Women's participation and representation key to improving adoption of LPG in India

Executive Summary

Explicitly acknowledging that women's participation and representation is essential for a complete transition from traditional fuels to clean fuels in India, sits at the cusp of this paper. Clean energy adoption patterns across India are fragmented, influenced by several factors – patriarchy being key among them. Divided into three sections, the first section of this paper investigates the drivers that constrain the mass adoption of Liquified Petroleum Gas (LPG) in rural India and argues for a gendered understanding and awareness of the issue, to eliminate barriers to adoption. The second section, explains the LPG governance landscape and progression in India, and identifies the energy governance ecosystem as gender-blind, with limited representation of women. The final section of this paper lays down policy recommendations for the short and medium term to not only improve the adoption of LPG in India, but also women's participation and representation in India's energy governance landscape.

Traditional fuel usage in India

The urgency surrounding the permanent removal of the traditional cooking stove, also called chulha, continues unabated, as the environmental and health impacts worsen. Nearly one-third of the world's population, about 2.6 billion people across the world use a simple cooking stove for cooking that is mostly fueled by firewood, coal, kerosene or biomass (WHO, 2021). In developing countries in particular, more than one-half of domestic energy comes from burned plant or animal material – wood, charcoal, dung and crop residues, also referred to as biomass fuels (Smith et al., 2004). Biomass fuels have significantly lower combustion efficiency and release large amounts of particulate matter into the atmosphere as a result of

incomplete combustion (Fullerton et al., 2008). They also release carbon monoxide, hydrocarbons, oxygenated organics, free radicals and chlorinated organics into the atmostphere (Naeher et al., 2007). Inhalation of such particulate matter and materials is known to cause lung cancer, stroke, chronic obstructive pulmonary disease among adults leading to nearly 4 million premature deaths (WHO, 2021). In most developing countries, and in rural settings in particular, women are culturally assigned the primary caregiving responsibilities – cooking being one of them. Given their high exposure to indoor pollution caused as a result of using the traditional chulha, they are disproportionately affected. Despite this, poor adoption of clean fuels has been observed in rural settings. This background paper will take a gendered approach and investigate the cultural drivers causing this poor adoption of clean fuels in rural India, and draw the link between gender inequality and cooking fuel choice. It also locates the agency of women in adopting clean fuels in rural India, and seeks to establish firm ground for targeting women in particular, to achieve the transition to clean energy.

Section 1: Drivers constraining adoption of LPG among women in India

According to the 2011 Housing Census data, about 0.2 billion people use fuel for cooking – of which "49% use firewood; 8.9% cow dung cake; 1.5% coal, lignite or charcoal; 2.9% kerosene; 28.6% liquefied petroleum gas (LPG); 0.1% electricity; 0.4% biogas; and 0.5% any other means". Given the high levels of morbidity and mortality in India caused by household air pollution, addressing the successful transition of households from inefficient fuels to cleaner, relatively more efficient fuels is critical (The Lancet, 2020). The environment and health impacts notwithstanding, this also incurs an economic loss to the country – lost output from premature deaths accounted for $28.8 billion and that from morbidity accounted

for $8 billion (The Lancet, 2020). The successful transition to cleaner fuels and the consequent reduction of air pollution in India is therefore critical to India's economic growth.

Applicability of the energy ladder model

According to conventional energy transition models, the energy ladder model in particular, the most important factor influencing a household's choice of cooking fuel is the household's socio-economic status – the higher the income, the greater the propensity of households to transition to more efficient and cleaner fuels (Wang & Bailis, 2015). However, Hiemstra-van der Horst & Hovorka (2008) observe that much against the theory of the energy ladder model, the shift from biomass to modern fuels does not necessarily occur in tandem with changes in the household's income and social status, indicating that such a transition is far more complex that it may seem at the surface. Masera et al. (2000) find that an alternate multiple fuel model better explains a household's energy choices in rural households and indicate four factors that more accurately depict a household's decision over fuel type – "(a) economics of fuel and stove type and access conditions to fuels; (b) technical characteristics of cookstoves and cooking practices; (c) cultural preferences; and (d) health impacts".

