



## **Technology Innovation in the Indian Clean Cooking Sector: Identifying Critical Gaps in Enabling Conditions**

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**ABSTRACT**

The health, environmental and livelihood problems resulting from an estimated 2.7 billion people worldwide still depending on biomass to meet their basic energy needs are well known, and have motivated efforts by governments, civil society, entrepreneurs and development agencies to introduce cleaner energy-use practices. Interventions have typically aimed to encourage the introduction of more efficient cookstoves and cleaner fuels, since cooking is the main use of biomass fuels. The disappointing accomplishments of over three decades of activity reflect how difficult this transformation is to achieve at any meaningful scale. This study applies a technical innovation systems framework to better understand the reasons why transformation of the clean cooking sector has failed to occur in India. It looks at the actors in the sector, the rules that govern their behaviour and the status of various essential processes that underpin a vibrant, self-sustaining market. The study, based on a series of interviews with key stakeholders, found that some key types of actor are absent from the clean cooking sector, and that significant gaps and weaknesses exist in all system processes. This knowledge should help to reorient current interventions and thus boost the chances of successful market transformation.



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## EXECUTIVE SUMMARY

The health, environmental and livelihood problems resulting from an estimated 2.7 billion people worldwide still depending on biomass to meet their basic energy needs are well known, and have motivated efforts by governments, civil society, entrepreneurs and development agencies to introduce cleaner energy-use practices. Interventions have typically aimed to encourage the introduction of more efficient cookstoves and cleaner fuels, since cooking is the main use of biomass fuels. The disappointing accomplishments of over three decades of activity reflect how difficult this transformation is to achieve at any meaningful scale.

Literature on technology development and diffusion stresses the importance of certain enabling conditions for innovation, production and market penetration of new technologies. By understanding the most pressing gaps or weaknesses in these conditions in a particular context, we can better direct both policy and technical efforts.

India has initiated a major policy effort, the National Biomass Cookstoves Initiative (NBCI), which aims to foster a vibrant sector for cleaner stoves and fuels. Taking a technological innovation systems approach, this paper describes the structural features of the Indian clean cooking sector – the actors, rules, and material and technical elements that comprise and govern it – and then assesses the health of various processes that are considered essential to the successful development and diffusion of new technologies.

The analysis is based on interviews with a diverse range of actors involved in promoting a clean cooking sector, including stove and fuel developers (entrepreneurs), technical research institutes, civil society organizations, development agencies and the Indian government; and on interviews and observation of cooking practices in rural households in Haryana state, northern India.

### Key findings

Much good groundwork is being done by the Ministry of New and Renewable Energy (MNRE) and other organizations, along with entrepreneurs, to promote clean cooking innovation. However, this report identifies some important gaps and weaknesses in the enabling conditions for technological innovation that could help to explain the very slow progress to date in stimulating widespread uptake and use of clean cooking products.

The MNRE is currently the only ministry involved in the NBCI. It seems a good time to bring in several other parts of the national and state governments that have resources, reach and expertise that could be highly beneficial for the NBCI. The NBCI works with several technological institutes, but other research institutes working in, for example, business, economics and social science could usefully be brought into the sector.

Most entrepreneurs in the sector run small-scale, independent operations. There is little sharing of information between them and, while innovative and committed, they mostly lack experience in the full range of commercial product design, development and delivery to market. They also have great difficulty accessing finance to develop and trial a range of products, and face logistical and financial barriers to bringing their products to potential customers.

Our research calls into question some important assumptions made about the target consumers in the sector – particularly about their ability and willingness to pay for clean

cooking products. Rural households have low awareness about the availability and advantages of clean cooking products. In general, insufficient attention seems to be paid across the sector to the agency of rural households, both in terms of their conscious choices about cooking practices and their potential contribution to product design and marketing.

Financial institutions have shown little interest in lending in the sector. Civil society organizations, which could act as a link between entrepreneurs and rural households, are also notably scarce.

International actors – including the Global Alliance for Clean Cookstoves (GACC) and the German development agency GIZ, both of which are active to some degree already in India – could play valuable roles, particularly in recruiting cross-government support for the sector. However, the GACC in particular needs to address scepticism about its approach in India.

No attempt seems yet to have been made to compile comprehensive information on the sector as a whole, which appears a major knowledge gap that must constrain policy-making and the activities of other sectoral stakeholders.

