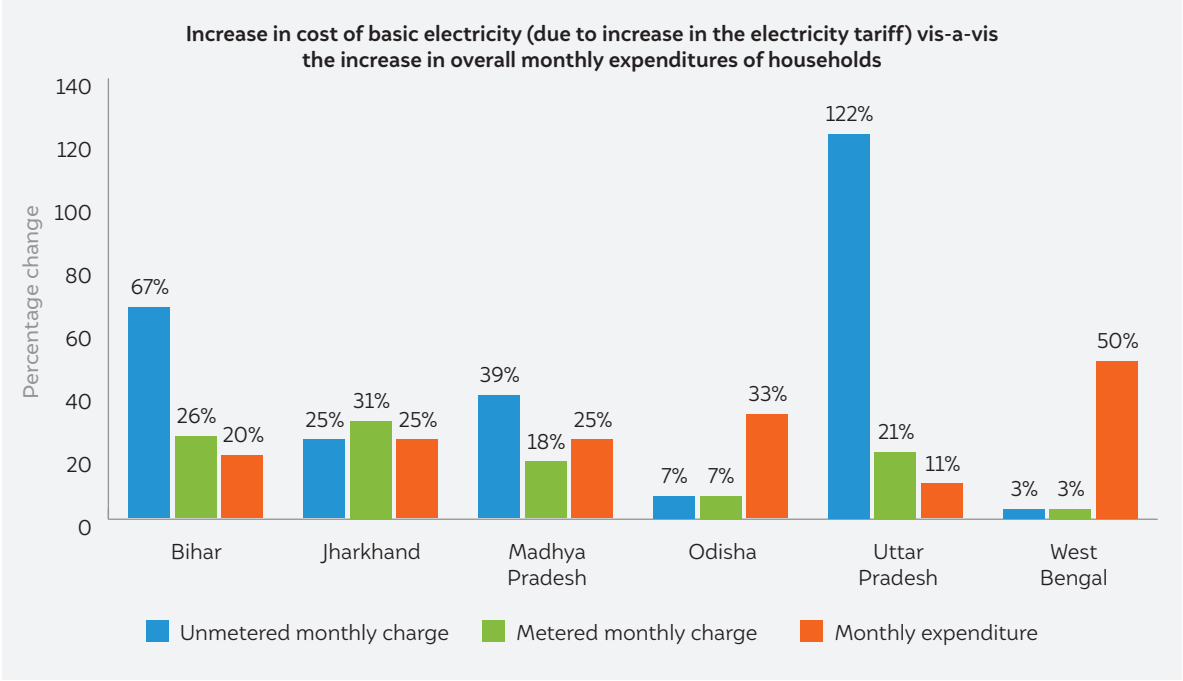
In case of Uttar Pradesh, Bihar and Madhya Pradesh, it is clear that unmetered connections witnessed a higher increase in the monthly charge as compared to metered households. Interestingly, one sees an opposite trend in Jharkhand. Based on our affordability limit definition[13], close to 75 per cent of unmetered households in Uttar Pradesh would find consumption of basic electricity unaffordable, whereas only 15 per cent of metered

13 Refer to Chapter 2 on Methodology for further details

households would find so. Unmetered households are charged a higher fixed cost, and possibly rightly so in many instances, assuming that they consume more than a unit per day, on average. But, for households, who are only consuming very limited electricity due to limited supply or due to their inability to afford larger appliances, the monthly charges for unmetered connection could be significantly high. Having said that, the choice of high charges for unmetered connections could be a way for regulatory commissions and discoms to discourage consumers from continuing with unmetered connections. Also, all the households covered under *Saubhagya* are required to install meters at the time of connection. To ensure consumer parity, however, the discoms must also ensure that meters are swiftly installed in existing unmetered households.

It is noteworthy to understand the way we assess and ascribe the affordability challenge for households. Many of the households, who would find consumption of basic electricity unaffordable, might not be actually experiencing this challenge in practise as of now, since a significant proportion them are actually not receiving any bills or paying anything for their electricity currently. However, once the as the billing and collection efficiency of the discoms would improve, these households would start finding basic electricity unaffordable. We take such an approach to analysis as current deficiencies of the discom operations is not a sustainable way to provide affordable electricity to households, instead we need to address systematic challenges to ensure basic electricity remains affordable for most households, while ensuring adequate revenue recovery for discoms.

FIGURE 34: Increase in electricity charges for unmetered households in Bihar, Madhya Pradesh, and Uttar Pradesh has outstripped the expenditure growth



Source: CEEW analysis, 2018

The government has taken various steps to improve the financial health of discoms while improving power supply—in part, some of these has led to the rise in electricity rates. Firstly, there has been a decrease in the energy demand–supply gap across India as reported in the Load Generation Balance Report (Central Electricity Authority, 2018). Secondly, under the Ujwal DISCOM Assurance Yojana (UDAY) scheme, the signatory states have committed to eliminating the difference between the average cost of supply (ACS) and the annual revenue realised (ARR). Implementation of the same to some degree could have increased the tariffs for domestic consumers (Ministry of Power, 2015). Finally, the supply hours are constantly increasing under the 24x7 Power for All initiative, which has led to a further increase in the cost of supply for discoms. Passing on the same to consumers would also further driving up the rate for consumers (Ministry of Power, 2018). Having said that, as long as metering could be ensured for all electrified households, along with regular billing and collection, affordability of basic level of electricity would not be a challenge for majority of rural households. It is primarily driven by unmetered connections and high charges associated with them.

TABLE 7: Monthly cost (INR) for one kW connection: 2015 versus 2018 (for a consumption of 30.5 units a month)

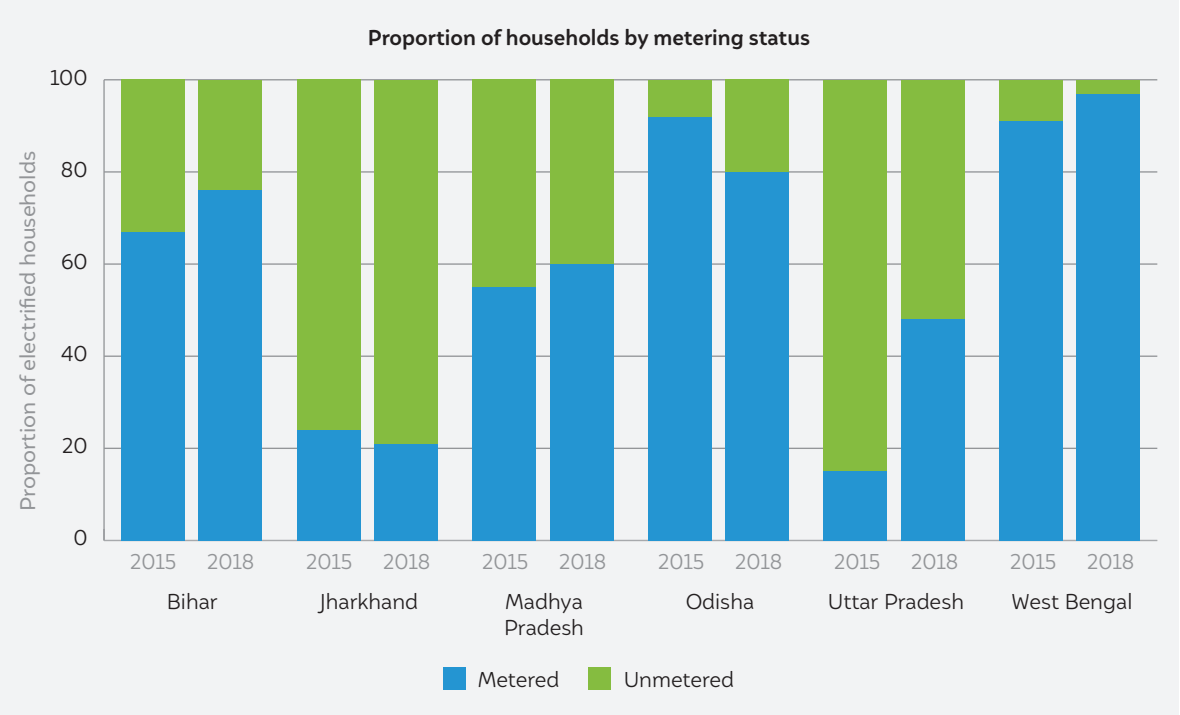
		2015	2018
Bihar	Metered	80	101
	Unmetered	160	268
Jharkhand	Metered	68	88
	Unmetered	100	125
Madhya Pradesh	Metered	129	152
	Unmetered	285	398
Odisha	Metered	90	96
	Unmetered	NA	NA
Uttar Pradesh	Metered	117	142
	Unmetered	180	400
West Bengal	Metered	145	148
	Unmetered	NA	NA

Source: CEEW analysis, 2015, 2018

3.9. Spotlight: metering

The proportion of electrified rural households that have been equipped with meters across the six states surveyed has increased from 53 per cent in 2015 to 65 per cent in 2018. It is also worth noting the significant increase in electrification of households itself in these years. The improvement in metering rate is a result of both, metering the unmetered connections, as well as the roll out of new connections with meters. However, the disparity among the states continues: while almost all rural households in West Bengal with grid electricity connections have meters, in Jharkhand, this is true for only 21 per cent of them.

FIGURE 35: The proportion of households with meters has substantially improved in Uttar Pradesh, but remains abysmally poor in Jharkhand



Source: CEEW analysis, 2018

In the last three years, Uttar Pradesh has made significant progress in terms of the proportion of electrified households that are now equipped with meters, despite the massive increase in the overall number of electricity connections in the state. Discoms in Uttar Pradesh seem to be focusing on the fact that meters are installed in households acquiring new connections as well as in households that have long had unmetered connections. However, further efforts are required on this front. Such efforts would help improve the accuracy of billing and potentially build trust among genuine consumers, as they will pay only for what they consume. However, this move will perhaps not be welcomed by all households, particularly those that are illegally drawing electricity, or the few whose power consumption outstrips the monthly charges of unmetered connections. The sharp increase in the tariff for unmetered connections in some states could well have played an important role in nudging households to demand the installation of meters.

The improvement in metering rate is a result of both, metering the unmetered connections, as well as the roll out of new connections with meters

While Odisha has high level of metering, but compared to 2015, both Odisha and Jharkhand show a dip in the metering rate. It indicates that the pace of installing meters has not kept up with that of providing new electricity connections. It is worrying to note that 57 per cent of households in Jharkhand that had meters during the last round of ACCESS state not having meters in 2018[14]. About half of these households were from Sahibganj and Bokaro. The reasons behind such shift in status of metered households to unmetered remain unclear and need further investigation at the local level. One would hope that such removal of meter is with consent or by the local discom itself, as electricity supply regulations specify that handling or removing a meter is illegal unless authorised by the concerned discom (JSERC, 2015).

3.10. Spotlight: billing and collection efficiency

When asked how frequently they received bills for electricity use, about 30 per cent of the households said that they had either not received a bill in the past year, or that they had never received an electricity bill. Of these households, 45 per cent had been electrified only in the past year, indicating that issues related to bill generation affect new and old connections alike. The failure to generate a bill is a wasted opportunity for revenue generation, as nearly three-quarters of households that have not received bills do not pay for the electricity they consume and a little over half of them are unmetered.

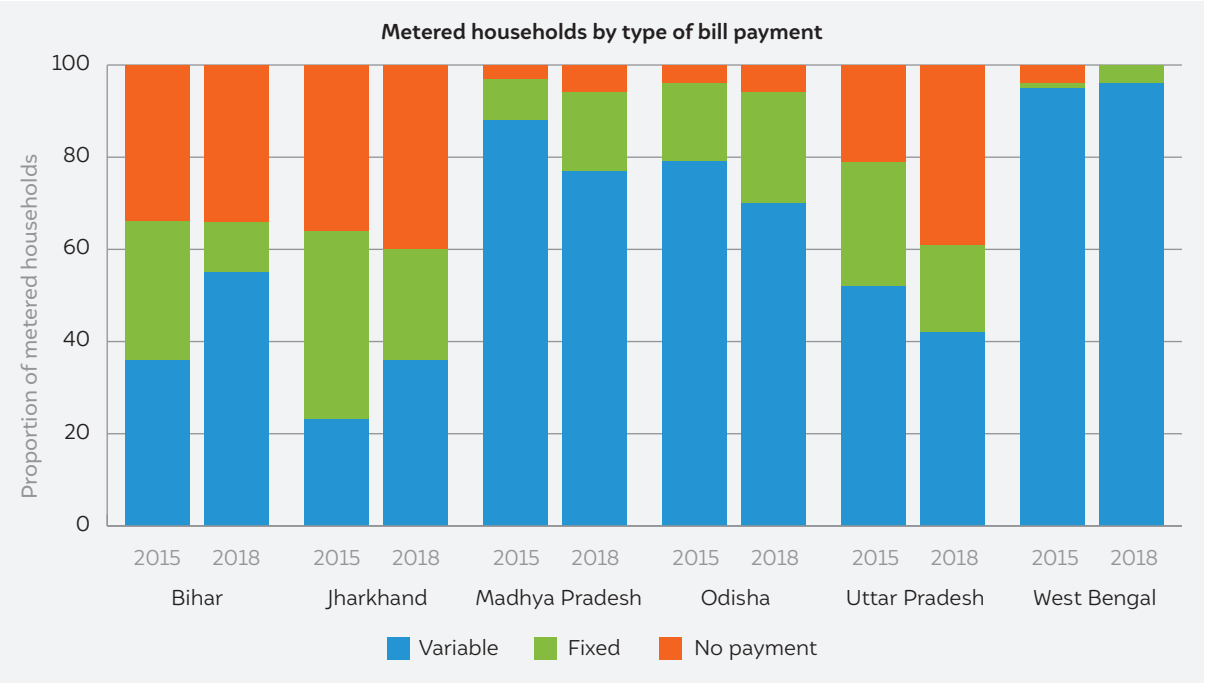
Of those, who were receiving a bill, about 27 per cent said that there was no regular pattern in getting them. Regular billing can help households plan their electricity expenditure proactively and align their cash flow with a predictable bill collection cycle.

Across the six states surveyed, a higher percentage of electrified households has not paid for electricity in 2018 (27 per cent), as opposed to 2015 (20 per cent). In absolute terms this means that in 2015 about 13 per cent rural households were not paying for their electricity, and the proportion has increased to 23 per cent of rural households. It essentially indicates that lost revenues of the discoms from the rural domestic consumers has nothing but increased over the last three years. West Bengal is the only exception, where almost all households are paying for the electricity that they are consuming. The incidence of non-payment is considerably higher among unmetered households (39 per cent) than metered households (20 per cent). In a clear sign of progress, the proportion of households receiving fixed-amount bills has reduced over the last three years and the proportion of households receiving variable-amount bills have increased. Specifically, almost half of those who received fixed-amount bills in 2015 were now receiving variable-amount bills.

Across the six states surveyed, a higher percentage of electrified households has not paid for electricity in 2018 (27 per cent), as opposed to 2015 (20 per cent)

14 Since the proportion of metered households in Jharkhand was very low to start with, this analysis is based on absolute observations of only about 100 households, and 57 of them have actually moved from being metered to unmetered.

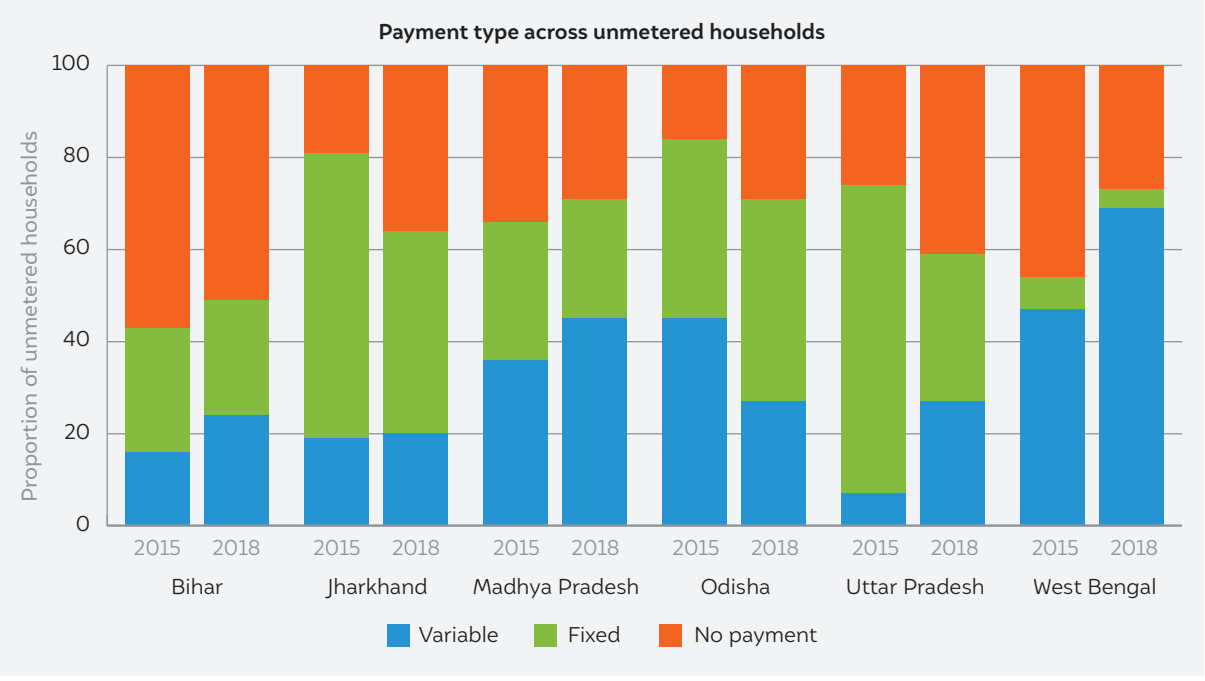
FIGURE 36: The proportion of metered households making no payment has increased since 2015



Source: CEEW analysis, 2018

Twelve per cent of households with metered connections receive fixed-amount bills, as opposed to variable-amount bills based on real consumption. This was particularly prevalent in Jharkhand, Odisha, and Uttar Pradesh. This could be the result of broken-down meters, or of discoms failing to read them regularly owing to deficiencies in manpower. Remarkably, there were no metered households in West Bengal that were not paying for the power they were receiving. In Madhya Pradesh and Odisha, the rate of non-payment among metered households was under seven per cent, whereas in Bihar, Jharkhand, and Uttar Pradesh, about 35 to 40 per cent of households were not paying for electricity.

FIGURE 37: The proportion of unmetered households receiving variable bills has nearly doubled since 2015



Source: CEEW analysis, 2018

Except in Odisha, where the proportion of unmetered households receiving variable-amount bills has declined over the last three years, all the other states witnessed an opposing trend—the proportion has nearly doubled since 2015. In the absence of a meter, it is possible for households to report having received variable bills if the frequency of bills is not predictable. This is corroborated by the fact that about 40 per cent of unmetered households who reported that they receive variable-amount bills, have no clear billing pattern. For instance, they could receive one bill after a month of use and the next one after four months of use, without prior knowledge.

In Madhya Pradesh and Odisha, the rate of non-payment among metered households was under seven per cent, whereas in Bihar, Jharkhand, and Uttar Pradesh, about 35 to 40 per cent of households were not paying for electricity

Legalisation of illegal connections

To mitigate the aggregate technical and commercial (AT&C) losses, it is important to focus on formalising existing illegal connections. While this will help in improving the monitoring and forecasting of electricity demand in rural areas, it will also improve billing and collection efficiency, and eventually reduce commercial losses. We estimate that about 17 per cent of the rural households with electricity across these states are potentially having illegal connection or follow unlawful approach to electricity payments. Proportion of such households is particularly high in Bihar and Jharkhand, followed by Uttar Pradesh and Madhya Pradesh. West Bengal exhibits hardly any instances of illegal connections. When asked if they thought people in their village stole electricity, 29 per cent of respondents across all states responded positively, as opposed to 33 per cent in 2015. Moreover, in 2015, our sample had about 14 per cent villages where more than 75 per cent of surveyed households reported occurrence of electricity stealing in their village – implying a significantly degree of certainty of presence of electricity theft in their village. In 2018, the proportion of such village had reduced to merely 2.5 per cent. Uttar Pradesh, in particular, has managed to reduce this number from 23 per cent of villages to only 5.5 per cent of them. Despite such progress, it still has the highest proportion of such villages as well as the highest share of respondents with the perception that electricity theft occurs in their village. It is reassuring to note that almost 94 per cent of households were aware that electricity theft is illegal, and about as many also thought that it should be stopped.

3.11. Spotlight: willingness to pay

While the government has planned to electrify all willing rural households in the country by March 2019, the interaction of each rural household with electricity provision will differ considerably. Not all households will be equally accepting of a grid connection or able to meet the recurring electricity expenses. Each household will use electricity differently, and as a result, there will be differing valuations of the same supply. In order for discoms to plan their next steps in rural power distribution, that is, to forecast electricity demand accurately, ensure quality power supply, and reduce billing- and collection-related losses, they will need to understand a rural household's ability and willingness to pay (WTP) for appliances and the electricity they will need to utilise them.

Over the past year, the *Saubhagya* scheme has given connections to unelectrified households at no upfront cost. Although this helps mitigate the lack of affordability associated with obtaining connections, the issue of recurring expenses remains unaddressed and poorly understood. We asked households for their monthly WTP for a basket of appliances that they would like to use, and compared the WTP across all respondents for a fixed basket of appliances. The former method helps respondents visualise their electricity use and contextualise it with appliances of their choice, and latter helps to draw a comparison against a standardised offering.