Another observation, relatively less investigated as compared to conventional theories explaining energy adoption, is the finding by Vyas et al. (2021) contending that gender norms and attitudes may better explain the persistent use of solid fuels, especially in rural areas, despite the prevalence of cleaner fuel options – nearly 75 percent of rural households continue using solid fuels for cooking (National Family Health Survey, 2015). To explore the gender dimension further, we evaluate the Government of India's subsidy plan for accelerating the adoption of Liquefied Petroleum Gas (LPG) among rural households. In May 2016, the Government of India launched the Pradhan Mantri Ujjwala Yojana (PMUY) that claims to have enabled 80 million connections. The main objective of the subsidy program was to

provide LPG connections to women below the poverty line, identified on the basis of the Socio Economic Caste Census data and is said to have increased LPG coverage in the country from 62% to 94% in a period spanning from May 2016 to March 2019 (PRS, 2019). However, despite the widespread increase in connections across states, repeated and sustained use has remained low, as measured by the average annual refill consumption for PMUY beneficiaries (PRS, 2019).

Role of patriarchy

Many underlying cultural norms may explain this. Patriarchy is one of them. While women in rural India are largely tasked with cooking and the preparation of solid fuels for cooking, the men hold the financial reins of the household and are the primary decision makers on making the transition to cleaner fuels (Vyas et al., 2021). Distanced from the task of cooking, men often fail to understand the need and the urgency of transitioning from traditional to modern fuels. This lack of agency, is one of the primary reasons prohibiting women from actively exercising their choice over fuel type. Gould and Urpelainen (2019) find the lack of gender equality is a significant obstacle to sustained LPG usage in India, indicating that households where women have greater agency and participate in decision making have a greater propensity to adopt LPG for cooking as compared to households where only men are the decision makers. Understanding energy-gender-poverty nexus and addressing the underlying cultural drivers is therefore essential to expanding clean energy access and to incentivizing a permanent removal of the traditional chulha. Choudhuri and Desai (2020) reassert this through their finding that increased access to salaried work among women and subsequent control over household expenditure is positively associated with increased use of clean fuel – reinforcing the energy transition theory correlating the socio-economic standing with increased adoption of clean fuel – as seen through a gendered lens. They further note that

three dimensions of gender equality in particular affect household level energy decisions – the employment status of women; the decision making power of women within households and women's mobility to travel along outside their homes (Choudhuri and Desai, 2020). Furthermore, Kishore and Spears (2014) find that a child's sex is also linked to a household's fuel choice and indicate that if the household's first child is male, the household is more likely to use clean cooking fuel as compared to households wherein the first child is a girl. While this study studies households in urban India, a similar study in rural India, is likely to only reassert the status quo, given the deep and stringent patriarchy in rural households.

Fuel stacking

While LPG ownership increases between 2015 and 2018, Jain et al. (2018) also observe an increase in fuel stacking referred to as the practice of using multiple cooking fuels. Vyas et. al. (2021) find that in rural north India despite the access to LPG fuel, as a result of the government driven PMUY initiative, poor and rich households alike continued to use solid fuels, and indicate that non-economic factors may have a key role in play in explaining cooking fuel choice. The link between rural India being largely an agrarian society, gender inequality and the persistent use of solid fuels as pointed out by Vyas et. al (2021) is particularly important to understand why having access to modern fuels like LPG does not lead to abandonment of the traditional fuels. Using agricultural residue and dung cakes, that are naturally produced while farming and animal husbandry, and can be accessed at no monetary cost, are bound to be preferred to LPG cylinder that need to be purchased. Therefore, households that depend for subsistence on agriculture and animal husbandry are less likely to use LPG.

Opportunity cost and low literacy

Another dimension linking patriarchy to fuel choice, is that women in stringent patriarchal structures may be discouraged to engage in wage labor that increases the opportunity cost of their time to collect solid fuel for cooking. Vyas et al. (2021) find that those women who did engage in wage labor generally belongs to households that do not depend on agriculture for their living, and such women were marginally more likely to choose gas.

A lack of sufficient knowledge and information about health and a general lack of literacy, particularly in rural India also influences fuel choice. Vyas et. al (2021) find that women prefer food cooked on a chulha reasoning that the taste is better and the food cooked over a traditional cookstove is healthier as compared to gas. Such positive attitudes, in relation to taste and health, point to the lack of public information on the issue, in rural India.

Religious factors

Singh et al. (2020) find that socio-religious factors also play a key role in determining a household's fuel choice. The authors find that not only does income and education levels in households influence fuel choice, but also the caste of the household – household belongs to a Scheduled Tribe (ST), ethnic groups identified as socially and economically disadvantaged, faced the issues of accessing LPG gas whereas upper caste Hindu households choose traditional fuels, on grounds of affordability or preference in taste for traditional fuels (Singh et al., 2020). Saxena & Bhattacharya (2018) explain that most Scheduled Tribes (ST) as well Other Backward Classes (OBCs) – comprising of castes that are socially and religiously disadvantaged, reside in remote areas close to the forests and away from economically vibrant regions, and have very limited access to LPG. Additionally, Muslims, a religious minority in India, are also disadvantaged, as they continue to be discriminated against in formal education and employment, reducing both access to LPG and the ability to afford it (Robinson, 2008;