### **Selected recommendations**

- The vibrancy of technological innovation and market uptake in the clean cooking sector could be enhanced by the Indian government making the promotion of the clean cooking sector a cross-government priority, bringing other parts of government in the NBCI, particularly the ministries of Health, Rural Development, and Environment and Forests, or even expanding the initiative into a National Mission. The GACC and other external actors with good contacts in many parts of the government could aid this process.
- The Indian government could implement or support awareness-raising campaigns for rural communities about the availability and benefits of clean cooking products, and the health and other impacts of inefficient biomass fuel use. It could also signal to entrepreneurs, for instance through its distribution of financial support, the need to emphasize design factors in new cookstoves beyond emission performance in order to make them more attractive for local households.
- The Indian government could consider issuing a formal directive encouraging financial institutions, particularly the regional rural banks, to lend to businesses in the clean cooking sector.
- The Indian government should support research into rural households' ability and willingness to pay for clean cooking products.
- The MNRE should review the financial and other support it gives to the sector, including current plans for carbon finance. Research into households' readiness to pay for clean cooking products would help to evaluate the utility of price subsidies. Possible alternatives include providing seed capital to entrepreneurs and supporting awareness raising for rural households.

## 1. INTRODUCTION

The health, environmental and livelihood problems that result from an estimated 2.7 billion people globally depending on biomass to meet their basic energy needs are well documented. Biomass fuels – mainly wood, charcoal and animal dung – can be time-consuming to collect and expensive to buy. Furthermore, they generate indoor air pollution and associated health problems when burned inefficiently (as they usually are), and in some places are a critical driver of deforestation. There is also growing concern about emissions of black carbon (soot), which is a short-lived climate-forcing agent, exacerbating the regional impacts of climate change.

For these reasons, governments, civil society organizations, technology entrepreneurs, and international development practitioners and funders have for decades sought ways of replacing traditional uses of biomass fuels with more efficient, and cleaner, alternatives. In India, household biomass fuel use is almost all for cooking; hence, interventions have typically sought to introduce more efficient cookstoves, cleaner fuels or both. However, over three decades of such activity have effected little change, reflecting how difficult this transformation is to achieve in practice.

Literature on technology development and diffusion stresses the importance of certain enabling conditions for innovation, production and market penetration of new technologies. In order to make interventions more effective in catalysing change, policy and technical efforts should be directed towards filling the most critical gaps or weaknesses in these conditions. In 2012, SEI in collaboration with the Indian Institute of Technology Delhi (IIT Delhi) carried out a survey of the clean cooking sector, based in Delhi and Haryana state in northern India, seeking to understand how far these enabling conditions are present – and how they could be strengthened in order to achieve the long-sought transformation of the clean cooking sector in India.

### 1.1 Objectives and outline of the paper

This paper presents insights, based on the findings of SEI research, that can guide policy and technical interventions by the Indian Government and others interested in promoting clean cooking in India. It presents empirical analysis of the way in which the market, producer and policy contexts in India support – or fail to support – innovation, product development and market uptake of clean cooking products. Although the evidence comes mostly from interviews with key players in the sector based in Delhi and Haryana, we attempt to draw conclusions and make recommendations that could be valid nationally. Despite the diversity to be found in India, especially in a sector that is so strongly influenced by local traditions and local market contexts, there is enough commonality in many of the overarching features to make a national analysis – while coarse – still useful.

Previous SEI work in northern India has focused on the household-level dynamics that shape cooking practices (Lambe and Atteridge 2012). Here we take a different approach, applying insights from literature on technology innovation to examine the wider context in which efforts to expand the production and use of clean cooking technologies in India take place. We look at both the *structural* and *process* features (as proposed by Bergek et al. 2008) of the present clean cooking sector, and seek to identify those elements and processes that appear most in need of strengthening in order to stimulate the formation of a vibrant, commercially viable market.

Section 2 introduces the theory underpinning our analysis. It looks first at existing literature on technology development and diffusion, particularly in the context of the Indian clean cooking sector. It then outlines and discusses the conceptual framework used in our own analysis. Section 3 presents the results of applying this framework to the Indian clean cooking sector, using data gathered through interviews and through household-level observations of cooking practices. It describes the actors and other structural elements that make up the sector, as well as the status of important technology innovation processes and how they are being supported. Section 4 then focuses on the main gaps and weaknesses in the clean cooking sector, outlining near-term priority actions that would progress the emergence of a viable sector as well as the contributions different types of actor can make to accomplish these.