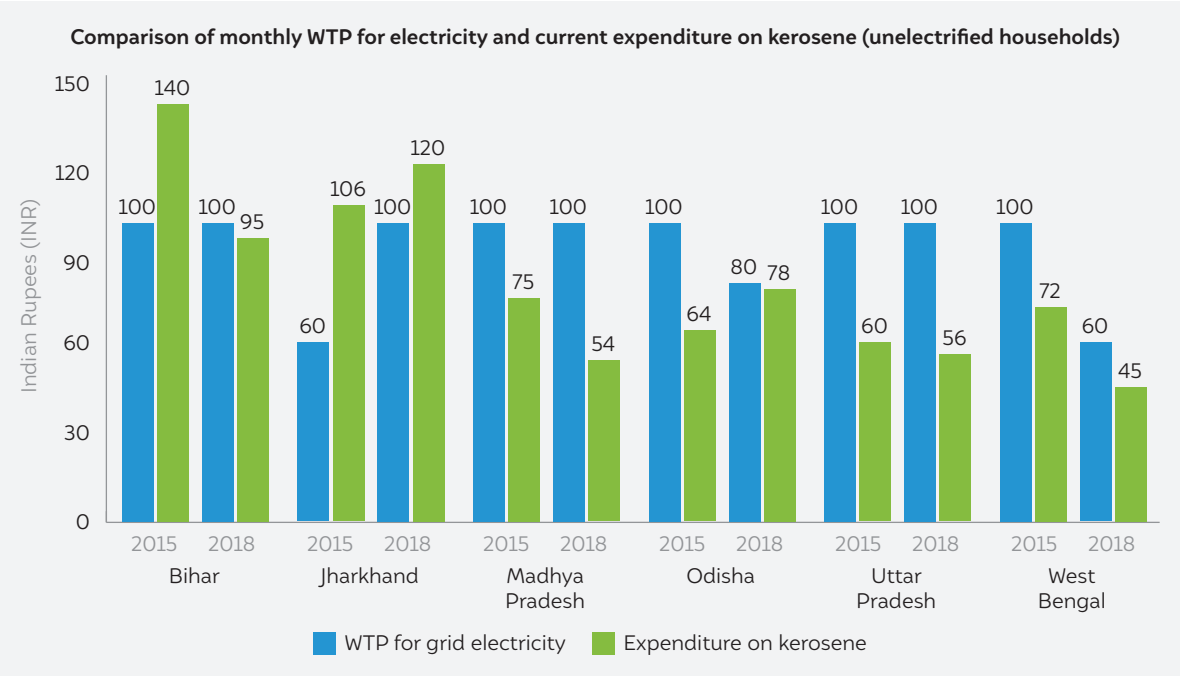
Unelectrified households

About 14 per cent of households across the six states were completely unelectrified; that is, they were not electrified though the grid, a solar home system, microgrid, or a diesel generator. When asked which appliances they would use, in order of importance, if they were electrified, households typically cited lights, fans, and televisions as the top three needs, in addition to mobile charging. After having identified the appliances that they would like to use, respondents stated their monthly WTP for electricity consumption against the selected appliances. The median monthly WTP across all unelectrified households in the survey was INR 100, which, incidentally, has not changed since 2015. While the WTP for electricity has increased among unelectrified households in Jharkhand, it has decreased in Odisha, and sharply so in West Bengal. The reasons for such variations over time remain unclear.

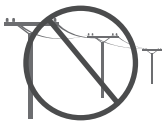
The median monthly WTP for electricity across all unelectrified households in the survey was INR 100, which, incidentally, has not changed since 2015

In general, among the unelectrified households, we have observed that the median monthly expenditure on kerosene has reduced marginally, despite an increase in the per-litre median price of fuel at Public Distribution System (PDS) stores and the market. This, coupled with a decrease in median consumption, implies that the demand for kerosene is quite elastic. Notwithstanding the increase in kerosene expenditure in Jharkhand over the last three years, there appears to be an unambiguous story in the state. Even though the WTP for electricity in Jharkhand has increased, households continue to heavily discount the utility that they will derive from grid electricity when compared to kerosene; so much so that their average monthly WTP is INR 20 less than their average monthly kerosene expenditure. It is worth noting that while kerosene is sufficient only for a household's lighting needs, electricity allows for the convenience of mobile charging and the use of fans. For many of these households, who concurrently also reported that the recurring cost of grid electricity was a barrier to electrification, there is a need for interventions to help explain how the prevalent tariff for electricity fares against their expenditure on kerosene. Some households' WTP for electricity might be lower than their outlay on kerosene if they view the latter as more reliable, since grid electricity may not be available when households most need it. This perception and their WTP are both likely to change as the duration of supply increases and the frequency of blackouts decreases.

FIGURE 38: For unelectrified households, even as median monthly expenditure on kerosene has reduced in four states since 2015, median monthly WTP for electricity remains the same



Source: CEEW analysis, 2018



14 per cent of unelectrified households said they would prefer not to be connected to the grid even at zero upfront cost

Households that did not have grid electricity were asked if they would accept an electricity connection if offered one for free. Surprisingly, 14 per cent of unelectrified households said they would prefer not to be connected to the grid even at zero upfront cost. While this does not directly reflect their unwillingness to make recurrent payments for electricity, it is telling of vital household decision-making behaviours that, although counterintuitive at first, are perhaps well-rooted in reason. The preference to remain unelectrified, at least legally, might be due to a reluctance to formalise an existing illegal connection or to avoid the liability to pay recurring expenses to local authorities; it may even result from a perception that even legally connected households are at times subject to misconduct and extortion if they are unable to pay the bill of many months together. For many households, it may well be an economically rational decision to not accept a free connection. In fact, we find that households that would reject a free connection have a lower WTP for electricity than those that would not, with the median WTP of both groups at INR 50 and INR 100 per month, respectively.

Further, when asked what they would be willing to pay for electricity that is available when needed, allows 12 hours of artificial light a day, a fan for eight hours a day, and mobile charging, unelectrified households in our survey typically stated INR 100 per month. This value did not deviate much from the WTP for electricity as stated by households after identifying the electrical applications they would like to use, and has remained more or less consistent across all six states.

Electrified households

Households that were electrified by the grid or a solar home system, microgrid, or diesel generator were asked what they would be willing to pay for improved access to electricity; the question was contextualised against appliances they would like to use but are currently unable to as a result of poor power supply. The hypothesis is that households will be willing to pay an amount different to what they are already paying per month if they are to receive quality, reliable supply, as this will enable them to use appliances that they do not otherwise have a chance to use.

Over seven per cent of electrified households felt that there were appliances that they were unable to use only because of poor-quality electricity. This is a remarkable improvement from 2015, when 55 per cent of households felt that limited supply interfered with their use of some appliances. The most common appliances mentioned in this regard were fans and televisions. Electrified households were typically willing to pay INR 200 per month for electricity that would enable the use of such appliances—this is no different to what these households are already paying every month for their current electricity use.

Image: Flickr

4. State of Clean Cooking Energy Access

Access to clean cooking energy is imperative for achieving overall human development. Globally, about three billion people lack access to clean cooking energy, and estimates suggest that India alone is home to about 830 million people who still rely on traditional biomass to meet their cooking energy needs (IEA, 2015; Gould et al., 2018; WHO, 2018). The dependence on traditional fuels affects families' health and safety, and results in drudgery and time poverty for many households. Every year in India, indoor air pollution, caused mainly by burning traditional biomass, leads to an estimated 1.24 million premature deaths (WHO, 2018).

As a result of PMUY and other initiatives, 84 per cent of households in India had LPG connections as of July 2018

Since the 1970s, the Government of India has attempted to provide access to clean cooking energy through initiatives promoting various fuels and technologies. In the early seventies, the government started providing LPG at subsidised prices. Since the 1980s, the government has also introduced various policies promoting biomass cookstoves (National Biomass Cookstoves Programme in 1985 and Unnat Chulha Abhiyan in 2013) and biogas (National Project on Biogas Development in 1981-82, National Biogas and Manure Management Programme in 2002-03, and New National Biogas and Organic Manure Programme in 2018). However, the adoption of non-LPG cooking energy solutions has been very limited owing to disproportionately low budgetary support, poor management of technology, deficient after-sales services, limited suitability for users, and low levels of awareness.

LPG adoption, on the other hand, has increased gradually in the country. Thus, so far, the clean cooking energy access story in India is in a way synonymous with the LPG story. However, while LPG access increased in the country, there remained a widespread disparity in access between urban and rural populations. In 2001, almost half of urban India was using LPG as their primary cooking fuel, which by 2011 had increased to 65 per cent (Census, 2011). In contrast, in 2011, only 12 per cent of rural Indian households used LPG as their primary cooking fuel.

Over the last decade, there have been a series of initiatives to improve LPG penetration and accessibility among deprived populations. The first such initiative was in 2009, when the government announced special guidelines for rural LPG distributors; this was followed in 2014–15 by other initiatives to improve LPG distribution such as direct benefit transfers (DBTs) - LPG subsidies were directly transferred to the bank accounts of users rather than being provided at the point of sale, in order to avoid the misuse of the subsidy. In 2015, the 'Give It Up' campaign was rolled out to encourage the voluntary surrender of LPG subsidies by users who can afford to pay the market price. In 2016, the government launched the *Pradhan Mantri Ujjwala Yojana* (PMUY), which was designed to ameliorate the upfront cost of LPG adoption for the

lower socioeconomic sections of society. Through this scheme, deprived households were given access to subsidised LPG connections, based on their categorisation in the Socio-Economic and Caste Census (SECC). As of November 2018, PMUY has provided subsidised connections to over 57 million households (MoPNG, 2018). As a result of PMUY and other initiatives, 84 per cent of households in India had LPG connections as of July 2018 (PPAC, 2018).

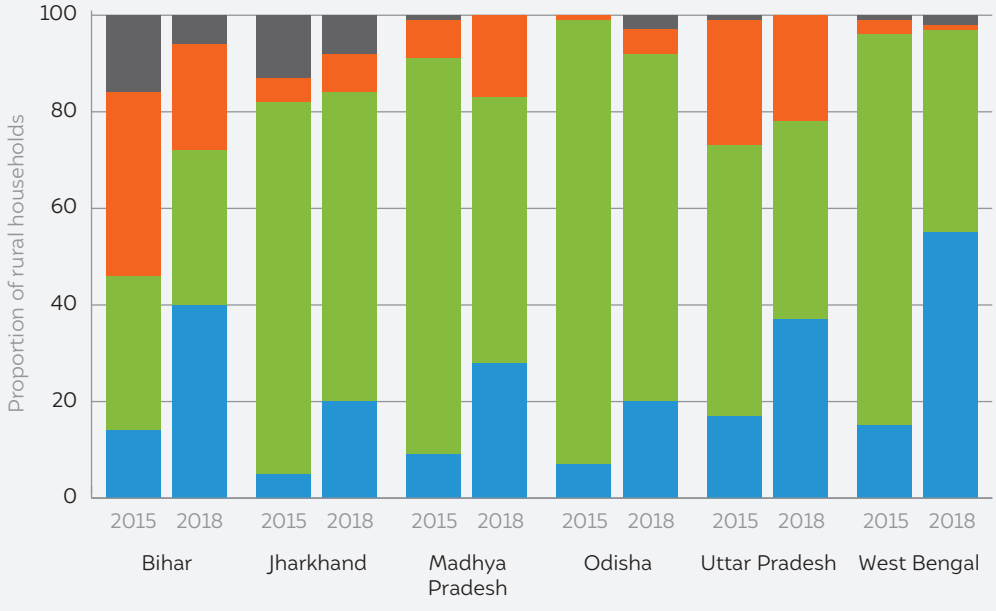
Between 2015 and 2018, PMUY has significantly changed the accessibility and availability of LPG. Using the multidimensional approach of ACCESS 2015 and 2018, we have captured the changes in the situation at a granular level to better understand the drivers and barriers for households in transitioning towards clean cooking energy.

Access to clean cooking energy between 2015 and 2018 for the six states

Over the last three years, across the six focus states, the proportion of households that are dependent on traditional biomass as their primary source of cooking has significantly declined, from 85 per cent in 2015 to 63 per cent in 2018. Each of the six states witnessed this decline to a different degree, ranging from a seven percentage points decline in Jharkhand to a decline of 40 per centage points in West Bengal (Figure 39). This decline also differs by forms of biomass—for instance, a significant proportion of households in Bihar moved from dung as their primary cooking fuel in 2015 to LPG as their primary fuel in 2018.

Despite the decline, close to two-thirds of households across the six states still report biomass as their primary cooking fuel, indicating that the dependence on biomass continues to be a major challenge in rural India. The reliance on traditional biomass is particularly high in Odisha, Jharkhand, and Madhya Pradesh, with more than three-fourth of households using it as their primary cooking fuel in 2018.

FIGURE 39: A significant movement of households from biomass to LPG has occurred, but disparities across states remain



	Bihar		Jharkhand		Madhya Pradesh		Odisha		Uttar Pradesh		West Bengal	
Others	16%	6%	13%	8%	1%	0%	0%	3%	1%	0%	1%	2%
Dung	38%	22%	5%	8%	7%	17%	1%	5%	26%	22%	3%	1%
Firewood	32%	32%	77%	64%	82%	55%	92%	72%	56%	41%	81%	41%
LPG	14%	40%	5%	20%	9%	28%	7%	20%	17%	37%	15%	55%

Source: CEEW analysis, 2018

Even on a multidimensional metric, all six states show a considerable improvement with regard to cooking energy access between 2015 and 2018. Looking at the clean cooking energy access index, we find that West Bengal performs the best among the six states in 2018, trebling its score from 11.1 to 32.9. Odisha has shown the highest improvement in its score, reporting an increase of 4.5 times in its score - from 4.2 in 2015 to 23 in 2018 (Table 8 and Figure 40). The disparity between the states has also declined, as illustrated by the halving of the coefficient of variation for the cooking energy access indices (Table 8). One of the reasons for the reduction in disparity across states is PMUY, which will be discussed in greater detail in later sections.

All six states show a considerable improvement with regard to cooking energy access between 2015 and 2018. The disparity between the states has also declined

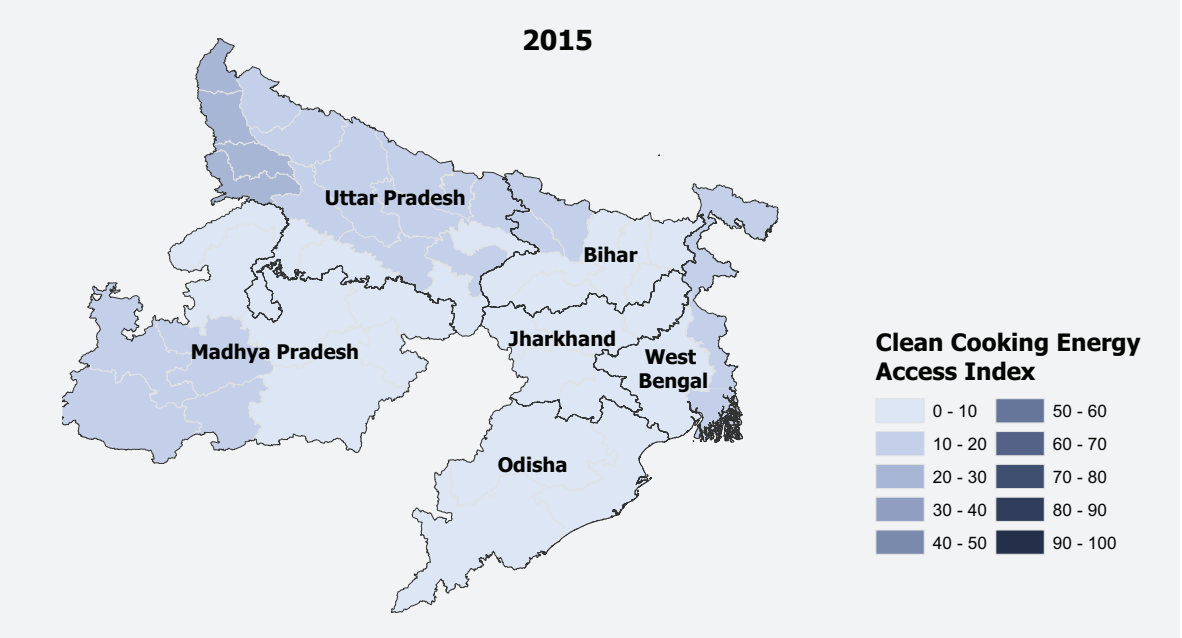
TABLE 8: Aggregate cooking energy access index in 2015 and 2018

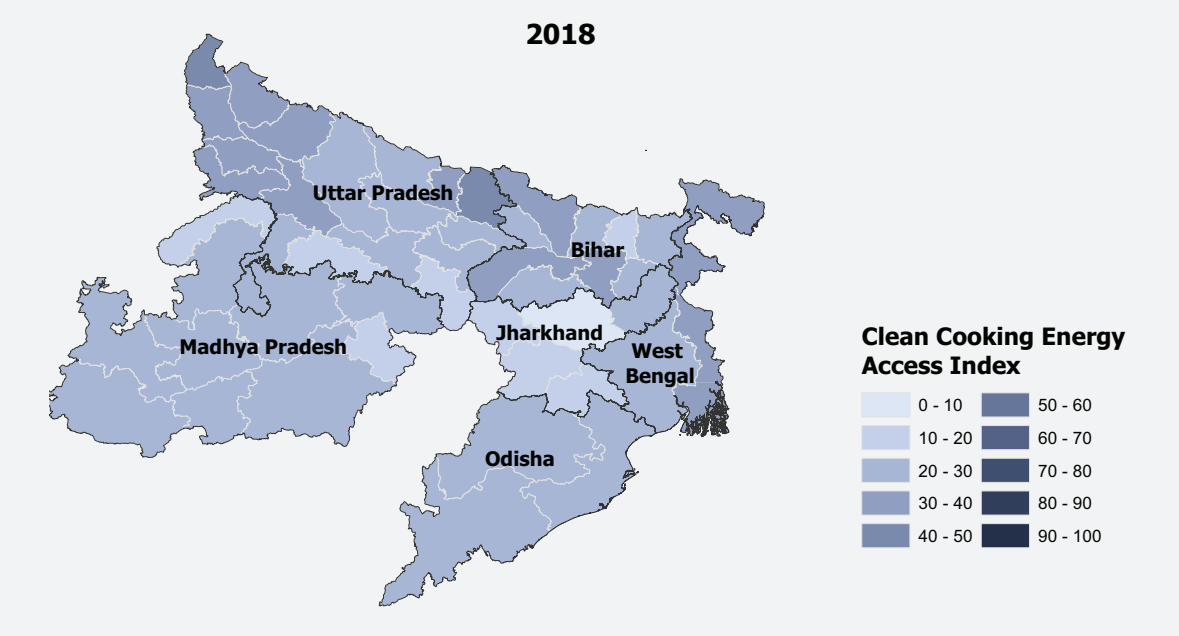
State	Aggregate cooking energy access index		Percentage increase in the Index value
	2015	2018	
Bihar	8.7	28.5	330%
Jharkhand	3.4	15.0	440%
Madhya Pradesh	8.2	23.1	280%
Odisha	4.2	23.0	550%
Uttar Pradesh	14	28.6	200%
West Bengal	11.1	32.9	300%
Standard deviation	3.68	5.70	
Mean	8.27	25.17	
Coefficient of variation (C.V.)	0.45	0.23	

Source: CEEW analysis, 2018

The improvement in the overall access to clean cooking energy, from a multi-tier perspective, is shown in Figure 41. Across the six states, a third of rural households have moved from Tier 0 to higher tiers. However, despite an increase in proportion of households in higher tiers, a lot remains to be addressed, as about 44 per cent of rural households remain in the lowest tier of clean cooking energy access.

