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Are Indian Homes Ready for Electric Cooking?

Insights from the India Residential Energy Survey (IRES) 2020

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Executive summary

Electricity-based cooking (eCooking) is an emerging phenomenon in India. In February 2021, the Government of India launched the *Go Electric* campaign to create mass awareness about the benefits of eCooking devices, counter the country's growing import dependency for liquified petroleum gas (LPG), and support the low-carbon transition (PIB 2021). However, there exists little understanding about the current extent of eCooking adoption and usage in India, its cost-effectiveness compared to other clean alternatives, and households' perception of switching to eCooking from their prevalent cooking fuels. This policy brief aims to

fill these critical knowledge gaps with the help of the data and insights gathered from the **India Residential Energy Survey (IRES) 2020** that covered 14,850 urban and rural households across 152 districts from the 21 most populous states of India (Agrawal et al. 2020).

As per IRES, five per cent of Indian households use eCooking devices, with a higher prevalence in urban areas (10.3 per cent) than rural areas (2.7 per cent). Induction cookstoves and rice cookers are the most popular devices, each used by nearly 40 per cent of the eCooking users, followed by microwave ovens. Choice of eCooking devices varies across states, with rice cookers dominating in Andhra Pradesh, induction plates in Tamil Nadu and microwave ovens winning the race in Delhi.

At present, most households use eCooking to supplement other clean fuels like LPG. Only half of the eCooking users use it daily, and a majority (93 per cent) rely on LPG or piped natural gas (PNG) as their primary cooking fuel. On a positive note, 60 per cent of the eCooking users perceive that it would be feasible to transition to eCooking entirely. However, we observed high scepticism about eCooking among non-users: only a third perceive eCooking as a feasible option to meet all of their cooking needs, and a sixth feel that it would be affordable to do so.

In terms of recurring expenses, eCooking would be more cost-effective than LPG only for households getting cheap electricity. At an unsubsidised LPG refill cost of INR 800 (USD 11) per cylinder, eCooking would be operationally cost-effective for households paying tariffs less than INR 6.6 (USD 0.09) per kWh.[1] However, if the subsidy on LPG resumes with an effective LPG refill cost of INR 600 (USD 8.2) per cylinder, only those who pay a power tariff of less than INR 5 (USD 0.07) per kWh would find eCooking cheaper. But such households would also be at the risk of moving to a higher tariff slab upon a significant use of eCooking, which may erode the perceived economic gains. High upfront investment needed for eCooking devices and compatible utensils would also deter many households, particularly from low-income groups. This explains why eCooking is currently concentrated among wealthier households in India. However, for households who can avail of it, PNG (depending upon infrastructure availability), would be the cheapest cooking energy fuel.

> 5% of Indian households (10.3% urban and 2.7% rural) use eCooking devices.

In conclusion, our analysis indicates presence of significant cost and perception barriers to the uptake of eCooking in India. **High-income urban households would most likely be the first to switch to eCooking**, predominantly to supplement their cooking energy needs. Supporting this transition along with adoption of PNG would help reduce the demand for LPG in urban areas and free up resources to meet the rising demand in rural areas. **Promotion of eCooking at scale would require efforts on multiple fronts**, including research and development of energy-efficient, low-cost devices, provision of suitable financing solutions, and reliable electricity services, and in-depth studies to capture the household experience and perception of eCooking under diverse social contexts. Finally, the **policy discourse on the role of electricity in India's clean-cooking journey must also reflect on its implications on future power demand and our ability to service the same through renewable sources**. From an emissions perspective, eCooking is currently less preferable than LPG and PNG due to higher emission intensity of grid-electricity. Thus, convergence between the national strategy on greening the grid and the vision on eCooking would be essential to completely decarbonise India's cooking energy use in the long run.

1 In India, household electricity tariffs vary widely (range: INR 0-11.5 per kWh) across states and consumption slabs, progressively increasing for households with higher consumption. We use a currency conversion factor of INR 73/USD.

1. Study motivation and objectives

Besides the use of spices, fire-based cooking is perhaps the most defining characteristic of Indian kitchens. While many Indians, particularly in rural areas, may still vouch for *chulha*-cooked *chapatis* and dishes, the use of biomass poses many challenges to the households and society at large (Smith and Sagar 2014).[2] To wean people away from polluting solid fuels, successive governments in India have implemented multiple policies and efforts to promote liquified petroleum gas (LPG) as the modern, clean cooking fuel (IISD n.d.; Jain et al. 2018). These efforts have yielded results. As per a nationwide survey conducted in 2020, nearly 71 per cent of Indian homes use LPG as their primary cooking fuel, up from 28.5 per cent in 2011 (Mani et al. 2021).

Even though LPG has become the mainstay cooking fuel in India, electricity-based cooking (eCooking) is emerging as yet another option. In 2011, only 0.1 per cent of Indian households reported using electricity as their primary cooking fuel (Census of India 2011). However, rapid electrification, rise in incomes, and lifestyle changes have fuelled the market for eCooking devices such as induction cookstoves and electric pressure cookers in India (Research and Markets 2016). Unlike LPG, which is a fossil fuel, eCooking offers an opportunity to decouple cooking from carbon emissions in the long term through a decarbonised grid. Near-universal electrification of households and significant improvements in power supply provision have made this opportunity plausible. In February 2021, the Government of India launched a 'Go Electric' campaign to create mass awareness about the benefits of eCooking devices, counter the country's growing import dependency for LPG, and support the low-carbon transition (PIB 2021).