## **2. ANALYSING SYSTEMS OF TECHNOLOGICAL DEVELOPMENT AND DIFFUSION**

Understanding the gaps and weaknesses in a range of enabling conditions can guide more nuanced – and hopefully more effective – interventions to stimulate a vital clean cooking market. Even though the overarching policy goal remains reducing the negative impacts of biomass burning for cooking, looking at the sector as a “socio-technical system” can reveal a range of policy and technical options that might not otherwise be obvious.<sup>1</sup> In itself, this kind of overview can be useful for energy policy-makers, clean cooking entrepreneurs, project funders and implementers, and other analysts to think about – and discuss with each other – needs in the Indian clean cooking sector.

Our technological innovation system approach does not imply an exclusive focus on the technology as a piece of engineering. Technological innovation is as much a *function* as a *goal* of what we call a technological innovation system. Several of the clean cooking products introduced in India have been innovative and met high technical (particularly emissions) standards, but have failed to find a market because necessary enabling conditions were too weak. Since our interest is in how to transform the broader socio-technical system, we thus look beyond the efficiency and emissions characteristics of the products to for instance how well they make sense culturally and through the prism of the users’ needs and preferences, and to the barriers that make it difficult for entrepreneurs to get new products to markets. We also look at how changes to policy, and to social institutions such as knowledge and education, can be used to create more conducive conditions for technological development and diffusion.

### **2.1 Literature on technological development models and the clean cooking sector**

Simon (2010) uses a “dual adoption framework” to analyse previous cookstove development and dissemination efforts in Maharashtra state, western India. He emphasizes the idea that in the technology development process interactions are bottom-up as well as top-down, an insight from actor-network theory. He also highlights the crucial role of local mediating agents in translating top-down policy directives to households. However, he argues that power relations between the actors ultimately shape the actions and perceived legitimacy of

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<sup>1</sup> A socio-technical system goes beyond processes of technology supply to explicitly incorporate the end users of the innovation (Geels 2004). In other words, it recognizes that both developers and users influence innovation and diffusion processes, and that technological change depends on some degree of social change.

each. This conclusion is echoed by Troncoso et al. (2011), who find that the objectives of funding agencies constrained the work of non-governmental organizations (NGOs) in a Mexican clean cooking initiative.

A number of Simon's other findings are also pertinent to wider Indian efforts to stimulate the clean cooking sector. One is the way that "powerful agencies" influence the sector's ideological agenda by setting objectives pre-emptively during the planning phase of technology development, and the limiting effect this has on the design of both technologies and business models.

Simon also points out that as market-based approaches have replaced centrally planned models of stove diffusion – a change in strategy promoted by international institutions such as the World Bank from the early 2000s – stove prices for consumers have risen. This is in part because subsidies were removed, but also because the government's withdrawal increased transaction costs for individual entrepreneurs associated with marketing, distribution and raw materials. Some entrepreneurs are reported to have subsequently re-oriented away from the "bottom of the pyramid" market towards wealthier consumers.

Furthermore, Simon (2010) describes how the involvement of some powerful actors – even those pursuing a market-driven transformation of the sector – can stifle market development. Citing in particular the Shell Foundation, which previously supported the development of stoves and of business models, he shows how powerful international actors have often given preferential support to a few Indian entrepreneurs, crowding out others. When this happens, success in the market can depend on "special deals and privileges" rather than developing better products that meet users' needs.

Rehman et al. (2012), seeking to understand the failure of numerous interventions to achieve real technical and social change in cooking practices in rural India, apply a "strategic niche management" lens. This approach stresses the need to create "spaces" in which entrepreneurs, "grassroots implementers" and end users can each experiment in the early phases of technology development. They discuss four "niches" as a lens for analytically defining technological development and uptake: (a) technological experimentation, (b) formation of a niche market for the new technology, which in some cases can develop into (c) adoption of the technology to the point where it establishes itself as dominant (i.e. market transformation), and (d) a technology losing its market position and regressing to an earlier phase of development (i.e. it returns to the technological experimentation phase). Arguably, clean cookstoves have never progressed as far as (c) in India. A few may have progressed beyond technical pilots to establish a market niche, but of the two initiatives examined in detail by Rehman et al., neither had progressed to the point of market transformation, or even established a stable market niche.

