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ENERGY 4.0: ENERGY TRANSITION TOWARDS 2030
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Energy 4.0: Energy transition towards 2030

Reaching the last mile

February 2018

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Executive summary

Energy is a critical enabler for driving forward the economy of any nation, both from a social necessity perspective for the betterment of human lives, as well as from an economic standpoint for enhancing economic output. As per the Economic Survey of India, 2017, over the past 10 years, India has achieved an average GDP growth of around 7%. To maintain this accelerated pace of development, there needs to be a focus on tapping the potential of the energy sector. India has also recognised the importance of the United Nation's Sustainable Development Goals (SDGs), in particular Goal 7, to ensure universal access to affordable, reliable and modern energy services and take significant strides towards increasing the share of renewable energy in the energy mix and the improvement of the energy efficiency rate.

The achievement of this goal will require a wide range of interventions and considerable efforts from various stakeholders. The fundamental differences of opinion on the definition of 'access to energy' is the beginning of the complexities that challenge the achievement of this goal. Differing views on energy access further give rise to issues around the involvement of the 'right stakeholders'. Even if stakeholders are rightly identified, differing 'benefit realisation goals' of the stakeholders would affect the realisation of the bigger goal of universal access. One of the important reasons for improvement or deterioration of access can be attributed to last-mile connectivity, which mainly indicates how well or badly the end user is sustainably connected in the energy chain.

Access to electricity in India has long been driven by a number of policies and schemes of the central and the state governments. Despite a large proportion of the national budget being allocated to the cause of electrification of villages and households, India is still to achieve 100% electrification. While the schemes prior to the 10th Five Year Plan period entailed a piecemeal approach, the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) was the first of its kind to lay a comprehensive approach to provide electricity infrastructure to unelectrified villages and households. It was better envisaged with proper need assessment, planning, surveys and sufficient budgeting, along with the encouragement of off-grid solutions to ensure that electricity reaches difficult terrains.

Carrying the baton forward, the ongoing Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) scheme has made significant progress in covering the pending tasks of the 10th and 11th Five Year Plans which covered all households as per the 2011 Census, with an aggressive target of reaching 100% electrification by 2019. The focus is to ensure not only the availability of electricity but also adequate finance so that each household is connected to the grid on a long-term basis and with the help of a metered connection.

Apart from electricity, another major challenge towards the achievement of Goal 7 of the SDGs is the lack of access to clean fuel sources for cooking purposes in households. As per the 2011 Census, a staggering 56% of households were still dependent on firewood and chips for cooking. However, the fact that this trend is prevalent in higher expenditure households (i.e. 50–77%) is of greater concern, as it means that other than affordability, other factors such as free fuel, traditions, lack of education among women, and health and environmental awareness strongly influence the use of cleaner fuel.

The Pradhan Mantri Ujjwala Yojana (PMUY), which was launched in 2016, aims to address this by targeting rural women through massive campaigning, simplifying the process of applying for new connections for women and subsidy support. The scheme aims to make liquefied petroleum gas (LPG) connections available to 50 million BPL families by 2018–19. Further, in rural areas, a subsidy mechanism will be required until the consumer mindset changes and he/she begins using clean fuel sources for cooking, along with the realisation of social, health, education and other intangible benefits.

Sustainability of last-mile connectivity is dependent on a number of factors such as the reliability of the network, efficiency and effectiveness of the utility's technical and commercial processes, innovative electricity distribution arrangements in the face of challenging geography and demography, and customer participation. In addition, socioeconomic conditions of consumers also play an important part in the form of 'willingness to pay' to contribute to the sustenance of last-mile connectivity. Being capital intensive in nature, the commercial returns of such investments are also low because of low consumption and paying capacity of rural consumers. This necessitates low-cost technological options such as single-phase distribution systems, decentralised distribution and generation, and the use of high-voltage distribution systems. Innovations in generation and fuel-like natural gas combined cycle (NGCC), washing of coal with minimum or no water consumption, gasification of coal for power generation, carbon capture and storage (CCS) technologies in the future are needed for the efficient and cost-effective supply of electricity.

At a policy level, interventions are necessary to reduce complexities in terms of attracting investments, availing of subsidies, improving socioeconomic conditions through integrated agenda to include awareness on the productive use of electricity and clean methods for the usage of energy. Similarly, a monitoring framework is required which checks not just the progress of the schemes but also socioeconomic indicators such as literacy rate, clean use of energy for cooking in households, new jobs created and increase in economic activity. Along with the policy framework, last-mile connectivity also needs to be supported and enabled by a robust regulatory and legal framework. The role of the regulator in ensuring the sustainability and effectiveness of last-mile connectivity is important in terms of the approval of appropriate tariffs, monitoring the supply standards of licensees, etc.

Unlike the electricity sector, it is difficult to pick out a single major factor for improving the last-mile connectivity for cooking gas. The problem is multidimensional and has to be dealt with accordingly. Major issues which are leading to lower progress on this front are lack of public awareness, issues with distribution channels, and pricing and affordability. Apart from the above factors, there are other challenges in the form of uneven distribution of gas depots, bottling facilities and pipeline networks. Other issues include paperwork for getting a new connection and malpractices in distribution channels.

In this regard, spreading awareness should be the foremost step in ensuring the last-mile connectivity of cooking gas. The general public should be well informed on government schemes, processes for new connections and refilling, subsidies, pricing, health benefits, best practices and safety aspects, etc. This will help to make people aware of their entitlements, reduce malpractices in distribution channels and also lead to the safe adoption of cleaner fuel. Providing support through appropriate regulatory mechanisms and oversight should be the next step for the effective implementation of policies and to curb malpractices.

Finally, the participation of all stakeholders is key to achieving any objective. To address issues and challenges in electricity and clean cooking source availability, there is a need for think tanks and the workforce to work hand in hand. Apart from the government, regulatory bodies, utilities, oil marketing companies (OMCs), self-help groups (SHGs) and NGOs need to display a participative approach to diagnose, report and manifest quick changes to planned activities and further implement them with improved solutions. A one-size-fits all approach may not work for all areas considering the socioeconomic standard of consumers, financing and technology options available and the terrain in different parts of the country. However, close monitoring and reporting mechanisms through the involvement of all stakeholders will help identify the best deployed strategies in one area and later expand them to others.

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1. Introduction

Access to energy has always been considered vital to the achievement of the social, economic and human development goals of any nation. For energy to be supplied and accessed, it must qualify on a number of attributes in order for it to be considered meaningful and significant for citizens, enterprises and communities to use. Further, it should be available in a desirable quantity and at a desirable price; it should also be of good quality and should have as low an impact as possible on the environment and the health and safety of the individuals/communities using it. Only when these factors are met can energy contribute to improving the quality of human lives, industrial/agriculture activities and output, transport and communication, and education and healthcare, all of which contribute to the creation of more employment opportunities and increase the earning potential of citizens, resulting in an overall improvement in social, economic and human development indicators.

The availability of *affordable and clean energy* has been included as one of the 17 Sustainable Development Goals (SDGs) of the United Nations, adopted at the UN Sustainable Development Summit, in September 2015. One of the targets under this goal is to *ensure universal access to affordable, reliable and modern energy services by 2030*.

The achievement of this goal will require a wide range of interventions and considerable efforts from various stakeholders. The fundamental differences of opinion on the *definition* of 'access to energy' is the beginning of the complexities that challenge the achievement of this goal. Differing views on access further gives rise to issues around the involvement of the 'right stakeholders'. Even if the stakeholders are rightly identified, their differing 'benefit realisation goals' would affect the realisation of the bigger goal of universal access. An important reason for the improvement or deterioration of access can be attributed to *last-mile connectivity*, which mainly indicates how well or badly the end user is sustainably connected in the energy chain.

It is important to note that physical access to energy and energy-using end-use equipment are prerequisites for access to energy services and improvement of last-mile connectivity. However, physical access alone does not ensure that the household does in fact have access to energy services. Real last-mile connectivity could be due to the lack of the purchasing power of the household. The traditional view on fuel switching in the household sector of developing countries has been that households gradually ascend an 'energy ladder' and that there is a simple progression from relatively inefficient fuels and energy end-use equipment to more efficient fuels, electricity and equipment, with increasing income levels and urbanisation. This aspect further adds to the scope of examining the success of energy access.[1]

Access to energy and last-mile connectivity have been plagued by several issues and challenges in India. Despite substantial progress since independence, India still has a significant number of households with no access to energy, especially in rural areas which comprise approximately 70% of India's population. In the absence of access to electricity or clean gas, citizens in these areas use solid fuels such as coal or firewood for cooking and lighting, which creates indoor as well as outdoor air pollution through the emission of CO_2 and other hazardous substances.

[1] Centre for Energy Policy and Economics. Swiss Federal Institutes of Technology. (2003). Energy use and energy access in relation to poverty. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.197.5755&rep=rep1&type=pdf (last accessed on 23 January 2018)

The usage of liquefied petroleum gas (LPG) is growing, especially in rural areas, thanks to the implementation of a number of Government of India (GoI) schemes such as the Pradhan Mantri Ujjawala Yojana (PMUY); however, a number of challenges such as the cost of cooking apparatus and utensils and the informal and illegal use of LPG in motor vehicles and small industries hinders effective supply to targeted groups. Motor vehicles, industries and gas distribution agencies are all usually owned by rich and influential people who often prioritise the distribution of LPG cylinders to suit their own economic interests.

Access to electricity is more important than access to cooking gas. Despite the implementation of a number of electrification schemes, driven both by the central as well as state governments, challeng es in access still exist. Against this backdrop, this paper intends to examine some of the policies and measures implemented in India to improve last-mile connectivity, both with regard to electricity and cooking gas. It also aims to analyse the requirement of electricity and cooking gas vis-à-vis cost dimensions from the perspective of the consumer, review the roles of key stakeholders to resolve last-mile challenges and, lastly, deliberate a number of measures to improve last-mile connectivity situations for establishing and running sustainable energy chains.

2. Last-mile connectivity in electricity

2.1. Electrification definitions

Prior to the Rural Electrification Policy (REP), the definition of an electrified village, as notified by the Government of India (GoI) in 1997, was, *'a village will be deemed to be electrified if electricity is used in the inhabited locality within the revenue boundary of the village for any purpose whatsoever'*.

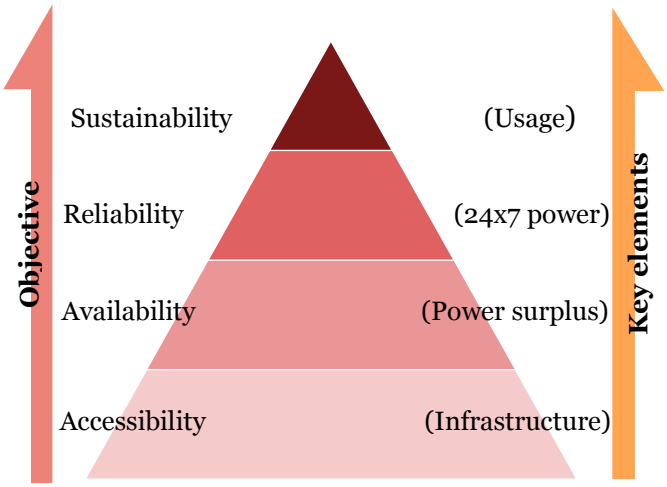
However, after the implementation of the REP, the definition of electrified villages was changed. According to the REP, a village would be classified as electrified based on a certificate issued by its gram panchayat stating that:

a. Basic infrastructure such as transformer and distribution lines are provided in the inhabited locality, as well as a minimum of one dalit basti/hamlet where it exists;

b. Electricity is provided to public places such as schools, panchayat offices, health centres, dispensaries and community centres; and

c. The number of households electrified are at least 10% of the total number of households in the village.

While it is imperative that all past schemes and policies have been implemented to ensure 100% access to electricity infrastructure, the measurement unit of electrification was confined to the village—that is, electricity access to 10% of households and even, laying down lines up to distribution assets like transformer and poles was also regarded as 100 % electrification.



With the launch of the **Pradhan Mantri Sahaj Bijli Har Ghar Yojana** (Saubhagya), the focus has shifted from *basic infrastructure funding* to *establishing last-mile connectivity to individual households*. While this is a one-step closer towards achieving last-mile connectivity, the essence lies in the retention of the new connection on a sustainable basis. This means that unless the recipient of the new service connection uses electricity for day-to-day activities, the shift from conventional methods of cooking , lighting etc., the purpose of electrification and social benefits of the infrastructure laid lies unachieved.

Thus, the definition of last-mile connectivity should incorporate components that capture the usage of electricity in a sustainable manner and include parameters like:

a. Overall available hours of electricity/household, and/or

b. Minimum unit of consumption per household/day, signifying the usage and affordability of electricity in improving the standards of living and productivity achieved through last-mile connectivity.

2.2. Enabling provisions

The Electricity Act, 2003

Section 6 of the act mandates the hitherto implied universal service obligation by stating that *the government shall endeavour to supply electricity to all areas, including villages and hamlets*.

Section 5 further mandates the formulation of a National Policy on Rural Electrification, focusing specially on the management of local distribution networks through local institutions.

Section 4 frees standalone generation and distribution networks from licensing requirements which enables electricity access to remote areas through off-grid solutions.

National Electricity Policy, 2005

The National Electricity Policy, 2015, evolved in consultation with and taking into account the views of the state governments, the Central Electricity Authority (CEA), Central Electricity Regulatory Commission (CERC) and other stakeholders. The aims and objectives of the policy are as follows:

- Access to electricity – available to all households in the next five years
- Availability of power – demand to be fully met by 2012. Energy and peaking shortages to be overcome and adequate spinning reserves to be made available.
- Supply of reliable and quality power of specified standards in an efficient manner and at reasonable rates. Per capita availability of electricity to be increased to over 1,000 units by 2012.
- Minimum lifeline consumption of 1 unit/household/day as a merit good by 2012
- Financial turnaround and commercial viability of the electricity sector
- Protection of consumer interests

National Rural Electrification Policy, 2006

The National Rural Electrification Policy was notified in compliance with Sections 4 and 5 of the Electricity Act, 2003, by the Central Government.

The main goals of the National Rural Electrification Policy, 2006, were:

- Provision of access to electricity to all households by the year 2009,
- Quality and reliable power supply at reasonable rates, and
- Minimum lifeline consumption of 1 unit/household/day as a merit good by the year 2012.

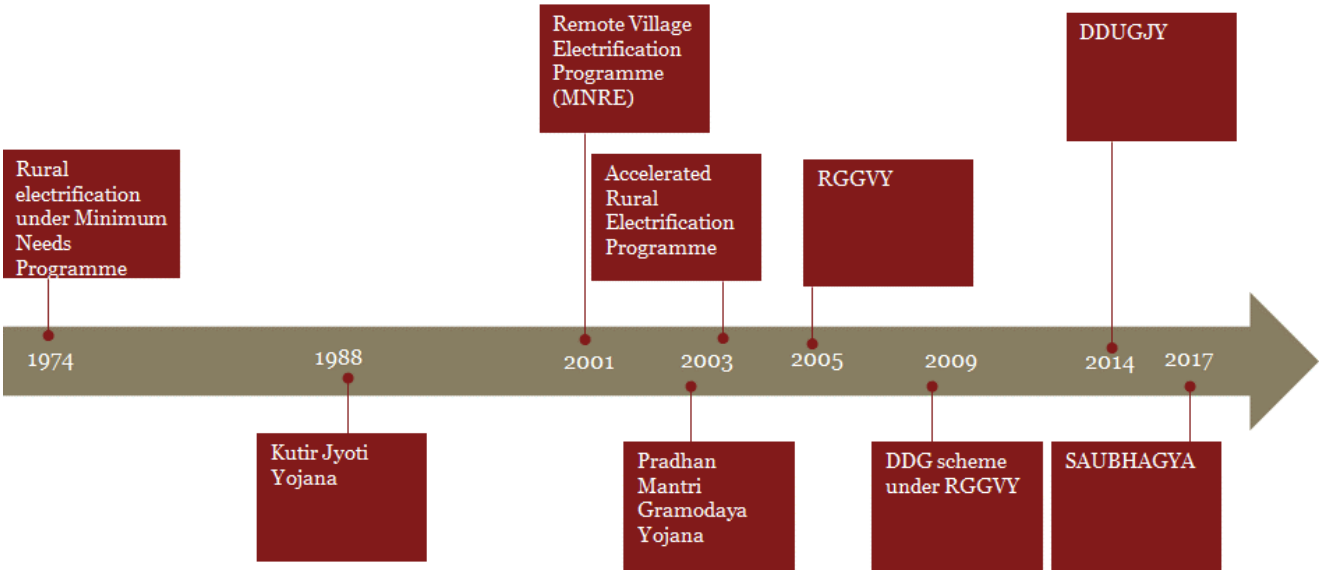
To achieve these goals, the scheme outlined the following actionable items:

- For villages/habitations where grid connectivity would not be feasible or cost effective, off-grid solutions based on standalone systems may be taken up for the supply of electricity. Where these are also not feasible and if the only alternative is to use isolated lighting technologies such as solar photovoltaic, they may be adopted. However, such remote villages may not be designated as electrified.
- State governments should, within six months, prepare and notify a rural electrification plan which should map and detail the electrification delivery mechanism. The plan may be linked to and integrated with district development plans. The plan should also be intimated to the appropriate commission.
- The gram panchayat shall issue the first certificate at the time of the village becoming eligible for declaration as electrified. Subsequently, the gram panchayat shall certify and confirm the electrified status of the village as on 31 March each year.

- The state government should set up a committee at the district level within three months under the chairmanship of the chairperson of the zilla panchayat and with representations from district-level agencies, consumer associations and important stakeholders with an adequate representation of women.
- The district committee would coordinate and review the extension of electrification in the district. It will also monitor factors such as consumer satisfaction.
- Panchayat raj institutions would have a supervisory/advisory role.
- Institutional arrangements for backup services and technical support to systems based on non-conventional sources of energy will have to be created by the state government.

2.3. Brief overview of enabling schemes

Some of the major initiatives by the GoI to ensure 100% village and household electrification and improve the situation on access to electricity and last-mile connectivity is represented below:



Minimum Needs Programme (MNP)

The MNP, exclusively targeted states with less than 65% rural electrification (by the old definition) and provided 100% loans for last-mile connectivity. The programme resources were drawn from the central plan assistance. Under this scheme, 775 crore INR was released from 2001–03 for rural electrification. The scheme was discontinued in 2004–05 on account of difficulties in implementation.

Kutir Jyoti Programme (KJP)

KJP was initiated in 1988–89 to provide single point light connections (60 W) to all below poverty line (BPL) households in the country. KJP provided a 100% grant for the one-time cost of internal wiring and service connection charges, with a provision for 100% metering for the release of grants. Nearly 5.1 million households were covered under the scheme till it was merged into the 'accelerated electrification of one lakh villages and one crore households' in May 2004 and now into the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY).

Pradhan Mantri Gramodaya Yojana (PMGY)

The PMGY, launched in 2000–2001, provided additional financial assistance for minimum services by the Central Government to all states on a 90% loan and 10% grant basis. These included rural health, education, drinking water and rural electrification. The PMGY, with an outlay of about 1,600 crore INR during the 10th Five Year Plan period, was being monitored by the Rural Development Division of the Planning Commission. More importantly, under the PMGY, states had the flexibility to decide on the inter-reallocation of funds amongst the six basic services such as primary healthcare, primary education, safe drinking water, affordable shelter, food and rural electrification. Thus, states could enhance allocations to expedite the pace of rural electrification. The scheme was discontinued in 2005.

Accelerated Rural Electrification Programme (AREP)

The AREP, launched in 2002, provided an interest subsidy of 4% to states for rural electrification (RE) programmes. The AREP covered the electrification of unelectrified villages and households and had an approved outlay of 560 crore INR under the 10th Five Year Plan. The interest subsidy was available to state governments and electricity utilities on loans availed from approved financial institutions such as the Rural Electrification Corporation (REC), Power Finance Corporation (PFC) and from the National Bank for Agriculture and Rural Development (NABARD) under the Rural Infrastructure Development Fund (RIDF).

Rural Electricity Supply Technology Mission (REST)

REST was initiated on 11 September 2002. The mission's objective was the electrification of all villages and households progressively by the year 2012 through local renewable energy sources and decentralised technologies, along with conventional grid connections. REST proposed an integrated approach for rural electrification and aimed to (a) identify and adopt technological solutions, (b) review the current legal and institutional framework and make changes when necessary, (c) promote, fund, finance and facilitate alternative approaches in rural electrification, and (d) coordinate with various ministries, apex institutions and research organisations to facilitate meeting national objectives.

Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)

The RGGVY was the first full-fledged RE scheme launched by the Ministry of Power to execute the vision for rural electrification. The RGGVY primarily attempted to give effect to the National Electricity Policy, 2005. The plan was instated in April 2005 with the following objectives:

a. 100% electrification of all villages and habitations in the country

b. Electricity access to all households

c. Free of cost electricity connection to BPL households

For achieving the said objectives, the RGGVY envisioned to create:

a. Rural Electricity Distribution Backbone (REDB), with at least one 33/11 KV (or 66/11 KV) substation in each block

b. Village Electrification Infrastructure (VEI), with at least one distribution transformer in each village/habitation

c. Decentralized Distributed Generation (DDG) systems, where the grid is not cost effective or feasible

This scheme was merged with the MNP for rural electrification with the accelerated electrification of one lakh villages and one crore households scheme.

A special emphasis was given to rural household electrification of BPL households under this programme, wherein the electrification of unelectrified BPL households would be financed with 100% capital subsidy as per the norms of the KJP in all rural habitations. Above poverty line (APL) households would be paying for their connections at prescribed connection charges and no subsidies would be available for this purpose.

DDUGJY

This scheme, launched in December 2014, focuses on feeder separation (rural households and agricultural) and the strengthening of sub-transmission and distribution infrastructure, including metering at all levels in rural areas. This will help in providing round the clock power to rural households and adequate power to agricultural consumers. The earlier scheme for rural electrification—namely, the RGGVY has been subsumed in the new scheme as its rural electrification component.