Singh, 2010). Upper-caste Hindu households, on the other hand, are observed to either be fuel stacking or having transferred to LPG for cooking (Singh et al., 2020). The trend of adoption is particularly stark between developed states and least developed states - in least developed states, with the exclusion of upper caste Hindu households, nearly 90 percent of the households use traditional fuels, and in rural areas in particular, the inequality between disadvantaged socio-religious and upper caste Hindu households in terms of access to LPG and affordability of LPG, is noticeable (Singh et al., 2020). Furthermore, education levels among women in Muslim households had a lesser impact on fuel choice as compared to those belonging to other socio-religious households (Singh et al., 2020). The research by Singh et al. (2020) clearly indicates that the household's religion, caste as well as whether the household is based in a developed or a least developed state has a profound impact on fuel choice.

This section concludes that while the Government of India's subsidy program lead to widespread increase in ownership of LPG stoves, it did not necessitate sustained usage and repeated purchase of LPG cylinders. This explains that supply-side efforts of providing subsidies has only limited short-term impact but does not motivate any long-term behavioral change. To influence behavior, the government would need to engage in consistent and frequent campaigns to question entrenched patriarchy and its impact on fuel choice.

Section 2: Challenges and opportunities for LPG governance in India

An analysis of any energy system governance mandates a deeper understanding of both supply-side and demand-side research and the varying conditions within which diverse stakeholders act. This paper will focus on understanding the LPG industry governance structure in India and how it has evolved over the last 70 years, and presents the constraints and opportunities for improved adoption among rural women in the current governance paradigm.

Innovation in the public sector faces unique challenges. Struggling with scarce resources, a lack of innovation capacity and pressures to deliver public value, the aversion to risk-taking is high within the bureaucratic structures of the public sector (Windrum & Koch, 2008; De Vries et al., 2016; Green et al., 2014; Hoods & Peters, 2004; Bommert, 2010). The liquefied petroleum gas (LPG) industry in India has continued to grow over a period of seven decades, and currently has 280 million active consumers and 18000 distributors notwithstanding a large and complex network of LPG plant producers (Agarwal et al., 2021). This growth is the result of interactions and efforts between varied actors responding to unique consumer needs and challenges that have shaped each evolutionary period, distinctly (Agarwal et al., 2021). Any public sector effort in the area of energy systems is driven by an underlying need for profitability and sustainability, and on building value creation, which then enables a supply-side capture (Priem, 2007; Teece, 2010; Priem et al., 2018). Agarwal et. Al (2021) point out to significant gaps in the understanding of how governments can create value, capture and appropriation whilst meeting the expectations of varied stakeholders and actors and find that "supply-side value capture, demand-side value creation, and value appropriation over time" are key factors that underline energy system governance (p.4). Over a period of seven decades, the Indian LPG industry has made several interventions on the supply and the demand side and experimented with various business models. Studying the Indian public sector-run LPG supply chain, calls for a deeper understanding of various political, legal and commercial exploitation risks that accompany such transitions in the energy sector (Agarwal et al., 2021; Murray & Elston, 2005). How value is captured and created in a network depends largely on underlying frameworks, also defined as business models (Shafer et al, 2005).

LPG's progression in India

Using data on sales and subsidy, number of LPG consumers and distributors, Agarwal et. Al (2021) follow the scientific progress made in the Indian LPG industry and its impact on economic and social change, in four distinct phases between 1995 and 2013 –

In 1995, the supply of LPG began in India, and this period, defined as Period 1, by Agarwal et al. (2021), continues till 1970. The second period, Period 2 starts in 1970 when the Government of India introduces the subsidy program for LPG supply. This period continues up until 2002. The subsequent period called period 3 starts in 2003 and continues until 2011 wherein the subsidy program is dismantled. It is in 2012 when the Government of India introduces the capping and the direct benefit transfer of LPG subsidy, that the fourth period commences. What distinguishes one phase from another is the way in which LPG was provided and managed (Agarwal et al., 2021).

Two enterprises, Burmah-Shell and Stanvac companies took to producing the clean domestic fuel LPG in 1995 at their refineries in the state of Maharashtra, in West India (Agarwal et al., 2021). Packaged in cylinders, LPG was delivered door-to-door among towns surrounding the refinery, wherein the distribution and consumption of LPG was a transaction between consumers and the monopolistic public sector oil companies – a period described as one where "suppliers determined their selling price based on market pricing based on production and logistics costs with no government subsidies" (Agarwal, 2021, p.5). Unlike the first period, the second period was underlined by government control wherein an increased demand for LPG led to the introduction of nationalized oil marketing companies (OMC) and an overall expansion of LPG across India (Nautiyal, 2013). This nationalization led to the introduction of an administered pricing mechanism (APM), that enforced price controls using a 'cost plus basis' mechanism (Agarwal et al, 2021; Moore, 2005).