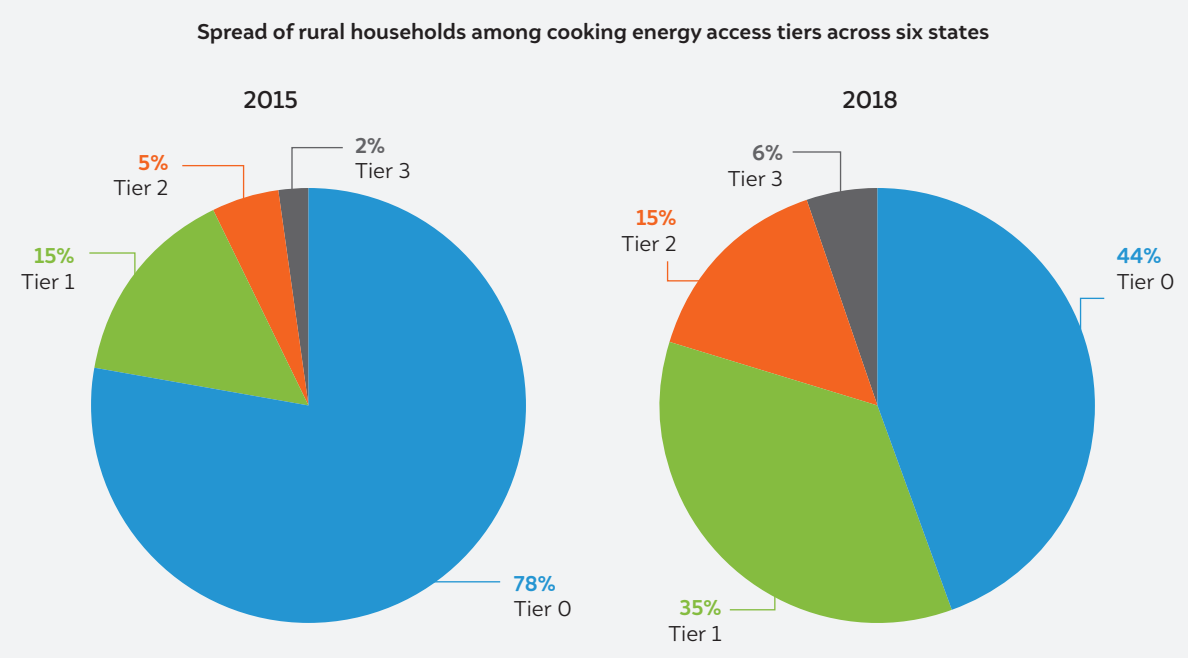
FIGURE 40: Clean cooking energy access indices across six states in 2015 and 2018





Source: CEEW analysis, 2018

FIGURE 41: A significant movement of households from Tier 0 to higher tiers in the last three years



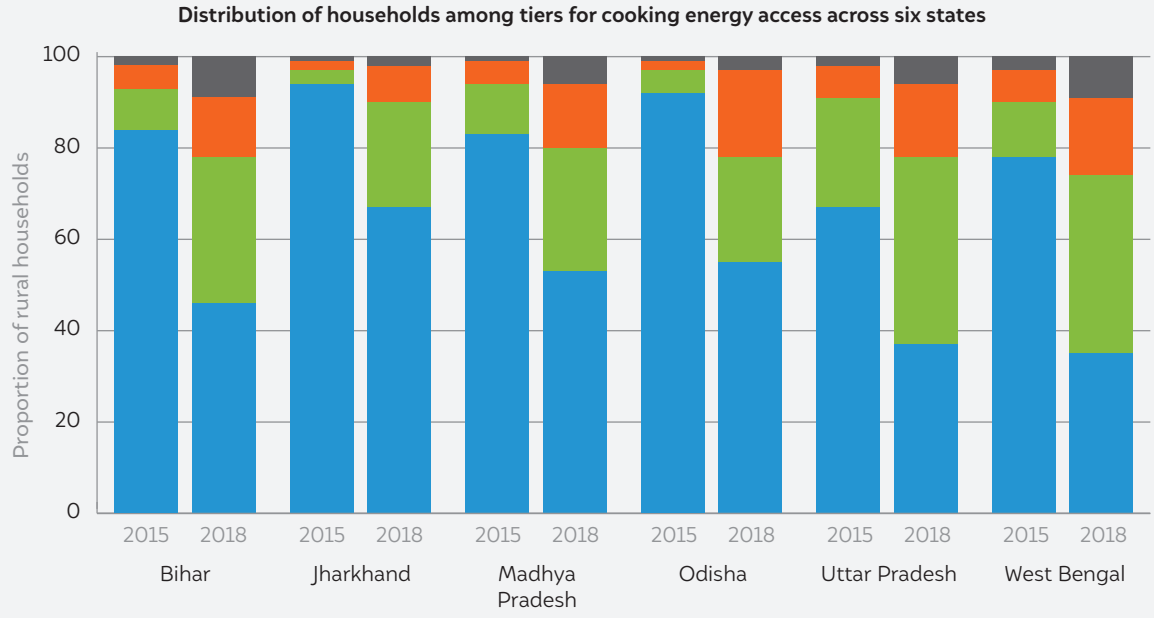
Source: CEEW analysis, 2018

As of 2018, 44 per cent of households across the six states are in Tier 0, as compared to 78 per cent in 2015. Of the households that have moved from Tier 0 to higher tiers, all did so because they have acquired access to LPG. Other non-traditional cooking energy solutions have very little penetration in the six states. We find that only 0.77 per cent of rural households in these states use an improved biomass cookstove or biogas for cooking—a decline from 0.95 per cent in 2015. LPG stands out as almost the only clean cooking fuel to have enabled households to move to higher tiers of

Of the households that have moved from Tier 0 to higher tiers, 42 per cent are PMUY beneficiaries, implying that PMUY has been a critical factor in enabling this transition. However, among these PMUY beneficiaries, majority (62 per cent) have moved only to Tier 1, and merely six per cent have moved to Tier 3

cooking energy access. Of the households that have moved from Tier 0 to higher tiers, 42 per cent are PMUY beneficiaries, implying that PMUY has been a critical factor in enabling this transition. However, among these PMUY beneficiaries, majority (62 per cent) have moved only to Tier 1, and merely six per cent have moved to Tier 3. It implies that though PMUY has moved some households up from Tier 0, in order to achieve the highest tier, there is a need to focus on the exclusive use of clean cooking energy, as well as to address challenges associated with affordability, convenience, quality, and availability.

FIGURE 42: West Bengal in 2018 is the best-performing state in terms of access to clean cooking energy



	Bihar 2015	Bihar 2018	Jharkhand 2015	Jharkhand 2018	Madhya Pradesh 2015	Madhya Pradesh 2018	Odisha 2015	Odisha 2018	Uttar Pradesh 2015	Uttar Pradesh 2018	West Bengal 2015	West Bengal 2018
Tier 3	2%	9%	1%	2%	1%	5%	1%	3%	2%	6%	3%	9%
Tier 2	5%	13%	2%	8%	5%	14%	2%	19%	7%	16%	7%	17%
Tier 1	9%	32%	3%	23%	11%	27%	5%	23%	24%	42%	12%	40%
Tier 0	83%	46%	94%	67%	83%	53%	92%	55%	68%	37%	78%	35%

Source: CEEW analysis, 2018

Among the six surveyed states, West Bengal has the highest access to clean cooking energy (Figure 42). The proportion of the state's households in Tier 0 declined by 43 percentage points, the largest improvement among the six states. Bihar also has an equally high proportion of households in Tier 3 as West Bengal. The movement of households to Tier 3 in Bihar has been primarily driven by the complete avoidance of stacking among non-PMUY LPG households. Categorisation as Tier 3 requires the exclusive use of clean cooking energy, something that only 16 per cent of PMUY households have been able to achieve, in comparison to 40 per cent of non-PMUY households, in all six states.

4.1. Tier 0 households

Households are categorised as Tier 0 under two conditions:

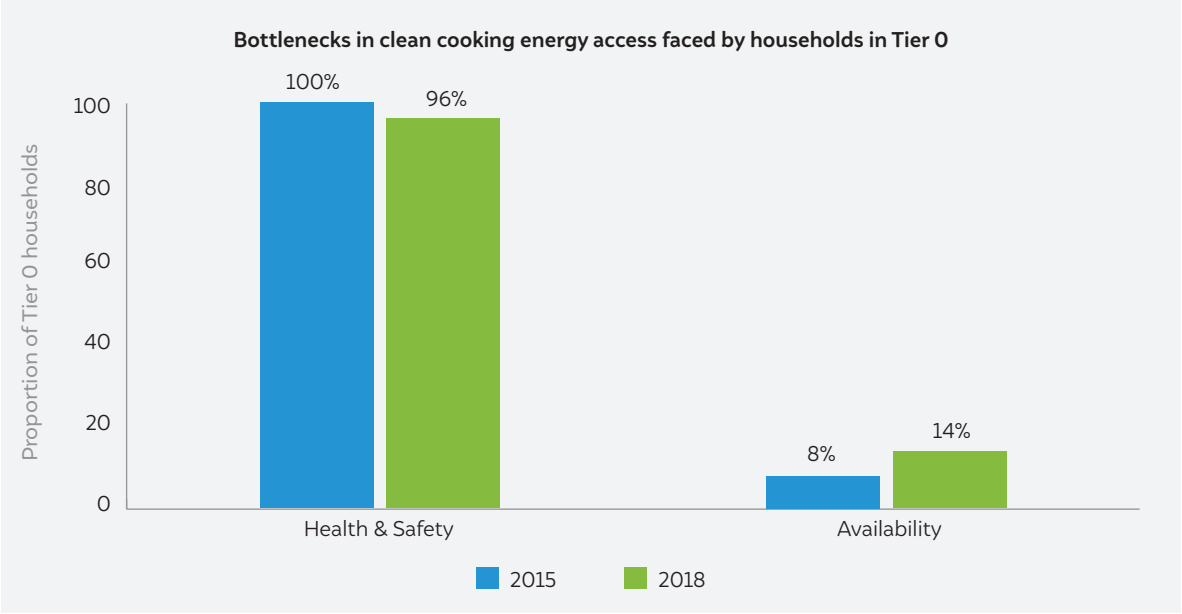
- Complete dependence on traditional fuels for cooking energy, putting health and safety at risk
- Lack of fuel availability to the extent that it restricts the amount of food cooked

Almost all (96 per cent) of the households in Tier 0 fail on the 'health and safety' dimension as they depend entirely on biomass for cooking (Figure 43). Further, the proportion of households in

> Almost all (96 per cent) of the households in Tier 0 fail on the 'health and safety' dimension as they depend entirely on biomass for cooking

Tier 0 who are cooking less than their requirement[15] because of the unavailability of fuel has increased over the last three years in relative terms from eight per cent to 14 per cent of Tier 0 households. In absolute terms, the proportion of such households remain at about six per cent of rural households since 2015. This remains a worrying situation given its potential impact on the nutritional uptake of these households.

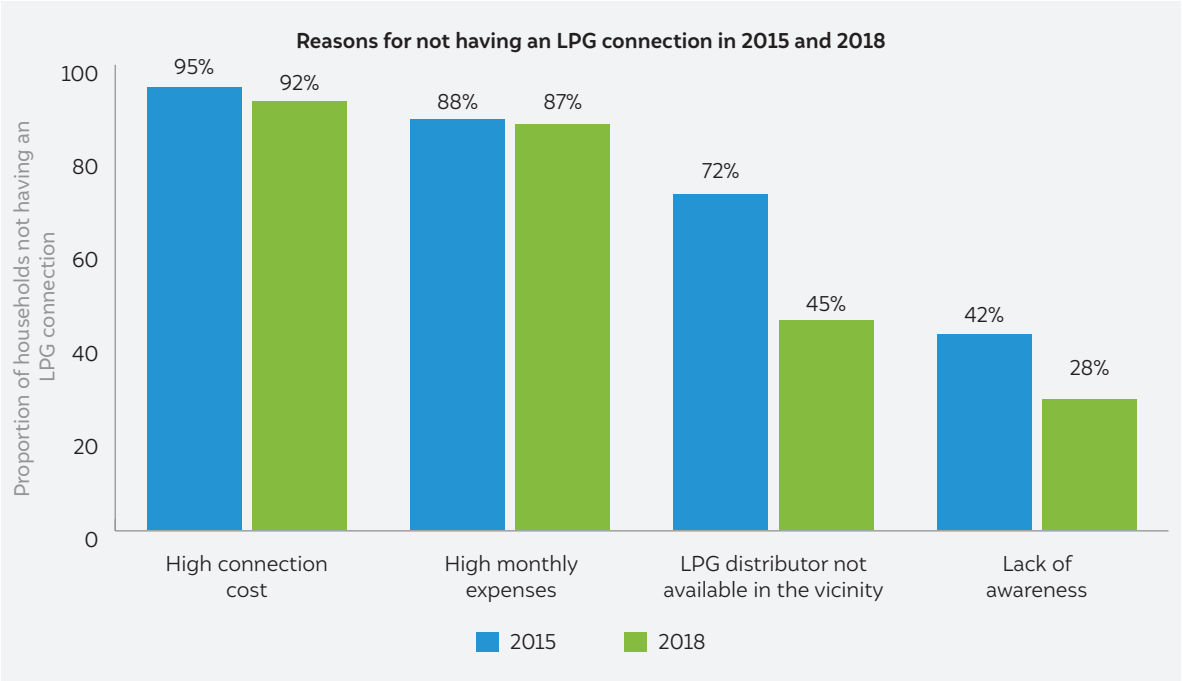
FIGURE 43: Complete dependence on traditional biomass continues to prevent Tier 0 households to transition to the higher tiers



Source: CEEW analysis, 2018

Given that lack of health and safety remain the primary bottleneck for Tier 0 households, it is important to look at the barriers for these households to adopt clean cooking energy solutions. As there is negligible penetration of other clean cooking energy options, we focus on understanding the barriers in accessing LPG.

FIGURE 44: High connection cost and high recurring expenses continue to be the two primary reasons for non-adoption of LPG



Source: CEEW analysis, 2018

15 Households were asked in particular if they are cooking less than they want because of poor availability of cooking fuel.

As in 2015, high connection costs and monthly expenses remain the biggest bottlenecks to the adoption of LPG (Figure 44). While PMUY has improved access to LPG connections by reducing the initial cost burden for BPL households which qualify under the SECC, most of the remaining households still report the high upfront cost as the reason for the non-adoption of LPG. Apart from affordability concerns, the non-availability of LPG distributorship in the vicinity and lack of awareness are also bottlenecks in the adoption of LPG. For instance, despite an increase in penetration of LPG across states, and the launch of PMUY, about 28 per cent of households that do not have an LPG connection still do not know how to get one. Most interestingly, the lack of an LPG distributorship in the vicinity is no longer as crucial a bottleneck,[16] which reflects the government's efforts to improve LPG availability in rural areas through new distributorships.

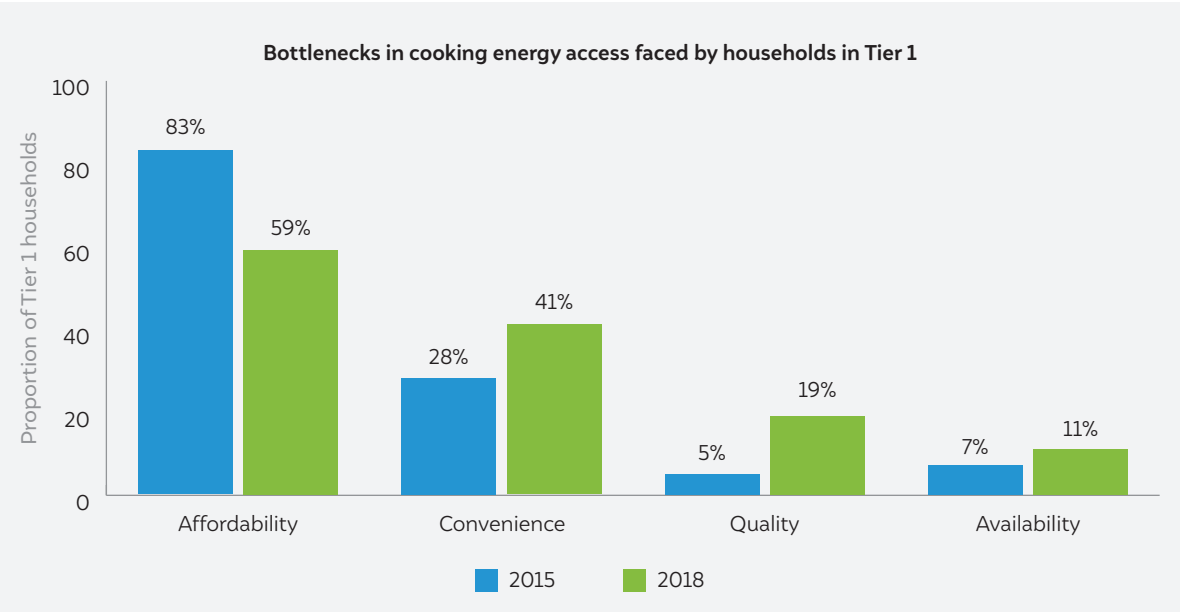
Even though affordability as a bottleneck has declined by 22 percentage points for Tier 1 households in 2018, it continues to be the most common barrier for them to transition to higher tiers

Of the households not using LPG, 83 per cent are interested in acquiring a connection. This is a significant increase from 2015, where only 48 per cent of households not using LPG had expressed an interest in getting a connection. It is likely that PMUY and its associated awareness efforts would have played a role in increasing this interest. Further, households interested in adopting LPG are willing to pay INR 300 per month (median value) for using LPG for all their cooking needs.

4.2. Tier 1 households

The proportion of households in Tier 1 more than doubled between 2015 and 2018. Even though affordability as a bottleneck has declined by 22 percentage points for Tier 1 households in 2018, it continues to be the most common barrier for them to transition to higher tiers. For 59 per cent of households in Tier 1, more than six per cent[17] of their monthly expenditure is on cooking fuels. A detailed discussion on affordability will follow in the next section.

FIGURE 45: Affordability of cooking energy is still the biggest limiting factor for Tier 1 households



Source: CEEW analysis, 2018

16 West Bengal does not show much improvement here, but the bottleneck was anyway lowest in West Bengal in 2015.
17 Six per cent of the monthly expenditure has been considered as the threshold to determine the affordability of the cooking fuel for the households. Please refer to the chapter on methodology for further details.

While affordability as a bottleneck is hindering lesser proportion of Tier 1 households compared to 2015, the other three dimensions—convenience, quality, and availability of cooking fuel—have become more prominent bottlenecks. Convenience as a bottleneck for Tier 1 households essentially means that their primary cooking arrangement is both time-consuming and difficult to use. Of the Tier 1 households who face convenience as a problem, 77 per cent use biomass as their primary cooking fuel; and more than 90 per cent stack LPG along with biomass. This implies that they have at least some experience of using LPG and are therefore aware of the perceived advantages of using LPG with respect to ease of use and time consumed (refer Table 9 and Table 10). Almost three-fourths of the Tier 1 households that cited convenience as the bottleneck were in Tier 0 in 2015 and moved to Tier 1 in 2018. This bottleneck can be addressed by either providing alternative cooking arrangements to household for using biomass in a manner which is convenient and not time consuming or by shifting their primary cooking fuel from traditional biomass to LPG.

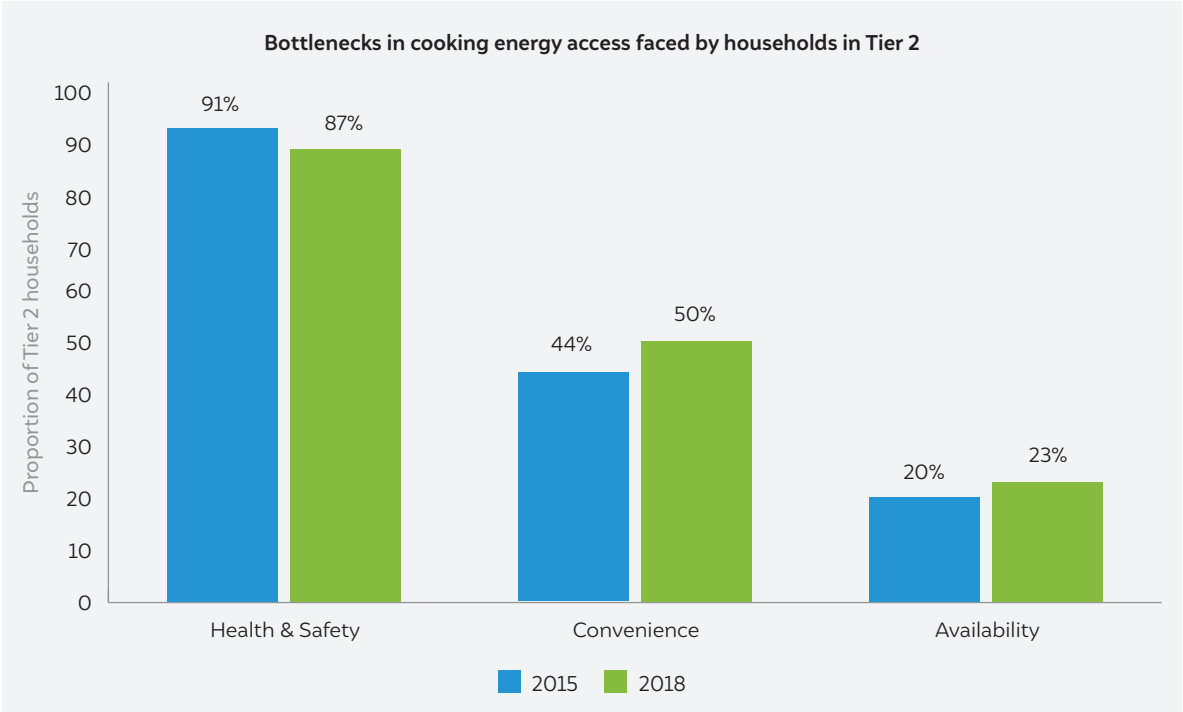
Due to the continued use of biomass and thus exposure to household air pollution, 'health and safety' dimension remains the biggest barrier for households in Tier 2

Quality of cooking is also a perception-based dimension. Though, it affects a much smaller proportion of Tier 1 households, of all the Tier 1 households that mention that quality of cooking as a problem, about 80 per cent are using LPG as their primary cooking fuel. The issue is state specific: 43 per cent of the households that are dissatisfied with cooking quality of LPG are in West Bengal. This indicates that cultural factors and local food preferences could play an important role in households' perception of cooking quality with modern fuels.

4.3. Tier 2 households

The proportion of rural households that are in Tier 2 tripled between 2015 and 2018. However, due to the continued use of biomass and thus exposure to household air pollution, 'health and safety' dimension remains the biggest barrier for households in Tier 2. Although almost all Tier 2 households are using LPG, about 37 per cent are still using biomass as their primary cooking fuel and other 50 per cent continue to stack biomass with LPG to meet their cooking needs.

FIGURE 46: Stacking of traditional biomass with LPG is the major bottleneck for households in Tier 2



Source: CEEW analysis, 2018

For about half of Tier 2 households, convenience of cooking is the other main issue, indicating that they find their primary arrangement either too difficult to use or too time-consuming. Around 59 per cent of this group uses traditional biomass as their primary cooking fuel.

About a quarter of Tier 2 households indicate lack of satisfaction with the availability of their primary cooking fuel. About 52 per cent of these households use LPG as their primary cooking fuel, with most of households located in West Bengal. Interestingly, compared to the other five states, West Bengal performs the best in terms of LPG home delivery, yet some of the households seem not entirely satisfied with its current availability.