The scope of the scheme covered 12,489 crore INR for spillover works into the 10th and 11th Five Year Plan, including an additional 22,598 crore INR for electrifying 1.76 lakh villages, electrification of 0.77 lakh habitations with a population or more than 100, and providing free connections to 2.73 crore BPL households.

The full scheme entailed an investment of 43,033 crore INR, which included the requirement of budgetary support of 33,453 crore INR as grants from the GoI over the entire implementation period. The overall outlay, with the subsumed rural electrification works, was 75,893 crore INR, including a grant of 63,027 crore INR from the GoI.

(Saubhagya)[2]

This new scheme was launched on 25 September 2017 to ensure the electrification of all willing households in rural as well as urban areas.

The scheme covers the provision of electricity to households, including the release of electricity connections by drawing a service cable from the nearest electricity pole to the household premise, installation of energy meters and a mobile charging point, and the wiring for a single light point with an LED bulb. In case an electricity pole is not available near a household for drawing service cables, the cost of erection of an additional pole along with a conductor and the associated accessories shall also be covered under the scheme.

The scheme outlays the funding of 16,320 crore INR over and above the investment being made under the DDUGJY for last-mile connectivity. Wherever it is not feasible to extend grid lines, solar power packs of 200 to 300 W and battery pack with five LED lights, 1 DC fan, 1 DC power plug along with repair and maintenance for five years would be provided.

The scheme aims to cover three crore households for access to electricity over and above the one crore BPL households covered under the DDUGJY, thus providing 100% electricity access to the estimated four crore households in total.

Ujjwal DISCOM Assurance Yojana (UDAY) and 24x7 Power for All (PFA)

The power sector in India has suffered immensely due to its poor financial positioning and the inefficiencies of power utilities, especially distribution utilities, which have hampered the progress of electrification schemes and the ability of power utilities to supply reliable and quality power to rural areas. The financial health of the power sector, especially the distribution sector, is important for achieving the objectives of last-mile connectivity and ensuring the sustainability of rural electrification schemes. The GoI has undertaken various measures to improve the financial position of power utilities, especially in the distribution sector. In fact, the latest phase of reforms and developments in power is focused on supplying 24x7 power for all, increasing the share of cleaner energy, improving energy efficiency and structured turnaround of the power distribution sector and making the same operationally and financially viable and sustainable.

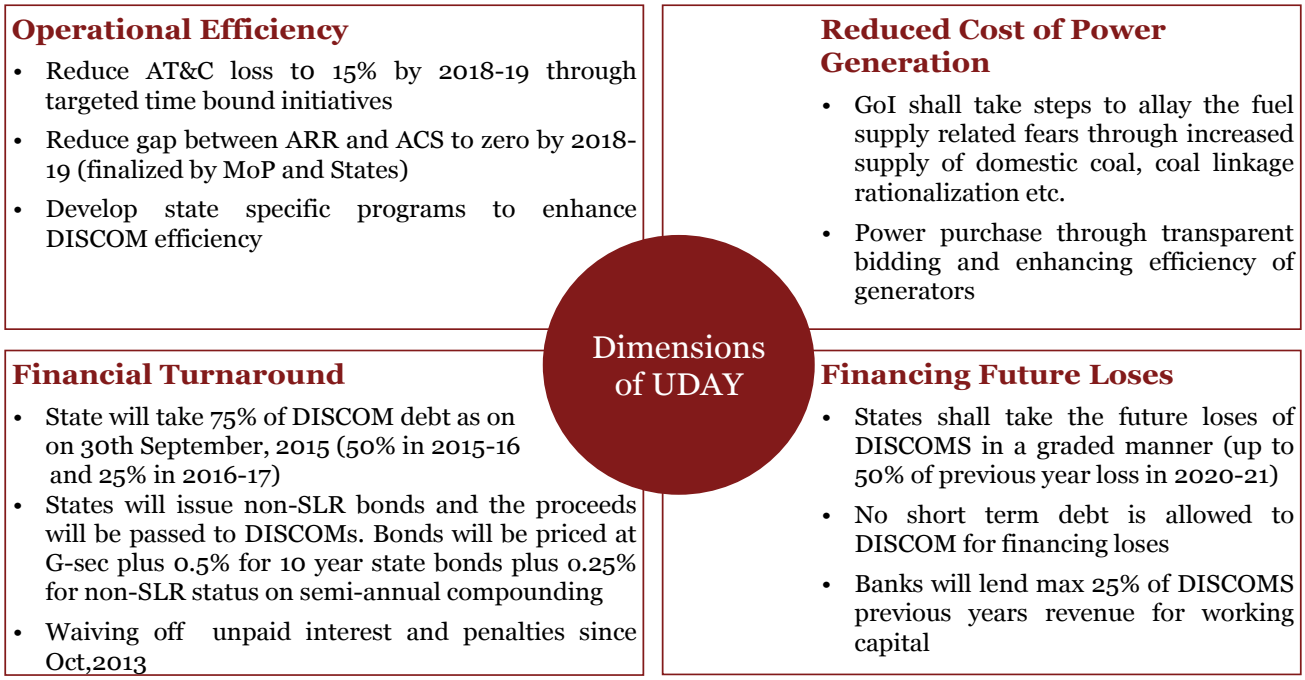
In this context, the two latest schemes of the GoI—namely, 24x7 PFA and UDAY, have been implemented to achieve the overall objective of providing reliable, quality and affordable power to all segments of the society while achieving financial and operational turnaround of the power sector. The details of the schemes are provided below:

UDAY was approved by the Union Cabinet on 5 November 2015 and focuses on (a) financial turnaround of DISCOMs, (b) improvement of operational efficiency, (c) reduced cost of power, (d) compliance of renewable purchase of power obligation and (e) promotion of energy efficiency and energy conservation.

The 24x7 PFA programme is a joint initiative of the GoI and state governments. Its objective is to provide 24x7 power to households, industry, commercial and other consuming entities, and adequate power to the agricultural sector by 2019. This programme aims to identify the requirements to meet the above objectives for each state based on the ongoing projects of the Central Government such as DDUGVY, IPDS, R-APDRP, state government schemes and the requirements of new schemes in generation, transmission and distribution.

[2] http://pib.nic.in/newsite/PrintRelease *dated 27 September 2017*

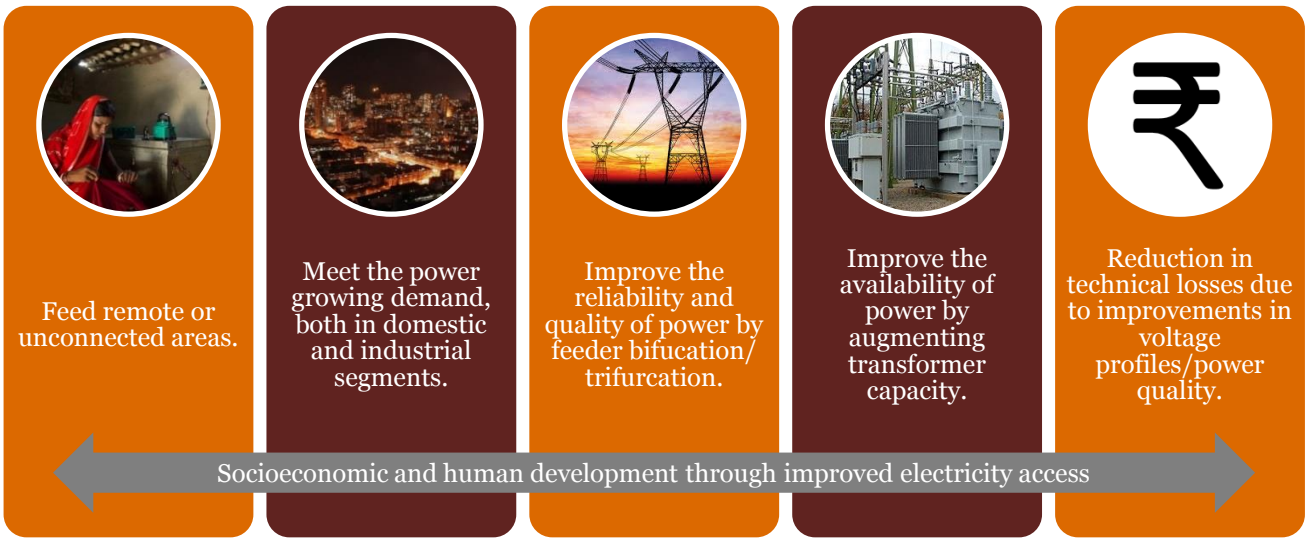
UDAY: The key features of this scheme are summarised below:



24x7 PFA: The key features of this scheme are:

- Reliable 24X7 power supply to all consumers within three years of the launch of the programme and 6.5–7 hours of power to agricultural consumers within the same timeframe.
- All unconnected households to be brought under grid connectivity by FY 2019.
- Adequate capacity addition and tie-ups with various generation sources for meeting the projected electricity demand at affordable prices.
- Strengthening of the transmission and distribution network to cater to the growing demand for power.
- Financial measures including investment optimisation and the undertaking of necessary balance sheet restructuring to improve liquidity.
- AT&C loss reduction as per the targeted trajectory.
- Focus on energy mix optimisation, reduction of power procurement costs and improvement of operational efficiency of state-run generation stations.
- Introduction of modern technologies for monitoring purposes.
- Timely completion of power infrastructure development projects.
- Adhering to performance standards for supply of electricity, as mandated by regulators.

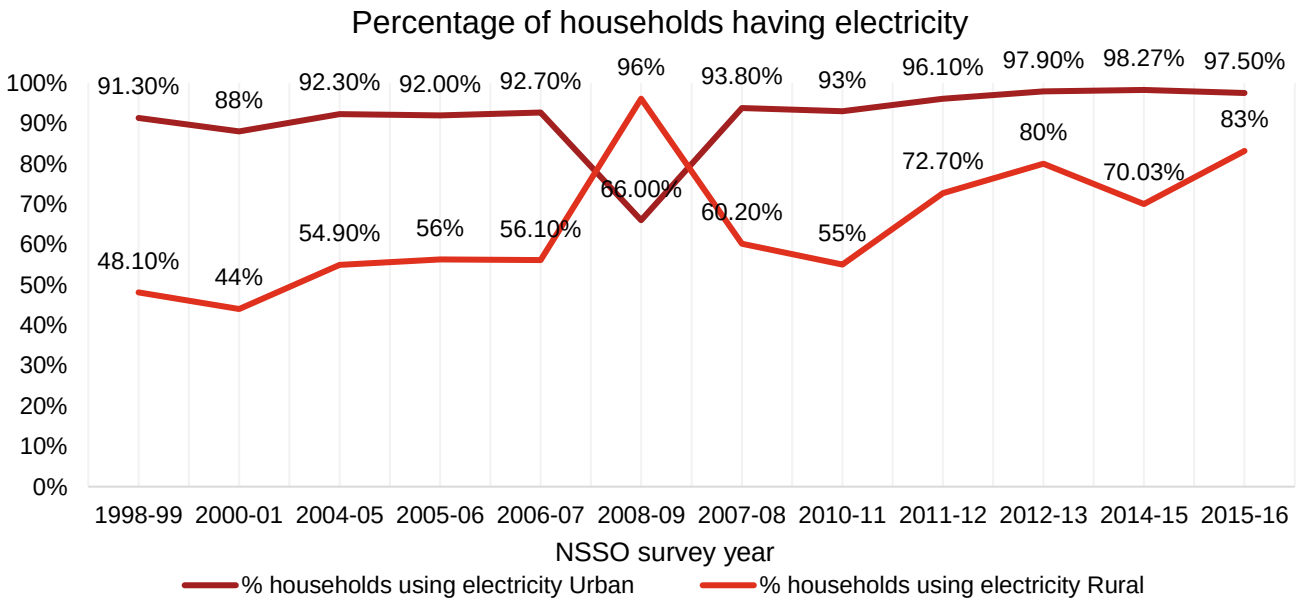
Key objectives of the 24x7 PFA programme have been presented in the figure below.



2.4. Overall progress

A per the 2011 Census, access to electricity in terms of households using electricity as the major source of lighting was 67%—a 11% rise from 55% in 2001. However, in terms rural access to electricity, the figures showed a dismal status of only 55% of households using electricity as a major lighting source. This forayed into new aggressive electricity schemes such as 'DDUGJY' and 'Saubhagya' to plug the institutional gap for rural access.

The following chart shows trends in households using electricity in India.



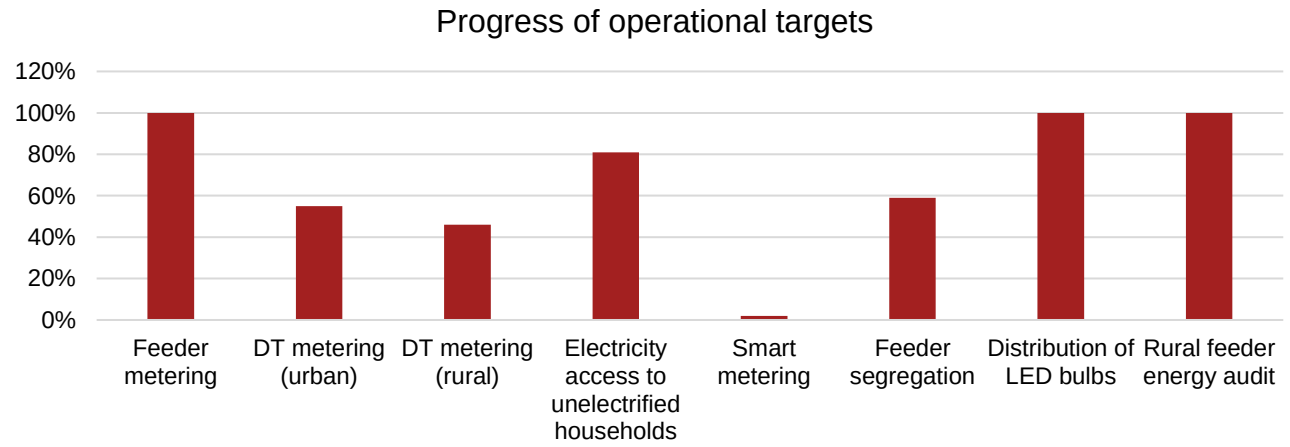
Source: NSSO

The latest figures from the DDUGJY portal as on 9 October 2017 show the following status on rural electrification:

Items	Numbers
Total unelectrified villages (2011 Census)	5,97,464
Total unelectrified villages under the scheme	18,452
Unelectrified villages to be electrified	2,842
% of unelectrified villages remaining under DDUGJY	20.8%
% of unelectrified villages remaining as per the 2011 Census	0.6%
Total households	17,93,87,124
Electrified households, including habitations	13,89,71,187

The UDAY scheme has helped in the improvement of the financial positions of distribution utilities as the outstanding liabilities have been taken over by the respective state governments. Moreover, it has provided a framework for undertaking targeted activities for loss reduction and monitoring of the same. The overall progress of the UDAY scheme is shown below:

Items	Numbers
Number of states/UTs joined	27
Amount of bonds to be issued (crore INR)	2,32,163
Percentage of bonds issued till October 2017	86.3%
Overall level of AT&C losses	24.01%
Overall gap of average cost of supply (ACS) and average revenue realised (ARR)	0.26 INR per unit
Number of states that have revised their tariffs	25 states



Source: Ministry of Power

It may be observed that while the progress on some of the targets such as feeder metering, distribution of LED bulbs and energy audit have been good, distribution utilities are struggling to achieve targets under smart metering, DT metering, etc., owing to the lack of funding, institutional capacity, etc. The long-term objectives of the UDAY scheme will not be met unless distribution utilities undertake necessary activities for loss reduction and achieve the target of 15% by FY 2019–20. This requires the institutional strengthening of distribution utilities and the availability of required investments in the distribution sector for performance improvement.

Progress under the Power for All 24x7 is as follows:

Schemes	*Objective*	*Progress*
Remote Village Electrification Programme (RVEP)	Providing basic lighting through renewable energy sources in unelectrified villages and hamlets of electrified census villages.	So far, 9,006 villages and 2,329 hamlets have been covered under RVEP.
Integrated Power Development Scheme (IPDS)	To provide quality and reliable 24x7 power supply in urban areas in 4,041 eligible towns.	20 out of 21 already commissioned data centres 1,246 towns (out of 4041 target) have been declared 'go-live' All India short code '1912' for consumer connect adopted in 44/51 DISCOMs in India
Street Lighting National Programme (SLNP)	Aims **to replace 3.5 crore conventional street lights** with smart- and energy-efficient LED street lights by March 2019.	30 lakhs bulbs/street lights replaced 104.19 MW was the avoided peak demand 39 crore kWh/year of energy saved till August 2017 3.29 lakh tonnes Co_2/year of reduction in carbon footprint Implemented across 23 states and union territories
Domestic Efficient Lighting Programme (DELP)	**The DELP scheme** was launched to provide LED bulbs to domestic consumers aiming to replace 77 crore incandescent bulbs with LED bulbs.	25.28 crore bulbs/street lights replaced 6575 MW was the avoided peak demand 32.84 billion kWh/year of energy saved till July 2017 26.60 million tonnes Co_2/year of reduction in carbon footprint Reduction of approximately 88% in the procurement prices of LED bulbs Implemented across 36 states and union territories

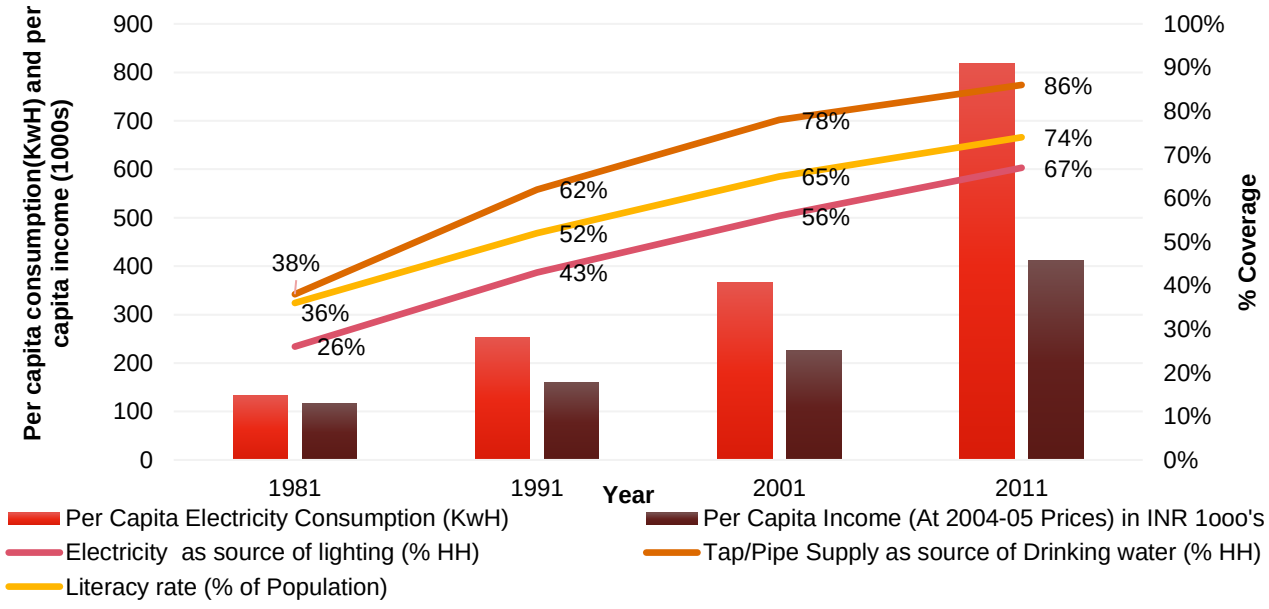
	February 2014	July 2017
LED bulbs prices	310	70 (post GST)
Retail price	550	65

Schemes	Objective	Progress
Power situation in Northeast India	To supply power to Northeast India (Assam, Manipur, Meghalaya, Mizoram, Tripura and Nagaland) for strengthening the intra-state transmission and distribution system.	Six thermal power units/modules aggregating to 1,103.1 MW were commissioned during the 12th Five Year Plan (2012–17) period in Northeast India. Peak power deficit reduced to 0.05% in the northeast Five thermal units/modules aggregating to 625.5 MW are presently under construction in the Northeast for benefits during the 12th Five Year Plan twelfth five-year plan period and beyond.

	2016–17 (April–October 2016)	2015–16 (April–October 2015)
Peak power shortage	0.50%	8.40%
Energy shortage	3.50%	6.90%

2.5. Socioeconomic impact of improved access to electricity

The graph below shows the decadal progress on various socioeconomic indicators along with electricity consumption.



Source: Ministry of Power; NSSO

Analysis of statistical data related to energy and other social parameters from the 2011 Census shows a strong and positive correlation between the increase in electrification and lifestyle changes of citizens, as shown in the table below.

Socioeconomic parameters	Per capita electricity consumption
Per capita income (at 2004–05 prices)	0.991
Clean source of lighting (electricity)	0.998
Drinking water (from tap/pipe distribution)	0.994
Literacy rate	0.999

As per the 2011 Census, India's electricity access rate increased by 15% points to 74% between 2000 and 2010. The population growth in rural areas contributed to a 65% increase alone. The massive electrification under the RGGVY scheme contributed to this growth, with electricity access rates in rural areas increasing from 48% to 66% between 2000 and 2010. As a rise in electrification and access, there was a decline in the usage of kerosene, as shown in the table below.

	Electricity			Kerosene		
	2000	2004	2010	2000	2004	2010
Total	59%	64%	74%	40%	35%	25%
Urban	89%	93%	94%	10%	7%	5%
Rural	48%	56%	66%	50%	46%	34%

Source: World Bank study on rural access, 2011; NSSO, 2000, 2004 and 2010

2.6. Issues and challenges

Despite the formulation and implementation of a large number of central/state-driven schemes over the past few years, there has been limited impact in improving the status of electrification and last-mile connectivity. A number of reasons could be attributed to the same.