What do we know about eCooking in India?

Numerous studies have shed light on the barriers and solutions to support the clean cooking energy transition, albeit focusing on LPG and improved cookstoves (Lewis and Pattanayak 2012; Schunder and Bagchi-Sen 2019). "Electric cooking has traditionally been considered only an option at the top of the energy ladder, i.e., for the wealthy urban household" (Smith and Sagar 2014). As a result, only a few studies have evaluated the role and rollout of eCooking. For instance, Yangka 2016 employed an integrated energy system modelling to assess the emissions savings from a switch to eCooking in Bhutan (Yangka and Diesendorf 2016). As per a recent economic assessment for sub-Saharan African countries, energy-efficient eCooking devices are increasingly becoming cost-effective in weak-grid and off-grid contexts (ESMAP 2020). However, gaps in the supply chain, consumer awareness, and high upfront cost of devices may constrain the rapid adoption of eCooking (ESMAP 2020).

> **With a fully decarbonised electricity system, a shift to eCooking will be imperative, to reduce emissions attributed to cooking.**

An experimental study in rural Nepal indicates that eCooking is suitable to cook most local food (*dal*, rice, vegetables), except *chapatis* (Clements et al. 2020). Based on a survey of 1,000 rural households in Himachal Pradesh (India), Banerjee et al. (2016) found that induction cooktops (provided at a discount cost) only replaced LPG as secondary fuel while most households continued to use firewood as the primary fuel. Further, the fear of high electricity bills or inadequate voltage supply kept households from relying on eCooking. Another empirical research in two Indian states (Rajasthan and Chhattisgarh) found that induction cooktops have comparable operating costs to LPG and can replace LPG in places where distributors are located at a distance (Parikh et al. 2019).

While these studies offer useful nuances about factors that would typically influence eCooking uptake, little do we know about the current extent of eCooking in India, its cost-effectiveness compared to other clean alternatives, and household perception of switching to eCooking from prevalent cooking energy fuels. This study aims to fill these critical knowledge gaps with the help of the India Residential Energy Survey (IRES) 2020, conducted by the Council on Energy, Environment and Water in collaboration with the Initiative for Sustainable Energy Policy. IRES covered 14,850 urban and rural households across 152 districts from 21 most-populous states of India. Refer to Agrawal et al. (2020) for details on survey design and data collection.

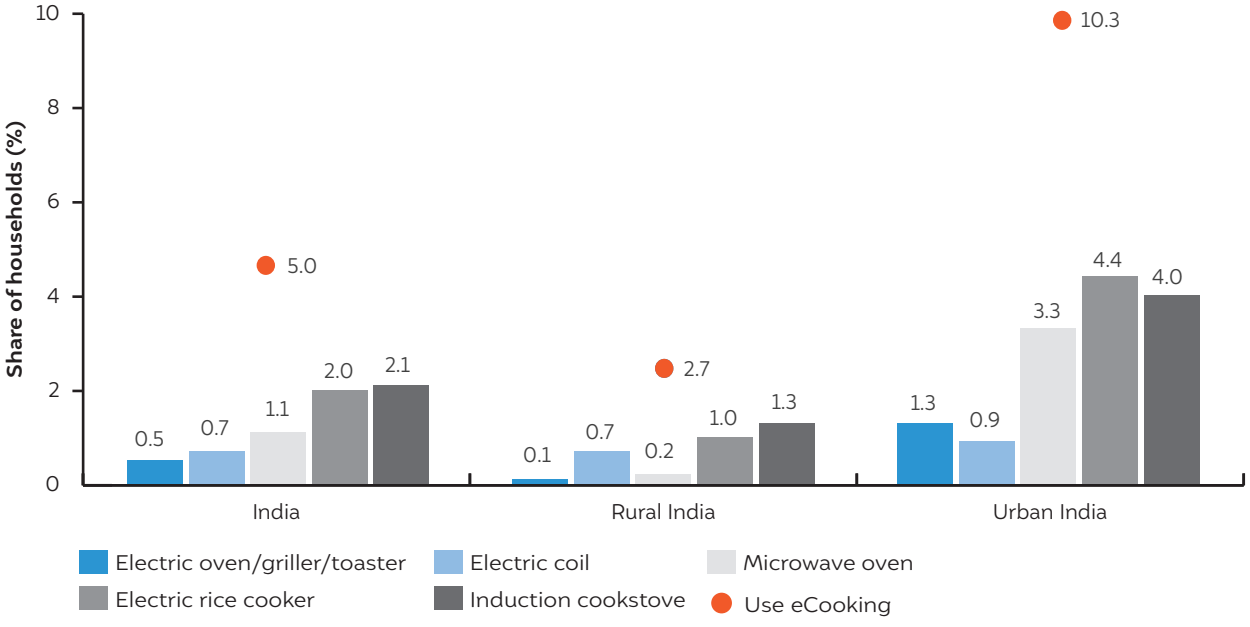
2 Chulha-cooked food refers to the food cooked on traditional stove using polluting solid fuels.