TABLE 9: Cooking convenience for households using traditional *chulhas*

For households using the traditional chulha as their primary cooking arrangement		Too time-consuming	
		No	Yes
Difficult to cook	No	7%	30%
	Yes	4%	59%

Source: CEEW analysis, 2018

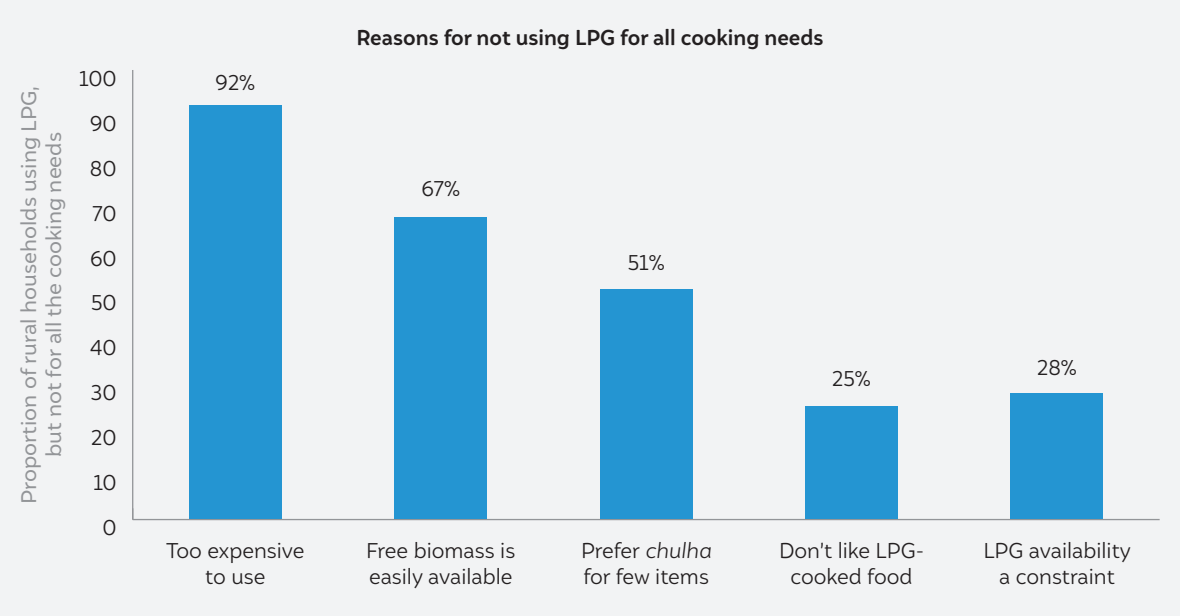
TABLE 10: Cooking convenience for households using LPG

For households using LPG as their primary cooking arrangement		Too time-consuming	
		No	Yes
Difficult to cook	No	73%	9%
	Yes	8%	9%

Source: CEEW analysis, 2018

Since most of the problems across tiers are associated with households using biomass as their primary cooking fuel (63 per cent) or stacking it with LPG or other clean cooking fuels (39 per cent), it is necessary to understand what is impeding the complete transition to clean cooking energy solutions. The three states where fuel stacking is most prominent are Uttar Pradesh (49 per cent), Odisha (43 per cent), and Madhya Pradesh (37 per cent).

FIGURE 47: The cost of using LPG and the availability of free-of-cost biomass are the two most common factors preventing transition to LPG, as cited by households



Source: CEEW analysis, 2018

When asked why households were not using LPG for all their cooking needs, 92 per cent reported that it was too expensive, while 67 per cent mentioned easy availability of free-of-cost biomass as the reason (Figure 47). Cultural factors, such as preferring to use a chulha for cooking few items were also reported as a reason by significant proportion of households.

Of all the LPG-using households, almost one-third are using it exclusively i.e. no stacking with traditional biomass

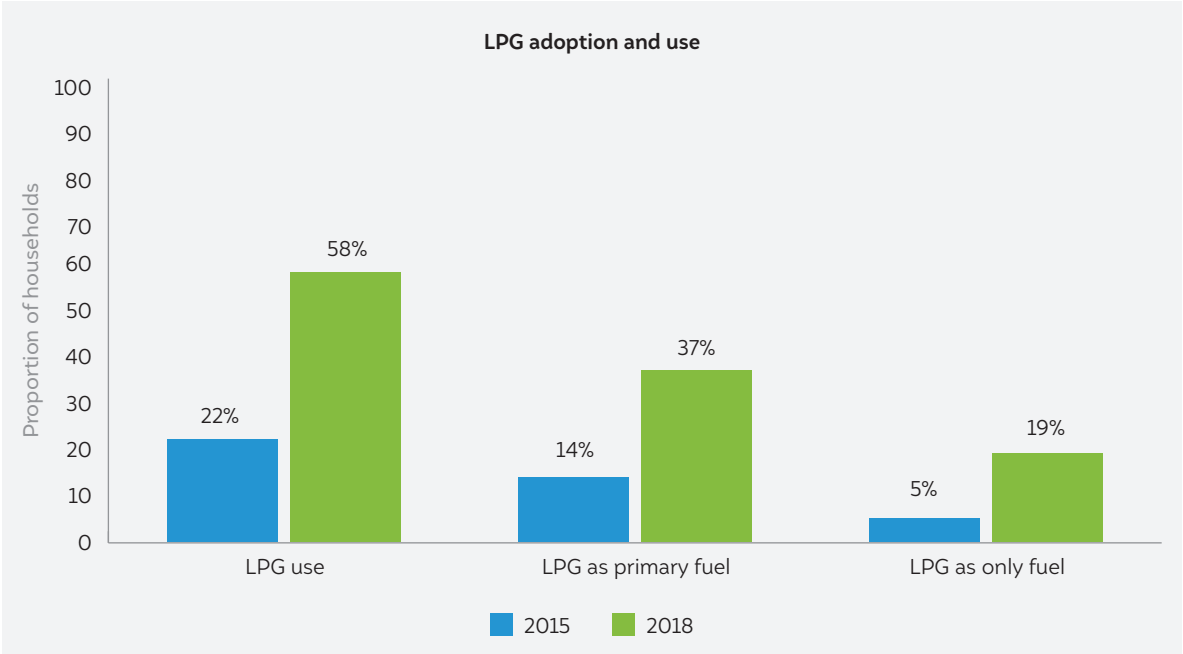
4.4. The big focus: LPG

As discussed earlier, since 2016, the national discourse on access to clean cooking energy has predominantly focused on increasing the penetration of LPG, with a significant focus on the PMUY scheme. The use of other clean cooking energy solutions remains very limited, as was seen in ACCESS 2015. Even in 2018, only 0.7 per cent of all rural households reported the use of improved biomass cookstoves, which often fail to meet the necessary emission standards to be considered clean from the health perspective. Biogas on the other hand is a clean fuel, but witnesses very low penetration at 0.1 per cent of rural households in these states using them. In this context, the following section focuses on understanding rural households' access to, and use of, LPG across the six states. We focus on understanding the changes in primary fuel for cooking, the extent of LPG use, and its availability and affordability. We also look at the decision-making within households with regard to the procurement of LPG.

4.4.1. Adoption and use of LPG among households

In addition to the increase in the proportion of rural households using LPG (from 22 per cent in 2015 to 58 per cent in 2018), the proportion of households reporting it as their primary, and their only, cooking fuel has also increased significantly. Of all the LPG-using households, almost one-third are using it exclusively i.e. no stacking with traditional biomass.

FIGURE 48: Not just connections, but LPG as a primary fuel and as an exclusive fuel has increased significantly since 2015



Source: CEEW analysis, 2018

Nevertheless, the gap between the proportion of households using LPG, and the proportion using it as their primary fuel, continues. This gap indicates the stacking of LPG with traditional biomass. Based on the data from the NSS (1987—2010), Cheng and Urpelainen (2014) explain that cooking fuel stacking increases as

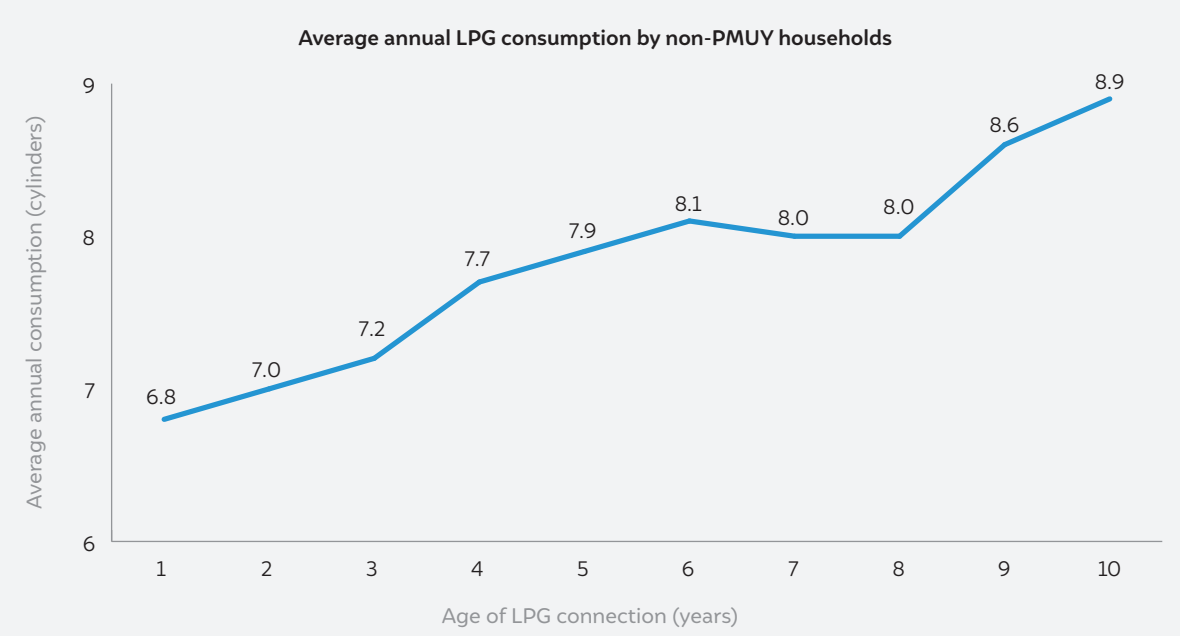
more households adopt LPG, since they do not completely replace traditional biomass. Analysing ACCESS 2015 and 2018 data, we also find an increase in stacking among the surveyed households. In 2018, about 39 percent of households reported stacking, as compared to 18 per cent in 2015. The proportion of households that are stacking cooking fuels varies among states, with 49 per cent of households in Uttar Pradesh following this practice, as against 28 per cent in West Bengal.

We note that the average consumption of LPG is strongly correlated with the age of the connection

We note that the average consumption of LPG is strongly correlated with the age of the connection. This analysis was limited to non-PMUY households to better understand the empirical evolution of consumption for households who are self-selecting themselves to get LPG by paying significant upfront cost. By the time of the survey, PMUY households have used LPG for only two years or less, and hence were not considered for this analysis. PMUY households have been analysed separately in the later chapters.

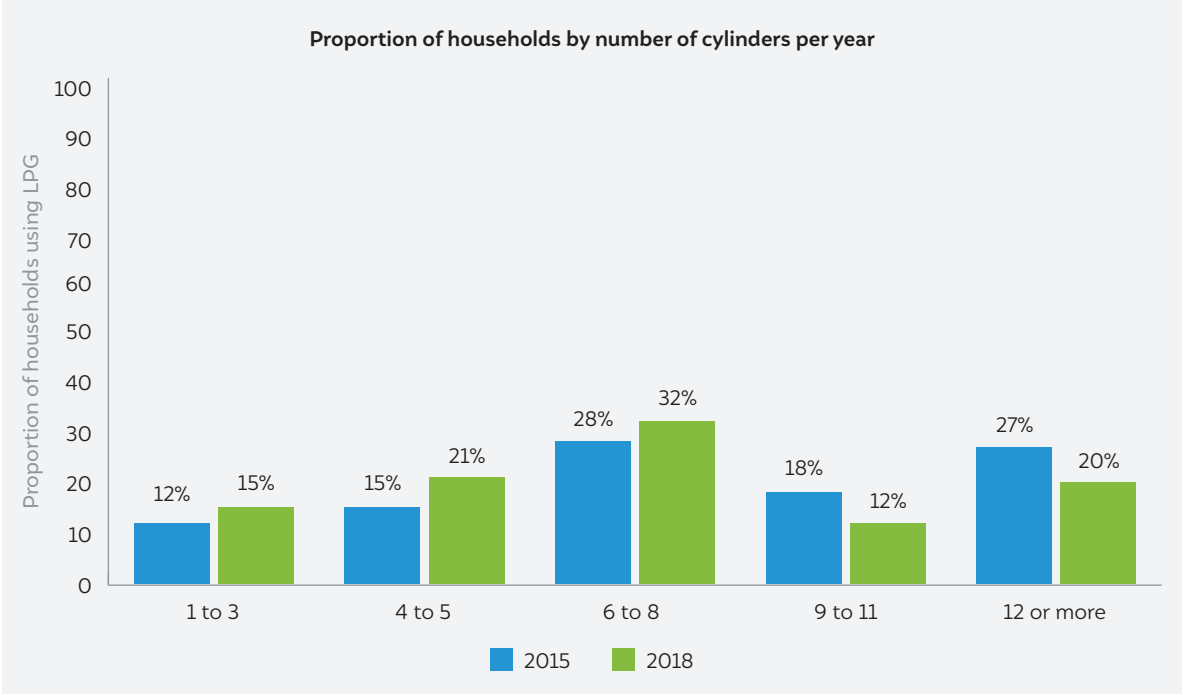
The median yearly LPG consumption of households with at least a year-old LPG connection has reduced from eight cylinders in 2015 to six in 2018. It is a consequence of significant addition of new connections in the last three years. The consumption of new connections takes time to evolve, as indicated in Figure 49, and could not match the consumption of older connections in a short span of two to three years.

FIGURE 49: LPG consumption among all non-PMUY households is strongly correlated with the age of the connection



Source: CEEW analysis, 2018

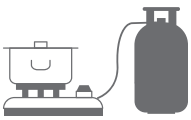
FIGURE 50: As a consequence of significant addition of new LPG connections over the last three years, the proportion of households with lower level of consumption has increased



Source: CEEW analysis, 2018

Median consumption of LPG among households gives us a broader picture of the situation on the ground. However, to adequately understand the evolution of household LPG consumption, we need to look beyond the mean or median values, and juxtapose the consumption pattern with its key drivers, including household income, education level, cooking practices, household size, and social category of households. For instance, we note that despite similar rate of rural LPG connections in Uttar Pradesh and West Bengal (64 per cent and 68 per cent respectively), in West Bengal a higher proportion of households are using LPG as their primary fuel (55 per cent) in comparison to Uttar Pradesh (37 per cent). We see consumption vis-à-vis household size could be playing a role here. Our preliminary analysis indicates that the average household with four members in West Bengal typically uses seven cylinders per year, whereas the average household with six members in Uttar Pradesh typically use a median of six cylinders per year. Similarly, households' economic situation also exhibits some correlations. The median expenditure among households in West Bengal and Uttar Pradesh not using LPG as primary cooking fuel is INR 5,000 which is lower than the median expenditure of households using LPG as primary cooking fuel in these states (INR 6,000 in Uttar Pradesh and INR 7,000 in West Bengal). The difference in expenditures was found to be statistically significant. These are preliminary indications of drivers for LPG use. Using this dataset, we would be undertaking further analysis on the issue in our subsequent research.

4.4.2. Availability of LPG in rural areas

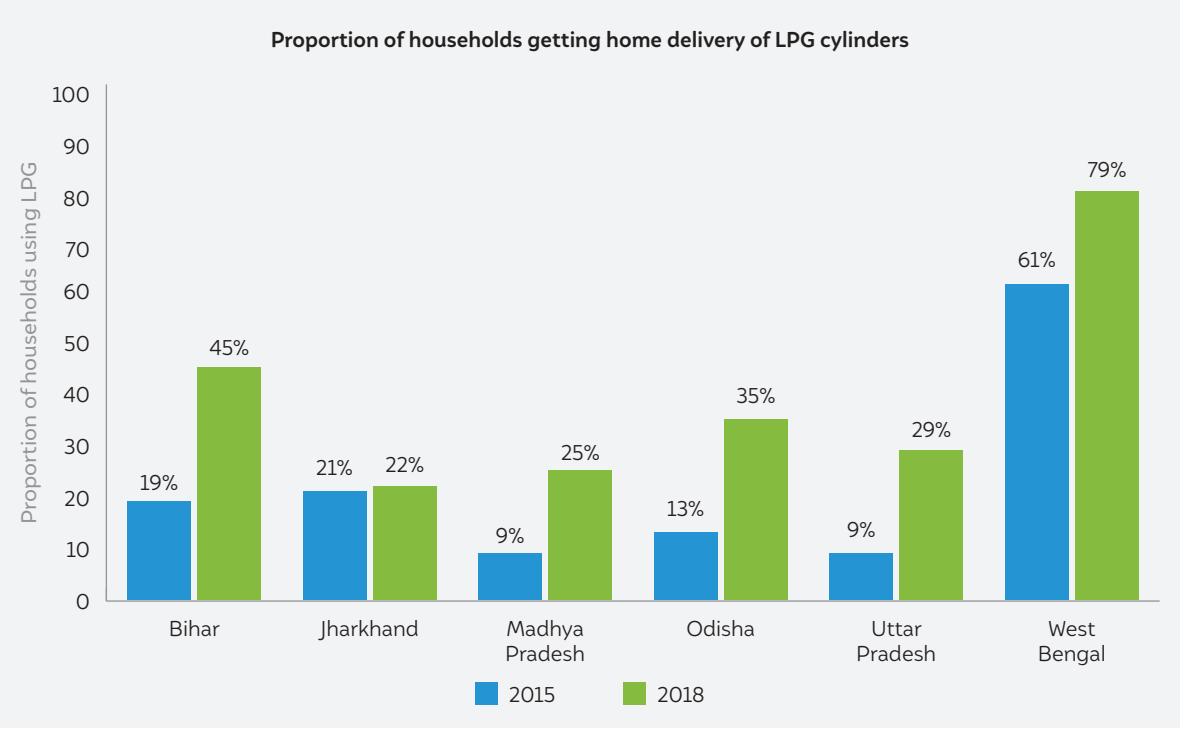


Home delivery of LPG cylinders

The LPG distribution network has expanded and strengthened between 2015 and 2018, with a higher proportion of rural households in the six states getting home delivery of LPG cylinders. However, except for West Bengal, in all other states less than 50 per cent of the rural LPG households receive home delivery. Jharkhand has the lowest proportion (22 per cent) of rural LPG consumers receiving home delivery of cylinders.

To adequately understand the evolution of household LPG consumption, we need to look beyond the mean or median values, and juxtapose the consumption pattern with its key drivers, including household income, education level, cooking practices, household size, and social category of households

FIGURE 51: Home delivery of LPG cylinders has improved across all states, but is still far from 100%



Source: CEEW analysis, 2018

Despite having a similar proportion of households using LPG and a similar level of annual median LPG consumption per connection, West Bengal and Uttar Pradesh show a significant difference in the percentage of households receiving home delivery of LPG cylinders, at 79 and 29 per cent respectively.

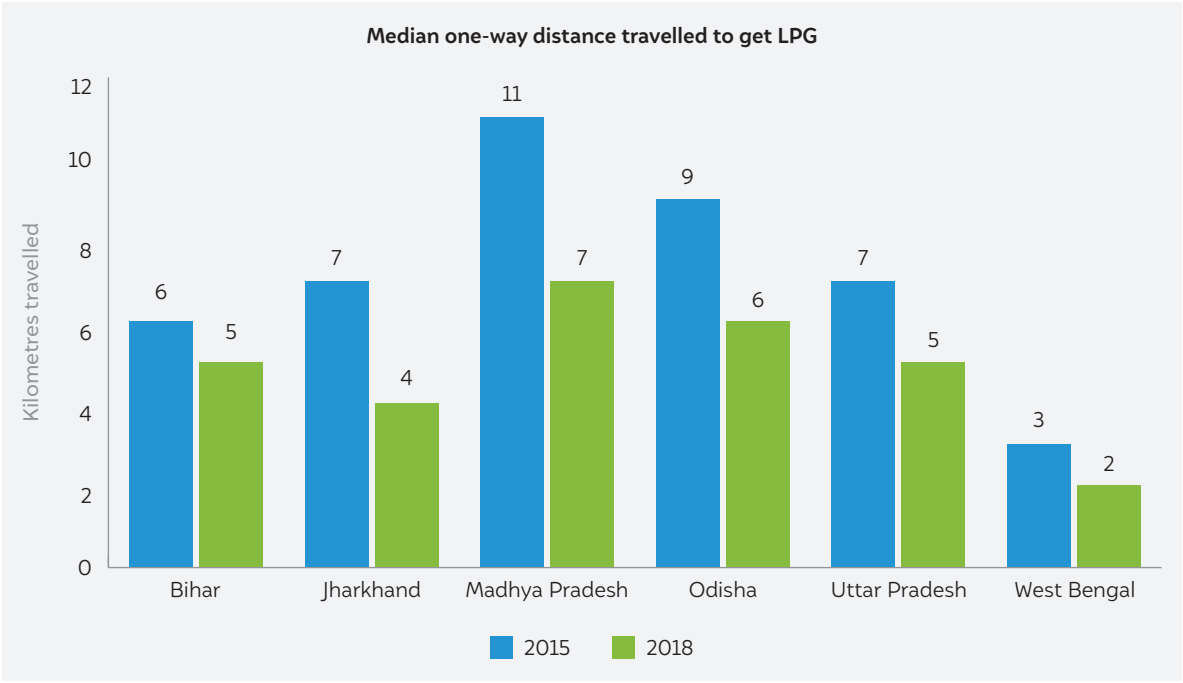
As of 1 July 2018, West Bengal has one distributor for about every 17,000 connections (urban and rural), while Uttar Pradesh has one distributor for about every 9,000 (PPAC, 2018). If we consider the physical area served by the distributors, there is one distributor for every 82 sq. km in West Bengal, in comparison to one for every 68 sq. km in Uttar Pradesh. Despite catering to a larger customer base and larger geographical area, the distributors in West Bengal are able to provide LPG cylinder home delivery to a greater proportion of households than in Uttar Pradesh, potentially because of greater customer density. Greater density of customers improves the economics of home delivery for distributors, which could be a factor in the better rate of home delivery in West Bengal. The density of LPG users in West Bengal is 206 per sq. km, in comparison to 132 per sq. km in Uttar Pradesh.[18] Further, refill rates per rural connection are marginally higher in West Bengal, as compared to Uttar Pradesh, potentially further favouring the economics of home delivery in West Bengal.