2.6.1. Technical issues and challenges

- **Topologically difficult terrain**: Erecting power distribution infrastructure in hilly areas is often a challenge due to its susceptibility to damage due to landslides. Also, difficult terrains restrict the movement of sophisticated equipment to erection sites, leading to makeshift arrangements which are vulnerable to damage and sometimes compromise safety. Further, once damaged, replacements are, usually, time consuming, either due to difficulties in accessing the site or the lack of willingness on the part of utility officials in rectifying the damage, especially when the area is earmarked as a potential high-loss and/or low-revenue area.
- **Scattered nature of area**: In very large areas, household tend sometimes to be scattered. Therefore, connecting each household may require higher investments, which may not be fetching good return due to the low revenue potential of the consumers.

- **Suppressed power demand:** Electricity demand, especially in rural areas, is limited to lighting, and in some instances, to cooking (through heaters). In many villages, despite electricity being available, people resort to the use of firewood, kerosene and LPG (this has been a recent development) for cooking. Further, the economic conditions in a majority of rural areas discourage people from using electricity, unless it is absolutely critical, due to the perceived higher cost. Even if farmers prefer electricity for agricultural purposes (pumping and irrigation), the unavailability of reliable power prompts most of them to use diesel generator sets or other means to run pumps. As a result, the electricity demand in rural areas remains suppressed. The commensurate high infrastructure cost for catering to this suppressed demand hinders the willingness of the utility to focus and improve the last-mile connectivity of the areas.

- **Higher technical losses**: Due to many of the above reasons, the electricity distribution network in most rural areas is under-maintained. In many places, villagers themselves erect poles and string conductors. This results in undesirable electrical loading of the network. Sometimes, even galvanised iron wires, which are considered to be of poor quality, are used as conductors; smaller pieces of wires are joined to prepare longer conductors; etc. In addition to the above, unauthorised connections (e.g. hooking) also contribute to higher technical losses.

- **Operation and maintenance challenges**: Even for a well-staffed organisation, long low tension (LT) lines that traverse through difficult terrain and connect far-flung areas are always difficult to maintain. Many utilities, having no recruitments in the workmen/supervisor cadres for a long time or having limited recruitments, face shortage of staff for adequate deployment and therefore fail to deliver the desirable operation and maintenance services.

2.6.2. Commercial issues and challenges

- **Higher capital cost**: The capital cost for the erection of transmission and distribution networks in far-flung rural areas with difficult terrain is higher as compared to the returns on the investments. This discourages DISCOMs to invest in electricity infrastructure in rural areas.

- **Lack of affordable financing source**: Many a times, even if the utility wants to expand the grid network to far-off places, it is constrained by the non-availability of funds/funding source for such expansion where the return is uncertain. The Power Finance Corporation and Rural Electrification Corporation generally provide funds for grid expansion in rural areas under various government schemes.

- **Low revenue potential:** Utilities generally get a major chunk of their revenue from industries which are located in or near cities or specially designated zones. Even if utilities invest for network expansion into rural areas, its revenue potential is very less. Moreover, subsidies applicable to rural/ agriculture consumers further reduce its economic viability.

- **Theft:** Power theft is one of the major contributors to losses for distribution utilities and further low support from administration makes it worse.

- **Investments for reducing AT&C losses:** As mentioned earlier, the UDAY scheme has laid down various operational targets for reducing AT&C losses on initiatives such as smart meters, DT metering and consumer indexing. However, ***the completion of these targets requires significant capital investment and the distribution utilities and the respective state governments face a huge challenge in raising the required investments to achieve operational targets. In the absence of this, the distribution utilities would not be able to take necessary steps to reduce AT&C losses and the long-term objectives of the UDAY scheme for achieving financial sustainability of the DISCOMs would not materialise.***

2.6.3. Regulatory issues and challenges

- **Inadequate legal framework for mini/micro grid systems:** There is no holistic centralised framework for the implementation of micro/mini grids in rural areas for last-mile connectivity. Off-grid projects are implemented as pilot projects and no efforts are made to make it commercially viable.
- **Tariff rationalisation:** The tariff determined for rural areas does not reflect the actual cost of procurement of power by distribution utilities. Rural/agriculture consumers are heavily subsidised by other categories of consumers. This leads to an undue burden on genuine consumers. For example, a 2011 World Bank study indicated that the cost of supply for a rural domestic consumer ranged between 4.22 INR (in Andhra Pradesh) and 8.96 INR (in Bihar). Compared to that, the rural domestic consumer was charged between 1.10 INR and 3.50 INR per unit in all the states of India. The study had also quoted NSSO data between 2008 and 2010, wherein the total cost of lower cost recovery for rural services delivery was pegged at 5,400 crore INR.
- **Improper use of subsidies:** There is no regulatory mechanism to make sure that the subsidy provided by the government reaches its true benefactor. A similar direct benefit transfer (DBT) scheme, as has been implemented in the LPG sector, may be implemented for transparent and efficient delivery of financial subsidy to needy customers.

2.6.4. Socioeconomic issues and challenges

- **Unrealistic political commitment**: The government sometimes declares free power supply to certain sections of consumers (agriculture or low-income category). These types of commitments have an adverse impact on the financial health of utilities, which, in turn, find it difficult to invest in network upgradation or to improve their quality of services. This type of commitment also leads to the abuse of energy available at the disposal of consumers.
- **Low paying capacity:** Rural populations have low paying capacities due to their economic status. Much of the rural population in India is engaged in agriculture. These groups are vulnerable to the loss of income that occurs due to disturbances in agriculture activities. For example, in the case of crop damage, farmers are unable to recover their investment and, therefore, fail to pay for their subsistence, as well as other services they avail. Due to this, they are unable to pay their electricity charges.
- **Psychology of free power:** Many people assume that electricity/power is provided by the government free of cost. Due to this mindset, people generally don't pay up their bills. It is important for utilities to dispel any such understanding by organising camps and increasing consumer awareness.

3. Last-mile connectivity in cooking gas

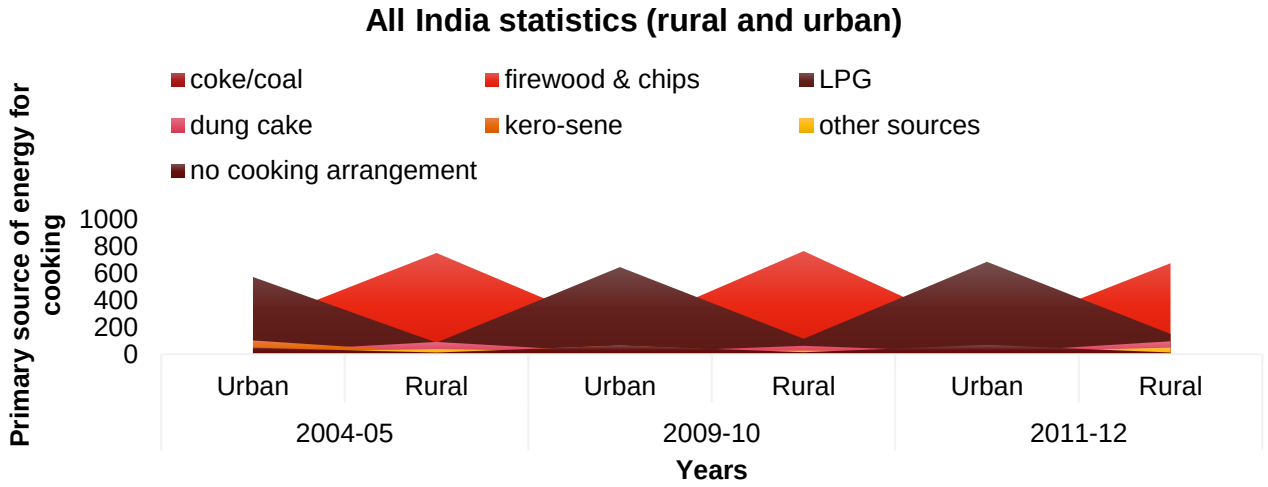
3.1. Cooking fuels in India: Trends and patterns[3]

In India, a majority of households use solid fuels such as firewood and cattle dung for deriving cooking needs unlike in developed nations like the US and many European countries where cleaner cooking fuels are commonly used for the same.

In India, the rural and urban populations rely on different fuels for cooking. As per the National Sample Survey (NSS), 68th round (July 2011–June 2012), about 68% of rural homes in India continue to use biomass, which includes firewood, crop residue and cow dung cakes, as their primary cooking fuel. The high usage rate of biomass is because of its availability at almost zero cost (a by-product of agricultural activities and animal husbandry). This trend is continuing even though firewood and cow dung cakes are cumbersome to obtain, store and use. Also, the resultant smoke pollution leads to health hazards but the 'free' factor overrides all such considerations. Many rural homes lack a closed kitchen and cooking is often done in an open area, which, to some extent, mitigates the impact of the *chulha*.

On the other hand, in urban India, cleaner and convenient cooking fuels are mostly opted by people for cooking. Around 69% of urban Indian kitchens use LPG, which is sold in portable cylinders, for cooking. The usage of LPG in urban India has increased by nearly 10% from 2004. Further, it is expected that in the coming years there will be an increase in the number of people moving towards using such cleaner fuels, thereby moving away from kerosene stoves and firewood or cow dung-fuelled *chulhas*.

The rising per capita incomes and the improvements in the levels of education are few of the major factors responsible for the usage of cooking fuels in urban and rural India. Urban areas report higher per capita incomes, larger per capita household expenditures, higher average levels of education and greater health- and environment-related consciousness. As a result, more urban homes opt for cleaner fuels such as LPG or piped natural gas (PNG) in comparison to their rural counterparts.



Source: TERI

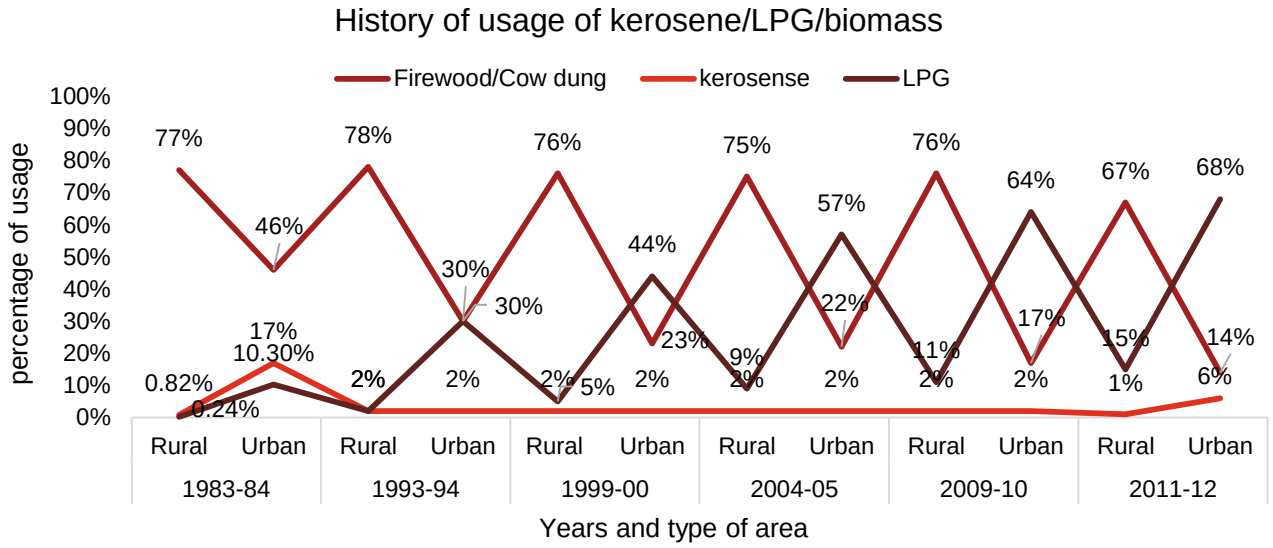
Rural and urban households per 1,000 distribution all over India by primary source of energy for cooking

[3] TERI. (2010). Cooking with cleaner fuels in India: A strategy analysis and assessment. Retrieved from http://www.teriin.org/div/CES/Policy_brief_cooking_fuels.pdf (last accessed on 23 January 2018)

3.2. History and progress over the years[4]

As per 38th NSSO survey (1983[5]), in rural India, more than 90% of the population was dependent on biomass and 0.24% on LPG for cooking, whereas in urban India, it was 74% for biomass and 2% for LPG.

From 1993–94 to 2004–05, the usage of biomass as the main energy source of cooking in rural households has come down from 78% to 75%, LPG has increased from 2% to 9%, whereas in urban India the usage of LPG has increased from 30% to 57% and the reduction in biomass is 13% since then.



Source: NSSO

Percentage distribution of households by primary source of energy used for cooking – all India, 1983–2012

As per NSSO survey reports, 2011–12, firewood and chips are primary sources of energy for cooking in rural India. At an all-India level, firewood and chips were used by more than two-thirds (67.3%) of rural households, followed by LPG, which was used by 15.0% households. Only 9.6% and 1.1% of the rural households used dung cake and coke and coal, respectively, as a primary source. The remaining 4.9% of households used other sources—that is, gobar gas (biogas produced from cow dung), charcoal, electricity and others. About 1.3% of rural households did not have any arrangement for cooking.

In the urban areas, most of the households used LPG as a primary source of energy for cooking. LPG was used by 68.4% of the urban households at an all-India level, followed by firewood and chips, used by 14.0% households. About 5.7% of the households used kerosene, 2.1% used coke and coal and only 1.3% of the urban households used dung cakes as a primary source of cooking. The remaining 1.5% households used other sources. Noticeably, 6.9% of urban households did not have any arrangement for cooking.

[4] NSSO. (2012). Energy sources of Indian households for cooking and lighting. Retrieved from http://mospi.nic.in/sites/default/files/publication_reports/nss_report_567.pdf (last accessed on 23 January 2018)
[5] NSSO. (1983). Report on source of drinking water and energy used for cooking and lighting. Retrieved from http://mospi.nic.in/sites/default/files/publication_reports/nss_report_336.pdf?download=1 (last accessed on 23 January 2018)

3.3. Inter-state variation[6]

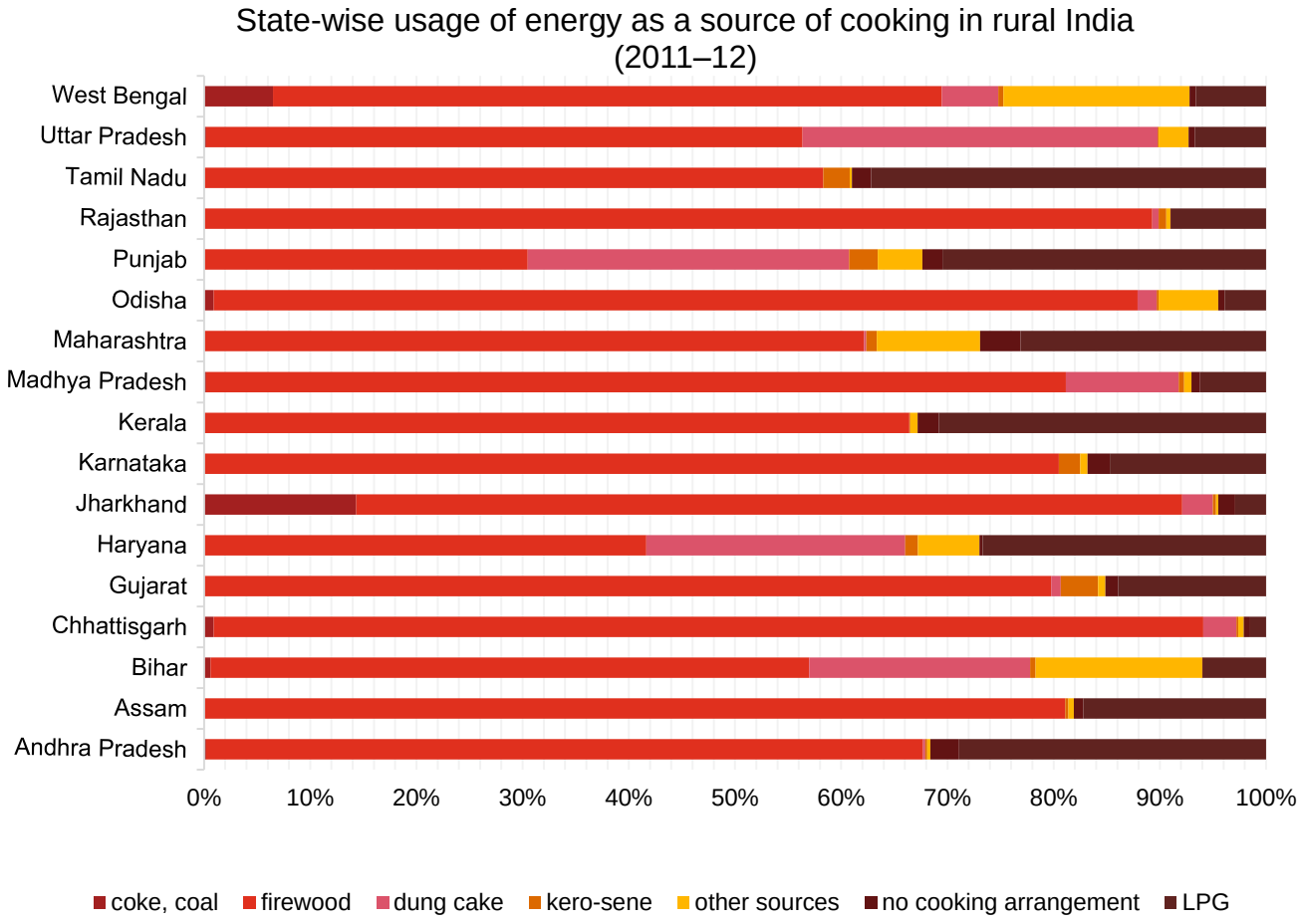
3.3.1. Rural India: State-wise stats

As per NSSO report, 2011-12, except Punjab and Haryana, more than 56% of households were still depending on firewood and chips for cooking. Chhattisgarh (93.2%), Rajasthan (89.3%) and Odisha (87.0%) are the top states where a majority of households used firewood and chips for cooking.

About 33.4% of rural households in Uttar Pradesh use dung cake as an energy source for cooking, followed by Punjab with 30.3%, Haryana with 24.4%, 20.8% in Bihar and 10.6% in Madhya Pradesh.

Rural households in Tamil Nadu (37.2%) were leading in terms of the usage of LPG in homes for cooking, Kerala (30.8%) comes in second, followed by Punjab (30.5%). However, for Punjab, the incidence of LPG use was almost at par with firewood and chips (30.5%), and dung cake (30.3%). The use of LPG in households was the least in Chhattisgarh (1.5%), preceded by Jharkhand (2.9%) and Odisha (3.9%).

The use of coke and coal as primary sources of energy for cooking was evidently reported in rural Jharkhand (14.3%) and rural West Bengal (6.5%). No cooking arrangement was reported in Maharashtra (3.8%) and Andhra Pradesh (2.7%).



Source: NSSO, 68th round (2011–12)

[6] NSSO. (2012). Energy sources of Indian households for cooking and lighting. Retrieved from http://mospi.nic.in/sites/default/files/publication_reports/nss_report_567.pdf (last accessed on 23 January 2018)

3.3.2. Urban India: State-wise stats

LPG, as a principal fuel, is used by nearly 40% of urban households in India for cooking across all major states. Haryana, with 86.5% households, is at the top with regard to usage of LPG in households for cooking, followed by Andhra Pradesh (77.3%) and Punjab (75.4%). The lowest was recorded in Chhattisgarh (39.8%).

Dependency on firewood and chips for cooking was the highest in Odisha (36.5% households), closely followed by Kerala (36.3%) and Chhattisgarh (34.7%).

Gujarat (10.5%), Maharashtra (10.1%) and Punjab (10.0%) use kerosene as the primary source of cooking. Households in Jharkhand (31.1%), West Bengal (13.5%) and Chhattisgarh (11.3%) used coke and coal as the primary source of cooking.

No cooking arrangement was reported by 6.9% of urban households all over India. The highest was recorded in Karnataka (13.9%), followed by Tamil Nadu (9.2%) and Andhra Pradesh (9.1%).