The third period was characterized by deregulation and a dismantling of the APM with the introduction of the subsidy regime, resulting in a drastic increase in LPG consumption from 64 million to 126 million by 2011 (Agarwal et al., 2021). However, the impact of increased adoption meant a ballooning of the LPG subsidy that rose to approximately $900 USD, and the widening gap between the prices of subsidized and commercialized LPG invited an illegal market to emerge – that used domestic LPG for commercial purposes (Agarwal et al., 2021). This had a cascading effect on distribution and consumption – increased financial and organizational strain affected the supply chain and induced a deterioration in the quality of service, making it difficult to expand services across urban and rural India (Agarwal et al., 2021).

The final phase was a response to these challenges and took shape in the form of Project Lakshya, launched in June 2012, and PaHal in June 2013, that introduced multiple initiatives to digitalize the interactions between LPG distributors and OMCs, develop a unified consumer database to cap the number of subsidized cylinders per consumer household, to ensure direct subsidy delivery into consumer accounts and to encourage middle and higher income households to give up subsidies and buy LPG at market price (Agarwal et al., 2021). Integrating technology in the LPG distribution improved LPG governance and led to the emergence of a new government-industry business model. In each of these phases, stakeholders – OMCs, distributors, consumers and the government, shared distinct collaborative relationships with each other to meet the production, delivery and supply of LPG across India (Agarwal et al., 2021). We observe through these phases that when the consumer base was small and a direct relationship existed between oil suppliers and consumers, cost of fuel was low and the distribution network reliable. As the consumer base grows from urban to rural, the government is incentivized to induce price controls, control supply through subsidies and nationalize OMCs. Invariably, continued use of LPG led to increased subsidy burden for the government,

ballooning costs for the OMCs and reduced service delivery for the consumers. We also observe that as digital technology is integrated into the overall distribution and governance of LPG, the fuel is restored as being affordable and reliable. With the introduction of market pricing, a more stable cost of operations was assured to the OMCs and distributors, and improves oversight of LPG supply and quality (Agarwal et al., 2021).

It can be seen how different phases bring a new routine between government, industry and consumers as they strive to create, capture and appropriate value (Pentland et al, 2012; Sorensen & Torfing, 2011). We note from a governance perspective, it is key to observe and notice shifting roles of government and industry as they transition from "enabling value creation to enabling customer value capture to value appropriation" (Agarwal et. Al, 2021, p.7).

Applying this understanding to the issue of adoption of LPG among women in rural India, we find that targeted policy interventions, and closer partnerships between distributors of LPG in rural India, banking institutions and women customers can help tighten the governance structure focused on improving adoption. There is a need to "balance supply-driven and demand-led interventions across evolving industry and consumer actors to position value generation across creation, capture, and appropriation" (Agarwal et al., 2021, p.12).

Under-representation of women in energy governance

Rao et al. (2020) find specific constraints related to infrastructure and distribution policies among rural communities constraining adoption of LPG and reveal gaps in "workforce training, infrastructure, and interface of the technology with social norms" (p.1). In particular, despite women being primary beneficiaries, it has been found that women are largely underrepresented within energy governance systems (Rao et al., 2020). The Pradhan Mantri Ujjwala Yojana (PMUY), the scheme introduced by the central government in India to

transition towards clean energy, while targeted in its intent, may need to do more to improve adoption of LPG among rural women in India. Rao et al. (2020) observe that LPG dissemination in rural India is often managed by private distributorships that are set up under public or private gas companies. Given that such private distributors are mostly tasked with interacting with rural women, their contribution in improving adoption is key. However, several constrains may need to be addressed to improve the last mile distribution to improve adoption. Rao et al.,(2020) find that personnel engaged in distribution are not adequately trained in consumer interaction or safety training and that there are discrepancies in training norms that were not uniform across agencies. Furthermore, lack of sufficient infrastructure, such as poor road conditions, absence of adequate human resources for delivery, the high price of refills and the incidence of subsidy fraud and deception wherein – consumers buy LPG at subsidized rates and resell it at market prices were seen as key constraints in maximizing the benefits of current schemes and policies (Rao et al., 2020).