The other possible explanation for lower rate of home delivery in Uttar Pradesh vis-à-vis West Bengal could be the limited ability of new distributors to provide home delivery to majority of their customers. About 26 per cent of the distributors in Uttar Pradesh are new (after the launch of PMUY in 2016), compared to 16 per cent in West Bengal. The (predominantly rural) new distributors may find it challenging to provide home delivery in a scenario of low customer density and low refill rates. Uttar Pradesh had only nine per cent of rural LPG consumers receiving home delivery in 2015, whereas in West Bengal a pre-existing network could have aided the higher rate of home delivery despite the increase in households using LPG.

While home delivery of LPG cylinders is far from 100 per cent, we find a reduction in the one-way distance that households have to travel to get their cylinders.

18 We have not segregated density of LPG connections into urban and rural, and we have assumed that the level of urban-rural disparity in terms of LPG connections is similar across both states.

FIGURE 52: Median one-way distance travelled for procuring LPG has declined in comparison to 2015, but continues to be high



Source: CEEW analysis, 2018

For the households that did not receive home delivery of LPG cylinders, we asked the 'one-way' distance they had to cover to procure a cylinder. Our data shows that though the median one-way distance travelled to procure LPG has declined since 2015, it remains high (four kilometres or more) in all states except West Bengal. In comparison to West Bengal, households in Uttar Pradesh travel a median of five kilometres, one way, to procure the cylinder, yet LPG connection rate remains as high as in West Bengal. As indicated in ACCESS 2015, a potential reason for high rate of LPG connections in Uttar Pradesh—despite the hardships of procuring it—is the higher cost of purchased biomass in the state.

We asked households for the number of days they had to wait between placing the order for LPG cylinder and receiving it. The median waiting time across states was one day. In Madhya Pradesh and Uttar Pradesh, the median waiting time was zero days, indicating the LPG cylinder was delivered or procured the next day of placing the order. In West Bengal, despite the high rate of home delivery and possibly because of it, the median waiting time was three days, the highest among all states.

4.4.3. Awareness, perception, and affordability of cooking fuel

Awareness of health impacts of using biomass for cooking

In 2018, 85 per cent of all rural households using biomass as the primary fuel for cooking believed that the use of traditional cookstove had an impact on their health. The proportion has increased in comparison to 2015, where 78 per cent of households using biomass as primary fuel believed so. When asked to compare traditional cookstoves to LPG, in 2018, a similar proportion of households using LPG as primary cooking fuel (89 per cent) and using biomass as primary cooking fuel (84 per cent) indicated that LPG-based cooking is better than using a traditional cookstove considering the health impact. This indicates that majority of rural households are aware about adverse health impact of using biomass and potential health benefits of transitioning to clean options such as LPG.

Though the median one-way distance travelled to procure LPG has declined since 2015, it remains high (four kilometres or more) in all states except West Bengal

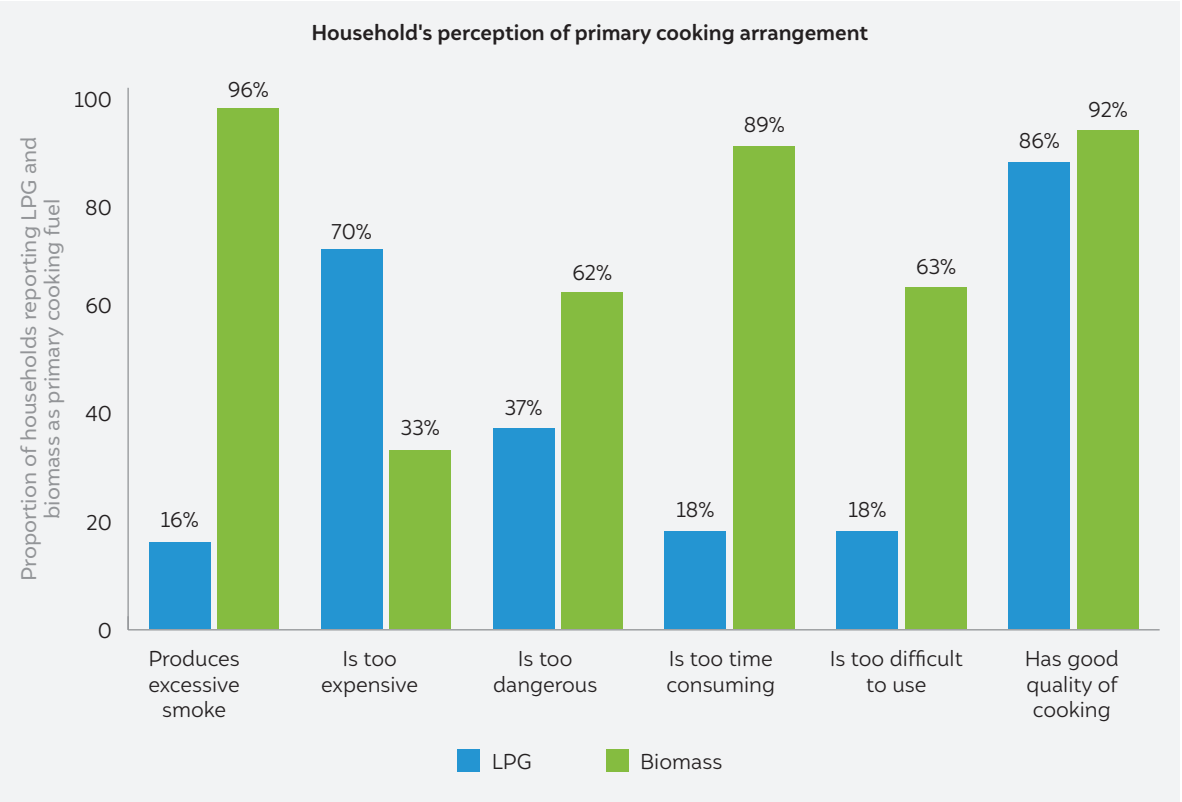
Perception of the primary cooking arrangement

While 86 per cent of households using LPG as their primary cooking fuel stated that they were satisfied with their cooking arrangement, only about 40 per cent of the households using biomass reported the same

While 86 per cent of households using LPG as their primary cooking fuel stated that they were satisfied with their cooking arrangement, only about 40 per cent of the households using biomass reported the same. Compared to their counterparts relying on biomass, a significantly higher proportion of households using LPG as their primary cooking fuel expressed satisfaction with it on aspects such as smoke produced due to cooking, safety, time required, and ease of cooking. However, over two-thirds of the households using LPG as their primary cooking fuel (as compared to a third of biomass users) found it expensive to use. Interestingly, the proportion of biomass users who reported good quality of cooking was marginally higher than LPG users who reported the same. This perception of cooking quality could be driven by a cultural preference for the taste of food cooked on a *chulha*. But the fact that 86 per cent of households that used LPG as their primary fuel had reported good quality of cooking indicates a high degree of comfort with LPG cooking quality among rural households.

In 2015, about 57 per cent of households using LPG as their primary cooking fuel thought it was too expensive, as compared to 70 per cent in 2018. The increased concern around the affordability of LPG could be due to three factors. One, a greater inclusion of economically weaker households into the LPG consumer fold. Two, an increase in the subsidised price of LPG by about 10-15 per cent in the interim years. And three, the perception associated with having to pay upfront the market price of an LPG refill now as compared to the subsidised upfront payment three years ago. However, in 2018, only 37 per cent reported LPG as dangerous to use, compared to 62 per cent in 2015, showing that the perception of LPG as being dangerous is declining. We noted that there was no significant difference in this perception among PMUY and non-PMUY households, implying that this shift in perception hold for all households using LPG as their primary fuel.

FIGURE 53: LPG users consider it to be better in many ways, but find it too expensive



Source: CEEW analysis, 2018

Affordability of cooking fuel

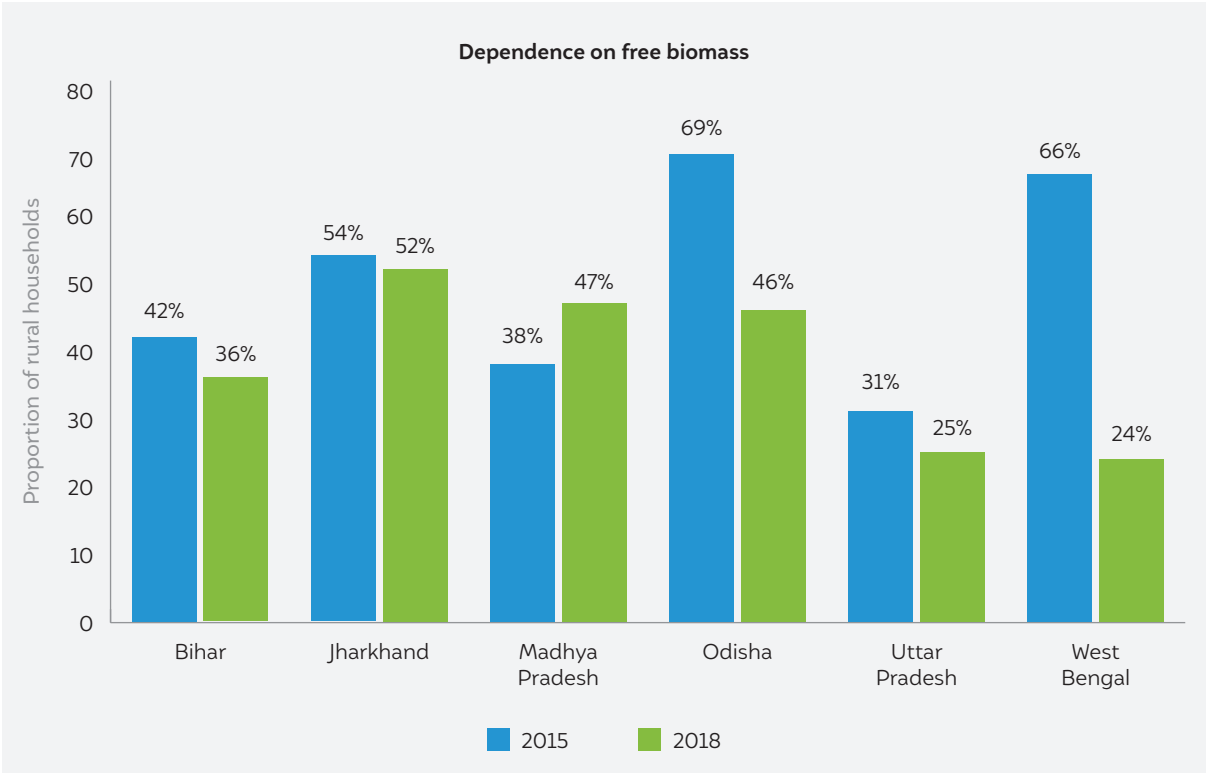
Dependence on free-of-cost biomass for cooking

As of June 2018, we found that about 35 per cent of households were dependent entirely on free-of-cost biomass for cooking, as compared to 44 per cent in 2015, suggesting that more households are now spending money on buying some of their cooking fuel. In West Bengal, where we witnessed the highest increase in LPG use, the proportion of households that are dependent on free-of-cost biomass has decreased significantly and is now the lowest among the six states. Odisha shows the second highest decline, though it continues to be among the states with the highest reliance on free-of-cost biomass along with Jharkhand and Madhya Pradesh; high percentages of forest cover[19] and easy availability of firewood could be the reasons for the high reliance on free-of-cost biomass in these states (Forest Survey of India, 2017; PPAC, 2016).

About 35 per cent of households were dependent entirely on free-of-cost biomass for cooking, as compared to 44 per cent in 2015, suggesting that more households are now spending money on buying some of their cooking fuel

Of the 35 per cent of rural households that are not spending any real cash on the purchase of their cooking fuels, about a quarter could spend INR 370[20] a month on LPG, which would constitute six per cent[21] or less of their total monthly expenditure. Awareness campaigns could nudge such households to start adopting and using LPG. For the remaining rural households that do not spend cash on cooking fuel, transitioning to LPG remains far more difficult.

FIGURE 54: Dependency on free-of-cost biomass has decreased across states



Source: CEEW analysis, 2018

19 Forests constitute 30 per cent of the total area of Jharkhand, 25 per cent of Madhya Pradesh, and 33 per cent of Odisha. However, forests cover only 8 per cent of Bihar, 6 per cent of Uttar Pradesh, and 19 per cent of West Bengal.

20 This is based on an assumption of nine cylinders per year—the median number of LPG cylinders used by households reporting LPG as their primary cooking fuel in ACCESS 2015 and in NSSO 2011-12. We arrived at INR 370 per month by assuming an average cost of INR 490 per cylinder (the subsidised price) for nine cylinders per year.

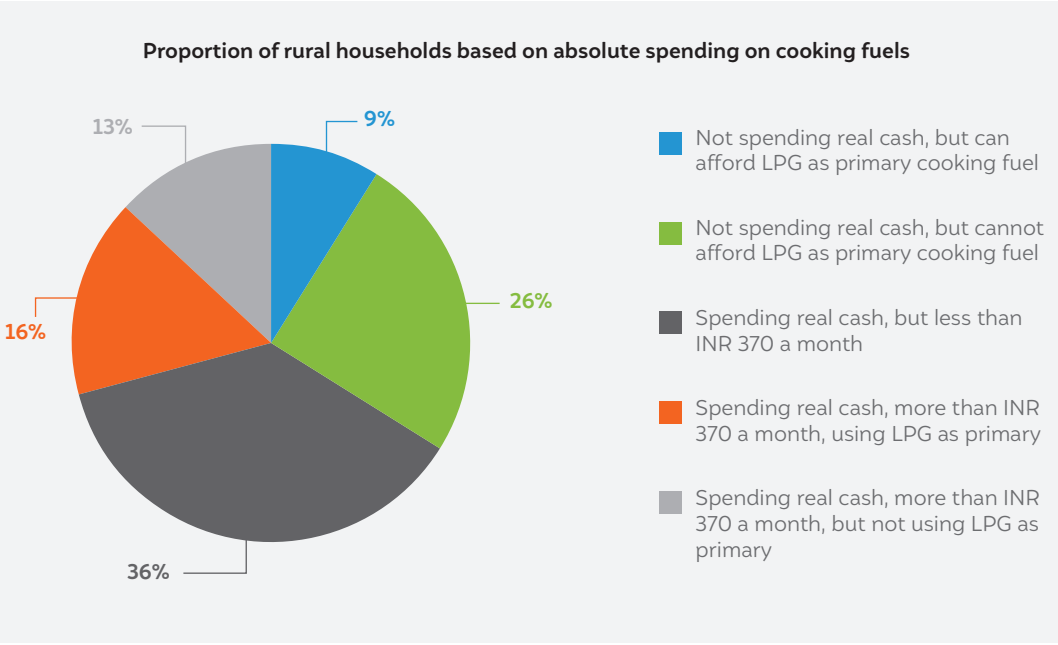
21 Six per cent of the monthly expenditure has been considered as the threshold to determine the affordability of the cooking fuel for the households. Please refer to the chapter on methodology for further details.

Gender dynamics of collection of firewood[22]

Across the six states, when asked who collects the firewood most often, 34 per cent of firewood-collecting households reported that it was the women of the household, while 66 per cent reported that the men of the household collected the firewood most often. However, when we disaggregated these proportions by state, we found that in Jharkhand, Odisha, and West Bengal, over 50 per cent of households reported that firewood is collected by women most often. In Bihar, Madhya Pradesh and Uttar Pradesh, the proportion of households reporting firewood collection by women is much lower: 32 per cent, 24 per cent and 25 per cent, respectively. The median one-way distance to collect firewood (for those who collect daily or weekly) is two kilometres in Jharkhand and Odisha and zero in West Bengal.

Interestingly, we also observe that the incidence of women collecting firewood is higher among households whose frequency of firewood collection is 'daily' or a 'few times in a week'. As the frequency of collection increases to 'few times a month' or 'few times a year', the proportion of households reporting that men collect firewood most often also increases. A significantly high proportion of households in Bihar (57 per cent), Madhya Pradesh (57 per cent) and Uttar Pradesh (72 per cent), report collection of firewood 'few times a month' or 'few times a year', explaining the low incidence of collection of firewood by women. West Bengal remains the only exception – 65 per cent of households reported collection of firewood few times a month or year, yet over 50 per cent reported collection by women.

FIGURE 55: Different categories of households (based on their monthly expenditure on cooking fuel) will require different forms of support to improve their affordability



Source: CEEW analysis, 2018

Of the households that spend real cash on the purchase of cooking fuel, 44 per cent spend INR 370 or more per month. About half are not currently using LPG as their primary fuel, and these households could be encouraged to shift to LPG with the appropriate incentives and nudges, as they are already spending an amount on cooking fuel that is equivalent to nine cylinders a year. The nature of these incentives or nudges would depend on what is preventing their transition to using LPG as the primary cooking fuel—for example, aligning LPG payments with a household's cash flow, improving the availability of LPG, and generating awareness about health impacts.

22 This analysis has been done on 94 per cent of the sample, based on the reported head-of-household and the primary decision maker.

Households spending up to six per cent of their median monthly expenditure on cooking fuel

Of the households that spend real cash on the purchase of cooking fuel, about 55 per cent spend up to six per cent of their monthly expenditure on it. Of these, 42 per cent of the households do not use LPG as their primary cooking fuel. For these households, the median monthly expenditure on cooking fuel is INR 161. Transitioning to LPG as their main cooking fuel, for these households, would mean spending beyond the affordability threshold of six percent of total monthly expenditure. For about 89 per cent of these households, spending INR 370 a month on LPG would constitute up to 10 per cent of their total monthly expenditure.

Households spending more than six per cent of their median monthly expenditure on cooking fuel

Of the households who spend cash on procuring their cooking fuel, 45 per cent spend six percent or more of their monthly expenditure on cooking fuel. Our analysis shows that 73 per cent of these households are spending at least INR 370 a month. For these households, targeted support needs to be provided to ensure the affordability of their cooking fuel.

The remaining 27 per cent of the households that spend six per cent or more of their total monthly expenditure on cooking fuel are unable to afford the INR 370 a month that is necessary to transition to using LPG as their primary cooking fuel. If we consider the expenditure of a household as a proxy for its income and well-being (Johnson & Shipp, 1997), these households lack the economic ability to pay for LPG cylinders, despite spending a significant proportion (six per cent or more) of their expenditure on cooking fuel.

There is a need to address affordability to ensure sustained use of fuel, potentially through a targeted approach that identifies households who are unable to pay for LPG, or who are paying unaffordable prices. A targeted approach would include differentiated support for households, considering their ability to pay for the clean fuel.

4.4.4. Women's participation in LPG decision-making

Among households that have LPG, only 23 per cent reported that the women of the household (whether the head of the household, spouse, daughter, or daughter-in-law) make the decision as to when to order a refill. In 67 per cent of the households, the men of the household (the head of the household, spouse, son, or grandson) decide when to order a refill, and in 10 per cent of households, both the head of the household and the spouse decide when to order a refill. The proportions are similar irrespective of whether the household is a PMUY beneficiary or has been using LPG for a prolonged period. Women's participation in decision-making was highest in West Bengal, where 59 per cent of households reported that either the women of the household or both spouses made the decision to order the LPG cylinder; it was lowest in Madhya Pradesh (16 per cent).

When asked of LPG-using households who have ordered an LPG cylinder at least once who places the order for a cylinder, i.e. booking a cylinder in person or on a call/SMS, only 17 per cent of households across the six states reported women place an order. Again, West Bengal had the highest proportion of households (41 per cent) reporting that the women of the household order an LPG cylinder.

While PMUY provides the connection in the name of the woman of the household, the intra-household decision-making with respect to purchase of LPG refills remains dominated by the men of the household. To further the sustained use of LPG, communication and awareness campaigns that are carried out in for a, such as LPG Panchayats[23], should take into consideration intra-household dynamics in decision-making.

Women's participation in decision-making was highest in West Bengal, where 59 per cent of households reported that either the women of the household or both spouses made the decision to order the LPG cylinder; it was lowest in Madhya Pradesh (16 per cent)

23 LPG Panchayats are organised by the Ministry of Petroleum and Natural Gas with an aim to provide a platform for LPG consumers to interact with each other, promote mutual learning and share experiences.

4.5. Spotlight: Pradhan Mantri Ujjwala Yojana

In May 2016, the government launched a major scheme to provide subsidised LPG connections to SECC BPL households in India. As of November 2018, over 57 million households have received subsidised LPG connections under this scheme. Although the scheme was rolled out in phases, the six states covered in the survey have received sufficient connections—60 per cent of the total connections provided under PMUY (MoPNG, 2018)—for us to evaluate the adoption and use of LPG among these households. Because the scheme was launched in 2016, we are able to use the data from 2015 as a baseline for tracking LPG adoption and consumption among the surveyed households.

The data on LPG marketing as of 01 July 2018, from the Petroleum Planning and Analysis Cell (PPAC, 2018), Ministry of Petroleum and Natural Gas, shows that in absolute terms Uttar Pradesh, West Bengal, and Bihar have received the highest number of PMUY connections, though as a proportion of new LPG connections since April 2016, Odisha, Madhya Pradesh and Jharkhand have received the highest proportion PMUY connections (refer column 6 in Table 11).