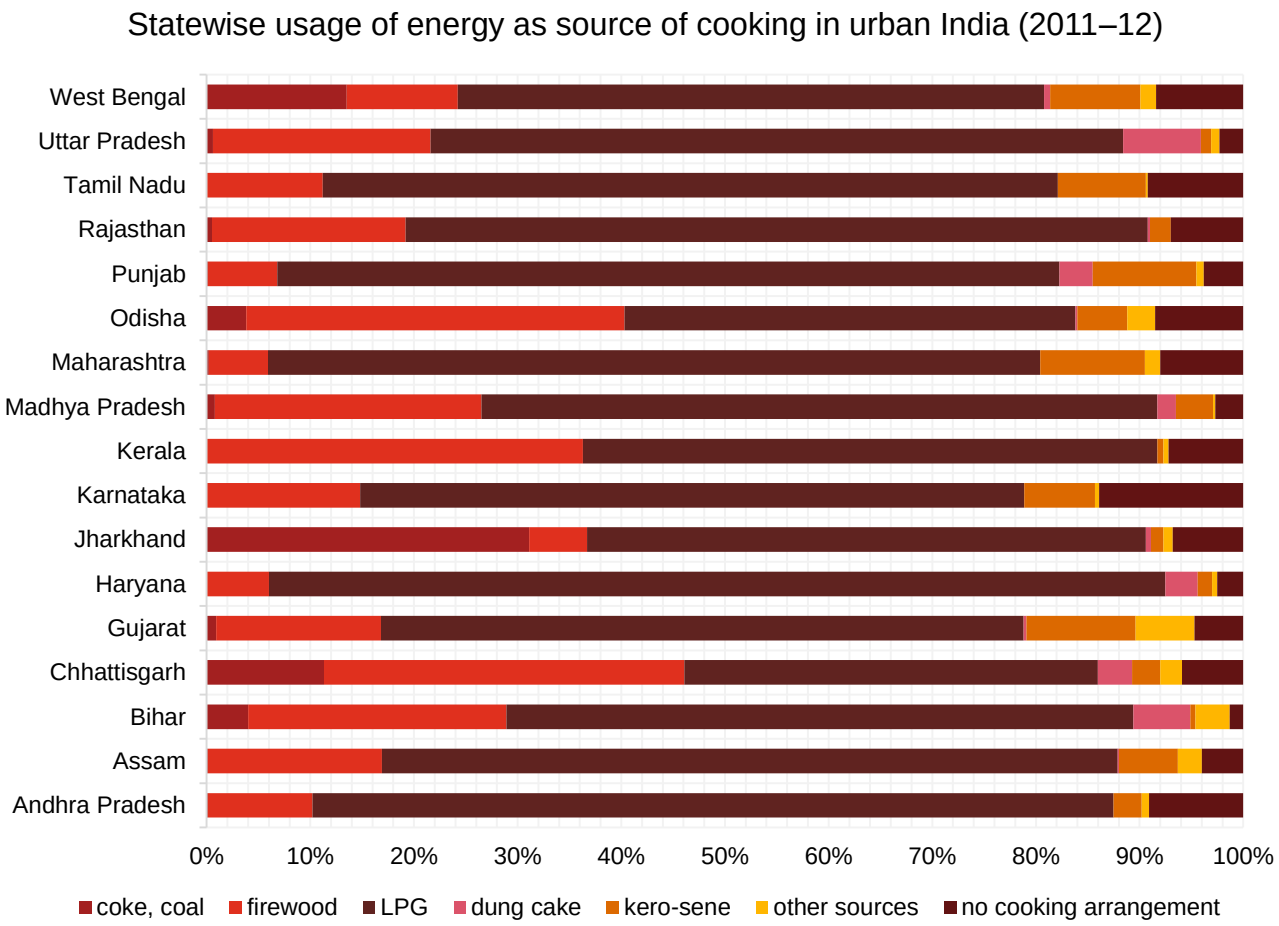


Fig: 4 Percentage of urban households across states using different fuel types for cooking
Source: NSSO, 68th round (2011–12)

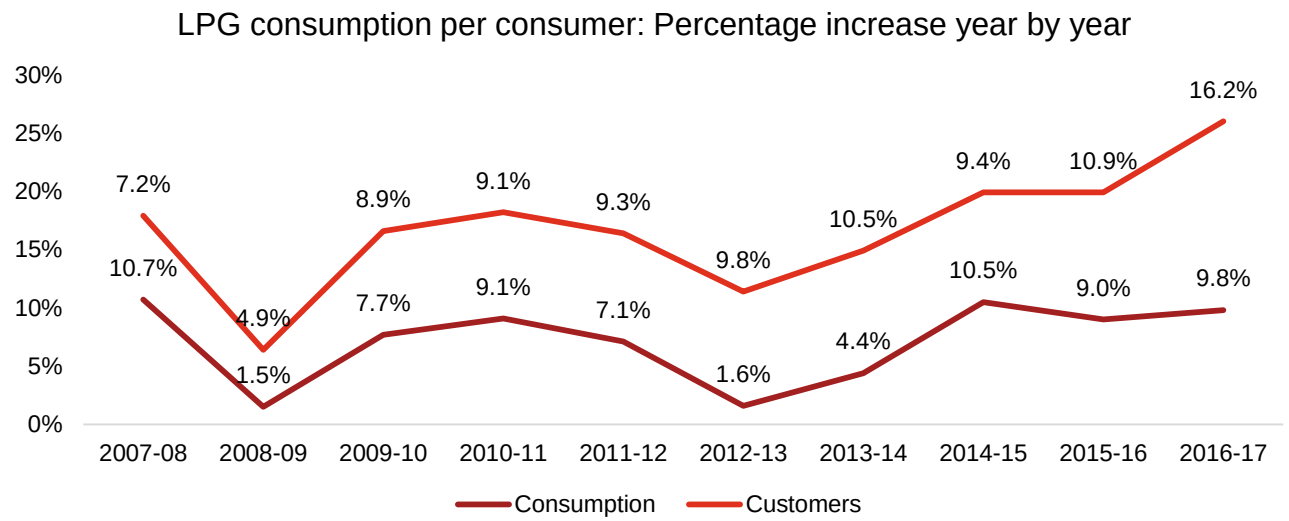
3.4. Factors influencing consumer behaviour[7]

Affordability is one of the main reasons that is driving the choice of customers. With the increase in monthly per capita consumption expenditure (MPCE), the move to LPG in rural and urban homes increases. This limits the use of traditional fuels—namely, firewood and cow dung.

Presently, a significant number of households, even in the higher expenditure category, still use firewood as their primary cooking fuel. In the top three expenditure percentiles, 50–77% of households admitted to the usage of firewood as their primary fuel.[8] This means that other than affordability, other factors such as free fuel, tradition, the lack of education among women, and health and environmental awareness strongly influence the use of cleaner fuel.

The influence of factors other than affordability is also reflected in the data carried in NSSO's 63rd round (July 2006–2007). With an average MPCE level of 647 INR, 75% of rural households' primary source of cooking was firewood. On the other hand, for urban households, the same was recorded at only 22% and had an average MPCE level of 691 INR. This shows that despite the proximity of MPCE levels in rural and urban set-ups, the use of firewood varies drastically. It is apparent that additional factors such as awareness, ease of availability, cooking space constraints, social customs and demographics (e.g. educated and working women) play a significant role in the choice of fuel in urban households.

Below is the graph showing the yearly increment in percentage of LPG consumption among customers all over India from 2007 to present.



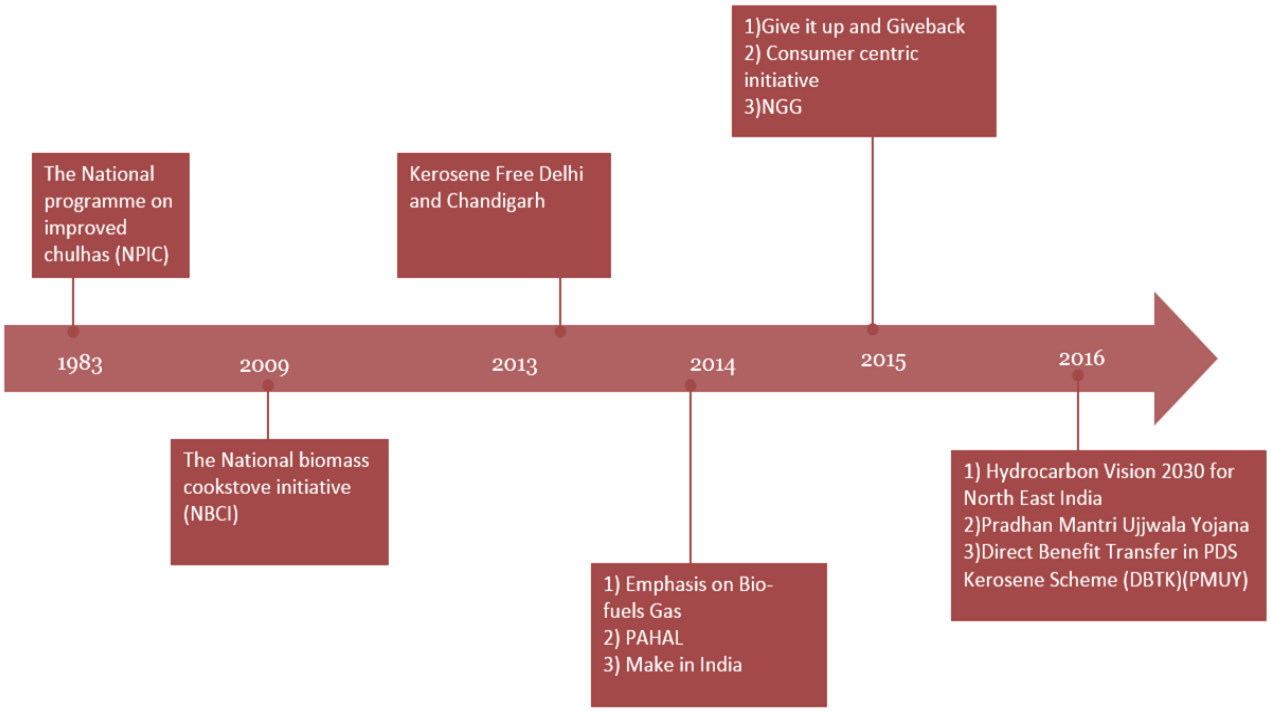
LPG consumption across India from 2007–2017[9]

The above graph shows that even with the yearly rise in the consumption of LPG from 9% to 9.8% from 2015–17, the yearly increase in LPG customers during the same time period rose only from 10.2% to 16.2%. This indicates that customers are not returning for a refill after receiving the free LPG connection. A reason for this is the high cost of a subsidised cylinder, which is 450 INR (2017); kerosene (20 INR per litre) or firewood, in that case, are much cheaper options.

[7] TERI. (2010). Cooking with cleaner fuels in India: A strategic analysis and assessment. Retrieved from http://www.teriin.org/div/CES/Policy_brief_cooking_fuels.pdf (last accessed on 23 January 2018)
[8] NSSO. (2005). Energy sources of Indian households for cooking and lighting (2004–05). Retrieved from http://mospiold.nic.in/national_data_bank/pdf/NSS%2061st%20Round-511.pdf (last accessed on 23 January 2018)
[9] The Wire staff. (28 June 2017). The poor got LPG cylinders under Modi's scheme but they cannot afford gas refills. The Wire. Retrieved from https://thewire.in/152066/modi-lpg-scheme/ (last accessed on 23 January 2018

3.5. Overview of government schemes[10]

A large number of policies and schemes have been launched by the Ministry of Petroleum and Natural Gas (MoPNG) to encourage last-mile connectivity. Few of these policies are discussed below.



[10] http://petroleum.nic.in/sites/default/files/AR16-17.pdf, http://pib.nic.in/newsite/PrintRelease.aspx?relid=155686

1. National Programme on Improved Chulhas (NPIC) (1983)

The Department of Non-conventional Energy Sources (now the Ministry of New and Renewable Energy) launched its very first National Programme for Improved Cookstoves (NPIC), with the primary objective of reducing fuel wood consumption and removing/reducing smoke from kitchens.

NPIC was responsible for introducing improved biomass cookstoves (ICS) to around 35 million households but failed to ensure their sustained use.

As per the studies done by the Global Alliance for Clean Cookstoves, only a fraction of Indian households (0.25%/1 million households) actually used ICS.[11] Certain independent studies also suggest that the NPIC 'improved' stoves often had higher emissions than their traditional counterparts.

In the year 2002. The key reasons for its failure were:

- **Large government subsidies with minimal user contribution:** Under the NPIC, the government covered the major share of costs of stoves, with consumers providing small monetary contribution. Heavy subsidies meant that the stove builders were only concerned with fulfilling government specifications, incognizant of consumers' preferences. Further, this inhibited the development of a market-based approach which could have promoted greater competition and innovation in this space.
- **Lack of an effective monitoring and evaluation system:** The government's only measure of the programme's success was the number of stoves developed or disseminated. Indicators such as the sustained use of the stove and improvements in indoor air quality and cooking convenience were not monitored or considered.
- **Limited awareness raising and training programmers:** The NPIC had failed to generate sufficient awareness regarding the adverse health impacts of indoor air pollution caused by traditional cooking practices. This limited the adoption and sustained use of improved cookstoves. The lack of training for using ICS also led to their non-usage.
- **Limited after-sales support:** NPIC also failed to provide essential maintenance and after-sales services, which are critical to enable the sustained use of the improved stoves.

2. National Biomass Cookstoves Programme (NBCP) (2009)

The MNRE had formulated the NBCP for implementation during the 12th Plan period. It launched on 2 December 2009 and pilot scale projects were taken up for demonstration of improved biomass cookstoves for domestic cooking.

Scheme highlights:

- Improved biomass cookstoves will be disseminated for domestic and community cooking applications on a cost-sharing basis.
- Under this programme, demonstration projects, comprising existing and better cookstoves and different grades of process biomass fuel, will be undertaken which will facilitate exploring a range of technologies, biomass processing and delivery models.
- The MNRE has strengthened three test centres for carrying out performance testing of improved biomass cookstoves to maintain the quality of products. Only cookstoves which satisfy the stipulated performance tests and which are approved by the MNRE are considered in the demonstration programme.
- Pilot projects have been taken up in J&K, Uttar Pradesh, Bihar, Madhya Pradesh, Jharkhand, Chhattisgarh, Karnataka and Odisha. The programme will cover all Indian states in its next phase.
- State-wise targets will be set for pilot scale demonstration of different models of improved biomass cookstoves for domestic cooking.

[11] GIZ. (2014). Integrated company report. Retrieved from https://www.giz.de/en/downloads/giz2015-iub2014-barrierefrei-web-en.pdf (last accessed on 23 January 2018)

State-wise targets for pilot scale demonstration of different models of improved biomass cookstoves for domestic cooking[12]

Sr. no.	States	Number of cookstoves
1	J&K	3,000
2	Uttar Pradesh, Bihar and Chhattisgarh	3,000
3	Madhya Pradesh, Bihar, Orissa, Chhattisgarh and Karnataka	3,000
4	Jharkhand, Bihar and Orissa	3,000

3. Kerosene-free Delhi and Chandigarh (2013)

The MoPNG, with the help of the Chandigarh Administration, launched this scheme to make Chandigarh a 'kerosene-free city'. This initiative was started to promote LPG in homes.

Scheme highlights:

The following steps have been taken by the Chandigarh Administration and government to make the city kerosene-free:

- Camps were organised at various localities in consultation with the Chandigarh Administration to provide hassle-free LPG connections.
- Interest-free loans were provided for APL households and zero deposit LPG connections were provided to BPL households.
- An Indian Energy Congress (IEC) campaign in the form of distribution of pamphlets and radio jingles was done to create awareness among the masses.

Scheme outcomes:

- During this campaign, a total of 15,249 LPG connections were provided in Chandigarh city, including 1,574 for BPL households.
- The national capital territory (NCT) of Delhi and the UT of Chandigarh were declared kerosene-free cities on 1 October 2013 and 1 April 2016 respectively and hence no public distribution system (PDS) allocation has been made to them.

[12] Press Information Bureau. Government of India. Ministry of New and Renewable Energy. (2013). National Biomass Cookstove Programme. Retrieved from http://pib.nic.in/newsite/PrintRelease.aspx?relid=94877 (last accessed on 23 January 2018)

4. PAHAL – the world's largest Direct Benefit Transfer scheme (2014)

This scheme was launched in 2014 for the direct transfer of LPG subsidy to consumers without involving any intermediary across the country from January 2015.

Scheme highlights:

Name of key initiative/programme	**PAHAL**		
Launch date and place	15 November 2014		
Objectives	• Protect entitlement and ensure subsidy to the consumer. • Ensure saving of precious public money by eliminating diversion. • Improve the availability/delivery of LPG cylinders for genuine users. • Weed out fake/duplicate connections. • Allow self-selection in subsidy.		
Target beneficiaries	Registered LPG consumers		
Physical targets (if any)	NA		
No. of beneficiaries (actual)	173.6 million		
Performance and achievement in the last three years (2014–17)	Year	Subsidy savings (in billion INR)	Consumers that joined the scheme (in million INR)
	2014–15	144.18	122.6
	2015–16	64.43	30.4
	2016–17	16.54	13.0
Compare with performance during 2011–14	This scheme entered the Guinness Book of World Record for being the largest direct benefit transfer scheme. Earlier Scheme launched in 2012 was discontinued in 2013.		

Scheme outcomes:

- A total of 404.46 billion INR of subsidy was already transferred through 2.04 billion transactions to all LPG consumers since launch of the scheme.
- To avoid duplicate/fake/ghost/inactive domestic LPG connections, the government took steps and exercised various activities by which, as of 1 April 2015, 33.4 million such connections were identified and their subsidies have been blocked.

5. Emphasis on bio fuels (2014)

The following initiative was undertaken by the government and oil marketing companies (OMCs) to encourage the use of bio fuels in the country.

Ethanol Blended Petrol (EBP) programme

The EBP programme was run in collaboration with OMCs who were responsible for selling ethanol petrol with up to 10% of ethanol in it. In order to improve the availability of ethanol, the government fixed the delivered price of ethanol in the range of 48.50 INR per litre to 49.50 INR per litre on 10 December 2014. Further, ethanol produced from other non-food feedstocks besides molasses such as cellulosic and lingo-cellulosic materials including petrochemical route has also been allowed to be procured.

Due to these efforts, in 2014–15, a quantity of 674.2 million litres was procured, almost doubling the supply of ethanol as compared to previous years. In 2015–16, OMCs contracted 1,300 million litres of ethanol till 26 July 2016.

Biodiesel Programme

On 10 August 2015, the government issued a notification to allow biodiesel (B100) to be sold by private manufacturers to bulk consumers such as the railways, state transport corporations and other bulk consumers. Further, the retailing of biodiesel blended diesel by OMCs was also has started on the same day.

As on 1 July 2016, 13.2 million litres of biodiesel was procured by OMCs.

Second generation ethanol

In furtherance of the decision of the government to allow the procurement of ethanol produced from cellulosic and ligno-cellulosic feedstock, Numaligarh Refinery Limited (NRL) completed a detailed feasibility report (DFR) for a project that involved the setting up a bio-refinery for production of 49 TMT of bioethanol per annum from bamboo, in collaboration with Chempolis Oy, Finland.

6. Make in India (2014)

All oil PSUs have formulated indigenisation groups (INDEG) to increase the domestic component in all kinds of procurements. MoUs have been signed with research and academic institutions to develop indigenous technologies. The work on the feasibility for establishing a petroleum economic zone is at an advanced stage. A concept note on the use of the Oil Industry Development Board (OIDB) funds for Make in India has been sent to the Ministry of Finance and Niti Aayog for comments.

7. GiveItUp and Giveback (2015)

The scheme was launched by the government in 2015 as an initiative to encourage those domestic LPG consumers who can afford to pay the market price to voluntarily surrender their LPG subsidy. This will enable the government to utilise its limited resources to reach out to the economically backward classes.

Scheme highlights:

Name of key initiative/programme	*GiveItUp and Giveitback*
Launch date and place	27 March 2015
Objectives	To motivate well-off LPG consumers to voluntarily give up their LPG subsidy. To provide LPG to poor BPL households utilising the CSR funds of oil PSUs.
Target beneficiaries	Well-off LPG households for GiveItUp and BPL households for GiveBack.
Physical targets (if any)	NA
No. of beneficiaries (actual)	10.5 million GiveItUp consumers; 6.5 million BPL households got LPG connections
Performance and achievement in the last three years (2014–17)	Achieved 10 million beneficiaries by 23 April 2016
Compare with performance in 2011–14	Not launched earlier

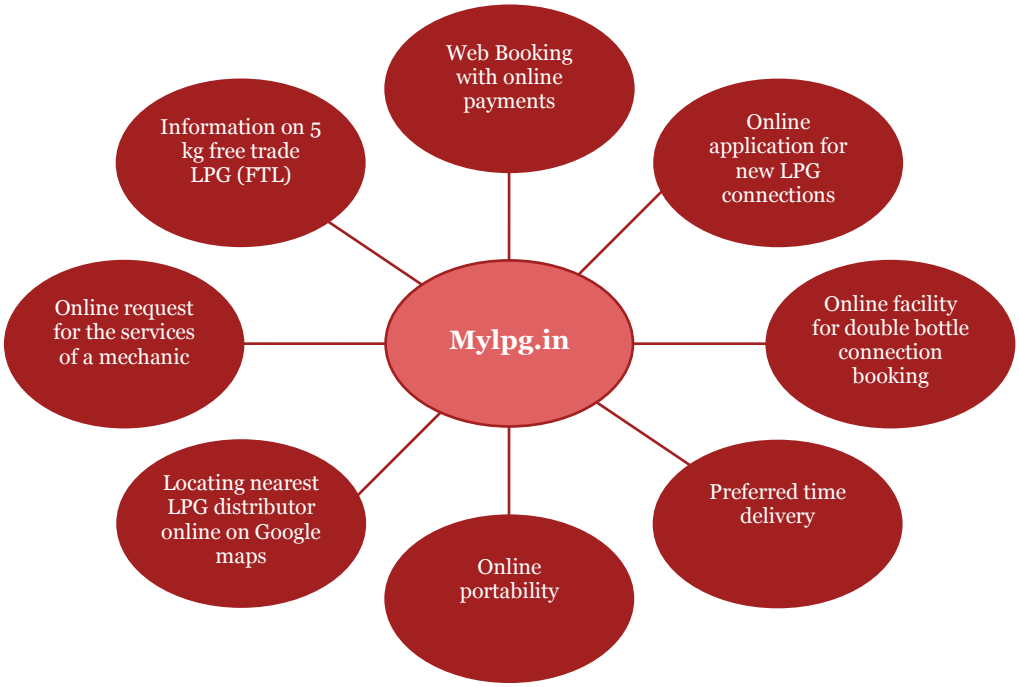
Scheme outcomes:

- By July 2015, a total 1.4 million consumers have given up subsidy on LPG, resulting in an average savings of approximately 2.2 billion INR.
- As on December 2016, around 10.5 million households have voluntarily given up their LPG subsidy. Nearly 6.3 million new LPG connections were released to BPL families in FY 2015–16.

8. Consumer-centric initiative (2015)

Online services to LPG consumers are provided through www.Mylpg.in. Some of the major services are depicted below.

Scheme highlights:



Other than the above-mentioned services, information on LPG connections for PNG consumers, online surrender connection request, enrolment to the 'GiveItUp' subsidy, rating of distributors, submission of feedback/grievances, viewing of important contact information and transparency portal are also available on the same portal.

Also, the same can be accessed through mobile applications to make it feasible and convenient for consumers to avail of any service and make payments from anywhere through the Internet.

Scheme outcomes:

- More than 0.2 million LPG connections have been issued using the online facility.
- 1 million LPG consumers have booked refills by using this facility.
- Moreover, nearly 0.12 million consumers used online logging to voluntarily opt out of subsidy under the 'GiveItUp' campaign.
- Discussion forums have been launched and are available on mylpg.in and myGov.in.
  LPG consumers/citizens participate and share their thoughts via these forums.
  Valuable suggestions/comments are welcome and are considered for improving the available customer-oriented services.

9. Direct Benefit Transfer in PDS Kerosene (DBTK) scheme (2016)

The government launched DBTK on 1 April 2016 in 33 districts identified by nine state governments— namely, Chhattisgarh, Haryana, Himachal Pradesh, Jharkhand, Madhya Pradesh, Maharashtra, Punjab, Rajasthan and Gujarat.