A number of additional findings in Rehman et al. (2012) are worth highlighting here. One is that the overall stability of the current regime – that is, traditional household cooking practices – is closely connected to cultural habits and norms. The authors argue that to disrupt this stability and nurture innovation in clean cooking, stove designers need to tap further into users' latent needs, which are much broader than reducing emissions and being more fuel-efficient. Their surveys reveal that variables such as stove aesthetics, the taste and quality of the food cooked, and "overall comfort" are important variables that define user perceptions of the benefits of new cookstoves.

Further, Rehman et al. argue that stove production costs need to be reduced (specifically, through further research) in order to achieve the mass adoption of clean cooking technologies, and this will require more creative mechanisms for financial support to the sector.

Other, more general, literature points to an array of factors that could be important at the system level for successful technological development in the clean cooking sector. Shrimali et al. (2011) look at stove businesses themselves to identify which features might be most critical as “independent variables”. Among their findings, the authors offer several interesting insights about the role of (and need for) finance in the sector. Firstly, they identify access to start-up capital for entrepreneurs as a critical challenge, and one of the strongest explanatory variables in the relative success of different organizations in creating a viable enterprise and market. Secondly, their data call into question commonly held assumptions about the need for consumer subsidies – although stove price is important, it was not deemed a major issue by any of the 12 businesses they interviewed (which included both large multinational initiatives and smaller artisanal approaches).

Reflecting on the experiences of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ, the German development cooperation agency), with clean cookstove interventions around the world, Keez and Feldmann (2011) suggest four primary reasons for the relative success of a GIZ-funded programme in Uganda: the affordability and convenience of the technology itself, the way in which local actors and economies are involved in production and distribution (arguing that creating local value chains has a positive effect), a robust monitoring system to ensure product quality, and widespread political buy-in to the initiative, in order to help massively increase the availability of public resources. The authors also suggest that the most critical roles for public resources, and particularly for international development organizations, generally include supporting campaigns to raise awareness among potential consumers, as well as working to mainstream the clean cooking agenda within national governments.<sup>2</sup>

### **2.2 Governance of innovation**

There are still unanswered questions about how governance should be arranged in the household energy sector. “Governance” here includes public policy as well as underlying institutional arrangements and capacities for societal coordination (Pierre and Peters 2005). This lack of clarity about how to arrange governance is not unique to the sector but concerns technological diffusion much more broadly.

The traditional “S-curve” for change and market development in technology systems has been used as a basis for identifying different governance needs, suggesting that they change as technologies move from pre-market development phases through to niche markets and scaling up (Azar and Sandén 2011; International Energy Agency 2011). For instance, early-stage technologies may need technology-specific support schemes, along with protected spaces for experimentation and learning. Here, research and development (R&D) investments, technology partnerships and technology-specific niche-market measures can have important roles to play. In the more mature technology phase, governance based on broader market efficiency appears more appropriate. Under these schemes, different technologies will have to

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<sup>2</sup> Keez and Feldmann (2011) also suggest donors could support the development of technologies but are not specific on the key question of how this should be done or about whether there are certain roles donors should not play in supporting technology development.

compete under equal market conditions, so governance would preferably focus on compensating for externalities.

### ***Applying the technological innovation system as a conceptual framework***

Our own analysis has its basis in the study of processes and structures in technological innovation systems. Technological innovation systems are socio-technical systems that aim to promote the development, diffusion and use of a particular technology (Bergek et al. 2008). “Technology” can here refer to a field of knowledge, such as rural energy, or to specific products, such as cookstoves (Carlsson et al. 2002). A technological innovation system can cut across national, regional and sectoral boundaries (Markard and Truffer 2008; Hekkert et al. 2007).

Technological innovation systems are often defined by their *structural elements* – actors, rules (which could range from legislation to cultural norms to policy initiatives such as the NBCI), and material and technical elements. *Actors* can be individuals but are often organizations and networks, such as firms, universities, authorities and NGOs, as well as less formal associations. They can relate to the studied technology in various ways, for example as suppliers, producers, users or policy-makers. *Rules* (or *institutions*) delineate what actors can and should do, and how they interact in networks and use the material and technical elements. *Material and technical elements* include the physical artefacts, such as infrastructure, machines, equipment and natural resources.