Table 11: LPG connections across states before and after PMUY (rural and urban) *

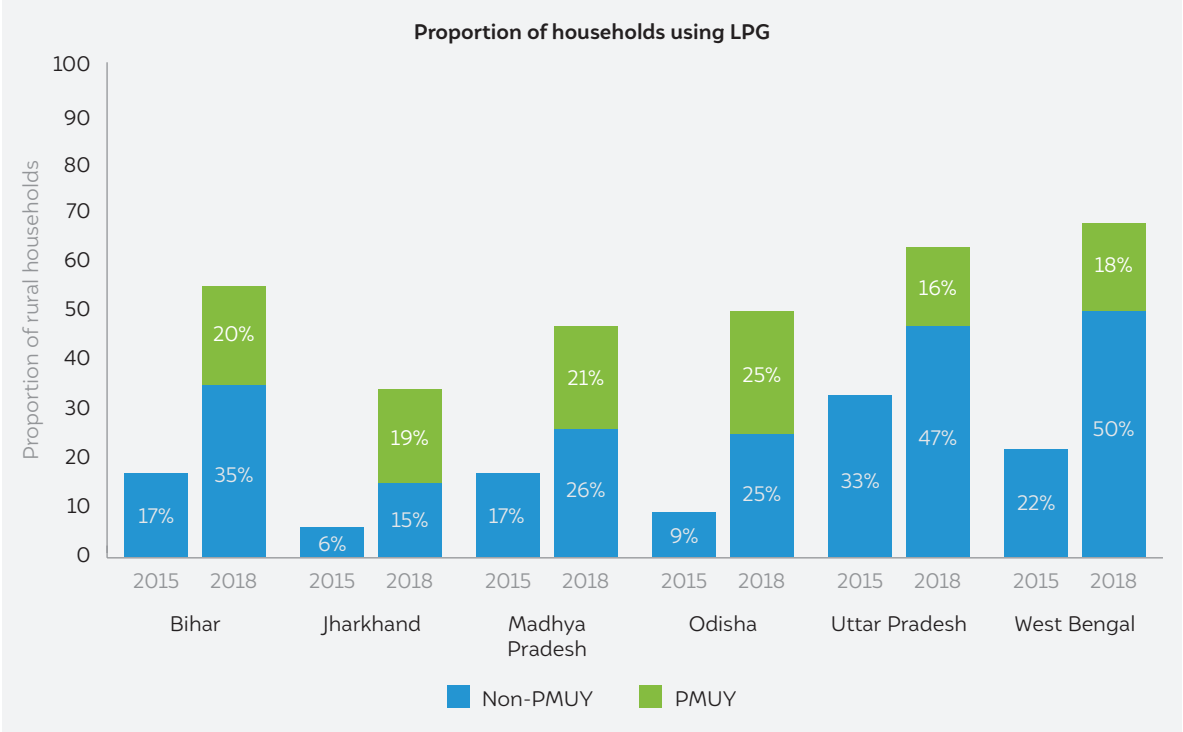
States	Number of connections released under PMUY as of 1 July 2018	Active LPG connections as of 1 April 2016#	Active LPG connections as of 1 July 2018	PMUY connections as a percentage of total active LPG connections, as of 1 July 2018	PMUY connections as proportion of new LPG connections from April 2016 till July 2018	LPG coverage as of 1 July 2018
Bihar	55,74,058	65,98,000	137,29,000	41%	78%	61.1%
Jharkhand	15,69,390	18,73,000	37,57,000	42%	83%	52.2%
Madhya Pradesh	40,27,407	68,21,000	115,59,000	35%	85%	67.2%
Odisha	27,97,766	32,22,000	64,63,000	43%	86%	60.7%
Uttar Pradesh	82,03,605	1,98,13,000	321, 50, 000	26%	66%	85.1%
West Bengal	56,41,638	1,09,54,000	183,04,000	31%	77%	82.8%

Source: PPAC, 2016; PPAC, 2018; MoPNG, 2018

*This analysis is based on the most recent LPG marketing data available on the PPAC website. Since the data in the report is as of 1 July 2018, we have used the same cut-off for our analysis. The actual connections under PMUY as of 1 October 2018 are more than the numbers reported here.

#Estimated by subtracting active LPG connections as of 01.04.2017 by new connections added during April 2016 till March 2017.

FIGURE 56: PMUY has played a role in improving access to LPG connections, though to a different degree across states



Source: CEEW analysis, 2018

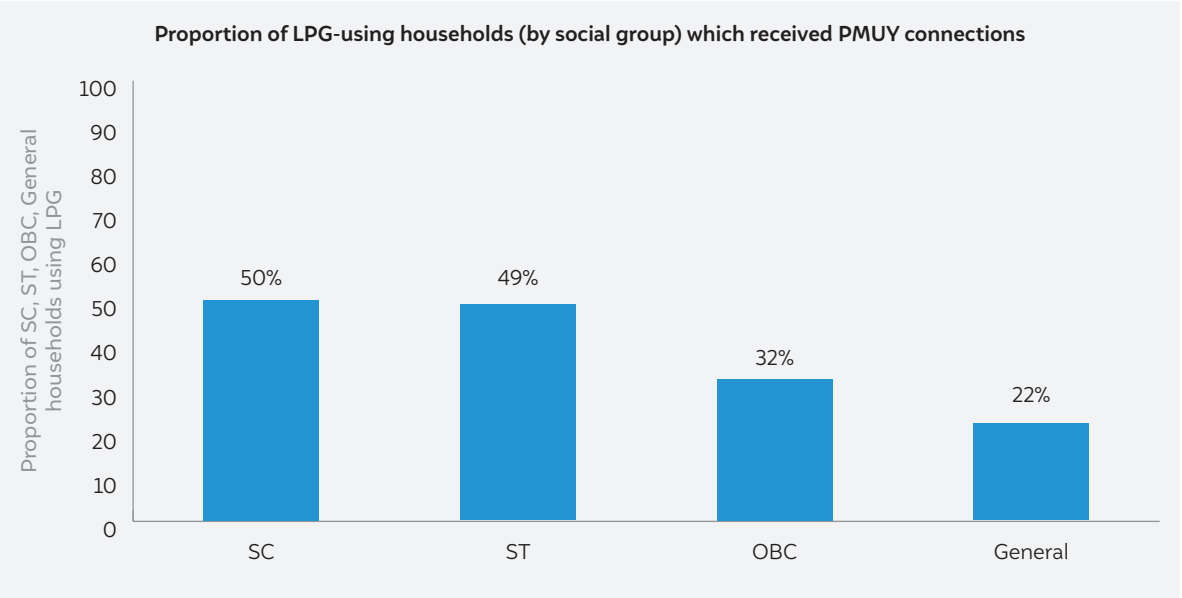
We note that the proportion of households with LPG connections is lower in our survey as compared to the data from PPAC that is shown in Table 11. Our sample also includes a higher proportion of PMUY beneficiaries in all states, except for Bihar and West Bengal. This is possibly because our sample is only rural, whereas the LPG coverage and PMUY connections reported by PPAC includes both rural and urban households.

PMUY has played a significant role in increase, of LPG penetration in rural areas, though to a varying degree in each state. In Jharkhand, Madhya Pradesh, and Odisha, PMUY has been a dominant driver of LPG adoption, as also corroborated from the PPAC data (Table 11). In Uttar Pradesh and West Bengal, despite the high absolute number of connections provided under PMUY, the contribution of the PMUY scheme to the overall adoption of LPG is relatively lower than in the other four states.

We also observed that PMUY has managed to reduce the inequity in access to LPG between different social groups. The proportion of SC, ST, and OBC households who reported using LPG in 2015 and in 2018 has increased from 12 to 55 per cent, 8 to 38 per cent, and from 22 to 56 per cent respectively, significantly improving the LPG penetration among marginalised groups.

We also observed that PMUY has managed to reduce the inequity in access to LPG between different social groups

FIGURE 57: Majority of SC and ST LPG-using households have received connections under PMUY



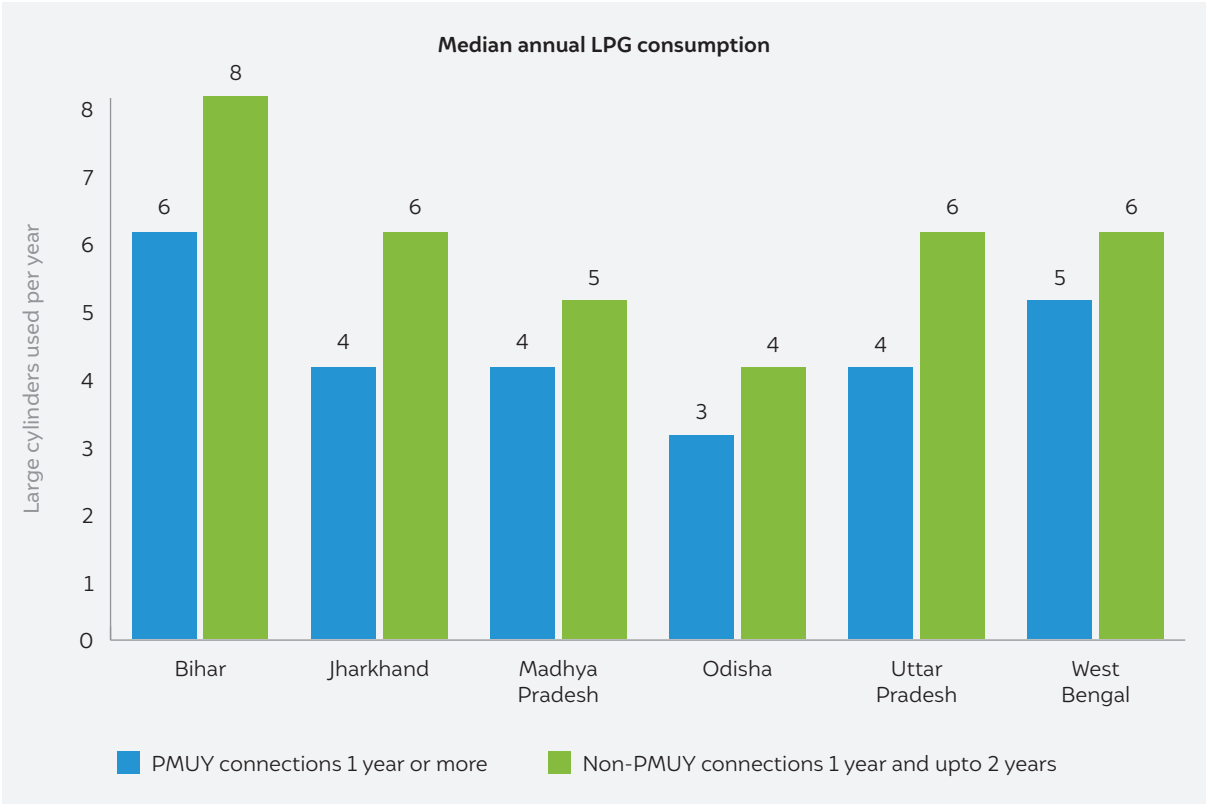
Source: CEEW analysis, 2018

LPG consumption and use among PMUY and non-PMUY households

Of all the new LPG users across the six states (between 2015 and 2018), 43 per cent have received the connection under PMUY. But among the households using LPG as their primary fuel, 76 per cent are non-PMUY users, implying that fewer PMUY households are using LPG as their primary cooking fuel. Another way to outline this comparison is: 45 per cent of PMUY households reported using LPG as their primary fuel as compared to 73 per cent of non-PMUY households.

We further analysed consumption among LPG-using households using two frames of analysis: i) between PMUY and non-PMUY households (across the same time frame); and ii) non-PMUY households by age of connection. Since all PMUY households will have used LPG for two years or less as of the date of the survey, we compared them with the non-PMUY households who have been using LPG for the same amount of time. Within this group, PMUY households were found to have a lower median consumption than non-PMUY households, as shown in Figure 58. We also know from the earlier analysis (Figure 49) that the consumption of LPG differs among non-PMUY households by age of the connection, and consumption is higher among households that have been using LPG for more than two years. However, this does not necessarily suggest that the path for PMUY households will be similar to that of non-PMUY households: a necessary caveat to be considered is that the non-PMUY households are those who were able to afford the upfront cost of the LPG connection; hence, they are presumably better off economically than the PMUY households that qualify as BPL under SECC. We do note a significant difference in median monthly expenditure between PMUY and non-PMUY households. So, the LPG consumption for PMUY and non-PMUY households may exhibit different rate of increase over time.

FIGURE 58: Among households using LPG for two years or less, median annual LPG consumption is higher among non-PMUY households

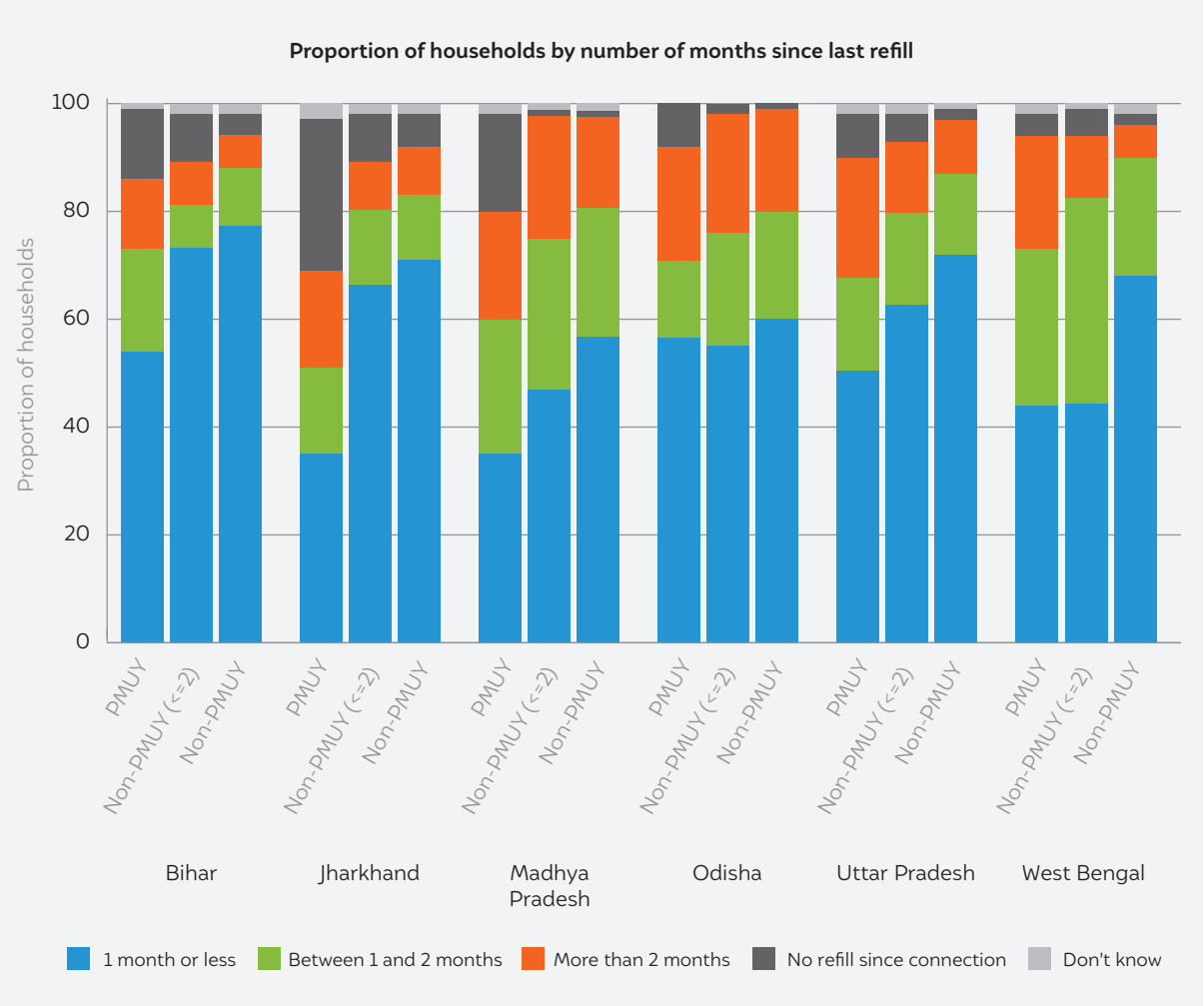


Source: CEEW analysis, 2018

Refill rates and expenditure on cooking fuel among PMUY and non-PMUY households

Figure 59 maps households according to the number of months since their last LPG refill. PMUY households exhibit a greater time gap since their last refill than their non-PMUY counterparts. Across the states, the proportion of non-PMUY households that ordered their last refill within the last two months (as of the date of survey) is higher than that of PMUY households, indicating that non-PMUY households are more regular users. Furthermore, the proportion of households who had not ordered a refill since they acquired their connection (at least a year ago) is higher among PMUY households. We observed that the median monthly expenditure on cooking fuel for non-PMUY households is 35 per cent higher (INR 327) than PMUY households (INR 243). This difference again varies by state: in Bihar, Jharkhand, and Odisha (the states with higher proportions of PMUY connections), the difference between the median monthly expenditure on cooking fuel for PMUY and non-PMUY households is at least 64 per cent.

FIGURE 59: Frequency of refill is higher among non-PMUY households

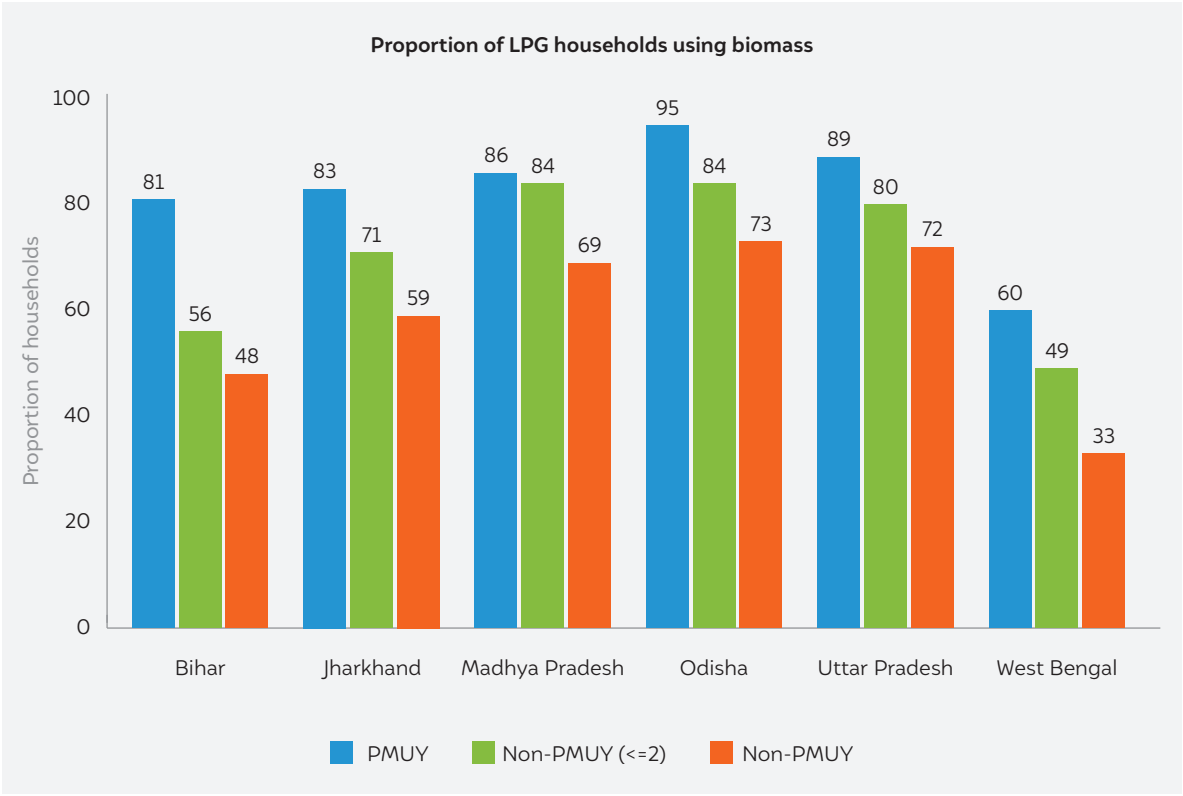


Source: CEEW analysis, 2018

Stacking among PMUY and non-PMUY households

Stacking of biomass with LPG remains a common practice in rural areas. We use the same frames of analysis that we used for understanding LPG consumption to analyse stacking: comparing PMUY and non-PMUY households (across the same time frame); and analysing non-PMUY households by the age of their LPG connection. Across the states, a higher proportion of PMUY households stack LPG with biomass than non-PMUY households, and among non-PMUY households, stacking reduces with the age of connection. This analysis aligns with Figure 49 above, which highlights an increase in LPG consumption over time among non-PMUY households.