Scheme highlights:

- The consumer will have to pay the non-subsidised price of kerosene at the time of its purchase so as to avail the direct transfer of subsidy. The amount of subsidy will be directly transferred to the bank account of the beneficiary.
- An initial amount of subsidy shall be credited to all eligible beneficiaries to avoid any inconvenience to the beneficiary during the initial purchase through the payment of non-subsidised price.
- As a part of this scheme, implementing states will be given fiscal incentives equivalent to 75% of subsidy saved in the first two years, 50% of subsidy saved in third year and 25% of subsidy saved in fourth year.
- In case the states voluntarily agree to undertake cuts in kerosene allocation beyond the savings due to direct benefit transfer, a similar incentive would be given to those states/UTs. The initiative of the government is aimed at rationalising subsidies based on approach to cut subsidy leakages but not subsidies themselves. The scheme will also stop the diversion of kerosene.

Scheme outcomes – performance and achievement in last three years (2014–17)

- The Government of Jharkhand implemented DBTK in four districts and has become the first state in the country to implement DBTK. Karnataka, Haryana, Telangana and Nagaland have taken voluntary cut in their PDS kerosene allocation.
- The Government of Karnataka had volunteered to undertake a cut in kerosene allocation and a similar proposal has also been received from the Government of Haryana and the Government of Telangana. Further, the Government of Haryana has requested to make kerosene free by 31 March 2017.

10. PMUY (2016)[13]

The scheme was rolled out on 1 May 2016 in Balia in Uttar Pradesh with an aim to provide 50 million LPG connections to BPL families by 2018–19, with a support of 1,600 INR per connection in the name of women of the household for which 80 billion INR has been approved by the government.

Under the scheme, BPL families identified through the Socio-Economic Caste Census (SECC) 2011 data were provided deposit-free LPG connections. The identified households were also provided security money of one cylinder, a pressure regulator, hose pipe and Domestic Consumer Gas Card (DGCC) book and installation charges were also taken care of.

The consumer might need to buy an ISI standard gas stove; however, this is optional. Further, BPL customers are being financed by OMCs for the purchase of LPG stoves. They will also be granted the first refill on an instalment basis, if they so desire.

To meet the demand and supply chain of LPG cylinders, the government is in the process of setting up of 10,000 new distributorships. A majority of these distributorships will cover rural areas with a view to catering to unserved consumers.

[13] http://pib.nic.in/ndagov/Comprehensive-Materials/compr23.pdf

Scheme highlights:[14]

Name of key initiative/programme	*PMUY*		
Launch date and place	1 May 2016 in Balia, Uttar Pradesh		
Objectives	Empowering women and protecting their health LPG connection to BPL families for access to clean cooking fuel Reducing serious health hazards associated with cooking based on fossil fuel/biomass. Preventing young children from a significant number of acute respiratory illnesses caused due to indoor air pollution by burning the fossil fuel/biomass.		
Target beneficiaries	BPL households identified through the SECC list		
Physical targets (if any)	15 million in 2016–17		
No. of beneficiaries (actual)	17.5 million		
Performance and achievement in the last three years (2014–17)	Year	Target	Achievement
	2016–17	15 million	100%
Comparison with performance from 2011–14	No such scheme was launched.		

Scheme outcomes
• As on December 2016, OMCs released 12 million new LPG connections under PMUY.

[14] http://pib.nic.in/ndagov/Comprehensive-Materials/compr23.pdf

11. Hydrocarbon Vision 2030 for Northeast India (2016)

On 9 February 2016, the GoI's Act East Policy and the MoPNG launched Hydrocarbon Vision 2030 for Northeast India

Highlights of the Hydrocarbon Vision 2030:

- The Hydrocarbon Vision 2030 aims to double oil and gas production by 2030, making clean fuels accessible and fast tracking projects.
- It also aims to generate employment opportunities and promote cooperation with neighbouring countries.
- The vision focuses on developing the Northeast of India into a dominant hydrocarbon hub at the forefront of India's energy economy, and is a step towards realising our Prime Minister Narendra Modi's vision to develop the Northeast of India.
- The vision rests on five pillars: people, policy, partnership, projects and production.
- The vision not only envisages doubling the oil and gas production but also chalks out an action plan to double the availability of petroleum products such as petrol, diesel and LPG by the year 2030.
- It proposes for the expansion of Guwahati, Bongaigaon and Numaligarh refineries, the establishment of a bio-refinery at Numaligarh and the development of a network of natural gas, petrol, oil and lubricant (POL) and LPG pipelines in the state.
- The Hydrocarbon Vision 2030 document provides for an investment to the tune of 1.3 lakh INR by the year 2030 in oil and gas sector in NE.

Outcomes:

- For the Siliguri-Parbatpur pipeline, NRL has entered into an MoU with Bangladesh Petroleum and a route survey and DFR has been completed.
- Guwahati Indmax was commissioned in April 2016.
- For BGR Indmax project has been approved and will be completed by the year 2019.
- Augmentation of Gopanari bottling plant has been completed.
- Additional LPG tankage at Silchar, Manipur and Nagaland has been completed.
- In order to address serious LPG shortage issues, IOCL has planned for an LPG terminal at Chittagong and is laying an LPG pipeline in Agartala. IOCL signed an MoU with Premium LPG in May 2016.

12. Expansion of the city gas distribution (CGD) network and PNG supplies

In a major policy drive to give a boost to the petroleum and hydrocarbon sector, the government unveiled a series of initiatives from. The highlights of same are:

- From 2014–17, 31 new cities/districts were awarded for their development of CGD.
- A total of 78 cities/districts in the country are covered for development and further expansion of the CGD network.
- With concentrated efforts by all stakeholders, 104 new CNG-dispensing stations were developed in Delhi and NCR in 2016.
- A process to award another seven new cities/districts in the eighth round of CGD bidding is at an advance stage.
- About 11% annual growth was recorded in petroleum and natural gas connections over the last three years.
- A total of 3.4 million domestic households in the country are benefiting from the supply of clean cooking fuel.
- A total 2.75 million vehicles in the country are benefiting from the usage of CNG.

13. National Gas Grid (2015)

Plan highlights:

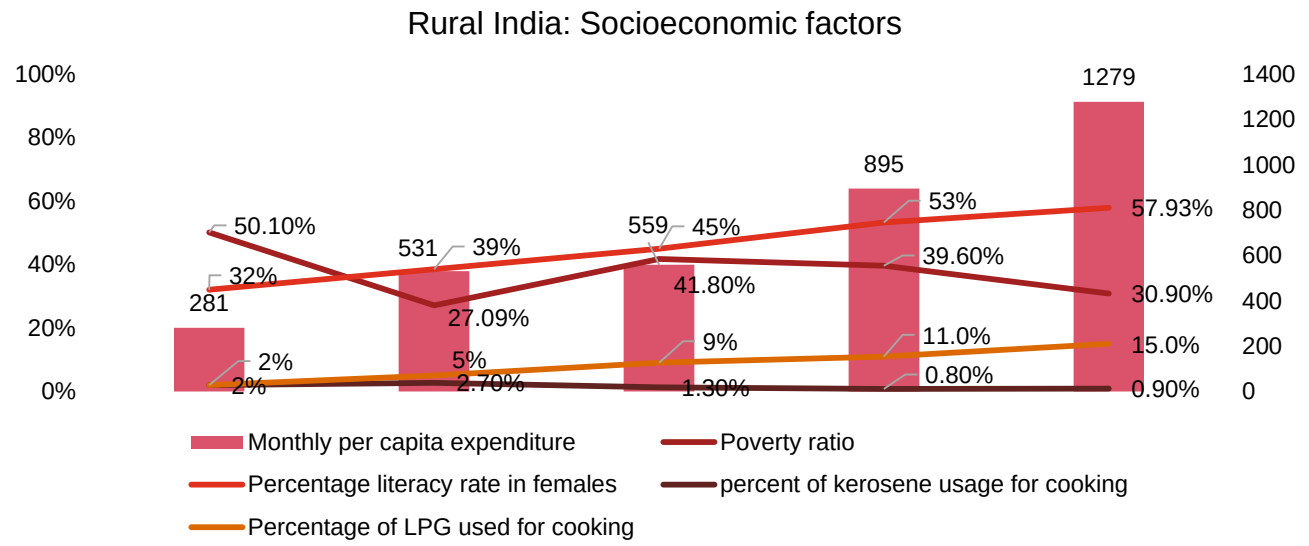
- The government is committed to develop a natural gas pipeline infrastructure across the country. The existing natural gas pipeline infrastructure is approximately 15,000 km long.
- The government is aiming to develop an additional 14,765 km of gas pipelines as part of the National Gas Grid. It is also focusing on increasing the availability of natural gas across the country.
- The list of approved natural gas pipeline projects, which are currently under development, have been annexed.
- The government has taken a decision to provide budgetary support of 51.76 billion INR @ 40% of the estimated capital cost of 129.40 billion INR to GAIL for the development of the Jagdishpur-Haldia/Bokaro-Dhamra Gas Pipeline (JHBDPL) project, popularly known as the ‘Pradhan Mantri Urja Ganga’ of Eastern India. The work on this project has commenced.

Outcomes expected:

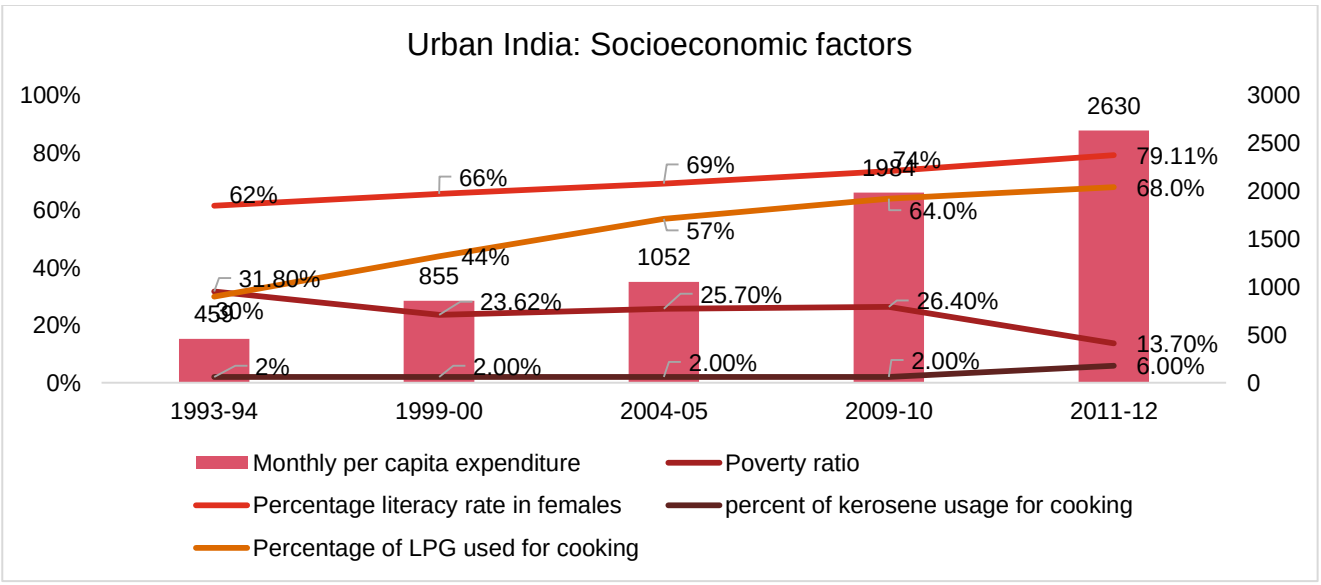
- Availability of clean and eco-friendly fuel—that is, natural gas to the Eastern part of the country.
- Will bring clean cooking fuel at the door step of domestic households.
- Will provide clean fuel to the transport sector through CGDs.

3.6. Socioeconomic impact of improved access to cooking gas

The graph below shows the decadal progress on various socioeconomic indicators in rural and urban regions:



Source: Ministry of Power; NSSO



Source: Ministry of Power; NSSO

As per Census 2011 data, rural India's usage of kerosene as cooking fuel has decreased from 2% in 1993–94 to 0.9% in 2011–12. Population growth in rural areas alone contributed to a 65% increase. Over the years, the poverty ratio has also decreased from 45% to 22% during 1993–2011, due to which people have started shifted to using LPG as the main cooking fuel in rural India. LPG consumption has increased by 0.8% from 2015 till 2017.

	Cooking arrangements			Kerosene as cooking fuel		
	1993–94	2004–05	2011–12	1993–94	2004–05	2011–12
Urban	91.70%	93.50%	91%	23.20%	10.20%	6%
Rural	95%	95%	94%	2%	1.30%	0.90%

3.7. Factors associated with use of LPG[15]

1. Pricing issues

Best of LPG subsidies: Pricing plays a vital role in the implementation of any mass product in the country, because of the different per capita income and expenditure of rural and urban India. Subsidy options would also have to be decided upon—either on the initial costs of connections/stoves, or on the fuel, through funds from cross-subsidies or budgeted from the government and so on. Subsidising initial costs helps to overcome the first-cost sensitive and seems preferable to fuel (or refill) subsidies because the latter could be diverted to other uses/users. However, first-cost subsidies leave possibilities for dropouts among those who cannot afford the fuel costs, resulting in 'dead' investments.

Operating (fuel) subsidies: Precautions to be taken to avail of continued LPG refill subsidy.

- Rationing/quotas for the subsidised fuel (as with ration cards) and/or coupons (as with food stamps)
- Differentiated containers to prevent use by those outside the scope of the planned benefits
- Use-based subsidies with prices increasing with the level of consumption, thereby helping only the minimum-level users and restricting 'subsidy capture'

Cross-subsidies from other distillates: This has been the Indian practice for many years, but would need to be weighed against the disadvantages of higher costs of transport.

Funding of subsidies:

- LPG companies: In the current Indian situation, it is a government mandate for providers to sell below their costs, but this has to be temporary or else there could be financial adversities.
- Regulated cross-subsidies from one consumer category to another will be effective as long as the funding category's price elasticity is not so high that it limit sales.
- Progressive tariffs: Here, the more well-off consumers who use more pay more. This would be more effective if the upper segment were large enough to support the lower segments. And a similar principle could be considered for cross-subsidies from higher income consumers to the others.

Pricing of contending fuels: The relative prices of contending fuels has to be considered while evaluating the pricing of LPG to understand whether or not inter-fuel shifts are desirable.

- Reducing/removing the subsidy on kerosene could make LPG relatively cheaper without a burden on the government.
- LPG subsidies can be claimed to be not required if the relative costs of LPG and other fuels were calculated after accounting for their calorific values and the efficiencies of the related stoves.

[15] D'Sa, A., & Narasimha Murthy, K.V. (2004). Report on the use of LPG as a domestic cooking fuel option in India. International Energy Initiative. Retrieved from http://www.bioenergylists.org/stovesdoc/Iei/IEIBLR-LPG-IndianhomesReport.pdf (last accessed on 23 January 2018)

2. Increasing affordability

The problem of affordability affects the household's decision in several ways:

- Relatively high initial cost: The deposit for a LPG 'connection' is high as compared with the equipment for other fuels.
- Domestic perception of future saving: With the poor using higher discount rates, future savings would be less valuable than current expenditure.
- Larger minimum quantities of LPG usually have to be bought at each refill (as compared to kerosene, charcoal and wood), undermining the use of LPG in low-income households.
- Repayment difficulties: It could be difficult to repay a loan for household convenience alone. People pay for some conveniences; beyond this level, there needs to be some productive outcome to justify the expenses.
- LPG can be more expensive when the total cost is added, unless consideration is given for reduced pollution and the resulting health effects.
- Currently, the poorest sections of the population who do not 'pay' for fuel because they depend on whatever they can collect cannot even consider it.

3. Direct cash benefits instead of subsidised fuel

There could be schemes through which LPG is priced at its full cost, but targeted households get some pre-determined compensation. This would avoid careless use of the fuel while assisting the economically disadvantaged. Such programmes would require funding from the government, with transfer payments directly to the deprived, but the better the targeting, the higher are the administrative costs.

4. Marketing (financing and packaging) schemes

Instalment payments for the cost of connection and stove, and each fuel refill in much smaller containers (e.g. 2–5 kg, instead of the regular 14.2 kg cylinders), will reduce the unevenness of successive cash outlays.

5. Public awareness

Awareness of the adverse impacts on the health hazards of indoor pollution and the benefits of cleaner fuels would increase their acceptance and willingness to pay.

6. Supply issues: Reliable supply of LPG requires:

- Adequate and well-functioning single import facilities
- Indigenous processing plants
- Availability of storage capacities throughout the country
- Competing demands: There are likely to be further problems of supply if LPG is used increasingly for automobile fuelling.
- Indigenous production: The costs of new production infrastructure, refinery capacity and gas fractionation, and bottling units are already high and difficult to recover with the current price structure.

7. Distribution and delivery issues

- Infrastructure: The existing infrastructure at Indian ports for LPG is inadequate to meet the present demand. In India, around 32% of such transport is through pipelines. Due to non-availability of tank-wagons, 30% of oil product movement is undertaken by road, which is not only hazardous and polluting but also involves 15 to 20 times the specific energy use as pipelines and five times the energy use by rail.
- Consumer problems: Presently, the vast rural areas of the country are located far from distribution centres, so that users have to pay for the extra costs for transportation. Moreover, for small and remote markets, refills often take more than a week, so that for those without a second cylinder, there are gaps in fuel supply, requiring a standby fuel.
- Distributor problems: For LPG dealers considering rural markets, the poor road infrastructure makes it difficult to establish distribution networks.
- Safety: Safety is crucial as LPG delivery involves cylinder management. This requires more cautious transport than kerosene or firewood and in turn imposes additional requirements on prospective dealers.

8. Poverty

Even at the present subsidised rates, LPG cannot serve as an effective substitute to those using biomass. In particular:

- LPG and other modern fuels would be more efficient and also more environmentally friendly in comparison with traditional biomass-based stoves. However, without direct linkages to income generation, there is no obvious effect on reducing poverty.
- Thus far, the middle and upper classes on the income ladder have benefited. Thus, on the energy ladder, kerosene is being replaced by LPG, but not free biomass. Hence the labour of fuel collection and traditional stove tending for the poorest has not been reduced.

9. Regulation

The government would have to set standards to maintain safety and avoid corruption, impose measures for ensuring that the cylinders are checked for their user worthiness and properly filled, and provide consumer protection. The government implements policies to provide energy services to the economically deprived. Development assistance and grants from aid agencies can help only small sections of the population. In this case, the government and market forces have to handle their level of involvement and effectiveness to meet the current and growing needs.

4. Review of cost aspects of usage of electricity and gas for cooking

Estimated cost of rural electrification by last mile extension of network

Cost of release of one rural service connection in different scenarios[16]

The cost of laying down an electrical network/infrastructure for the electrification of rural areas or the cost of release of a connection to a new rural consumer depends on a number of factors like:

- Remoteness of the rural area or distance from the existing network,
- Density of population in the rural area,
- Existing electrical infrastructure in the area or existing electrification level of the area.

Some of the above-mentioned parameters cannot easily be quantified under a single variable and, as such, the cost model developed used a different approach for calculating the cost of rural electrification for different areas. The cost of release of a rural connection or laying down the electrical network for a new customer basically comprises of the following costs:

- Cost of end consumer meter and its associated accessories;
- Cost of LT service cable used for extending supply from the nearest distribution transformer up to the meter;
- Cost of the additional distribution transformer, if required;
- Cost of the high tension (HT) line length, if required for extending the supply from the existing nearby HT network or the nearest substation to the local distribution transformer; and
- Cost of the new substation (33kV/66kV), if required for electrification.