2. Prevalence of eCooking in Indian kitchens

Image: Rahul Singh, Uttarakhand

As per the IRES, electricity use for cooking remains marginal in Indian homes, with just five per cent of households using any electric cooking appliance. As expected, eCooking use is higher in urban India (10 per cent) than in rural areas (3 per cent). We also find that households use diverse electric appliances for cooking their food, from induction cookstoves and rice cookers (for cooking staple foods) to microwave ovens and grillers (Figure 1). Induction cookstoves and rice cookers are the most popular eCooking appliances, each used by nearly 40 per cent of eCooking users, followed by microwave ovens.

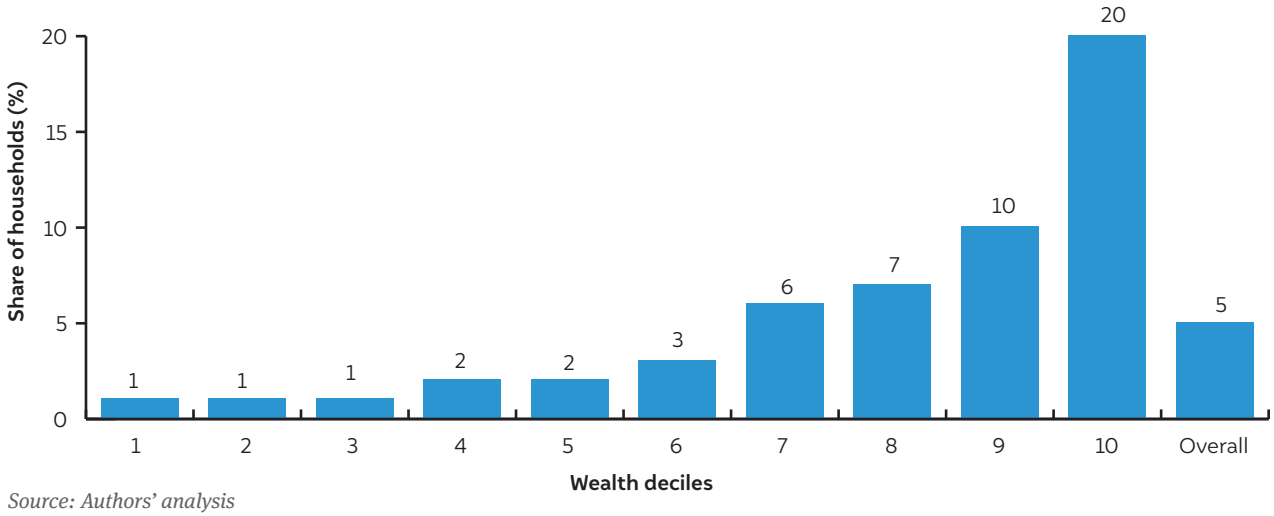
Figure 1 Induction cookstoves and rice cookers are the most commonly used electrical appliances for cooking in Indian homes



Source: Authors' analysis

Note: To estimate the extent of eCooking use, we only considered appliances used for heating or cooking the food and excluded kitchen appliances like refrigerators, juicers, etc.

Figure 2 eCooking is significantly more popular among wealthier households



Source: Authors' analysis

We find that the use of eCooking is concentrated among wealthier households in India (Figure 2). Around 85 per cent of eCooking users belong to the top-five wealth deciles, suggesting that households' economic situation plays a vital role in the adoption of eCooking.[3] A state-level analysis indicates similar trends. Microwave oven ownership is even more strongly driven by the economic status of the households, with nearly exclusive ownership by the wealthiest 10 per cent of households.

However, usage rates vary significantly across states (Figure 3). Tamil Nadu and Delhi have the highest proportion of eCooking users (17 per cent). Telangana, Kerala, and Assam are other states with at least a tenth of households using eCooking appliances. However, most northern, western, and eastern states in India have a very low rate of eCooking use.

We also analyse the eCooking appliance choice in the top-five states (Table 1). In Tamil Nadu and Kerala, most users use induction cookstoves followed by rice cookers. In contrast, microwave ovens are the most commonly used eCooking devices in Delhi, followed by induction cookstoves. In Telangana and Andhra Pradesh, almost all of the eCooking can be attributed to rice-cookers. The observed variations are reflective of differences in culinary habits as well as lifestyle choices across Indian states.