FIGURE 60: Stacking is higher among PMUY households, and in non-PMUY households it decreases with age of LPG connection

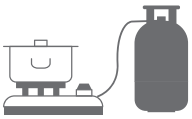


Source: CEEW analysis, 2018

Primary fuel for cooking among PMUY and non-PMUY households

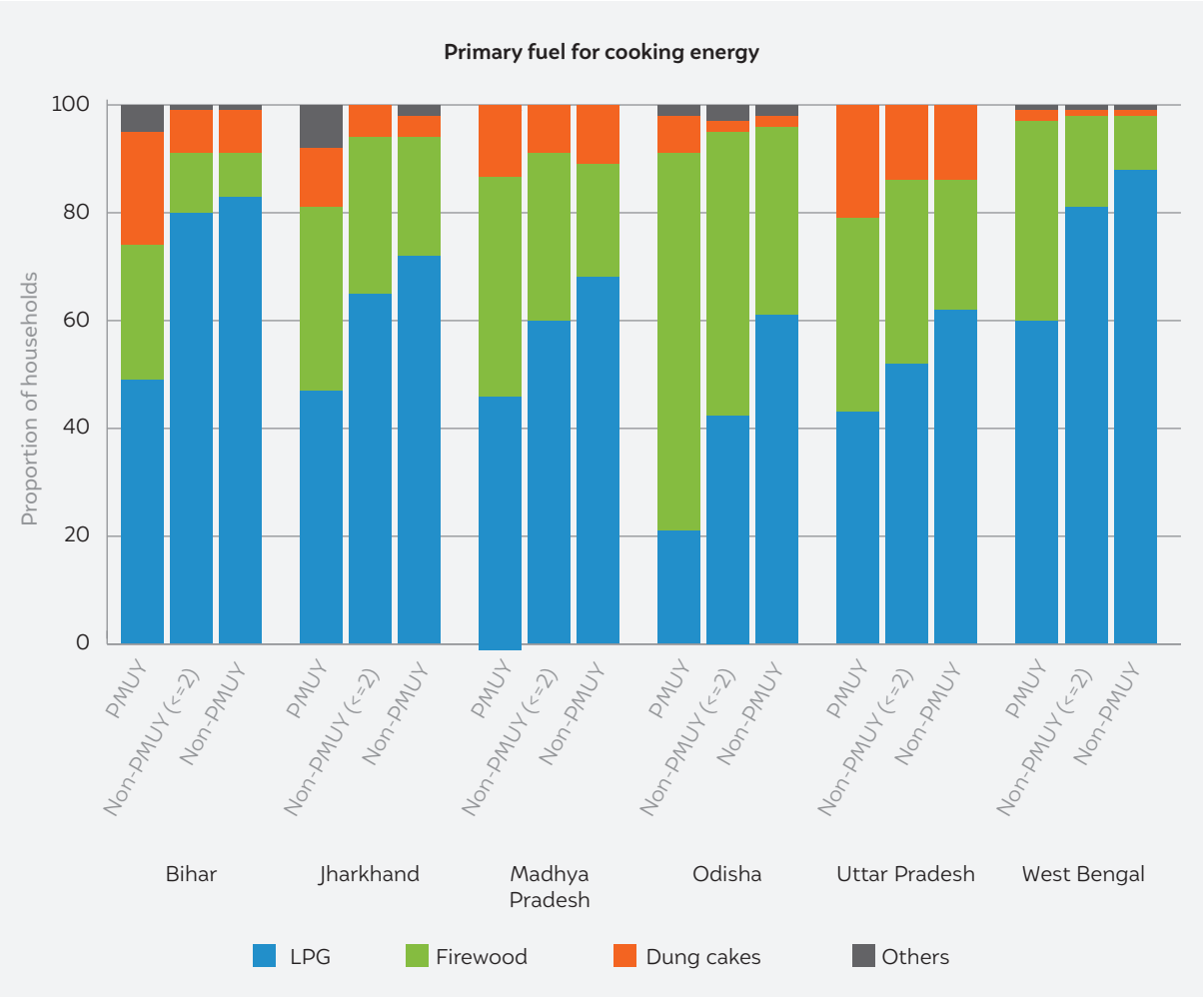
About 73 per cent of non-PMUY households reported using LPG as their primary fuel while only 45 per cent of PMUY households report the same. In Bihar and West Bengal, a significantly high proportion of non-PMUY households use LPG as their primary cooking fuel. The same two states also reported the highest proportion of non-PMUY households exclusively relying on the fuel, i.e., no stacking. Jharkhand and Odisha have the maximum difference (in percentage points) in the proportions of PMUY and non-PMUY households using LPG as their primary cooking fuel.

However, even among the non-PMUY households, as indicated in the preceding paragraphs, the proportion of households using LPG as their primary fuel was observed to increase with the age of the connection or duration of use.



About 73 per cent of non-PMUY households reported using LPG as their primary fuel while only 45 per cent of PMUY households report the same

FIGURE 61: Use of LPG as the primary cooking fuel is higher among the non-PMUY households and increases with the age of the connection

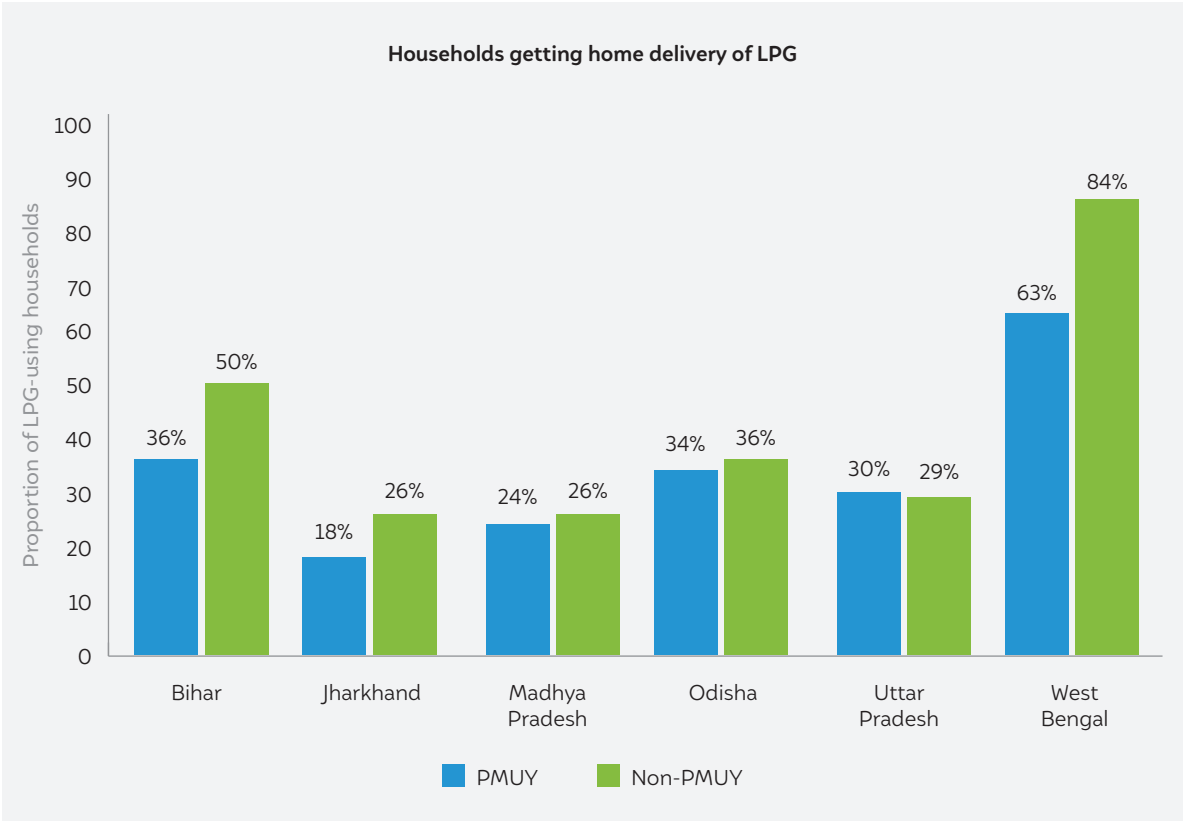


Source: CEEW analysis, 2018

Home delivery of LPG cylinders among PMUY and non-PMUY households

Interestingly, we find some difference in the home delivery of LPG cylinders between PMUY and non-PMUY households. This difference is highest in West Bengal, followed by Bihar. This could possibly be due to the greater probability of PMUY households to be in areas far from the current distributor network in these states. Analysing the distributor numbers from PPAC, we find that between April 2016 and July 2018, Bihar has added only 87 new distributors, while West Bengal has added 152. At the same time, the number of LPG connections has increased by 81 per cent in Bihar and 50 per cent in West Bengal (PPAC, 2018). We are not certain if the capacity of existing distributors to service the new customers is leading to the disparity in home delivery. Further research on the capacity and location of distributors could clarify the reasons for such disparity.

FIGURE 62: West Bengal shows the largest disparity in home deliveries among PMUY and non-PMUY households



Source: CEEW analysis, 2018

Satisfaction with the use of LPG among PMUY and non-PMUY households

About 76 per cent of non-PMUY households, as compared to 63 per cent of PMUY households, are satisfied with the LPG situation in their household. The difference is starker in some states than others. About a quarter of the PMUY households in Bihar, Jharkhand, and Uttar Pradesh reported dissatisfaction with their LPG situation. In Bihar and Jharkhand, this translates into 20 percentage points less satisfaction than in the non-PMUY households.

The most common reasons for dissatisfaction among both PMUY and non-PMUY households are that LPG is expensive to use, and that distributors are too far away. However, we do find variances among the states. For instance, poor maintenance services are a reason for dissatisfaction in Bihar, whereas cylinders being too far away to procure is a recurrent challenge in Jharkhand, Odisha, and Uttar Pradesh. Interestingly, Madhya Pradesh has the highest median one-way distance to go to procure LPG cylinders (eight kilometres) and 86 per cent of PMUY households in the state report cylinders being too far away to procure as the reason for dissatisfaction, yet overall only 11 per cent of households reported being unsatisfied with their LPG situation.

The most common reasons for dissatisfaction among both PMUY and non-PMUY households are that LPG is expensive to use, and that distributors are too far away

Enrolment process of beneficiaries under PMUY

As seen with non-PMUY households, PMUY households may also show an improvement in LPG use with time, given they are relatively new adopters

Across the six states, 92 per cent of the villages with LPG had received LPG connections under PMUY[24], with a majority of them (66 per cent) receiving connections in 2017. About 37 per cent of villages[25] reported concerns with regard to the selection of beneficiaries under PMUY, particularly in Madhya Pradesh (83 per cent) and Odisha (55 per cent). The most commonly reported concerns were that many poor households that should be beneficiaries were not part of the list, and that it was difficult to find the beneficiaries who were on the list. Interestingly, 60 per cent of the villages that reported concerns with regard to the selection of the beneficiaries mentioned that many well-do-to households—who could otherwise afford LPG connections—were on the list. Even though the concerns were reported in only about 20 per cent of all villages, it is important to understand this in the light of its potential social implications. Implementation of government schemes, if do not focus on communicating their process to the local population, could cause knowledge asymmetry, which could impact people's trust in such schemes. It would be useful to bridge this perception gap within communities. It is possible that the village community is unaware of the SECC classification and therefore perceives the well-being of the households differently than the SECC deprivation criteria. Or it indicates gaps in SECC data or deprivation criteria used to identify the proper beneficiaries—those who would not otherwise be able to afford the cost of an LPG connection. Whether it is a perception gap or gap in data and/or methodology or both, it should be addressed through either effective communication with households in the community, or through adoption of a more sophisticated mechanism to identify deserving households.

PMUY has demonstrated a promising start by improving the equity of LPG access through the inclusion of socially marginalised groups. In the previous chapter, we looked at improvements in the adoption of LPG across states. In this chapter, we observe that while overall LPG consumption and its use as a primary cooking fuel has improved, PMUY households lag behind non-PMUY households in these aspects. However, as seen with non-PMUY households, PMUY households may also show an improvement in LPG use with time, given they are relatively new adopters. The median age of an LPG connection for PMUY households is only one year, compared to four years for non-PMUY households. We also conclude that the poor availability and affordability of LPG, and availability of free-of-cost biomass continue to be barriers for PMUY and non-PMUY households, albeit to different degrees. The government's next steps should include a set of targeted interventions based on the challenges faced by different categories of consumers, enabling their transition towards the sustained use of LPG.

24 This analysis has been conducted on two-thirds of the sample (504 villages).
25 A village survey was conducted with the help of a Gram Sabha member, a primary school teacher, or any person knowledgeable about the village, in order to gather information about energy access at both the household and the community level.

Image: Jaun Rizvi

5. People's Policy Preferences

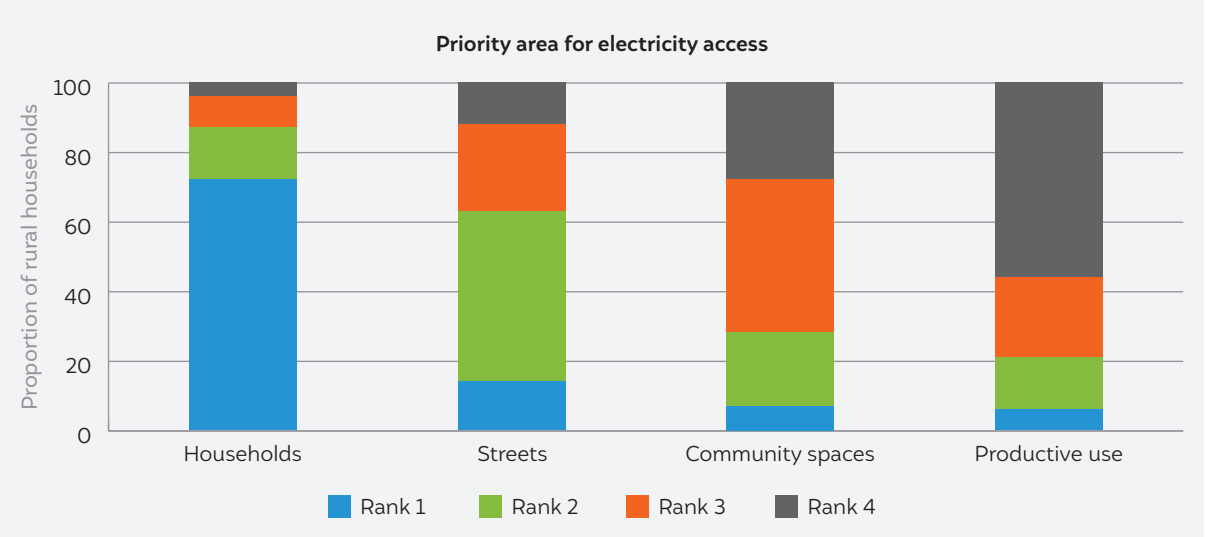
In this chapter, we discuss a series of questions that were asked of households to ascertain their preferences with regard to various issues (including that of governance and policy) pertaining to energy access.

What spaces do households most want to see electrified?

72 per cent of the respondents prioritised household electrification over the electrification of other spaces

Although the focus point for electrification in India has been the household for the last few years, access to electricity is critical in other realms too: to power street lighting, community spaces, as well as productive or livelihood applications. We asked households to rank the spaces that they feel are most important to electrify, by order of importance. We found that households' priorities have largely remained the same over the last three years. Predictably, 72 per cent of the respondents prioritised household electrification over the electrification of other spaces, with Tier 0 households particularly emphasising the need for household electrification—more so than households in any other tier. The next big priority for respondents was street lighting—similarly, those who were unsatisfied with their village's street lighting were more likely to name street lighting as their top priority.

FIGURE 63: Electrification of households was the top priority for nearly three-quarters of respondents



Source: CEEW analysis, 2018

The majority of respondents did not consider the use of electricity for productive applications and activities as important, at least not when compared to the electrification of households, streets, and community spaces. This clearly indicates that many households do not depend on electricity for their livelihoods, or that they do not view electricity as having the potential to boost their income. This is corroborated by the survey result that 86 per cent of households who do not use electricity for business, believe that electricity cannot contribute to increasing income from their primary occupation.

Support for subsidising grid electricity increased from 65 per cent in 2015 to 83 per cent in 2018

Which source of lighting should be prioritised for subsidies?

Respondents were asked to identify which type of lighting they would like to see prioritised if the government could only subsidise one of the following: grid electricity, solar home systems or lanterns, kerosene, or microgrids. Support for subsidising grid electricity increased from 65 per cent in 2015 to 83 per cent in 2018, primarily at the expense of support for subsidising kerosene and microgrids. The proportion of households that would like to see microgrids subsidised ahead of other sources of lighting has plummeted by 10 percentage points to a meagre two per cent of households in 2018. Kerosene was the preferred choice for only five per cent of households in 2018, although most of them were understandably Tier 0 households, who are far more likely to rely on kerosene for their primary lighting needs. The shift in households' preference to subsidise grid electricity may be due to the increased number of connections in 2018 and general improvements in power supply. Respondents perhaps see themselves as having a more realistic chance at getting good quality electricity access through the grid, compared with other options.

A little under 10 per cent of respondents would like solar home systems or lanterns to be prioritised for subsidies. Although most of these respondents were from lower-tier households, it is interesting to note that the vast majority of them did not use a solar home system or lantern at the time of the survey. This indicates good knowledge of solar lighting products, and possibly good word-of-mouth awareness of their performance. This expression of preference for solar products, especially if not arising out of first-hand experience, is also reflective of a desire for subsidies on these products so that households may be able to afford the steep upfront costs associated with them, and particularly with solar home systems.

Subsidy for solar lanterns or kerosene?

After being provided with a brief description of solar lanterns, respondents were asked to choose between government support for solar lanterns or for kerosene, if the former were subsidised by reducing the subsidy on the latter by a commensurate amount. By directly pitting improved access to, and affordability of, one source of lighting against another, respondents were compelled to carefully consider the consequences of selecting either option. To pick either option, they would have to think about their requirement for artificial lighting, the one-time and recurring outlay for each source of lighting, and the utility and disutility of switching from one fuel to the other.

Eighty-six per cent of households (increased from 79 per cent in 2015) were in support of the government providing subsidies on solar lanterns even if it resulted in a reduction in subsidies on kerosene

Eighty-six per cent of households (increased from 79 per cent in 2015) were in support of the government providing subsidies on solar lanterns even if it resulted in a reduction in subsidies on kerosene. In Odisha and West Bengal, there was lesser support for such a move compared to the other states: in those two states, only about two-thirds of households expressed a preference to move subsidies from kerosene to solar.

Unsurprisingly, households that were aware of the adverse health impact of kerosene fumes were more likely to support a move to subsidising

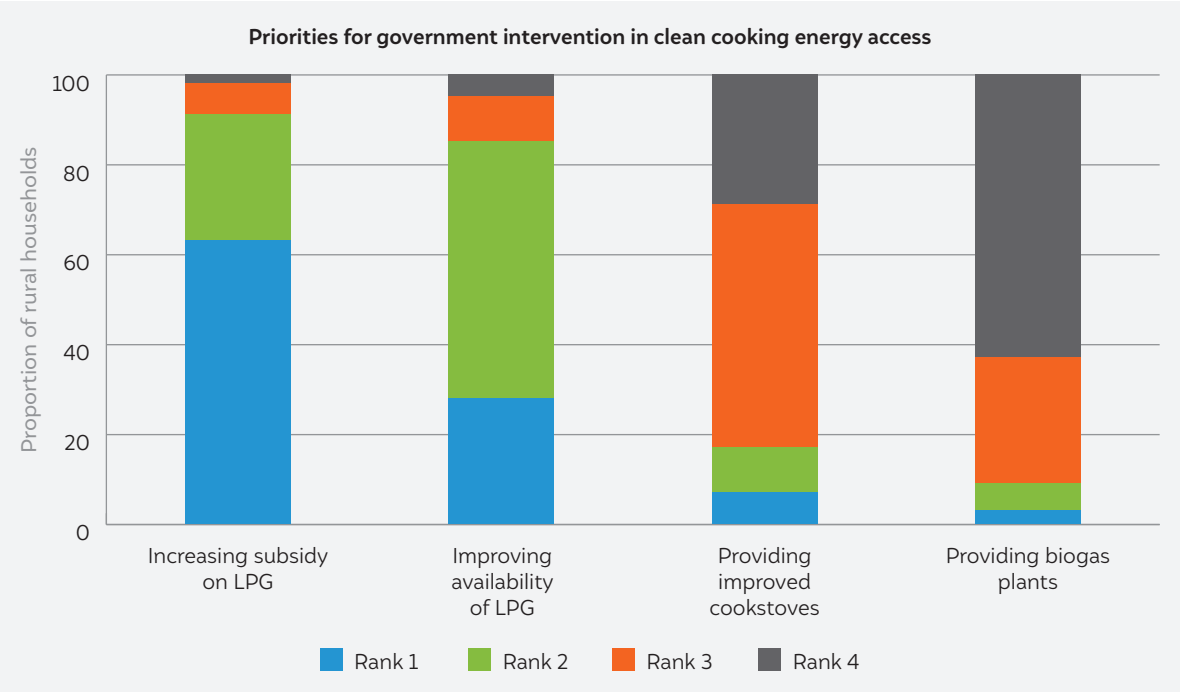
solar products than those that were not, with the proportion of households for each group at 87 per cent and 70 per cent, respectively.[26] Furthermore, a lower proportion of kerosene users than non-users were willing to support such a change in the subsidy regime.[27] This might be reflective of behavioural inertia on the part of kerosene users or, more generally, may indicate a heavy reliance on kerosene for their lighting needs.

Over half of all households stated a preference for increasing the subsidy on LPG cylinders in order to ameliorate the burden of expensive recurring payments

Where should the government intervene in clean cooking energy access?

We asked respondents which interventions the government should prioritise in the clean cooking energy access space: providing improved biomass cookstoves, increasing the subsidy on LPG, providing biogas plants, or improving the availability of LPG. This list is not exhaustive, as it does not the possibility of government intervention in the provision of natural gas, or in the use of electricity for cooking. Preferences for interventions in cooking energy have not notably evolved in the last three years. Over half of all households stated a preference for increasing the subsidy on LPG cylinders in order to ameliorate the burden of expensive recurring payments—surprisingly, the proportion of households that held such a view was nearly identical across all tiers. Irrespective of how well-off rural households are in terms of access to clean cooking energy, the majority would like an increase in the LPG subsidy. The second-most important priority for government intervention, as identified by respondents, was improving LPG distribution in rural areas. Nearly three-fifths of the households that would like the government to prioritise the availability of LPG were not receiving home delivery of LPG cylinders as is mandated by the Unified Distribution Guidelines of the Ministry of Petroleum and Natural Gas.

FIGURE 64: Respondents want the government to prioritise access to LPG above other clean cooking energy solutions



Source: CEEW analysis, 2018

26 The difference between the proportion of households supporting a subsidy for solar lanterns that were aware of the adverse health impact of kerosene, and the proportion of those that were not aware, is statistically significant at the 1 per cent level.

27 The difference between the proportion of households supporting a subsidy for solar lanterns that were users of kerosene, and the proportion of those that were non-users, is statistically significant at the 1 per cent level.

A few households indicated a preference for a government intervention to provide improved biomass cookstoves or biogas plants, although the preference for improved cookstoves was higher than that for biogas plants. It is worth noting that a higher proportion of improved cookstove users than non-users had ranked its provision at first or second, implying a sense of satisfaction among users of the product. There did not seem to be much of a difference in the ranking pattern for biogas plants between households that had heard of the technology and those that had not. However, a much higher proportion biogas plant users than non-users ranked its provision as their main priority. This suggests a clear difference in users' perception of biogas technology as opposed to those who have only heard of it.