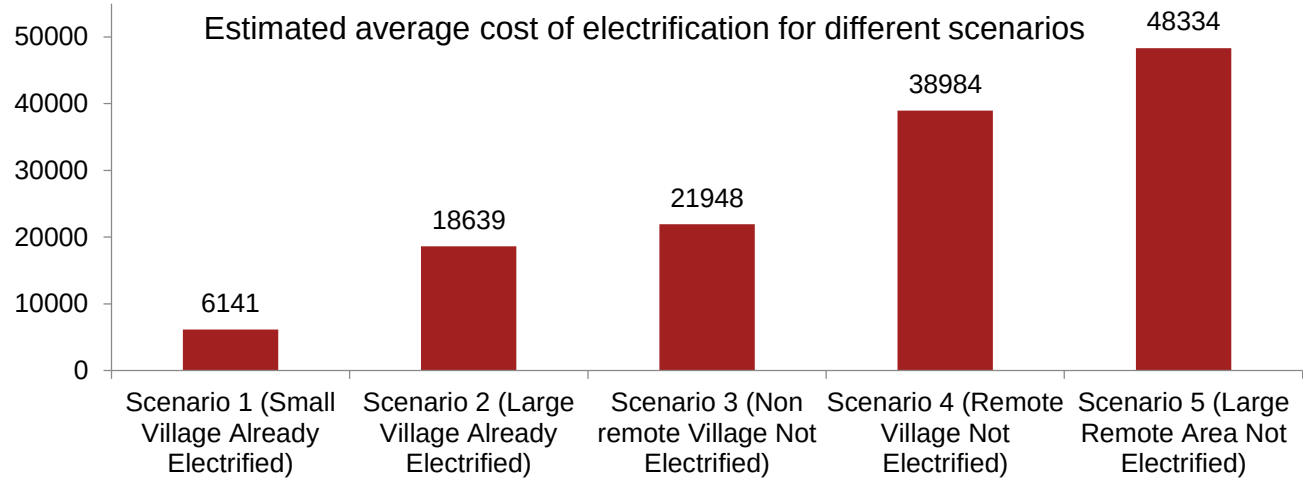
Each of the above-mentioned costs would vary based on the previously mentioned factors like remoteness of area, density of population and extent of electrification of the area. As such, in order to calculate the range of costs involved in the release of one rural connection, five different scenarios were defined for which a different range of costs shall be incurred on various elements of the electrical network. The scenarios and details of the electrical network required for each of the scenarios are tabulated below:

Scenarios	Meter required	Length of LT line required	Distribution transformer required	Length of HT line required	33 kV substation required
Scenario 1: Small village already electrified	Yes	30 m	No	No	No
Scenario 2: Large village already electrified	Yes	100 m	No	No	No
Scenario 3: Non remote village not electrified	Yes	100 m	Yes	500 m	No
Scenario 4: Remote village not electrified	Yes	100 m	Yes	5,000 m	No

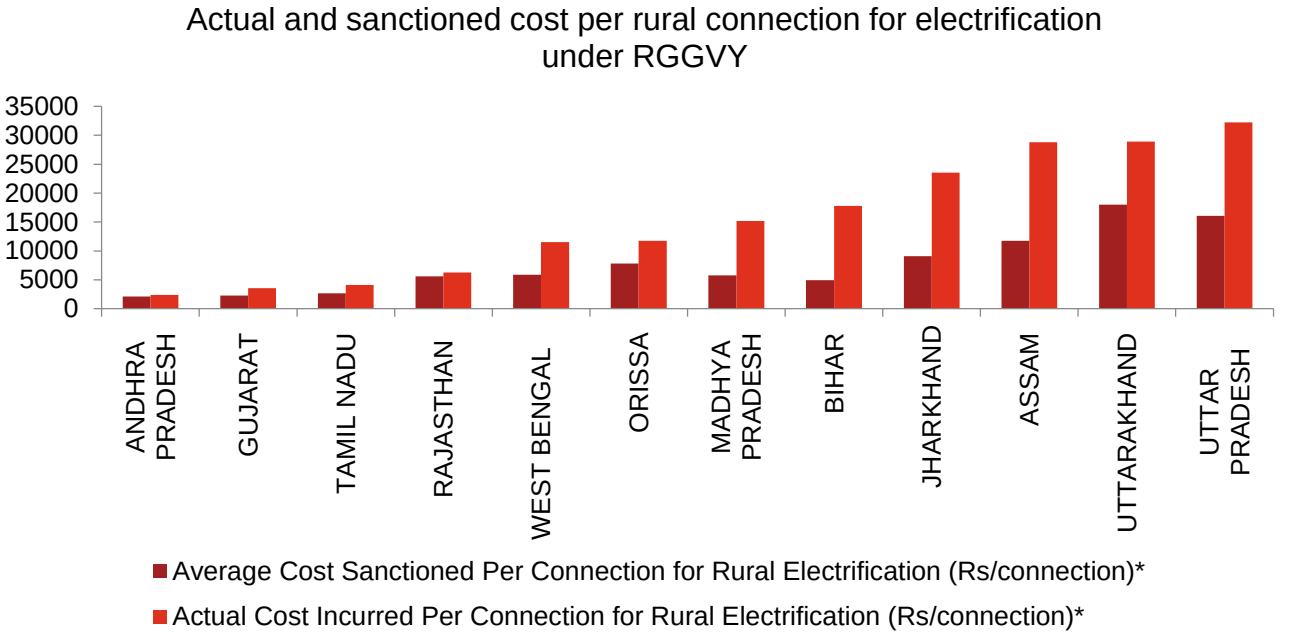
[16] PwC analysis

Scenarios	Meter required	Length of LT line required	Distribution transformer required	Length of HT line required	33 kV substation required
Scenario 5: Large remote area not electrified	Yes	150 m	Yes	5,000 m	Yes

The cost of laying down the electrical infrastructure for release of a new connection in a rural area can range from 6,000 INR per connection in the case of a small densely populated village which is already electrified to 48,000 INR per connection in the case of a large village area with a scattered population and at a remote location from the existing electrical network. Based on this, the total rural electrification cost for covering the balance households could be around 2000 crore INR.

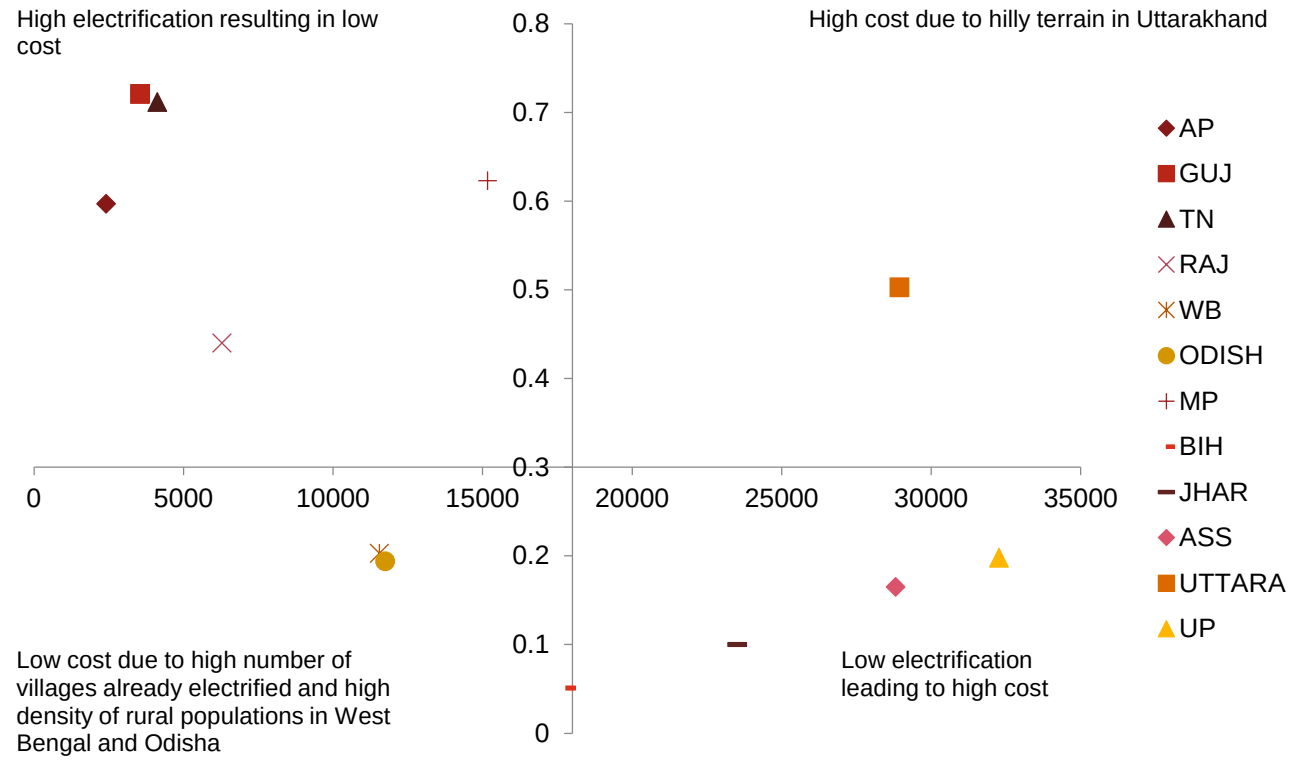


Actual average cost of rural electrification (cost of extending network per household)



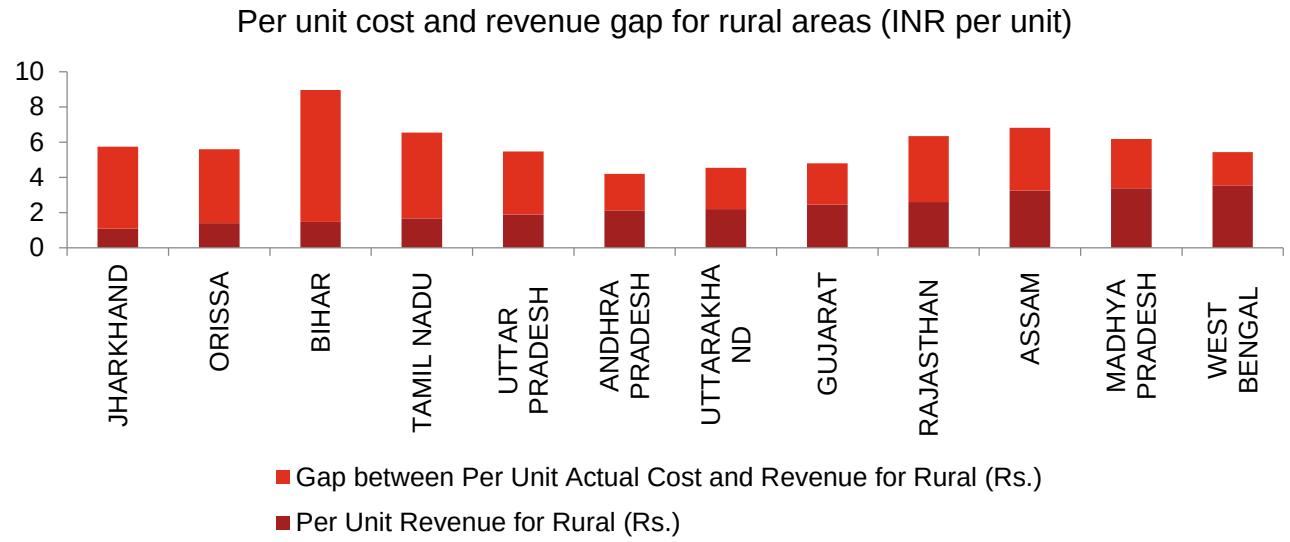
It may be observed that the actual cost of electrification ranges from 2,500 INR (for Andhra Pradesh) to 33,000 INR (for Uttar Pradesh), which is similar to the range of cost calculated in the hypothetical scenarios. If we try to map the states with the hypothetical scenarios, the states of Andhra Pradesh, Gujarat, Tamil Nadu and Rajasthan would be closer to Scenario 1 since these are states with a high level of electrification before RGGVY. The states of West Bengal, Madhya Pradesh, Odisha and Bihar are found to lie in between Scenario 1 and 3 since they have mediocre levels of electrification before RGGVY and the rural areas are not very remote. Similarly, the states of Assam, Uttarakhand, Jharkhand and Uttar Pradesh are found to be close to Scenario 4 since the existing electrification levels in these states are low and the rural areas are remote due to the hilly forest terrain.

In order to analyse the actual cost more clearly from this perspective, we mapped the actual cost of electrification in RGGVY with the household electrification levels of states as per the 2001 Census (or pre-RGGVY). The mapping is shown in the graph below, where the existing household electrification as per the 2001 Census is shown on the Y axis and the actual cost per connection in RGGVY is mapped on the X axis. Almost all states lie in the two quadrants of low electrification and high costs or high electrification and low costs. For Uttarakhand, although existing electrification was high, the cost was also high because of hilly terrains and remote villages. For West Bengal and Odisha, although household electrification was low, village electrification was high and the villages are densely populated; hence, the cost of electrification was comparatively low.



Annual subsidy estimate for providing electricity to rural areas

The per unit cost of service and per unit revenue assessed for a few states are shown in the table below. The cost of service for rural domestic consumers ranges from 4.22 INR in the case of AP to 8.96 INR in the case of Bihar. The rural domestic consumer is a subsidised consumer in all the states and the per unit revenue ranges from 1.1 INR to 3.5 INR. As such, the per unit gap between cost and revenue ranges from 1.90 INR (in the case of West Bengal) to as high as 7.48 INR (in the case of Bihar). This gap has to be borne as a subsidy from the state government or as a cross-subsidy from other consumers. In most of these states, the gap is not entirely covered by either, which results in huge financial losses for the utilities and huge outstanding borrowings by the distribution licensees.



Based on the overall data for all states, it is estimated that the total burden on states in India for providing electricity to rural consumers is as high as 1.2 billion USD annually. Recovering this gap is a huge challenge in providing electricity to rural electricity for most of the states.

Comparison of electrification through grid supply and off-grid

Currently, 70% of the households continue to use conventional fuels as the primary cooking fuel and 33% use lighting sources other than electricity. This strong inclination towards a non-clean sources is mainly due to affordability and availability in rural areas. While gradual awareness and government assistance are prerequisites for the development of infrastructure and access to modern fuel and techniques, pricing and impacts of cost escalation on such fuels pose a challenge for affordability in future.

In this section, we have provided a ballpark estimate of the last-mile connectivity charges rural consumers would incur for both electricity and cooking. A comparison of the cost of electricity between grid connected power supply and an off-grid solar PV system is shown below by considering average consumption to be 30 units per household for the BPL category.

GRID supply

The average tariff for BPL consumers in some of the states where a large number of un-electrified households still exist is 4.5 INR/unit of electricity consumed, while some states like Gujarat and Maharashtra provide electricity at 1.5 INR/unit due to higher cross-subsidisation.

Grid connected tariff across states with low energy access (up to 30 units) FY 2017–18

States	MMFC (for 1 KW)	Variable charge/unit	Total monthly charges	INR/unit
MP	40	3.10	133	4.43
Odisha	80	-	80	2.67
Gujrat	3	1.50	48	1.60
Maharashtra	15	1.08	47	1.58
Rajasthan	100	3.50	205	6.83
Bihar	10	5.75	183	6.08
Assam	15	4.70	156	5.20
Uttar Pradesh	180	-	180	6.00
Average cost of electricity charges	55	2.45	129	4.30

Off-grid: Rooftop solar photovoltaic (SPV)

While a cost analysis of electricity access through a rooftop solar PV system (1 KW capacity) with batteries for storage shows a levelised tariff between 2 INR to 3 INR/unit, the overall cost calculation has been arrived at for a 1 KW SPV system by considering the latest market rates of a PV module and components, including the MNRE assistance of 30% subsidy under the CFA scheme.

Breakup of 1 KW solar PV system with batteries	INR
250 W x 4 numbers	42,000
Inverter/portable charging unit (PCU)	20,000
MPPT controller	5,000
Batteries	25,000
Accessories (cables and fittings)	8,000
Cost without subsidy	100,000
Cost after MNRE subsidy under CFA (30 %)	**70,000**

Tariff estimation of 1 KW rooftop solar	INR
Cost of 1 KW system with batteries (after 30% subsidy under CFA)	70,000
Module efficiency	90%
Capacity utilisation factor (CUF)	19%
Degradation factor per year after 10 years (till 25 years)	0.5%
PV life (years)	25
Average units produced/year	1,498
Total units produced in life span	34,303
Levelised cost/unit (25 years)	**2.04**

As seen in the above table, an off-grid solar solution has greater potential for sustainable last-mile connectivity owing to lower tariff/unit along with tariff certainty. On the other hand, grid connected power poses a risk to consumers considering regular tariff revision every year. Besides, a continuous decline in the international price of solar modules, increasing industry competitiveness, bulk industry buying along with multilateral financing will further help in reducing the cost of electricity produced from solar, making the option viable and attractive.

Economics of cooking alternatives

A similar analysis is done for determining the monthly expenses a household would incur on cooking using electricity, LPG and PNG as alternatives.

The tables below compares the prices of all three sources.

LPG for cooking	Cost (INR)	PNG for cooking	Cost (INR)
Fixed charge			
New connection charges (INR)	1,600	New connection charges (INR)	6,000
Average lifespan (Years)	15	Average lifespan (years)	15
Monthly fixed charge	8.89	Monthly fixed Charge	33.33
Variable charge		**Variable charge**	
Cost of 5 kg cylinder (INR)	320	Domestic PNG price (INR/scm)	28
Calorific value (Kcal/kg)	11500	Calorific value (Kcal/scm)	9500
Price of LPG (INR/Mcal)	5.57	Price of PNG (INR/Mcal)	2.91
Price of LPG (INR/MJ)	1.33	Price of PNG (INR/MJ)	0.70
Average cost of cooking/month (assuming 7 MJ/day)*	279	Average cost of cooking/month (assuming 7MJ/day)*	146
Total monthly cost of fuel	**288**	**Total monthly cost of fuel**	**180**

Electricity for cooking	Cost (INR)
Average domestic tariff (INR/KWH)**	5
Assuming 7 MJ/day equivalent KWH consumption/day *	1.94
Total monthly cost for cooking	291

* Data suggests that on average, a household uses about 8 to 10 LPG cylinders or 170 scm of PNG or 1,022 kWh of electricity annually for cooking. Whether it is LPG, PNG or electricity, energy use due to modern fuels, after accounting for stove efficiencies, roughly translates to an average use of 7 MJ/day or 1.94 kWh/day. There can be variations in the demand for energy needed for cooking a meal due to increased use of energy-saving appliances like pressure cookers or due to a change in eating habits (using precooked or partially prepared meals, eating out, increased consumption of meat, etc.) (**Source: http://www.indiaenergy.gov.in/iess/docs/Cooking.pdf**)

** 5 INR is assumed since the use of electricity for cooking would increase monthly consumption beyond 30 units for the BPL category, resulting in billing under the domestic category.

It is observed that on average, the monthly price of cooking from LPG or electricity would be 40–45% higher than the supply of gas used for cooking through PNG.

5. Impact of innovative and disruptive technologies on last-mile connectivity in electricity

5.1. Micro grid

A micro grid is a connected network of distributed, clean-power assets operating independently with a larger electrical grid to produce high-quality, reliable power. Regardless of the size or components, a micro grid is an integrated system, often using intelligent software controls to seamlessly integrate distributed energy generation resources (solar, wind, base load power) with a customer's energy demand.

The benefits of a micro grid can be as numerous and varied as the unique micro grid configurations themselves:

- Risk reduction — with close proximity between supply and load, some of the deliverability risk associated with many utility systems and long-haul transmission is reduced
- Increase cost controls — micro grid solutions can enable customers to manage their energy commodity cost exposure
- Cutting-edge technology —micro grids comprise the latest technology, including power electronics control mechanisms and software

As can be noticed from the above brief discussion, establishing and operating micro grids is resource intensive, requiring financial as well as human resources to manage the operations. Even if we are able to find ways to generate capital to set up the unit(s), the question that remains to be answered is what revenue model would be sustainable to meet the operating requirements and expenses.

5.2. Mini grid

A mini grid (sometimes known as an isolated grid) is a set of electricity generators and, possibly, energy storage systems interconnected to a distribution network that supplies electricity to a localised group of customers. They involve small-scale electricity generation (10 kW to 10 MW) which serves a limited number of consumers via a distribution grid that can operate in isolation from national electricity transmission networks.

Mini grids have a unique feature as they can operate autonomously without being connected to a centralized grid. However, the mini grid may be designed to interconnect with the central grid which means it operates under normal conditions as part of the central grid with disconnection occurring only if power quality needs to be maintained—for instance, in the case of a central grid failure. Alternatively, a mini grid may be designed to operate autonomously in a remote location with the option to connect to a central grid when grid extension occurs.

A mini grid can be supplied by all sorts of energy resources and power plants; however, most of the time, a mini grid will use low AC voltage (220–380 V) with a centralised production and a storage system and will have an installed capacity of between and 5 and 300 kW even though bigger systems exist.

In 2016, the government planned to install **10,000 micro and mini grids** to help bring electricity to 237 million people living in energy poverty. The MNRE planned for 500 MW of installations by energy service companies (ESCOs). Plants with a capacity less than 10 kW are considered as micro grids and those with a capacity of 10 kW to 10 MW are considered as mini grids by the MNRE.

To encourage ESCOs, the ministry plans to set up a special category of private developer/operator known as rural energy service providers (RESPs). These RESPs would receive special incentives and privileges, including upfront capital from the ministry and streamlined approvals.

5.3. Off-grid systems

An off-grid system is not connected to the electricity grid and requires battery storage. Renewable technologies such as solar, small hydro and biomass are most suitable for such systems. These systems must be designed appropriately so that they will generate enough power throughout the year and have adequate battery capacity to meet household requirements. The high cost of batteries and inverters makes off-grid systems more expensive than on-grid systems and, hence, they are usually deployed only in remote areas. With a policy push from the government and improving technology, energy storage cost is expected to reduce rapidly, creating a growing market for off-grid storage based systems even in cities and towns.

There is large potential in off-grid energy supply with renewable energies in India, be for household-level applications, mini grids or larger industrial consumers. However, the markets are fragmented and not easily accessible. Technologies and business models need to be adapted to the regional context, and local partners with relevant knowledge play a vital role.

5.4. Small hydro

Small-scale hydropower has been used as a common way of generating electricity in isolated regions since the end of the nineteenth century. Small-scale hydropower systems can be installed in small rivers, streams or in existing water supply networks, such as drinking water or waste water networks.

In contrast with large-scale hydropower systems, small-scale hydropower can be installed with little or negligible environmental impact on wildlife or ecosystems, mainly because the majority of small hydropower plants are run-of-river schemes or implemented in existing water infrastructure.

Due to its versatility, low investment costs, and as a renewable energy source, small-scale hydropower is a promising option for producing sustainable, inexpensive energy in rural or developing areas.

The MNRE has been vested with the responsibility of developing small hydropower (SHP) projects with a capacity of up to 25 MW. The estimated potential for power generation in the country from such plants is about 20 GW, out of which about 4.4 GW has been developed till date. Most of the potential is in Himalayan states as river-based projects and in other states on irrigation canals.

If the capacity of the station is up to 100 kW, it is considered as micro Hydro; if the capacity is between 101 kW to 2,000 kW it is mini Hydro; and if the capacity ranges from 2001 kW to 25 MW, the station is considered as small hydro by the MNRE. The ministry is encouraging the development of small hydro projects both in the public as well as private sector. Equal attention is being paid to grid-interactive and decentralised projects.

5.5. Rooftop solar

Rooftop solar is a PV system that has its electricity-generating solar panels mounted on the rooftop of a residential or commercial building or structure. The various components of such a system include PV modules, mounting systems, cables, solar inverters and other electrical accessories.

Rooftop-mounted systems are small compared to ground-mounted PV power stations with capacities in the megawatt range. Rooftop PV systems on residential buildings typically feature a capacity of about 5 to 20 kW, while those mounted on commercial buildings often reach 100 kW or more.

The GoI plans to install 100 GW of solar power by 2022. Out of this, the target for grid interactive rooftop solar PV plants is 40 GW.

The key issues with rooftop solar are:

- Acceptability of solar meter as a commercial meter
- Placement of the solar meter – should it be next to the main utility meter or next to the solar inverter?
- Need for a solar check meter

Rooftop solar can play an important role in achieving last-mile connectivity, especially in far-flung areas where it is difficult to lay transmission and distribution lines. The major characteristics which makes it attractive for such regions is the low gestation period and hassle-free operation and maintenance (O&M) which can be managed by local technicians.