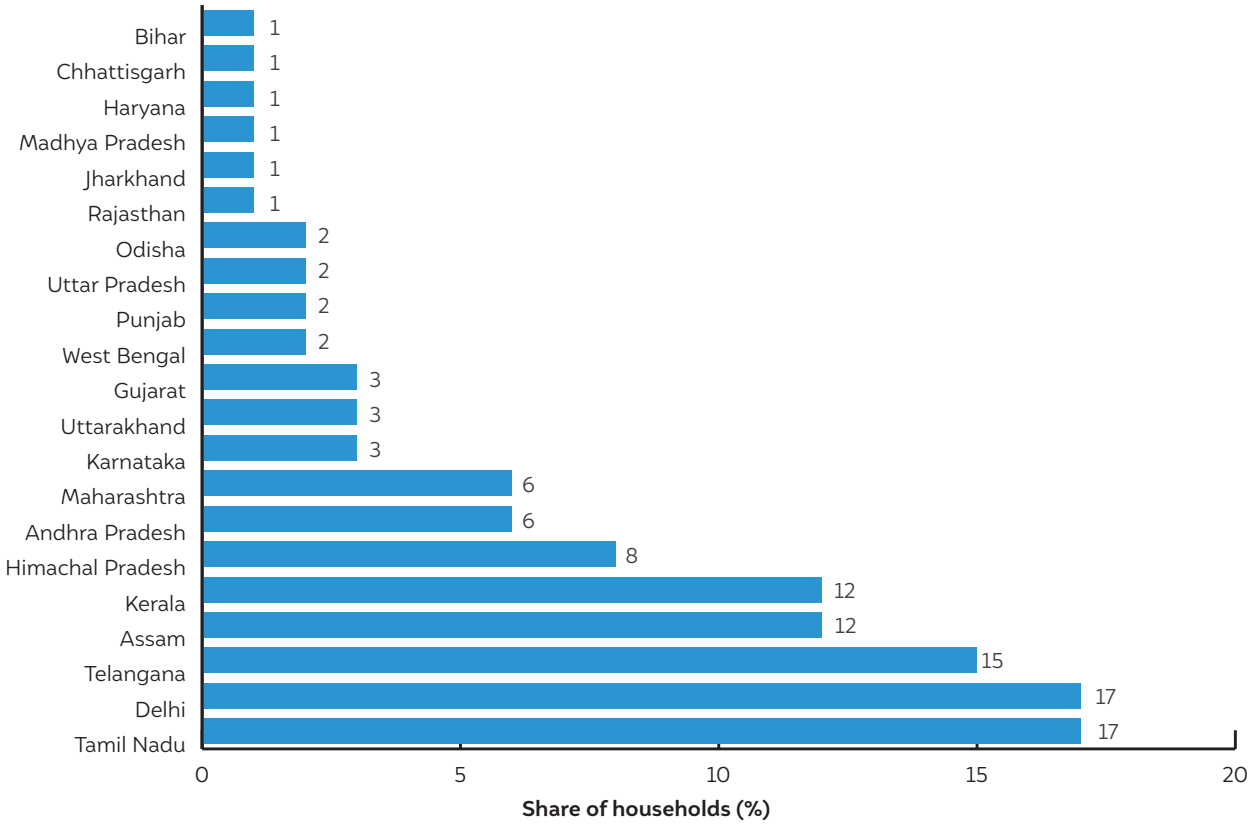
Power tariff rates and payment discipline are the other factors that may influence the adoption of eCooking. Tamil Nadu, which has the highest eCooking adoption, provides heavy subsidies on residential electricity. For instance, households consuming up to 100 units in two months receive free of cost electricity (TNERC 2020). Similarly, in Delhi, households consuming less than 200 units per month receive a 100 per cent subsidy, while those with 200–400 units per month get a 50 per cent subsidy (GoNCTD 2019; DERC 2020).

In Assam, while wealthier households use rice cookers or microwave ovens, low-income households use electric coil-based cookstoves. The latter can be partly attributed to poor payment discipline as most electric-coil users could neither recall their electricity expenses nor possessed a copy of their electricity bill at the time of the survey. Beyond electricity tariffs, the relationship between electricity payment discipline and the adoption of electric cooking is less well understood.

These trends suggest that future adoption of eCooking would likely be higher in states with lower power tariffs and/or gaps in billing and revenue collection. In the latter case, eCooking could further worsen the financial stress of the power distribution companies (discoms) and must be approached carefully.

3 To assess household economic status, we use wealth index based on principal component analysis of 11 indicators spanning house characteristics, and ownership of various consumer durables and motorised vehicles. Based on the relative values of this wealth index, households are divided into 10 wealth deciles. Refer to the technical document (http://bit.ly/IRES1) for further details.

Figure 3 More than one-sixth of the households in Tamil Nadu and Delhi use eCooking



Source: Authors' analysis

Table 1 Choice of eCooking appliance varies significantly across Indian states

State	Overall eCooking usage	Share of households using eCooking appliances				
		Electric-coil cookstove	Induction cookstove	Rice cooker	Microwave oven	Toaster/ griller
Tamil Nadu	17%	5%	73%	34%	4%	5%
Delhi	17%	6%	42%	9%	90%	16%
Telangana	15%	1%	9%	96%	8%	3%
Kerala	12%	2%	88%	18%	6%	2%
Assam	12%	38%	4%	46%	22%	8%

Source: Authors' analysis

3. Cost of switching to eCooking: a comparative assessment

The affordability of any cooking fuel is one of the most critical factors in its adoption and use (Jain et al. 2018; Stanistreet et al. 2019). To understand how the economics of eCooking may influence its adoption and usage, we estimate and compare the expenses of an average Indian household to meet its entire cooking-energy requirement through the exclusive use of electricity and LPG. As per IRES, a typical household in urban India—that relies exclusively on LPG for cooking—consumes eight large LPG refills (of 14.2 kg each) in a year. This is equivalent to 2.95 gigajoules of useful cooking energy. At an LPG refill price of INR 800 (USD 11) per cylinder (unsubsidised), household expenses on exclusive use of LPG would amount to INR 530 (USD 7.3) per month.[4] Assuming that an equivalent amount of useful cooking energy will be required for cooking exclusively with electricity, households would need to spend INR 446 per month (USD 6.1) on eCooking, assuming a power tariff of INR 5.5 per (USD 0.075) kWh.[5] Table 2 summarises the key assumptions and results.