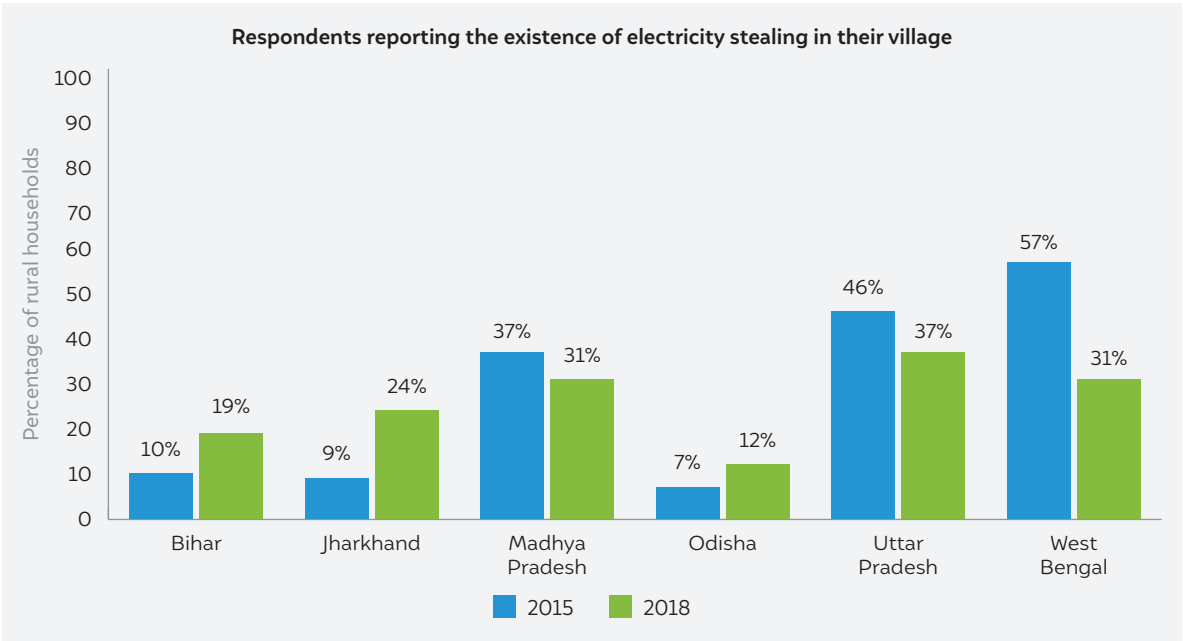
Around 94 per cent of all the respondents were of the view that stealing electricity is illegal and should be stopped but, 29 per cent of respondents reported that stealing exists in their village

How do households perceive electricity theft?

Worldwide, electricity theft is a growing problem and is a major obstacle to energy reforms (Winther, 2012). Even though there have been no official estimates of electricity theft in India, evidence suggests that it is substantial (Golden & Min, 2011; Tarannu et al., 2017). Without curbing electricity theft, it may become increasingly difficult to achieve the aim of providing reliable power for all.

In 2018, around 94 per cent of all the respondents were of the view that stealing electricity is illegal and should be stopped but, 29 per cent of respondents reported that stealing exists in their village. Almost 87 per cent of the 756 villages surveyed had at least one respondent who expressed this opinion. Furthermore, over 16 per cent of the respondents said that they do not know if stealing is prevalent in their village. Respondents who have a legal grid connection in their house have the most to lose from the electricity theft prevalent in their village, and it could be assumed that this group is likely to be more vocal about the occurrence of theft. However, among the 16 per cent of respondents who said "Don't know", 11 per cent had a legal electricity connection.[28] This either means that the issue is a sensitive one and some respondents may not want to disclose its prevalence or that they are genuinely not aware of its occurrence. It also suggests that mere awareness about the illegality of electricity theft does not help, and strong disincentives are needed if electricity theft is to be discouraged.

FIGURE 65: In 2018, Uttar Pradesh showed the highest proportion of respondents reporting electricity theft as being prevalent in their village



Source: CEEW analysis, 2018

28 These are respondents who fall in Tier 3 of the legality dimension of electricity access.

As in 2015, Odisha, Bihar, and Jharkhand had the lowest proportion of respondents who reported electricity theft in their village, at 12, 19, and 24 per cent, respectively. However, it is interesting to note that there is a clear divide between these three states and the remaining three of the six surveyed states, in that their reports of electricity theft increased from 2015 to 2018, whereas reports of theft decreased in Madhya Pradesh, West Bengal, and Uttar Pradesh, with the most significant decrease (26 percentage points) being in West Bengal. Even though the reason for this clear-cut divide needs to be researched further, it could possibly be argued that the theft-curbing measures taken by discoms would have been stronger in the states where the occurrence of theft was greater, and hence would have led to fewer respondents reporting the occurrence of theft in these states three years later.

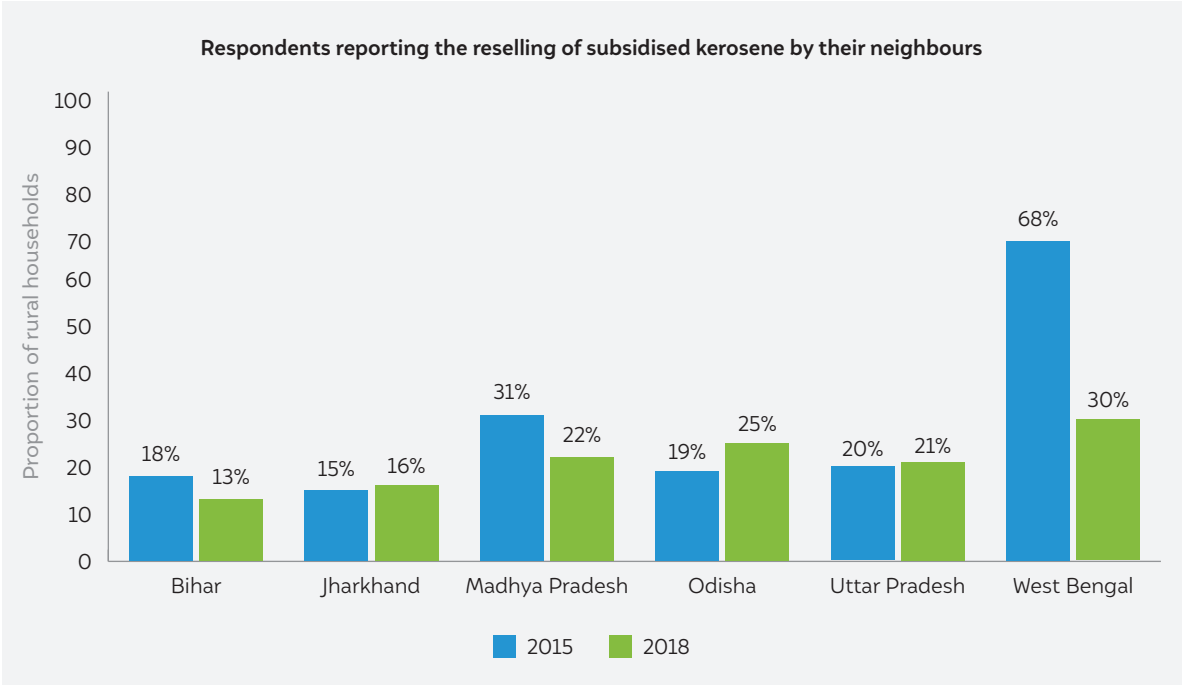
A positively significant correlation coefficient of 0.74 between the percentage of respondents reporting electricity theft in 2015, and the percentage points decline in the district-level reports of electricity theft in the last three years in all six states, does not rule out this hypothesis either. Further, it was found that among Madhya Pradesh, West Bengal, and Uttar Pradesh, it was only in West Bengal that all the districts saw a decline in the proportion of respondents reporting theft in their villages. This is perhaps because the six districts that were surveyed in the state are all served by a single discom—the West Bengal State Electricity Distribution Company Limited (WBSEDCL). However, In Madhya Pradesh, districts served by the Madhya Pradesh Paschim Khsetra Vidyut Vitaran Company Limited (MPPKVVCL) and, in Uttar Pradesh, districts served by the Madhyanchal Vidyut Vitaran Nigam Limited (MVVNL) and Dakshinanchal Vidyut Vitaran Nigam Limited (DVVNL), have not seen any decline in the last three years in the proportion of respondents reporting electricity theft.

Do people in your village resell subsidised kerosene?

We also asked respondents about the reselling of kerosene that had been obtained through the PDS. As the median price of kerosene in the market is INR 45, around 67 per cent higher than the median PDS cost of INR 27, it is always profitable to resell unused kerosene in the market. In 2018, about 21 per cent of the respondents from 83 per cent of the villages in the six states reported kerosene reselling, a decline of seven percentage points in the last three years. The overall reduction in the monthly quota for kerosene from three litres per month in 2015 to two litres per month in 2018 could be a significant reason for this decline. However, it is also interesting to note that although the PDS kerosene quota was reduced in all six states, the proportion of respondents reporting kerosene reselling has evolved differently across the states. West Bengal, by achieving the most significant decline of 38 percentage points, drives most of the overall improvement. The state-wise response to the question on kerosene reselling is reflected in Figure 66 below.

In 2018, about 21 per cent of the respondents from 83 per cent of the villages in the six states reported kerosene reselling, a decline of seven percentage points in the last three years

FIGURE 66: Reselling of subsidised kerosene seems to have drastically declined in West Bengal

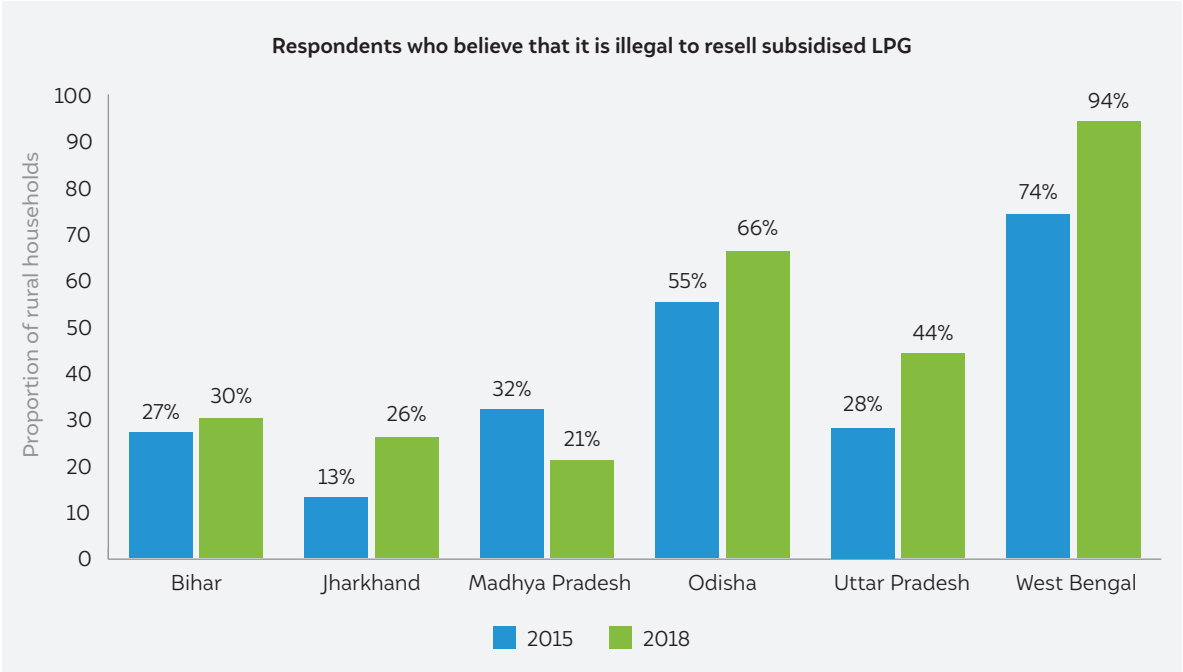


Source: CEEW analysis, 2018

Do people in your village resell subsidised LPG?

We also asked a similar question with respect to the reselling of subsidised LPG. We observed that around 46 per cent of the respondents now believe that reselling subsidised LPG is legal, as against 36 per cent in 2015. This includes 12 percent of the original respondents, who in 2015 believed that reselling subsidised LPG was not legal, but in 2018 believe it to be legal. The state-wise distribution of responses with regard to the legality/ illegality of reselling subsidised LPG is reflected in Figure 67.

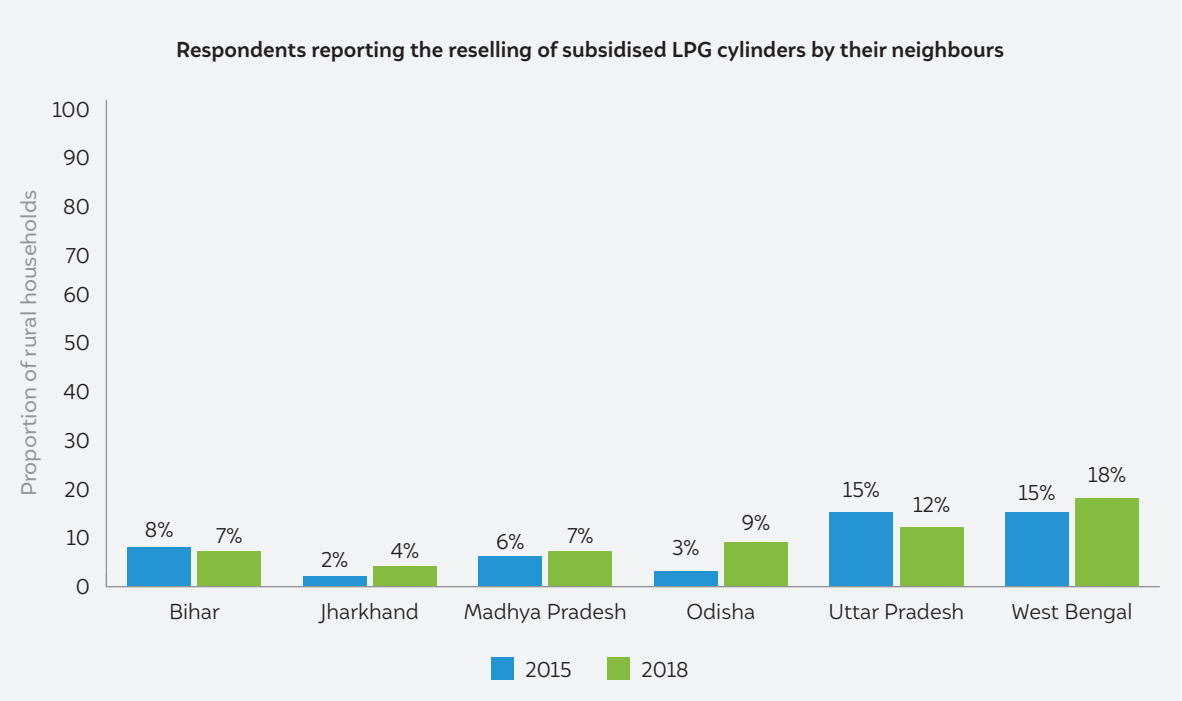
FIGURE 67: Madhya Pradesh is the only state with a decline in the proportion of respondents who believe that subsidised LPG reselling is illegal



Source: CEEW analysis, 2018

Furthermore, between 2015 and 2018, there is no change in the percentage of respondents (11 per cent, overall) who believed that people in their villages resell their subsidised cylinders in the market. However, it is also important to highlight that these 11 per cent now spread over 60 per cent of the villages in 2018, in comparison to 52 per cent villages in 2018. Further, in four out of the six states, the proportion of respondents reporting the reselling of subsidised LPG cylinders has increased (Figure 68). This clearly suggests the need to take steps to discourage the reselling of subsidised LPG and to make households aware of its illegality.

FIGURE 68: Uttar Pradesh and Bihar are the only states where the proportion of respondents reporting the reselling of subsidised LPG cylinders has declined



Source: CEEW analysis, 2018

Image: flickr

6. Conclusion

In 2015, when a multidimensional framework to evaluate energy access in India was first used, it shed light on various aspects of energy access that are often overlooked in favour of simplistic measures such as the number of connections deployed. In 2018, the results of this study have re-iterated clearly why it is imperative that we monitor the multidimensional aspects of access to energy. For instance, a household using LPG as its primary cooking fuel, but still stacking with traditional biomass would not be categorised in the top-most tier for cooking energy access, indicating the scope for improvement on health and safety dimension, despite being in the top tier for other dimensions. Or a household using BLEN exclusively for cooking but spending a disproportionately high share of its expenditure on procuring BLEN would have affordability dimension limiting their movement to higher tiers, considering that under any economic stress the household would most likely fall back to traditional fuels. The multi-dimensional approach helps to isolate such challenges. Each dimension of energy access contributes to building the experience and perception of households vis-à-vis energy. Many households that are connected to grid electricity or have LPG connections are satisfied with their energy access situation, but—despite having access to connections—many are not. In order to make high-quality energy available to all households, it is critical that we understand the real bottlenecks in households' access to modern sources of energy.

In the three years since we last visited our surveyed households, a host of factors—which we refer to as dimensions—have moved households closer to, or further from, modern forms of energy. To capture these movements over time, and to recognise the reasons for such transitions, it is equally important to study how households move across tiers of energy access. The case for tier-based analyses is made clear by the sheer scale of households' transitions across tiers in terms of electricity and cooking energy access, both progressive and regressive. For instance, a substantial proportion of households in West Bengal have moved to lower tiers of electricity access since 2015, despite traditional metrics indicating otherwise—such as an increased proportion of households with connections and a greater proportion of people using electricity as their primary source of lighting. The multidimensional and multi-tier approach allows for a nuanced understanding of problems. While the use of tiers helps in devising a targeted approach, the use of dimensions helps isolate the main issues afflicting households, thereby assisting in identifying localised recommendations for action.

In the intervening period since 2015, under the *Deen Dayal Upadhyaya Gram Jyoti Yojana* (DDUGJY; previously RGGVY), the government has accelerated the pace of expansion of electricity infrastructure in villages across India. This has significantly ameliorated the bottleneck caused by the lack of infrastructural capacity for unelectrified households. Further, through the *Saubhagya* scheme, the government has significantly accelerated the pace at which households are provided with electricity connections. Critical supply-side reforms to improve the financial viability of discoms (under the *Ujwal DISCOM Assurance Yojana* (UDAY) scheme) have also played a role in improving the general state of power supply and infrastructure. We observed significant improvements in the duration of supply, metering rates, and the formalisation of previously illegal

connections. Although these measures have helped many households move up electricity access tiers across various dimensions, several issues remain unresolved. Day-long blackouts and voltage issues continue to afflict many households, in particular those in Tier 0. It is reflective primarily of poor maintenance services or poor estimation of electricity demand in rural areas. The increase in the fixed cost of electricity for unmetered connections over the last three years in some states has rendered the use of electricity for basic consumption unaffordable for several Tier 1 households. Metering of connections, though have improved, needs further improvement particularly in the state of Jharkhand, Uttar Pradesh and Madhya Pradesh. While all new connections under Saubhagya are mandated to be metered, one does observe metering rates not keeping pace with new electricity connections in a few states. In addition, the billing and collection efficiency certainly needs more on-ground effort going forward as about a third of households had not received a bill in the past one year or ever since they got connected to the grid. In fact, proportion of households not paying anything for their electricity has increased to more than a quarter of electrified households, indicating lost revenues for the discoms. Such issues need to be addressed while improving the quality and reliability of supply to ensure long-term sustainability of high-quality electricity access.

Although electricity has occupied a larger space in the discourse on energy access in India, until recently, the role of cooking energy as an enabler of overall human development has received less attention in national policies. The government's flagship scheme on access to LPG—PMUY—has significantly reduced the upfront cost of procuring a connection for the socioeconomically weaker sections of society and has attempted to increase the agency of women by providing connections in the name of the female head of the household. PMUY did not only expand the discourse on cooking energy access among policymakers, researchers, and administrators, it also generated awareness about LPG on the ground, making it a much more aspirational commodity over the last few years. This is evident from the fact that in 2018, 83 per cent of the households currently without LPG expressed the interest in getting a connection compared to 48 per cent of such households in 2015. The widespread roll-out of the scheme has also improved equitable access to LPG, with members of deprived social cohorts gaining access to LPG connections. We observe a significantly greater proportion of SC and ST households using LPG since 2015.

We witness an increase not only in LPG connections, but also in its use as the primary as well as exclusive cooking fuel since 2015. Almost one-third of LPG-using households across the six states now use it as their primary cooking fuel. However, in spite of these improvements, most households continue to use traditional biomass (alone or with LPG) due to the high recurring cost of LPG and the availability of free-of-cost biomass. Home delivery of LPG, though improved, remains a challenge; reportedly less than 50 per cent of LPG-using households in all the surveyed states, barring West Bengal, receive their LPG cylinders at home. As the penetration of LPG increases, we also note an increase in the proportion of households stacking it with traditional biomass. When this happens, the potential health gains of using LPG cannot be achieved as there is continued exposure to dangerous levels of indoor air pollution.

However, we did find evidence that households take some time to begin using LPG for the majority of their cooking needs, and that the transition cannot be expected to happen in a few months. Among the non-PMUY LPG-using households, we note that the average consumption of LPG is strongly correlated with the age of the connection. That being said, affordability (recurring cost of LPG) continues to emerge as a concern across all LPG-using households. This necessitates a targeted approach that includes differentiated support for households considering their ability to pay for the clean cooking fuel. Finally, we found that intra-household energy decision-making plays a critical role in the sustained use of cleaner fuels. With men making the decision on when to procure LPG in two-thirds of the LPG-using households, policy efforts such as the LPG Panchayat should also target the primary decision makers in their engagement strategies.

It is abundantly clear that the policies undertaken by the government since 2015 to promote energy access have yielded encouraging results for rural households, but there remains much scope for policy action in both electricity and cooking energy space if better energy access is to be achieved for all. Multidimensional and multi-tier assessments are useful to gauge the impact of policies on a wide range of variables over time, offering critical insights that can lead to a more nuanced understanding of the situation, and targeted action that will result in an improvement of access to energy over time.

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