5.6. Biomass

Biomass has always been an important energy source for the country considering the benefits and promises it offers. It is a carbon neutral fuel source for the generation of electricity; and apart from providing the much needed relief from power shortages, biomass power projects could generate employment in rural areas.[17]

About 32% of the total primary energy use in the country is derived from biomass and more than 70% of the country's population depends upon it for their energy needs. The Ministry of New and Renewable Energy (MNRE), the potential and role of biomass energy in the Indian context and has initiated a number of programmes for the promotion of efficient biomass conversion technologies to be used in various sectors of the economy.

India has over 5,940 MW biomass based power plants comprising 4,946 MW grid connected and 994 MW off-grid power plants. Out of the total grid connected capacity, major share comes from bagasse cogeneration and around 115 MW is from waste to energy power plants. Whereas off-grid capacity comprises 652 MW non bagasse cogeneration, mainly as captive power plants, about 18 MW biomass gasifier systems being used for meeting electricity needs in rural areas, and 164 MW equivalent biomass gasifier systems deployed for thermal applications in industries.[18]

The major issue which the biomass sector is facing today is availability of fuel. Biomass availability is not certain for the entire year. Agricultural waste is available only after the harvesting period, which can stretch only for 2–3 months in a year. So, there is a need to procure and then store the required quantity of biomass within this stipulated time.

Another major concern for biomass energy is its cost. The growing O&M costs and stagnant tariffs have made biomass power development financially unviable for developers.

[17] http://biomasspower.gov.in/About-us-3-Biomass%20Energy%20scenario-4.php
[18] http://biomasspower.gov.in/About-us-3-Biomass%20Energy%20scenario-4.php

6. Role of stakeholders in improving last-mile connectivity

6.1. Role of stakeholders in the electricity sector

The following table presents the many in achieving last-mile connectivity in electricity and how these can be addressed through stakeholder involvement:

Issues and challenges	Probable solutions	Steps undertaken or can be undertaken by stakeholders to tackle various issues and challenges in ensuring last-mile connectivity of electricity			
		Government	**State Electricity Regulatory Commission (SERCs)**	**Distribution utilities/franchisees**	**Local bodies/consumers**
• **Lack of maintenance** or the use of poor quality or untested technology	• Strategic asset management of the power network • Introduction of more regress quality testing regulations and procedures • Consumer feedback via app on performance of franchisees/SHG to the utilities and SERC	• Introduction of a hybrid model between public utilities and the private sector, combining the technical expertise of public utilities and the financial expertise of the private sector in overcoming the challenge	• SERC shall introduce more regress quality testing regulations and procedures • SERC shall link the maintenance and quality of technology to the policy, thus gaining access to the legal system	• Strategic asset management of the power network; also, a standard practice for asset management can be introduced • Introduction of a central database, or related system that can capture historical performance, failure information, and maintenance articles for major electricity network equipment • Utility shall introduce and maintain separate funds for the testing, introduction and maintenance of new	• Consumer feedback via app on performance of franchisees/SHG to the utilities and SERC

Issues and challenges	Probable solutions	Steps undertaken or can be undertaken by stakeholders to tackle various issues and challenges in ensuring last-mile connectivity of electricity			
		Government	**State Electricity Regulatory Commission (SERCs)**	**Distribution utilities/franchisees**	**Local bodies/consumers**
				technology being implemented • Utility to perform periodic life-cycle analysis of infrastructure systems	
• Insufficient primary energy resource; for example, in bio gasification projects, there are challenges in finding sustainable sources of biomass and operating effective supply chains for biomass feed stocks. Similar challenges can affect diesel-powered mini grids in remote locations where infrastructure is not adequate; thus, most of these schemes remain in their pilot stages.	• Introduction of a supply chain involving sustainable sourcing of biomass, transportation, processing, quality control, storage, scheduling, measurement and delivery management of fuel, etc. • Set up a single entity or aggregator to initiate, control and manage the supply chain	• Mechanisation of the Indian agriculture sector, introducing a supply chain involving every aspect of sustainable sourcing, transportation, processing, quality control, storage, scheduling, measurement and delivery management of fuel, etc.; mechanism to collect and store biomass from small and fragmented farmers • Initiate long-term contracts with resource providers and logistics	• SERC to cap biomass rates and regulate power generated through biomass		

Issues and challenges	Probable solutions	Steps undertaken or can be undertaken by stakeholders to tackle various issues and challenges in ensuring last-mile connectivity of electricity			
		Government	**State Electricity Regulatory Commission (SERCs)**	**Distribution utilities/franchisees**	**Local bodies/consumers**
		• Appoint consultants to conduct a study and economic analysis on possible ways/options of setting up supply chain, storage facilities and successful case studies • Set up a single entity or aggregator (like EESL for LED) to initiate, control and manage the supply chain • Set up a large-scale government-funded biomass project with a sustainable supply chain so as to promote biomass generation • Promote and provide financial support to R&D activities in developing economical organic fuels/energy resources			

Issues and challenges	Probable solutions	Steps undertaken or can be undertaken by stakeholders to tackle various issues and challenges in ensuring last-mile connectivity of electricity			
		Government	**State Electricity Regulatory Commission (SERCs)**	**Distribution utilities/franchisees**	**Local bodies/consumers**
		• Provide subsidies for biomass production and supply			
• A few companies in the market deal with small capacity solar PV systems; utility scale system integrators (EPC providers) are reluctant to enter into the small SPV domain	• Financial support to developers in ease of doing business at decentralised locations • Provide subsidy on batteries so as to reduce the cost of SPV rooftop system • Track and improve the reimbursement of 30% of MNRE subsidy	• Financial support to developers in ease of doing business at decentralised locations • Government support for risk mitigation like agitation from local villagers at decentralised locations • Identify village clusters for rolling out DDG/off-grid generation, aggregating total generation to 20–50 MW, thus involving high return margin and revenue for the EPC providers • Off-grid solar rooftop involves additional cost of battery; the focus should be on providing subsidies on	• Introduction of net metering regulations to promote rooftop solar for grid-connected households	• Identify village clusters for rolling out DDG/ off-grid generation, aggregating total generation to 20–50 MW, thus involving high return margin and revenue for EPC providers • Capacity building of local villagers for the purpose of O&M of DDG, thus achieving cost economics in O&M	• Capacity building of local villagers for the purpose of O&M of DDG, thus achieving cost economics in O&M

Issues and challenges	Probable solutions	Steps undertaken or can be undertaken by stakeholders to tackle various issues and challenges in ensuring last-mile connectivity of electricity			
		Government	**State Electricity Regulatory Commission (SERCs)**	**Distribution utilities/franchisees**	**Local bodies/consumers**
		batteries so as to reduce the cost of SPV rooftop system • Track and improve the reimbursement of 30% of MNRE subsidy to consumers within a defined time period so as to gain consumer trust and increase demand			
• Reluctance of DISCOMS to encourage rooftop systems as they see it as a threat to their revenue	• Need for proactive regulators and transparent political direction • Promote solar rooftop through incentives to DISCOMs as well as consumers • Explore transformational business models in order to remain afloat and relevant	• Need for proactive regulators and transparent political direction would be the key to maintain a balance between solar rooftop and grid generation • **Example:** Utilities in the United States have asked their state regulators to assess high fees on homeowners that install solar PV panels but maintain their connection to the	• Need for proactive regulators and transparent political direction would be the key to maintain a balance between solar rooftop and grid generation	• DISCOMs will get incentives for promoting solar rooftop, thus reducing their carbon footprints and going green • The utility is responsible for ensuring that its transmission and distribution systems operate reliably. Regulators, meanwhile, need to allow the utility to recover the costs associated with	

Issues and challenges	Probable solutions	Steps undertaken or can be undertaken by stakeholders to tackle various issues and challenges in ensuring last-mile connectivity of electricity			
		Government	**State Electricity Regulatory Commission (SERCs)**	**Distribution utilities/franchisees**	**Local bodies/consumers**
		electric grid. An Arizona utility, for instance, proposed levying a monthly 50 USD grid interconnection fee for consumers with solar PV		maintaining the grid infrastructure and ensuring reliability • DISCOMs need to explore transformational business models in order to remain afloat and relevant	
• High cost of grid extension and low recovery due to highly subsidised tariff and low level of tariff collection, resulting in negative return	• Introduce a nationwide standard practice for establishing grid connection or DDG • Increase manpower efficiency, avoid human error and reduced technical losses	• Introduce a nationwide standard practice for establishing grid connection or DDG, so as to avail DDG benefits and, at the same time, levelise the grid extension cost over the years	• SERCs shall set tariff as per voltage-wise cost of supply and shall completely eliminate cross-subsidy	• Utility needs to take progressive steps towards reducing theft and increasing collection efficiency • Utility needs to move towards increasing manpower efficiency, avoiding human error and reducing technical losses	
• Supply rationing due to non-availability of power	• Conduct assessment of schemes that shall be viable for improving the power scenario in villages	• Conduct assessment of schemes that shall be applicable in village/rural areas like 'Mhara Gaon Jagmag Gaon'	• SERCs shall introduce regular checks through energy audit to avoid situation of load shedding	• Utility shall implement schemes focusing on villages and rural areas like 'Mhara Gaon Jagmag Gaon' (Haryana)	

Issues and challenges	Probable solutions	Steps undertaken or can be undertaken by stakeholders to tackle various issues and challenges in ensuring last-mile connectivity of electricity			
		Government	**State Electricity Regulatory Commission (SERCs)**	**Distribution utilities/franchisees**	**Local bodies/consumers**
	• Take steps to reduce commercial losses and increase collection			• Conduct assessment of more schemes that shall be applicable in village/rural areas • Utility needs to take progressive steps towards reducing theft and increasing commercial efficiency • Utility needs to come up with periodic collection drives focusing on specific areas/circles	
• High operation and maintenance costs	• Setting up a central/state agency to purchase O&M equipment and accessories through a competitive bidding process • Complete pass-through of O&M cost to consumers • Setting up of franchisees for the purpose of O&M	• Setting up a central/state agency will purchase equipment and accessories required for O&M in bulk through competitive bidding and maintain inventory for achieving cost economics	• SERCs shall set tariff as per voltage-wise cost of supply and will completely eliminate cross-subsidy • Complete pass-through of O&M cost to consumers	• Setting up of franchisees for the purpose of O&M only involving trained local villagers • Introduction of hybrid model (DISCOM+ private entity) for conducting cost-effective and timely maintenance activity	

6.2. Role of stakeholders in the cooking gas segment

Issues and challenges	Probable solutions	Steps undertaken or can be undertaken by stakeholders to tackle various issues and challenges in ensuring last-mile connectivity of cooking gas			
		Government	**OMCs**	**Distribution channel**	**Local bodies**
Lack of awareness • About LPG schemes for BPL and other households • About health, safety and environmental concerns related to cooking fuel	• Empowering and educating women regarding government schemes and benefits of using LPG • Toll-free grievance number should be set up and advertised widely to overcome this issue	• Launch of **mylpg.in** by the government (2015) • Government can further intensify the awareness programme through other stakeholders with a focus on the rural population	• OMCs keep running awareness camps; however, the efforts need to be intensified • OMCs can educate people on schemes, cost of various services, safety and malpractices in the distribution channels	• Distribution channels who are in direct contact with the end consumer can be used to spread awareness	• Gram panchayats or other local civic bodies can be empowered to organise sessions and activities on awareness of LPG usage benefits, safety and schemes launched by the government
Regulatory challenges • Pricing reform strategies for rural households • Misuse, malpractices and corruption by private dealers and distribution chain	• Government's role in setting standards to maintain safety and avoid corruption is essential • Consumer protection has to be provided • The government should follow a constant price for rural and BPL households	• Direct benefit transfer of LPG (DBTL) (2016) launched by the government to ensure that subsidy is received only by the needy • Rules and standards on safety and delivery issues of LPG cylinders	• There needs to be tighter scrutiny and revocation of licence if an OMC is found guilty of malpractices in the form of: • extra costs of transportation • delivery charges • commissions for new connections • forcing sale of other products along with a new connection	-	-

Issues and challenges	Probable solutions	Steps undertaken or can be undertaken by stakeholders to tackle various issues and challenges in ensuring last-mile connectivity of cooking gas			
		Government	**OMCs**	**Distribution channel**	**Local bodies**
Issues related to new connection • Many rural households have either no bank accounts or have difficulty accessing banking services • At times, KYC documents such as address proof are not available and people are denied new connections	• Innovative payment mechanisms such as mobile money to fill the gap of last mile access to banking services • Having wider acceptance for KYC documents, especially in rural areas	• Since the launch of Pradhan Mantri Jan-Dhan Yojana (2016) the number of rural households with bank accounts has increased substantially (>20 million new accounts were opened)	• OMCs can work with government to widen the options for acceptance of KYC documents	• Selling of smaller capacity cylinders (5 kg) will help households as address proof is not required to obtain the same • Set of strict guidelines should be given to LPG distributors to ease grant of new connections	• Gram panchayats can help people obtain address proof or valid government ID such as Aadhaar and Voter ID card for identification purpose. This will facilitate the process of availing of government schemes such as getting new connections and subsidies.
Distribution/delivery issue • Long travel for collecting the cylinder from a dealer • Dealers usually don't deliver to areas where they feel they cannot make profits on transportation	• Strong need for expansion of distribution networks to overcome the issue • Create awareness about actual cost of LPG cylinders and other associated services • Standard and safety to be followed from local dealer's end	• Launch of Rajiv Gandhi Gramin LPG Vitran Yojana (RGGLVY) to ease the requirements for allotting distributorship in rural areas • The government mandated that all distributors serving rural areas with sales exceeding 1,500 refills/month to provide home delivery of cylinders	• OMCs planning to add 10,000 distributors in the coming years • OMCs can work with the government to provide additional incentives for distributors to supply to remote areas	• Set of clear and strict guidelines should be given to LPG distributors to ease grant of new connections	• Local bodies can be considered to have a tie-up with distribution channels to maintain a local stock of cylinders. It will help to tackle the following issues to an extent: • Issue of refilling • Travelling long distances by villagers to collect cylinders every time

Issues and challenges	Probable solutions	Steps undertaken or can be undertaken by stakeholders to tackle various issues and challenges in ensuring last-mile connectivity of cooking gas			
		Government	**OMCs**	**Distribution channel**	**Local bodies**
Transportation issues • Limited pipelines • Poor connectivity • Poor distribution networks in rural areas	• Strong pipeline networks need to be laid • Infrastructure in rural areas needs to be improved to support the transportation of cylinders	• Expansion of the (CGD) network and piped natural gas supplies (2014) • National Gas Grid plan (2015)	• OMCs can work with the government to increase their reach to remote areas by better geographical distribution of bottling plants, storage units, etc. • They can also work on ensuring the optimum number of distributors, especially for rural areas	• Distribution channels should be empowered to work along with local bodies to ensure seamless availability of new connections and refills	• Village bodies/heads should ensure that: • The transportation and storage infrastructure in the village is good enough to support the cause
Storage • Limited storage capacity	• Government should consider optimum installations, depots, bottling and tank capacity to meet the demand-supply in rural areas	• MoPNG intends to construct 530,000 tonnes capacity	• 60,000 tonnes of LPG cavern storage projected in progress by HPCL	-	• The local village panchayats can maintain stocks with them by tying up with distributors for: • Supply in emergency situations • Saving the time and cost of individuals travelling to collect cylinders from dealers

Issues and challenges	Probable solutions	Steps undertaken or can be undertaken by stakeholders to tackle various issues and challenges in ensuring last-mile connectivity of cooking gas			
		Government	**OMCs**	**Distribution channel**	**Local bodies**
Pricing and affordability • Higher initial connection costs • Refilling cost is high in comparison to that of traditional fuel such as firewood and cow dung, which are available at almost zero cost as a byproduct of other economic activities • Poverty	• Introducing smaller capacity LPG cylinders • EMI facilities for those who cannot afford to pay the amount for a connection at once	• Launch of PAHAL (2014): To get subsidy directly in individual's bank account • Launch of PMUY (2016): To provide 50 million LPG connections to BPL households •	• Oil companies pushing subsidised 5-kg cylinders in the rural market through RGGLVY • Rasoi ghar: A community kitchen programme launched by HPCL • OMCs can work on a plan to provide easy EMIs for both new connection and refills	• Private contractors should ensure fair pricing • Subsidies and other information should be explained to uneducated connection holders • Should implement a flexible and fair system of payments	• Local bodies can be empowered to provide short-term credit on an EMI basis for new connections and refills • They can also be entrusted with selling small LPG cylinders

7. Key recommendations to improve the last-mile situation

7.1. Electricity

Distribution and retail supply are the most important links in the electricity value chain which interfaces with end customers, providing last-mile connectivity and revenue for the entire value chain. Indian electricity distribution caters to nearly 200 million consumers. Sustenance of other links in the value chain like generation and transmission and key players like equipment manufacturers is dependent on the commercial performance and financial viability of the distribution sector in India. Over the years, many states have worked to improve the commercial performance of their state utilities, unbundling state entities, creating independent regulatory systems, and putting in place measures to control losses and theft. However, progress has been difficult and slower than envisaged, making them unsustainable in the long run.

Sustainability of last-mile connectivity is dependent on a number of factors such as reliability of the network, efficiency and effectiveness of the utility's technical and commercial processes, innovative electricity distribution arrangements in the face of challenging geography and demography, and customer participation. In addition, socioeconomic conditions of the consumers also play an important part in the form of 'willingness to pay', to contribute to the sustenance of last-mile connectivity.

Against this backdrop, a number of technical, policy-level and regulatory interventions are required to enable the sustenance of various last-mile connectivity improvement projects and schemes.

Improving technical aspects of distribution/supply

- **Single phase distribution system:** The single phase distribution system is a low-cost solution which reduces the capital cost for the construction of extensions in the electrical network while meeting the requirements of rural domestic and commercial demand. This system has been extensively used in the United States in the 1930s and subsequently adopted by a number of countries like Costa Rica, the Philippines and Bangladesh. However, the system needs to be analysed in detail based on the demographics of the area, cost of living, geographical setting, etc., and should be accordingly well designed to make it sustainable in the long run with the increasing rural demand and consumption.

- **Decentralised distribution and generation:** Last-mile connectivity does not necessarily imply extension of the electrical network to each and every household. The off-grid or decentralised distribution and generation solution may be used in parallel or in sequence with the grid extension options. The Draft National Energy Policy, 2017, has envisaged that the government shall first endeavour to supply grid-connected power to all households and renewable-based off-grid solutions will be resorted in exceptional circumstances. Further, it also envisages that a business model/policy framework is required to encourage independent developers, NGOs and social businesses to develop micro off-grids by incentivising them. Micro grids can also supplement grid-connected schemes by supplying power during peak hours and ensuring reliable power supply. As such, a clear policy framework and business model are required to enable the choice of a grid-connected and off-grid solution based on techno-commercial and socioeconomic considerations. Further, suitable incentives are also required to promote off-grid solutions and make them economically and commercially feasible. In this regard, it would also be prudent to examine the reallocation of the existing power purchase agreements (PPAs) of DISCOMs and also look for ways and means to allocate the existing as well as upcoming renewable capacities.

- **Use of high-voltage distribution system:** Some states like Gujarat have used a high-voltage distribution system to extend the electrical network to villages. This system offers dual benefits of providing quality power supply on a sustainable basis as it prevents hooking of electrical lines, reduces theft of electricity and thereby reduces the cost of supply of electricity to such areas. Moreover, this system is also cost-effective if used in areas with no existing infrastructure and low population density.

- **Innovations in generation and fuel:** One of the key components of the cost of electricity is the cost of generating an incremental unit of electricity, which is primarily driven by the technology used for generation and the fuel utilised. In several countries, the adoption of a new technology or fuel in generation has helped enormously in increasing the pace of development of generation capacity and making the same affordable for the people. For example, the development of natural gas combined cycle (NGCC) technology in the 1990s was a significant efficiency breakthrough in the evolution of natural gas generation. In the US, for example, NGCCs became the predominant new-build baseload option in the early 2000s—well before the emergence of unconventional gas. In India, innovations in generation could be explored in geothermal, new renewables, nuclear, etc.

- **Strengthening transmission for renewable integration:** The intermittent nature of the availability of power from renewable sources poses a challenge for proper planning and operation of the transmission network. The Draft National Energy Policy, 2017, recognises the importance of grid integration of renewables and resolving technical issues for the same as a key barrier to increasing generation capacity and providing power for all. As such, the technical issues in the planning and development of the transmission system is a major issue in providing last-mile connectivity by integrating renewable sources of energy. This would necessitate upgrade of the technologies used in system planning and operating, upgrading system operation protocols, expansion of balancing mechanism or auxiliaries, etc.

Introduction/proper implementation of enabling policies

- **Institutional structures for implementation:** Given the complex nature and scale of large-scale grid-based electrification in a country like India, an effective implementing agency is one of the basic requirements to manage the programme of last-mile connectivity. Based on international experiences, a variety of institutional structures have been adopted and have also been successful. For example, Bangladesh had set up a separate rural electrification authority, Costa Rica had set up rural electric cooperative societies at local levels, Thailand had allocated the responsibility to a department of the national distribution company, and Chile had also included the private sector in the work of rural electrification. As the models for last-mile connectivity are evolving, the institutional structure for providing last-mile connectivity may also need review, institutional strengthening and capacity building for effective and speedy implementation.

- **Subsidy framework:** The present subsidy framework involves subsidising the one-time connection cost to the below poverty line (BPL) consumers as well as developing norms for providing revenue subsidy to such consumers. However, this subsidy mechanism has faced various challenges:

    - The unserved above poverty line (APL) consumers having a similar living standard as BPL consumers in a particular region have not been covered under the government schemes. The inclusion of such consumers has been taken up by some states in a limited manner, but a comprehensive scheme is required to cover all such consumers. As such, there is a need to review the policy for providing a subsidised connection cost to the remaining households. One of the methods could be the payment of a subsidy to the consumer after a third agency has verified certain living standard norms.