This section concludes that a strong energy governance system intending to improve adoption of LPG among rural women in India must be designed carefully to ensure that all actors – distributors, agencies, and women are incentivized through shared gains, and that information flows are robust at the last-mile. It may further be deduced that greater representation of women in the governance of energy systems will likely improve gender-focused outcomes, especially in the case of improved adoption of LPG among women in rural India.

Section 3: Policy recommendations for mass adoption of LPG among women

3.1 Short-term policy options

Addressing last mile challenges

Section 2 of this paper has indicated several last mile issues inflicting the adoption of LPG in rural areas, particularly the lack of a targeted approach to win the confidence and support of women. While the PMUY scheme was targeted towards women, and it increase the adoption of LPG in households, it could not incentivize sustained usage of a LPG and a full transition from biomass fuels. Akter & Pratap (2021) share evidence that a women's autonomy and participation in decision-making has a significant impact on the adoption of LPG, and LPG refill. This insight is particularly relevant in designing last mile distribution of LPG, particularly given that LPG refill accessibility is seen to have a positive correlation with LPG refill frequency (Akter & Pratap, 2021). A keen insight that Akter & Pratap (2021) share is that when LPG refill is available via door-to-door delivery, women are more likely to refill, as compared to when women have to physically collect LPG refill cylinders from the stores. Due to inadequate LPG distribution centers in remote areas, the travel time discourages women from continued use and it may be perceived as more time-consuming than collecting traditional fuels(Akter & Pratap, 2021). It may therefore be prudent to improve the number of distribution centers for LPG refills and door-to-door deliveries be made more readily available to improve adoption among women in rural areas.

Complement capital cost subsidies with improving women beneficiaries under MGNREGA, India's rural employment generation scheme

Capital subsidies, as experienced in the case PMUY scheme, are not sustainable solutions in the transition towards clean energy. While they do increased adoption, they do not incentivize sustained usage. LPG adoption may have increased across India, but LPG refill

remains dismal. Thomas et al. (2022) finds that when disposable income of poor households increases, they are more likely to transition to cleaner fuels. Taking the example of India's employment generation scheme – Mahatma Gandhi National Rural Employment Guarantee Act, (MGNREGA), guaranteeing 100 days of employment to rural households, Thomas et al. (2021) finds that the more employment a district has, the greater the purchasing power of households in those districts, the greater their propensity to transition to LPG. Yasmin & Srinivas (2020) echo the findings, and find that the scheme helped in addressing food insecurity and improved purchasing power, in addition to ensuring equal wages for both genders. Given this, the government should focus on increasing the percentage of women beneficiaries to improve the purchasing power of rural women in particular, and thereby helping them assume greater decision-making power over fuel choice.

It may also be beneficial to enhance the subsidy program, such that it rewards and incentivize refills and sustained usage through cash transfer programs.

Transitional measures to reduce health and environmental damage

A key impediment in adoption of LPG in rural areas is that of opportunity cost. The free availability of firewood in rural areas with little to no initial cost, makes the incentives to transfer to LPG, weak (Singh et al., 2020). In addition, the acquired taste preference for food cooked on firewood over LPG, can only be altered over time (Singh et al., 2020). In this context, Singh et al (2020) find that an alternative would be to improve the quality of chulhas, such that they are environmentally less hazardous and more efficient, while continuously expanding the distribution network for piped gas, which is relatively weak in India, as compared to other developed nations (Saxena & Bhattacharya, 2018). Such short-term measures may ease the transition towards large-scale energy transformation, and in small but significant measures begin to influence behaviors and attitudes towards fuel choice.

Public Communication measures to influence women and men in rural India

Kalli et al. (2022) find that one of the significant challenges the beneficiaries of PMUY scheme share is the lack of adequate information on the documentation required to access the subsidy scheme, and a general lack of awareness of the benefits of accessing such schemes. In the immediate short-run, it may be beneficial to expand public communication measures to inform the rural populations of the current subsidy and employment generation schemes and assist them in taking full advantage of the social protection and welfare services already in place. Public communication measures could also further enhance the awareness of the transition and target women in particular by leveraging communication mediums that women are more exposed to. For example, most women in rural areas may not own a phone, or may not be literate so communication via phones and written materials may not be as effective, as door-to-door communication and leveraging community radio and meetings.