The analysis of purely structural elements has, however, proved insufficient for understanding the determinants of change within innovation systems (Hekkert et al. 2007). To bridge this gap, innovation scholars point to the need to study a number of key *processes* that are deemed necessary for the overall function of developing, diffusing and using a particular technology (Bergek 2002).

A conceptual framework developed by Bergek et al. brings into focus the interplay between structural elements and functions or processes. Derived from the literature on innovation and technology diffusion, they contend that a number of processes are concurrent in a technological innovation system and that they are subject to different barriers and enablers. In this study we focus on six processes deemed critical to the success of technology diffusion in the case of cookstoves, which are summarized in Table 1 (from Bergek et al. 2008; Hillman et al. 2011).

The set of processes described by Bergek et al. (2008) implies a wider variety of roles for governance than traditional technology-support policies have tended to cover, including the formation of networks, government procurement, assured market sales and price stabilization (see, e.g., Edquist et al. 2000; Jacobsson and Bergek 2004; Jacobsson and Lauber 2006).

As Figure 1 shows, these processes in any system are shaped by its structural features – the actors and their networks, rules, and material and technical features – but also by external factors, such as political debates, public opinion, the economic situation or international markets (Hillman et al. 2011). Once initiated, however, the processes themselves also have a direct influence on structural features of the system, such as which actors emerge and how they interact.

**Table 1. Key processes underpinning systems of technology development and diffusion**

<b>Process</b>	<b>Description</b>
Knowledge development and diffusion	Deepening and broadening the knowledge base in the sector. Applies to different types of knowledge (e.g., scientific, applied, marketing), built and disseminated in different ways, and coming from different sources.
Setting strategic direction and goals	The provision of incentives for actors to enter the sector, and to direct their activities towards certain developments (e.g. technologies, applications, or markets).
Entrepreneurial experimentation	The actions of entrepreneurs on the supply side, exploring new technologies and applications with the aim of creating products and services that can generate revenue.
Market formation	The progressive emergence or promotion of markets for the products and services being developed; different sizes and types of market are needed at different stages of innovation.
Legitimation	Building the perception of the technology and its proponents as appropriate and desirable by relevant actors within and outside the sector. Legitimacy is a matter of both social acceptance and compliance with institutions.
Resource mobilization	The mobilization of different resources, including financial (seed and venture capital, equity and debt), competence/human resources in entrepreneurship, management and finance, and other assets such as complementary products, services, infrastructure.

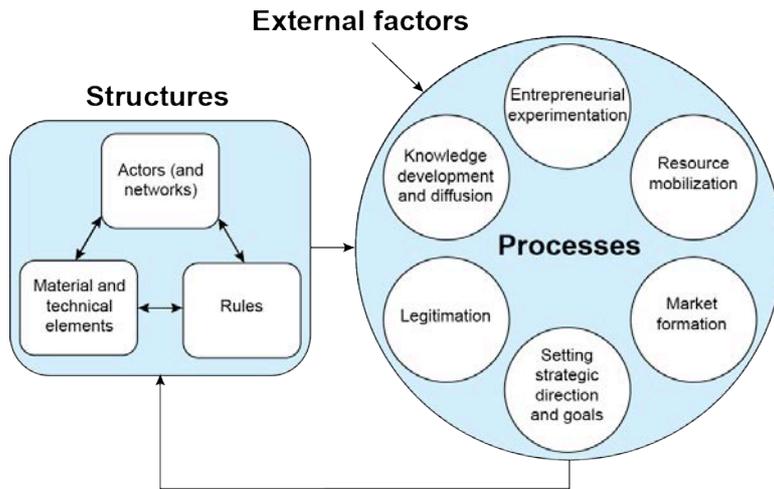
Source: adapted from Bergek et al. 2008, 414-419

When studying the process of technological development and diffusion, the concepts described above have two implications. First, the potential for development, diffusion and use of a technology can be assessed by how well the key processes are served. Second, it is possible to design specific governance measures to target and improve processes and structural elements that are particularly weak.