    - The revenue subsidy provided by the state governments has not provided the desired result in compensating the utilities appropriately for the revenue loss. The revenue subsidy framework is different across states and faces different issues. In some states, the state government does not pay the committed subsidy on time and at any point of time, the actual subsidy is less than the committed subsidy. In a few states, the total subsidy commitment is not properly defined in terms of paise per unit of consumption, which results in inappropriate commitment of subsidy from the state government. Even if the subsidy is sufficient, the present framework of payment of subsidy by the government to the utilities does not necessarily help the utilities recover the payment of the subsidised bill by the consumers. It has been observed that the subsidised categories of consumers often abuse the system by not paying the bills on time or misusing the connection agreement executed under the subsidised framework. Direct Benefits Transfer (DBT) may address some of the above-mentioned issues associated with the subsidy framework as it would involve the payment of a subsidy by the state government directly to consumers based on the actual monthly bill of each consumer and also on the condition that the consumer pays the balance amount to the utility. Further, there should be a system for monitoring the consumption pattern of subsided consumers so that the terms and condition of the connection agreement are not abused.

- **Policies for improving socioeconomic condition:** Any model of providing last-mile connectivity will not be sustainable unless it helps in improving the socioeconomic condition of the rural population. Access to electricity is one of the key enablers for improving socioeconomic conditions, and power is considered as a key driver for economic activities. A poor economy limits the paying capacity of consumers, which results in the non-recovery of the cost of supply by utilities and overdependence on the subsidy provided by the state government. As such, the improvement of the socioeconomic condition of rural areas is a key requirement for ensuring the sustainability of last-mile connectivity. Although the government has taken a number of steps to electrify remote areas, the desired results in terms of improving the socioeconomic condition have not been achieved. Some of the initiatives which could be taken in this regards are:

    - **Integrated rural development agenda:** Government schemes and policies for providing last-mile connectivity need a comprehensive agenda for the integrated development of rural areas along with providing last-mile connectivity. The integrated agenda needs to include awareness on the productive use of electricity, clean usage and methods of energy, use of education to improve socioeconomic conditions, women's empowerment and facilities for skill development to generate employment opportunities, training, access to affordable microfinance, information and knowledge sources like the Internet, business development services, and access to markets and required infrastructure for the same.

    - **Monitoring of socioeconomic parameters:** In order to measure the effectiveness of last-mile connectivity, a monitoring framework is required which not just monitors the progress of the schemes but also regularly monitors socioeconomic indicators like literacy rate, clean use of energy for cooking in households, new jobs created and increase in economic activities. Periodic studies also are required to analyse the impact of rural electrification and suggest appropriate interventions required.

    - **Linking of subsidy for various schemes:** One of the ways to ensure that the consumer regularly pays electricity bills on time is to link the subsidy payable to consumers with other desired activities like payment of bills and targets for the development of socioeconomic condition. For example, it may be mandated that a household will not receive the required subsidy for LPG connections if the overall targets for socioeconomic development are not met after a certain time. This will increase the awareness of the overall development agenda and consumers will also be aware that providing energy is just an enabler and not the end result of the government subsidy. A policy framework may also be developed for incentivising people who regularly pay their bills through cashbacks, loyalty points, etc.

- **Policies for private investment:** Till now, the involvement of the private sector in the work of rural electrification has been limited. Considering the scale and complexities of the work, the private sector may also be encouraged to participate with public bodies in order to increase the pace of rural electrification. A concession model for supplying electricity to rural areas and the development of the required infrastructure with viability gap funding from the state government is one such model which may be explored. The same has been used in some countries where the minimum assured supply is also a part of the concession agreement.

Providing support through an appropriate regulatory mechanism and oversight

Along with the policy framework, last-mile connectivity also needs to be supported and enabled by a robust regulatory and legal framework. The role of the regulator in ensuring the sustainability and effectiveness of last-mile connectivity is important in terms of approval of appropriate tariffs, monitoring the supply standards of licensee, etc.

- **Tariff rationalisation:** One of the key functions of the regulator is to determine the tariff for various categories of consumers based on the cost to supply, capacity to pay, quality and duration of power supplied, etc. The tariff of most of the states appears to be dominated by the presence of a large number of categories and slabs, a non-transparent cross-subsidy mechanism and non-linkage with the actual cost of supply for the applicable consumer. In order to ensure affordable tariff for rural consumers, it is necessary that the capacity to pay for different consumer categories be re-assessed and the norms for the same be established. Also, the actual cost of supply for various voltage levels and categories needs to be calculated to assess the actual cross-subsidy. Also, the tariff categories need to be simplified and standards need to be developed for a number of such categories and slabs. All these measures would help in ensuring that the benefits of the cross-subsidy reach the consumer who needs it the most.

- **Monitoring of quality of service standards:** Non-compliance with service standards and performance standards by the DISCOMs in rural areas is a major concern which affects the satisfaction of consumers and results in a lack of trust between the consumers and the utility. An unsatisfied consumer is most likely to become a non-paying customer or a dishonest consumer. DISCOMs tend to restrict investment in rural areas as they are not considered commercially viable. In such a situation, the role of the regulator becomes more important to monitor that the desired service standards like customer service requests and reliability of power supply on interruptions are within the regulatory norms. A mechanism for calculating subsidy and tariff which are linked to the overall achievement of service standards and quality and reliability of power supply by the utilities may be devised.

- **Review of capacity allocations and power purchase agreements (PPAs) of DISCOMs:** The power market in India has evolved considerably in the last decade, especially in the last few years, with an increasing share of renewables, reduction of prices of renewable sources, availability of cheap power in short term market, etc. The availability of cheaper power and reduction of power purchase cost would be extremely helpful for making power more affordable and reliable. In this regard, it would also be prudent to examine the reallocation of the existing PPAs of DISCOMs and also look for ways and means to allocate the existing as well as upcoming renewable capacities. As such, an enabling framework is required which allows distribution utilities to reallocate the existing PPAs, include cheaper sources of power available in the market and reduce the power purchase cost as per the requirements.

Improving the impact of UDAY

A number of issues have to be addressed to make the UDAY programme more effective:

Covering for power purchase liabilities under the scheme: Power purchase liabilities were not covered for takeover by the state government under the scheme, except in the case of Jharkhand and Jammu and Kashmir. In the case of many DISCOMs power purchase dues comprise a large share of their liabilities and add to their financial stress. The loan liabilities in these DISCOMs are minimum to gain significant financial benefits under the scheme. These states find it increasingly difficult to avail of loans from banks/financial institutions (FIs) to meet their power purchase liabilities. Therefore, a mechanism may be developed by the Ministry of Power (MoP), GoI, to enable these DISCOMs to deal with power purchase liabilities, thereby helping these companies to accelerate the achievement of the operational and financial turnaround as per the MoU.

Funding support to undertake investment for achieving a turnaround: DISCOMs face challenges in obtaining funds to undertake operational initiatives to achieve their loss reduction targets. While this is a welcome squeeze for ensuring efficiency improvement, GoI may also look at incentivising deserving DISCOMs by increasing capital allocation to states which met milestones or demonstrated improvement. Further, correlating the allocation of funds under the existing GoI schemes to the performance of the DISCOMs will instil competitiveness among the utilities to undertake performance improvement initiatives.

Inclusion of some special cases of electricity distribution utilities in the scheme: Presently, only state-government owned DISCOMs are covered under the UDAY scheme. While the inclusion of private sector-owned utilities has not attracted much support, some of these utilities are reeling under huge financial stress. For instance, the DISCOMs of Odisha are not covered under this scheme and are presently managed by the state regulator through an administrator. These utilities face huge challenges in raising capital for infrastructure works as they are not beneficiaries of many GoI-funded schemes. Therefore, it is suggested that this scheme may be extended to non-government power sector distribution utilities to facilitate their operational and financial turnaround.

Capacity building and skill development of DISCOM employees: The implementation of various interventions under the scheme will necessitate capacity building and skill development of DISCOM employees. Therefore, it is suggested that adequate interventions are planned to strengthen the Power Sector Skill Council and establish Regional Power Sector Skill Councils to provide impetus to skill development of manpower at the regional level in the power sector. The knowledge management mechanism of the National and Regional Council may also be strengthened through the participation of state public sector units (SPSUs) and central public sector units (CPSUs), and regional and national institutes of repute. Also, the MoP, GoI, may extend financial support to well-performing utilities for capacity building and skill development of DISCOM employees.

7.2. Cooking gas

Unlike the electricity sector, it is difficult to pick out a single major factor for improving the last-mile connectivity for cooking gas. The problem is multidimensional and has to be dealt with accordingly. Major issues which are leading to lower progress on this front are lack of public awareness, issues with distribution channels, pricing and affordability.

The rural population in India generally depends on biomass for their cooking fuel needs, which is usually available for free. Hence, they are reluctant to switch to paid cleaner fuels such as LPG. Even after getting an LPG connection, they generally use it only in emergency situations and hence the refilling rate is very low. Apart from the free of cost factor, general awareness regarding the safety and usage of LPG is also very low, especially in BPL and uneducated households.

Distributorship of LPG is managed through oil marketing companies (OMCs). Allocation of distributorship depends indirectly on the population of the region, leading to very few distributors for remote and scarcely populated areas. This has a detrimental effect on the availability of new connections and refilling. Bad road connectivity to villages adds to the challenges of LPG distribution.

Initial deposit money, cylinder cost and recurring refill cost are not affordable for most of the poor and BPL population. The government provides 12 subsidised cylinders (14.2 kg each) to each connection based on their income level. Even after the subsidy, a large section of the population finds it difficult to afford LPG.

Apart from the above factors, there are other challenges in the form of uneven distribution of gas depots, bottling facilities and pipeline network. Other issues include paperwork for getting a new connection and malpractices in the distribution channel.

From time to time, the government has announced and implemented policies to ensure last-mile connectivity. However, these policies only address the technical/operational issues and socioeconomic factors are left unaddressed.

In this regard, the following suggestions may be considered for improving last-mile connectivity and the overall energy access situation of the country.

Spreading awareness

Spreading awareness should be the foremost step in ensuring the last-mile connectivity of cooking gas. The general public should be well informed about government schemes, processes for obtaining a new connection and refilling, subsidies, pricing, health benefits, best practices, and safety aspects, etc. This would help to make people aware of their entitlements, will reduce malpractices in the distribution channel and will also lead to the safe adoption of cleaner fuel. Various stakeholders can play important roles in achieving this objective. A few of these are covered below:

- The government has been conducting awareness programmes through various media such as radio, television and newspapers. These programmes need to be further intensified to reach the end consumer, especially BPL and uneducated households in both rural and urban areas. Along with generic programmes, targeted programmes need to be designed and launched for better impact.
- OMCs can rope in their distributors and other market channels to spread awareness among the public through advertisements, door-to-door campaigns, roadshows, camps, etc. Such initiatives can also be utilised to understand ground-level issues and would have a greater impact.
- Distributors are in direct contact with end consumers and this makes their role very crucial in spreading the right information. They should be utilised effectively for door-to-door campaigns or in organising camps.
- Local civic bodies like the gram panchayat, block offices and municipalities are the closest link to the local population. They can be utilised by the government/OMCs for awareness programmes.

Introduction/proper implementation of enabling policies

The government has been announcing and implementing a number of enabling policies to ensure the last-mile connectivity for cooking gas. A few of the major policies include:

- DBTL (2016) targeted to ensure direct benefit transfer to consumers
- RGGLVY to improve the availability of LPG connections and refilling in rural areas
- PAHAL (2014) to get subsidy directly in consumer's bank account
- PMUY (2016) to provide 50 million LPG connections to BPL households

The above policies have led to a big turnaround in the situation; however, there is still scope for improvement in implementation in order to make these policies hassle-free for end consumers.

Providing support through an appropriate regulatory mechanism and oversight

Regulatory oversight is of paramount importance for the effective implementation of policies and to curb malpractices. There is a need to conduct tighter scrutiny and revoke distributor licenses if they are found guilty of malpractices such as:

- extra transportation costs/delivery charges
- commissions for new connections
- forcing sale of other products along with a new connection

Ensuring hassle-free smooth implementation of a new connection, delivery and refilling

New connections require certain documentation, including know your customer (KYC) documents. At times, these documents (identity proof, address proof) are not available and people are denied a connection. Also, many rural households have either no bank accounts or have difficulty accessing banking services (required for subsidy transfer). Since the launch of the Pradhan Mantri Jan-Dhan Yojana (2016), the number of rural households with bank accounts has increased substantially (>20 million new accounts were opened).

Delivery in rural areas is impacted due to limited pipelines/storage units/bottling plants, poor road network and distribution networks. RGGLVY was launched to address these issues by diluting the requirements for allotting distributorship in rural areas. OMCs are planning to increase the number of distributors in rural areas substantially.

Further, refilling in rural areas generally requires long travel to collect the cylinder from a dealer. Dealers usually don't deliver to areas where they feel they cannot make profits on transportation. For households using LPG, the median one-way distance to procure an LPG cylinder ranged from 3 km in West Bengal to about 11 km in Madhya Pradesh.[19] In this regard, the government mandated that all distributors serving rural areas with sales exceeding 1,500 refills/month have to provide home delivery of cylinders.

The following steps can help in easing the process of getting new connections, the delivery system and refilling:

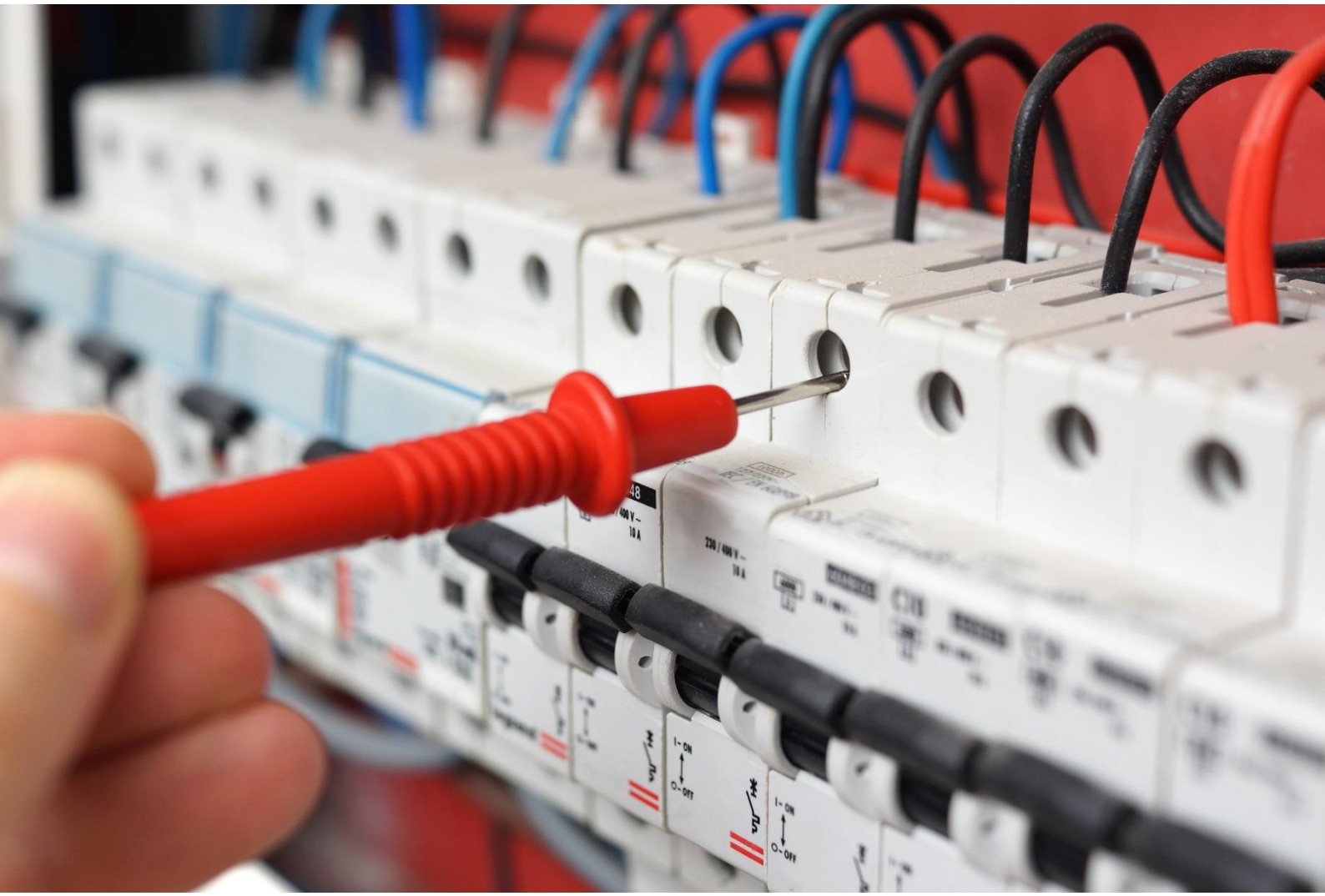
- The list of acceptable KYC documents should be widened, especially in rural areas. OMCs can work with the government to widen the options for acceptance of these documents.
- Innovative payment mechanisms such as mobile money should be promoted to fill the gap of last-mile access to banking services.
- Sale of smaller capacity cylinders (5 kg) will help households as address proof is not required to obtain them. While the government has already initiated this, local civic bodies can be entrusted to sell these cylinders.
- A set of strict guidelines with a strict scrutiny mechanism should be in place to ease the grant of new connections.
- Local civic bodies can be instructed to help people obtain address proof or other KYC documents with minimum hassles. This will enable consumers to avail of government schemes, get new connections, subsidies, etc.
- The government needs to speed up the work on the expansion of the CGD network and piped natural gas supplies (started in 2014). The National Gas Grid Plan (2015) needs to be implemented at a fast pace.
- OMCs can work with the government to increase their reach to remote areas through better geographical distribution of bottling plants, storage units, etc. They can work with the government to provide additional incentives for distributors to supply to remote areas. They can also work towards ensuring the optimum number of distributors, especially for rural areas.
- Distribution channels should be empowered to work along with local bodies to ensure seamless availability of new connections and refills. On the other side, local civic bodies should ensure that the transportation and storage infrastructure in their control is good enough to support the cause. It will help to tackle the problem of villagers having to travel long distances to collect cylinders every time.

[19] Aklin, M., Cheng, C., Ganesan, K., Jain, A., & Urpelainen, J. (2015). Access to clean cooking energy and electricity: Survey of states in India (ACCESS). Council on Energy Environment and Water. Harvard Dataverse, V1.

Addressing pricing and affordability issues

Initial connection costs and even refilling costs are high in comparison to the cost of traditional fuel, which is available at almost zero cost. Also, paying these costs in one go is often not possible for many households. Eighty-eight per cent of households not using LPG report high recurring costs as one of the bottlenecks to the adoption of LPG.[20] The launch of PAHAL (2014) to deposit subsidies directly into an individual's bank account and the launch of PMUY (2016) to provide 50 million LPG connections to BPL households are welcome steps in this direction. The following measures can help in addressing the issue of pricing and affordability:

- Introducing smaller capacity LPG cylinders in both urban and rural regions through different channels. This has already been implemented.
- Easy EMI facilities for those who cannot afford to pay the amount for a connection or refill at once. OMCs can work on a plan to provide easy EMIs for both new connection and refills.
- Private contractors should ensure fair pricing for cylinder and services.
- Subsidies and other information should be explained to uneducated connection holders in detail.
- A flexible, simple and fair system of payments should be implemented.
- Local bodies can be empowered to provide short-term credit on EMI basis for new connections and refills. They can also be entrusted with selling small capacity LPG cylinders.



[20] Ibid.

8. Discussion points

1. Do our last-mile goals reflect the ground realities in terms of meeting the deficit in energy access, both in terms of availability of reliable and affordable electricity and cooking gas supplies?

   (Explanation: Every time we have a new government at the centre, energy access figures change. This results in changes in energy goals. How do we address this anomaly?)

2. Is there a need for a radical thought to be put in place for improving the last-mile connectivity and overall energy access situation?

   (Explanation: With new governments and policymakers, there are a plethora of schemes/programmes being introduced. At times, a new scheme/programme is launched even if a similar one exists. This results in a diversion of focused attention of key implementers and results in undesirable wastage of financial and other resources.)

3. How have the existing set of policies/schemes supported improvements in the last-mile connectivity situation? Are the policies and measures adequately designed and implemented to promote the use of non-conventional energy and locally available resources to improve energy access, so as to optimise cost as well as establish a sustainable ecosystem?

4. How can we engage the private sector more, especially in the context of deploying innovative and disruptive technologies (e.g. micro grid, mini grid and off-grid systems in electrification and piped-gas supply, smaller gas cylinders in cooking gas), considering its business goals? What models of collaboration can be thought of? Do we already have policies to facilitate the same?

   (Explanation: Often, the private sector, due to its primary motive of profit-making, seems to be disinterested in investments to improve last-mile situations. How do we motivate the private sector in such cases?)

5. What kind of awareness/education programmes should last-mile beneficiaries be targeted with and how should these programmes be administered?

   (Explanation: Often, last-mile beneficiaries are not aware of the existing schemes/programmes, as well as the provisions under various acts/regulations [e.g. the Electricity Act, 2003, etc.], and are therefore unable to exercise their rights. How do we educate them to exercise their rights better?)

6. What kind of supply-side reforms are necessary in the electricity and cooking gas sectors to further improve last-mile connectivity issues in terms of improving reliability, affordability and consumer preferences?

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WEC India (World Energy Council India) is the country member of World Energy Council, a global and inclusive body (estd.1923 with over 90 country members) for thought leadership and tangible engagement in the pursuit of sustainable energy. WEC India functions under the patronage of Ministry of Power and with the support of all energy ministries and leading organisations in energy sector of the country.

India Energy Congress, an apex congregation of energy professionals from across the sector, is the flagship event of WEC India. Now into its 7th edition, the Congress is a joint event of **Ministries of Power, Coal, New & Renewable Energy, Petroleum & Natural Gas, External Affairs and Department of Atomic Energy**. The theme of the 7thedition ,"ENERGY 4.0: ENERGY TRANSITION TOWARDS 2030", will centre around transition led by disruptions that are fundamentally changing the way we live, work and relate to one another. Energy sector is going through a **grand transition** and as sector boundaries get blurred in this transition, the Congress seeks to have insights from Industry leaders on the challenges and response of subsectors.

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