4 We have used the LPG refill price prevalent in New Delhi in April–June 2021.
5 In India, household electricity tariffs vary widely (range: INR 0-11.5 per kWh) across states and consumption slabs, progressively increasing for households with higher consumption.

We also compare cooking-energy expenditure for households using piped natural gas (PNG), which is currently accessible only in a few Indian cities. We find that households will need to spend only INR 340 (USD 4.7) per month for the exclusive use of PNG for cooking. Thus, PNG is currently the cheapest cooking-energy option for households (who have this choice). As of December 2020, there were 7.29 million PNG connections (nearly two per cent of Indian households) in urban areas (PNGRB 2021). The Government of India plans to extend PNG connections to 50 million households in India (The Hindu Business Line 2020). Given PNG's cost-effectiveness, households with access to PNG would likely use eCooking only to fulfil specific cooking needs.

those in Maharashtra (a reflection of this can be seen in Figure 3). Households using electricity at a tariff higher than INR 6.6 (USD 0.09) per kWh (on the margin) would find LPG cheaper, at a refill cost of INR 800 (Figure 4). However, if the subsidy on LPG resumes such that the effective LPG refill costs INR 600 (USD 8.2) per cylinder, then LPG would be cheaper for households paying tariffs more than INR 5 (USD 0.07) per kWh.

However, it should be noted that many Indian households, especially those in rural areas, already struggle to afford LPG (even when subsidised) and cite high refill cost as a key reason for stacking (Giri and Aadil 2018; Mani et al. 2020; Mani et al. 2021). Further, despite power subsidies, non-payment of electricity

Table 2 Estimation of operational cost of using LPG, induction cookstove, and PNG to meet all the cooking needs for a typical Indian household

		Fuel type		
		LPG (unsubsidised)	Electricity (induction cookstove)	PNG
Standard measuring unit		**14.2 kg refill**	**1 kWh**	**1 SCM**
Calorific value per standard unit[6]	in kcal	1,54,354 kcal	860 kcal	10,000 kcal
	in GJ (kcal/239006)	$64582x10^{-5}$ per refill	$360x10^{-5}$ per kWh	$3766x10^{-5}$ per SCM
Appliance efficiency		57%	84%	57%
Useful calorific value after adjusting for appliance efficiencies (in GJ) (Calorific value x efficiency)		$36812x10^{-5}$ per refill	$302 x10^{-5}$ per kWh	$2146 x10^{-5}$ per SCM
Cost per standard unit (in INR)		800 per refill	5.5 per kWh	30 per SCM
Number of units required for exclusive use in cooking (annual)		8 LPG refills (113.6 kg)	974 units (kWh)[7]	137.2 SCM
Annual cost of using the fuel exclusively for cooking (in INR)		6400	5,357	4116
Monthly cost of using the fuel exclusively for cooking (in INR)		~530	446	~340

Source: Authors' updated analysis based on (Jain, Choudhury, and Ganesan 2015).

Note: We assume no stacking in the above scenarios, which means that at one point, one household will only use one of the three cooking fuels. Further, there are certain staple Indian dishes (such as chapati) that have a direct-flame requirement, and it is difficult for eCooking technology in its current form to adapt itself there. However, we still estimate the cost of exclusive use of eCooking, for a comparison.

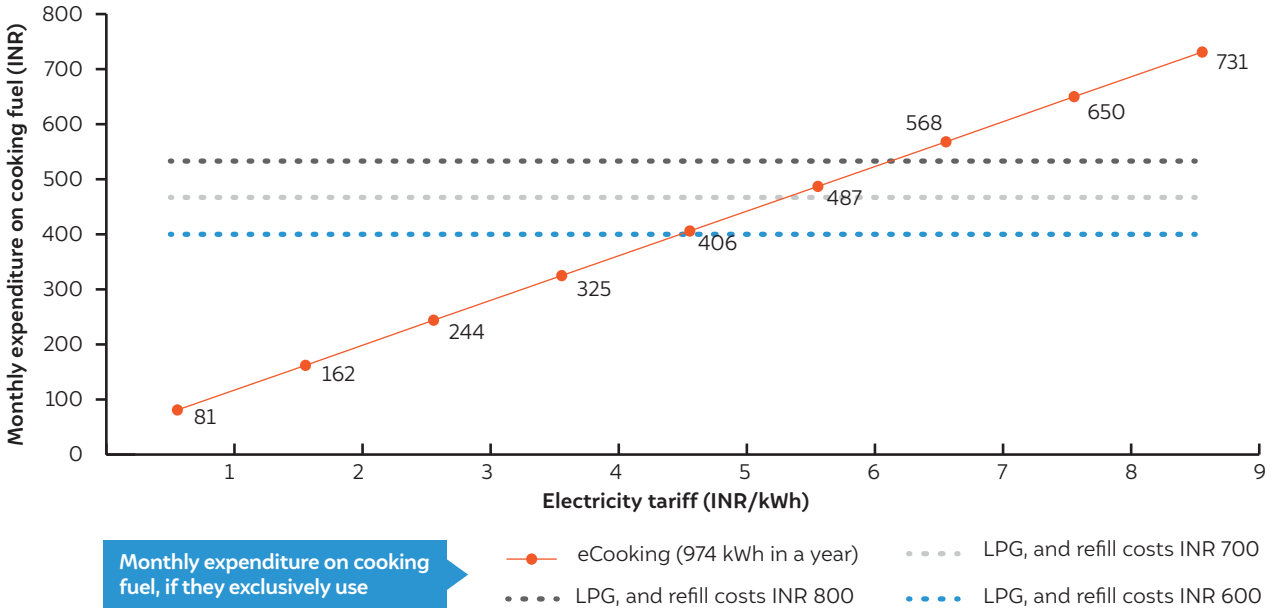
PNG aside, at an average power tariff (INR 5.5 per unit) and prevailing LPG price, eCooking is cheaper than LPG in terms of operational cost. However, electricity tariffs vary significantly across states and consumption slabs within each state. For instance, households using 500 units of electricity per month are charged INR 2.56 (USD 0.035) per kWh in Tamil Nadu, but INR 8.81 (USD 0.12) per kWh in Maharashtra. Thus, eCooking will be much more attractive for consumers in Tamil Nadu than