3.2 Medium-term policy options

Influencing behavioral change

Akter & Pratap (2021) focus the issue of improved adoption of LPG on women's welfare, and argue that the reduced time in fuel collection and cooking as well as a relatively easier cooking experience is likely to improve the propensity women's preference for LPG. However, they argue that in the absence of women's autonomy in household decision making, these positive externalities will have little to no impact in driving the transition towards LPG (Akter & Pratap, 2021). This indicates that there is a large social and cultural issue that must be addressed for a complete transition from traditional fuels to LPG. Behavior change strategies must be carefully curated, planned and implemented at the local, provincial and state levels,

concurrently. These strategies can include using mass media channels like radio, television and local language newspapers that have a strong penetration rate in rural areas, to consistently share information and knowledge about both the costs of continuing the use of Chulha and the benefits of transitioning to LPG.

Reducing cost of LPG

Powell et al. (2021) critique the recent increase in LPG prices, and the gradual phasing out of the subsidy program, arguing that by focusing purely on connections, the government is threatening any substantial and sustainable measure of energy transformation in India, and disincentivizing the transition to clean fuels. The authors suggest that energy access programmers must be instructional used for long-term gains, and not leveraged as a tool for populism politics (Powell et al., (2021). In this context, India's energy transformation mandates that LPG, as a common public good, be made more affordable, such that it improve LPG refills, and the subsidy program not only be continued but expanded further to improve access and reduce costs, especially for rural communities.

Encouraging women's autonomy and participation in household-decision making

Gould & Urpelainen (2020) find that women's autonomy and decision-making power in households can significantly improve the LPG adoption and LPG refill usage in rural areas. While women's autonomy is a deeply complex, multi-dimensional issue, targeted efforts can be made to empower women to assume greater participation in household decision making. This will mandate systemic and structural changes to improve access to education and skilling among women, such that their participation in the labor force increases. Previous literature in this paper has indicated that women who are financially independent are more likely transfer to LPG as compared to those who are either unemployed or depend on agriculture for their

livelihoods. An increase in education among women, will also help in improving awareness about health and the environment among women, that can be transferred to children and young adults, and can bring long-term benefit in improving generation adoption of cleaner fuels. If formal education systems are unable to reach remote rural areas, skilling, re-skilling and up-skilling facilities be made available to make women employable outside of agricultural roles. This will aid in increasing the opportunity cost of using traditional fuels and will incentivize more women to take to LPG adoption and refilling. Making women financially independent, especially in rural areas is key to women's autonomy, and efforts must be made to increase women's labor force participation rate, through structural policies and institutionalized partnerships between the public and the private sector. Furthermore, women's welfare gains in transitioning to LPG are seen as direct and immediate (Akter & Pratap, 2021). Given that women disproportionately undertake unpaid care work, reducing the time in traditional fuel collection, can make women's time available for pursuing education, skilling or alternative employment.

Therefore, for a systemic and sustainable transition from traditional fuels to LPG, structural issues of lack of education and employment, and improving women's economic participation must be addressed.

Improve local data collection and distribution at the intersection of women and energy governance

Limited data is collected, reported, monitored, evaluated and published that sits at the gender and energy governance. As the clean energy governance agenda is decentralized, resources must be invested in local data collection and sharing. Some of the gaps may exist only in distribution, where data may be available but not distributed due to lack of sufficient time or resources to publish the data. In some cases, data exists in a fragmented form across

line ministries but no consolidation effort has been made. In others, the data has simply not been collected. This lack of data limits exhaustive policy-measures to address a systemic issue and makes them particularly, gender-blind. For example, the LPG sales data, consumer purchase history and consumer demographics data, can converge to reveal data insights that would be valuable for large-scale impact evaluation. Given the limited capacities of local, provincial and state governments, a nodal data agency must be deployed to institutionalize and standardize data collection that is gender-oriented.

Most of the data on LPG penetration is linked to the LPG connections owned by households, which fails to take into consideration sustained usage metrics. To ensure that future policy measures are focused on addressing the issue of repeated use through LPG refills, it may benefit to ensure that the metrics on LPG penetration consider refills and repeated use as a measure.

Decentralizing energy governance and including women in clean energy value chain

Decentralizing energy governance and improving the representation of women at the local, provincial and state level is key to improving mass adoption of LPG in rural settings. Making the transition from traditional to clean fuels bottom-up, instead of top-down will lead to green jobs creation and improve employment opportunities of women. Women must not only have greater decision making power within households, but also in policy, as greater representation will assure women-oriented policy decisions. Women's representation must be institutionalized in the energy governance ecosystem, such upstream policy measures and downstream implementation efforts are gender forward.

Conclusion

This paper concludes that for a full transition from traditional fuels to clean fuels like LPG, women's participation and representation in household decision making as well in the energy governance ecosystem must be substantially enhanced. Continued efforts through subsidy programs by the Government of India, have increased the number of LPG connections in households, but have failed to incentivize LPG refills. To address the issue of repeated usage and for a sustainable energy transformation, the government will have to institutionalize a gendered-approach, in policy and implementation, to increase adoption as well as to improve governance. Policy recommendations indicated in this paper, can serve as a baseline for similar efforts in other country contexts that may be transitioning from traditional fuels to clean fuels.