bills (again due to affordability) is a critical issue afflicting distribution companies' financial health (Balani, Sharma, and Agrawal 2020). Using electricity for cooking will also push households into a higher tariff slab with additional cost implications. In their empirical study with 1,000 rural households in Himachal Pradesh, Banerjee et al. (2016) found that the use of induction cooktops pushed 84 per cent of the surveyed households into higher tariff slabs.

6 We only take into account the lower heating value (LHV) for all three cooking fuels. LHV is also known as net calorific value (NCV) or lower calorific value (LCV).

7 In an experimental study, Banerjee et al. (2016) found average electricity consumption for using induction cooktop among rural households to be 82 kWh/month or 984 kWh/year.

Figure 4 Households getting subsidised electricity would typically find eCooking more cost-effective than LPG



Source: Authors' analysis
Note: The above comparison is only based on the energy costs of the the LPG and electricity, and does not consider capital cost, one-time fixed charges for connection and maintenance costs.

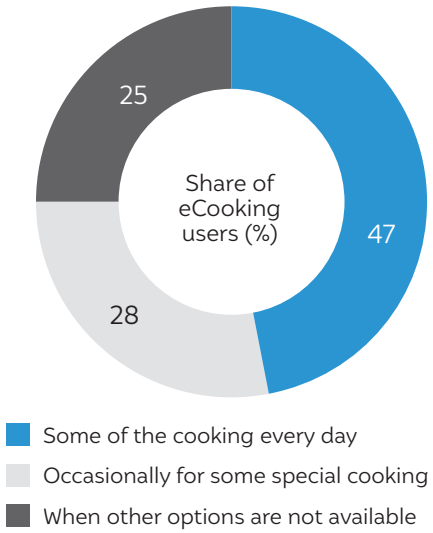
Low-income households would also face another challenge in the form of upfront investment of INR 2,500–4,000 (USD 34–52) to buy an electric cooktop and compatible utensils.[8] This expense, over and above the LPG connection cost (that many households already have), would be a significant barrier for most Indian homes. For perspective, the median monthly expenditure of Indian households is INR 6,000 (USD 82), as per IRES.

4. Household preferences and perceptions about eCooking

Similar to the case of LPG, ownership of an eCooking appliance does not imply its exclusive use. As per IRES, around 93 per cent of the households that use eCooking, use LPG or PNG as their primary cooking fuel. Thus, even among the households that have eCooking appliances, these are used to supplement cooking energy needs. To better understand user behaviour, we analyse the frequency of use of eCooking appliances.

> **A significantly higher proportion of non-users of eCooking are either sceptical or uncertain about its benefits.**

Figure 5 Around half of the eCooking users use it every day



Source: Authors' analysis

We find that a fourth of the eCooking users use eCooking devices as a backup when other alternatives are not available, while another fourth use these occasionally. Only around half of them reported using it daily for some of their cooking needs (Figure 5).

The usage frequency is highest among the households owning electric-coil cooktops, where 70 per cent use it at least once a day. Occasional usage is highest among households owning microwave ovens, while a third of

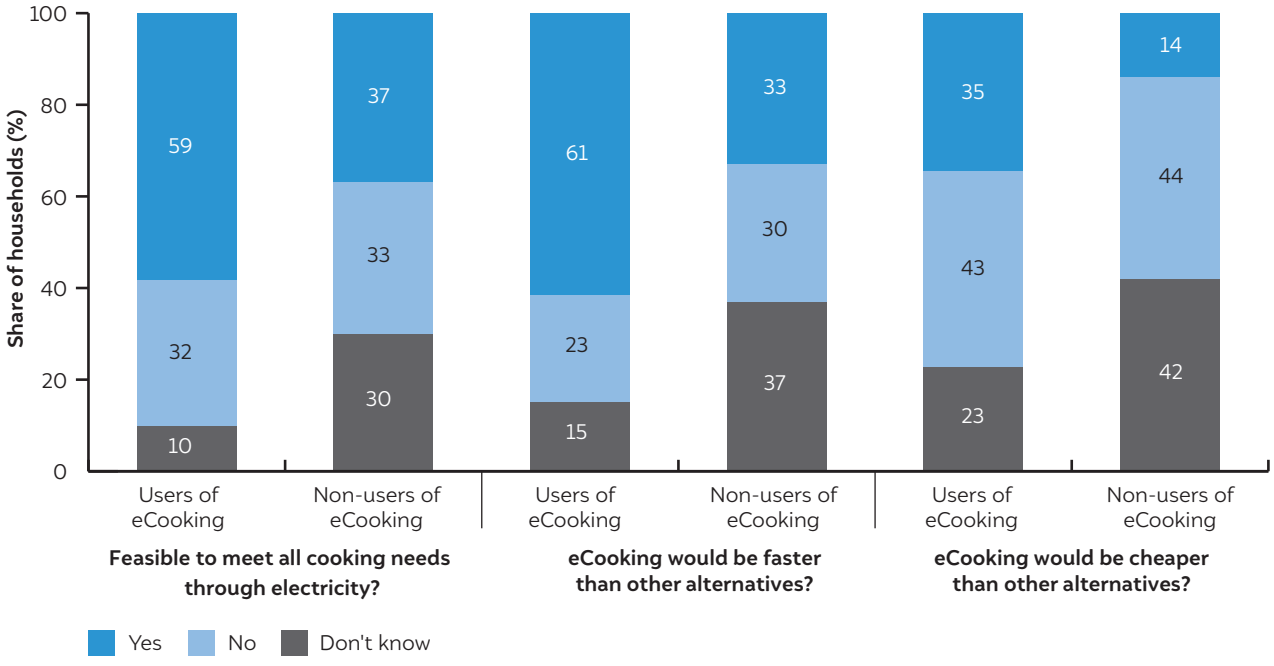
8 An online review suggests that induction cookstoves could cost between INR 1,500–2,000 (USD 21–27) and compatible utensils may cost another INR 1,000–2,000 (USD 14–27).

Image: iStock

households owning induction cookstoves keep it as a backup when other alternatives are not available.

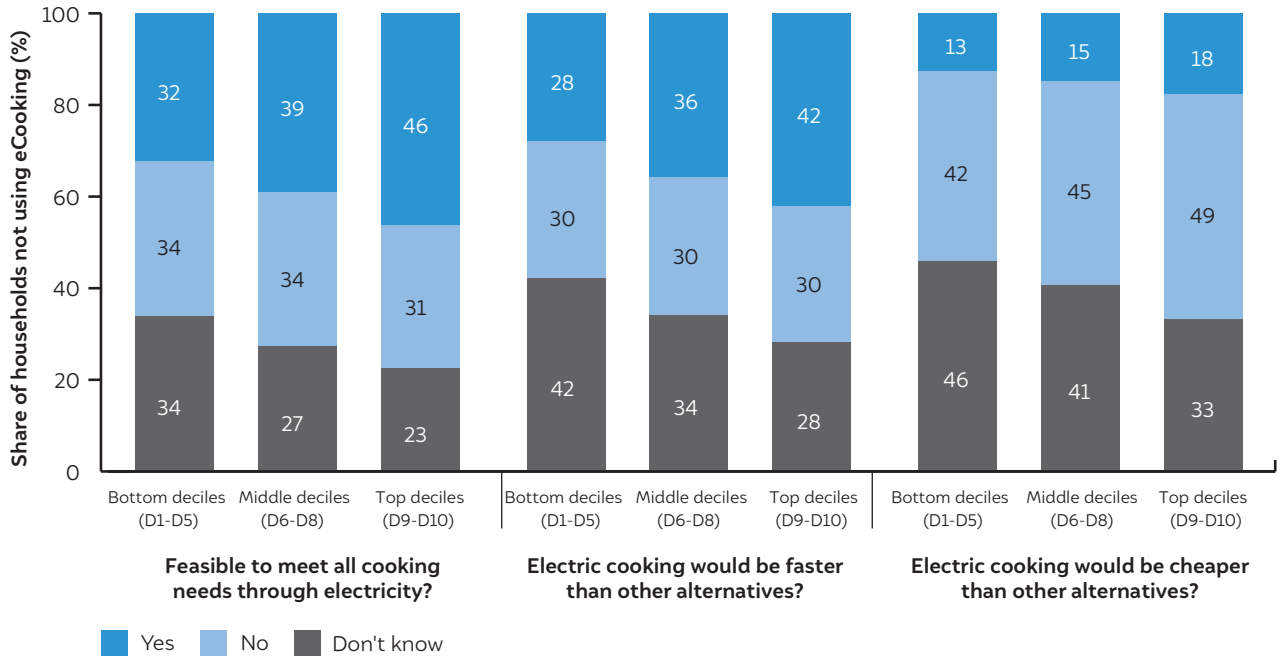
Such variation in cooking appliance usage patterns has a significant bearing on how the uptake of eCooking in future would interplay with demand for other cooking fuels. Further, with 95 per cent of the population having no eCooking experience, the perceptions about its relative benefits or challenges are yet to be developed, indicating a long uphill journey before eCooking becomes mainstream in India. To understand all households' (both users and non-users) perception of

Figure 6a Few Indian households think eCooking would be cheaper than other alternatives



Source: Authors' analysis

Figure 6b Among the non-users, perception towards eCooking improves with household economic status



Source: Authors' analysis

relying entirely on electric appliances for cooking, we asked them the following three questions on different aspects of eCooking:

1. Would it be feasible or not to meet all their cooking needs?
2. Would it be faster or slower than other alternatives?
3. Would it be cheaper or costlier than alternative cooking fuels?