References

Agarwal, R., Mittal, N., Patterson, E., & Giorecelli, M. (2021). Evolution of the Indian LPG industry: Exploring conditions for public sector business model innovation. *Research Policy* (50), 1-18. https://doi.org/10.1016/j.respol.2020.104196

Akter S., & Pratap, C. (2022). Impact of clean cooking fuel adoption on women's welfare in India: the mediating role of women's autonomy. *Sustainability Science*, 17, 243 – 257. https://doi.org/10.1007/s11625-021-01069-9

Bommert, B. (2010). Collaborative innovation in the public sector. International Public Management Review, 11 (1), 15–33. https://journals.sfu.ca/ipmr/index.php/ipmr/article/view/73/73

Choudhuri, P & Desai, S. (2020, August 20). Gender inequalities and household fuel choice in India. Journal of Cleaner Production. 265. https://doi.org/10.1016/j.jclepro.2020.121487

Fullerton, D. G, Bruce, N, & Gordon, S. B. (2008, September). *Indoor air pollution from biomass fuel smoke is a major health concern in the developing world*. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2568866/

Gould, C., F., & Urpelainen, J. (2020) The gendered nature of liquefied petroleum gas stove adoption and use in rural India. *The Journal of Development Studies*, 56 (7), 1309–1329. https://doi.org/10.1080/00220388.2019.1657571

Gould, C.F., & Urpelainen, J. (2019). The Gendered Nature of Liquefied Petroleum Gas Stove Adoption and Use in Rural India. *Journal of Development Studies.* 56 (7), 1309 – 1329. https://doi.org/10.1016/S0305-750X(00)00076-0

Green, R., Roos, G., Agarwal, R., & Scott-Kemmis, D. (2014). Shaping the Future Through Co-Creation. *University of Technology Sydney and Institute of Public Administration Australia*.

Hiemstra-van der Horst, G. and Hovorka, A. J. (2008). Reassessing the energy ladder: Household energy use in Maun, Botswana. *Energy Policy*. 36 (9), 3333-3344. https://www.sciencedirect.com/science/article/pii/S0301421508002280

Hood, C.C., & Peters, G.B. (2004). The Middle Aging of New Public Management: Into the Age of Paradox? *Journal of Public Administration Research and Theory, 14*, 267-282. DOI: 10.1093/jopart/muh019 https://apps.who.int/iris/bitstream/handle/10665/42770/9241580313_eng.pdf

Kalli, R., Jena, P.R., & Managi, S. (2022). Subsidized LPG scheme and the shift to cleaner household energy use: Evidence from a Tribal Community of Eastern India. *Sustainability*,14, 24-50. https:// doi.org/10.3390/su14042450

Kishore, A. & Spears, D. (2014, July). Having a son promotes clean cooking fuel use in urban India: women's status and son preference. Economic Development and Cultural Change. 62 (4), 673-699. https://doi.org/10.1086/676330

Masera O.R., Saatkamp B.D., & Kammen D.M. (2000). From linear fuel switching to multiple cooking strategies: a critique and alternative to the energy ladder model. *World Development*. 28 (12), 2083–2103. https://doi.org/10.1016/S0305-750X(00)00076-0

Ministry of Health and Family Welfare. (2015). *National Family Health Survey* (NFHS-4) http://rchiips.org/nfhs/nfhs-4Reports/India.pdf

Moore, M. (2005). Break-through innovations and continuous improvement: two different models of innovative processes in the public sector. *Public Money & Management*, 25 (1), 43–50.

Murray, S. F., Elston, M.A. (2005). The promotion of private health insurance and its implications for the social organisation of health care: a case study of private sector obstetric practice in Chile. *Sociology of Health & Illness* 27 (6), 701–721. https://doi.org/10.1111/j.1467-9566.2005.00470.x

Naeher L., Brauer M., Lipsett M., Zelikoff J., Simpson C., Koenig J., & Smith K. (2007). Woodsmoke health effects: a review. *Inhalation Toxicology*. **19**:1, 67-106. https://doi.org/10.1080/08958370600985875

Nautiyal, S. (2013). A transition from wood fuel to LPG and its impact on energy conservation and health in the Central Himalayas, India. *Journal of Mountain Science*, 10 (5), 898–912. https://doi.org/10.1007/s11629-013-2698-1