We find that among eCooking users, nearly 60 per cent agreed that it would be feasible to transition to eCooking entirely and an equal share believe that eCooking would be faster than the alternatives. However, only a third of the users find eCooking cheaper than the alternatives (Figure 6a). This may be because most eCooking users are high-income households (Figure 2), who also pay higher electricity tariffs (falling in higher consumption slabs).

We also find that a significantly higher proportion of households without prior experience of electric appliances (non-users) are either sceptical or uncertain about their benefits. However, an assessment of the perception of non-users falling in different wealth deciles indicates a relatively optimistic outlook among wealthier households (Figure 6b). This suggests that high-income households would most likely be the first to switch to eCooking, with the pace of transition likely to be higher in the states with lower power tariffs in urban areas.

Overall, our assessment indicates that there currently exists a significant perception barrier that would influence the pace and scale at which Indian households are likely to use electricity for cooking purposes. This is in line with the findings from an earlier study, which recorded significant misconceptions about electric cooktops not being adaptable to Indian cooking during a baseline survey with 200 rural and peri-urban households in Rajasthan and Chhattisgarh (Parikh et al. 2018). Public campaigns could help remove potential misconceptions among the non-users of eCooking. However, further research is needed to better understand the household experience and perceptions of eCooking and devise measures to support its adoption.

5. Conclusion and recommendations

Drawing insights from the IRES, we find that the adoption of eCooking in Indian kitchens currently stands at a low five per cent. The use of appliances such as induction cookstoves, microwave ovens, rice cookers, etc. is primarily concentrated among urban, wealthy households. Moreover, 93 per cent of the eCooking users rely on LPG as their primary cooking fuel and use electricity as a secondary fuel. Half of the users use eCooking appliances either occasionally or as a backup.

The economics of eCooking vis-à-vis LPG can partly explain these observed trends. Electric cooking appliances have a high upfront cost, which many households, particularly from low-income groups, would find unaffordable. Recurring costs are another critical constraint. At an unsubsidised LPG refill cost of INR 800 (USD 11) per cylinder, eCooking would be operationally cost-effective for households getting subsidised electricity (tariff less than INR 6.6/kWh or USD 0.09). However, if the subsidy on LPG resumes with effective LPG refill cost being INR 600 (USD 8.2) per cylinder, then only those who pay a power tariff of less than INR 5 (USD 0.07) per kWh would find eCooking cheaper. But such households would also be at the risk of moving to a higher tariff slab upon a significant use of electricity for cooking, which may erode the perceived economic gains. Besides economics, perceptions matter too. While 60 per cent of the eCooking users report that it would be feasible to transition to eCooking entirely, households without prior experience of electric appliances (non-users) are mostly sceptical or uncertain about their benefits. In cities where PNG is or would be made available, PNG would be the cheapest and thus consumer's choice of fuel.

Way forward

Our analysis suggests that high-income urban households would most likely be the first to switch to eCooking, predominantly to supplement their cooking energy needs. Supporting this transition along with adoption of PNG would help reduce the demand for LPG in urban areas and free up resources to meet the rising demand for LPG in rural areas.

A large-scale adoption of eCooking in the near term may not be not desirable from an emissions perspective, due to higher emission intensity of grid-electricity than LPG and PNG. While efforts are on to decarbonise the grid, bringing about a change in consumer behaviour and perception takes time. Promotion of eCooking at at scale in the long run would require key stakeholders – government, discoms, and the private sector – to undertake efforts on multiple fronts, as discussed below.

> **Supporting the transition to eCooking in urban India would free up resources to meet the rising LPG demand in rural India.**

- *Supporting research and development of energy-efficient, low-cost devices* to make eCooking affordable (ESMAP 2020). In parallel, the Bureau of Energy Efficiency should bring fast-growing appliances like rice cookers and induction cookstoves under the standards and labelling programme.
- *Devising financing solutions to stimulate demand for eCooking devices.* Discoms with surplus power could collaborate with financial institutions to enable credit-linked adoption.
- *Ensuring reliable and quality electricity services* to enable households to rely on electricity for cooking without a backup. Even though power services in India have improved significantly, issues like daily power outages, occasional extended blackouts, and voltage fluctuations persist (Agrawal et al. 2020).
- *Conducting in-depth studies to capture the household experience and perception* of eCooking under diverse social contexts, which in turn could help guide future policy interventions.

The policy discourse on the role of electricity in India's clean cooking journey must also reflect on its implications on future power demand and our ability to meet the same through renewable sources. A nationwide transition to eCooking (as an exclusive source) would translate into additional electricity and load demand of 243 TWh and 300 GW.[9] For comparison, India's residential electricity demand and generation capacity stood at 288 TWh (2018–19) and 383 GW (May 2021), respectively (CEA 2020; 2021). Such a rise in cooking-related power demand would be in addition to the expected doubling of residential power demand in India by 2030 (IEA 2021). Convergence between the national strategy on greening the grid and the vision on eCooking would be essential to completely decarbonise India's cooking energy use in the long run.

9 Assuming an annual household consumption of 974 kWh for eCooking alone, average induction power demand of 1600 W and 75 per cent coincidence factor for a population of 250 million households.

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About CEEW

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