Office of the Registrar General & Census Commissioner. (2011). *Houselisting and Housing Census Data Highlights*. (2011). http://www.censusindia.gov.in/2011census/hlo/hlo_highlights.html

Pentland, B.T., Feldman, M.S., Becker, M.C., & Liu, P. (2012). Dynamics of organizational routines: a generative model. *Journal of Management Studies*, 49 (8). https://doi.org/10.1111/j.1467-6486.2012.01064.x

Powell, L., Sati. A., Tomar, V., K. (2021). LPG subsidies: A quiet phase out?. *Observer Research Foundation*. https://www.orfonline.org/expert-speak/lpg-subsidies-a-quiet-phase-out/

Priem, R., L. (2007). A consumer perspective on value creation. A*cademy of Management Review*. 32 (1), 219e235. https://doi.org/10.5465/amr.2007.23464055

Priem, R.L., Wenzel, M., & Koch, J. (2018). Demand-side strategy and business models: putting value reviewer 3 creation for consumers center stage. *Long Range Planning*. 51 (1), 22–31. http://dx.doi.org/10.1016/j.lrp.2017.07.007

PRS Legislative Research. (2019). *CAG Report Summary: Pradhan Mantri Ujjwala Yojana.* https://prsindia.org/policy/report-summaries/pradhan-mantri-ujjwala-yojana

Rao, S., Dahal, S., Hadingham, S., & Kumar, P. (2020). Dissemination Challenges of Liquefied Petroleum Gas in Rural India: Perspectives from the Field. *Sustainability*, *12*(6), 2327. https://doi.org/10.3390/su12062327

Robinson, R. (2008). Religion, socio-economic backwardness & discrimination: The case of Indian Muslims. *Indian Journal of Industrial Relations*, 44(2). https://www.jstor.org/stable/i27768183

Saxena, V., & Bhattacharya, P. C. (2018). Inequalities in LPG and electricity consumption in India: The role of caste, tribe, and religion. *Energy for Sustainable Development*, 42,44–53. https://doi.org/10.1016/j.esd.2017.09.009

Shafer, S.M., Smith, H.J., & Linder, J.C. (2005). The power of business models. *Business Horizons*, 48 (3), 199–207. https://doi.org/10.1016/j.bushor.2004.10.014

Singh, R. (2010). Citizenship, exclusion & Indian Muslims. Indian Journal of PoliticalScience, 71(2), 497–510. https://www.jstor.org/stable/42753712

Singh, S., Ranjan, R., Gonsalves, O., N. (2020). Decomposing the gaps in access to LPG across socio-religious groups in rural India. *Journal of Social Inclusion Studies*, 6(1), 97-112. DOI: 10.1177/2394481120944780

Smith K.R., Mehta S., & Maeusezahl-Feuz, M. (2004). Indoor air-pollution from solid fuel use. *Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attributable to Selected Major Risk Factors*. (1), 1435–1493.

Sørensen, E., & Torfing, J. (2011). Enhancing Collaborative Innovation in the Public Sector. *Administration and Society*, 43, pp. 842–868, https://doi.org/10.1177%2F0095399711418768

Teece, D. (2010). Business models, business, strategy and innovation. *Long Range Planning*, 43, 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

The Lancet. (2020). *Health and economic impact of air pollution in the states of India: the Global Burden of Disease Study 2019*. https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(20)30298-9/fulltext

Thomas, L., Balakrishna, R., Chaturvedi, R., Mukhopadhyay, P., & Ghate R. (2022). *What influences rural poor in India to refill their LPG.* In A. K. Enamul Haque et al. (eds.), Climate Change and Community Resilience. https://doi.org/10.1007/978-981-16-0680-9_13

Vries, H.D., Tummers, L.G., & Bekkers, V. (2018). The Diffusion and Adoption of Public Sector Innovations: A Meta-Synthesis of the Literature. *Perspectives on Public Management and Governance, 1*, 159-176.

Wang, Y. and Bailis, R. (2015, August). The revolution from the kitchen: Social processes of the removal of traditional cookstoves in Himachal Pradesh, India. *Energy for Sustainable Development*. 27, 127-136. https://www.sciencedirect.com/science/article/pii/S097308261500037X?via%3Dihub

Windrum, P. & Koch, P. (2008). *Innovation in Public Sector Services; Entrepreneurship, Creativity and Management.* Edward Elgar Publishing.

World Health Organization. (2021, September 22). *Household air pollution and health.* https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health

Yasmin. K., & Srinivas, B., K. (2020). Impact of Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) on the livelihood security among rural people : A study from Kalahandi District of Odisha. *Journal of Sociology and Social Anthropology*. DOI: 10.31901/24566764.2020/11.1-2.346