While the technological innovation system framework was developed through the analysis of innovation processes in industrialized countries, it is also useful for understanding the opportunities and barriers for change in developing countries. A typical feature of technology development efforts in developing countries is the imbalance between the weak or absent demand side of the market and the producer (or supply) side of the market, which is where policy interventions tend to focus (Barnett 2008). This pattern is certainly visible in the clean cooking sector in many places. Barnett (2008) stresses that an innovation systems perspective is of great value in developing country settings precisely *because* such enabling conditions for research and development are often weaker.

Hall (2007), reflecting on a lack of progress globally in catalysing an “innovation spiral” in the agricultural sector in developing countries despite decades of attention and experience, argues that an innovation systems approach is a useful metaphor for understanding innovation diversity. Successful innovation requires not only different kinds of knowledge to develop (for example, among producers and users) but also a high degree of interaction between these different kinds of knowledge. It also requires different kinds of capacity and role to be supported simultaneously, rather than focusing on specific elements.

**Figure 1. The relationship between structures and processes in a technological innovation system**



An innovation systems approach has been used to study the development of the clean cookstove sector in Ghana (Agbemabiese et al. 2012). The findings demonstrate the way interactions between the different system processes create feedback loops that function as “motors” of innovation. They also illuminate the roles of different kinds of actor – those carrying out formal research, civil society, financial institutions – have in stimulating the system, and the ways in which each of these is motivated to engage with it.

In the following section, we present the results of applying a technology innovation systems framework to examine the clean cooking sector in India. Undertaking what Barnett (2008) calls a “diagnostic mapping”, we identify significant gaps or points of weakness in the current innovation system.

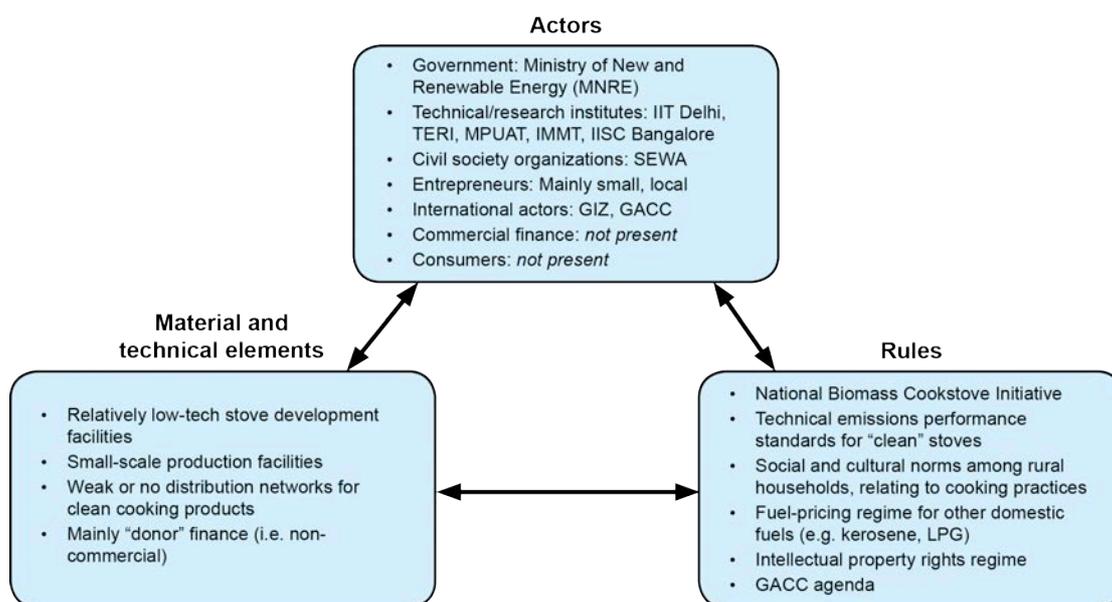
### **3. THE INDIAN CLEAN COOKING SECTOR AS A TECHNICAL INNOVATION SYSTEM**

#### **3.1 Data generation and analysis**

In December 2012, we conducted a series of semi-structured interviews with different kinds of actor involved in the biomass cooking sector in India. These included seven clean cooking entrepreneurs; the Director of the NBCI at the MNRE; two Delhi-based technical and research institutions: IIT Delhi and the Energy and Resources Institute (TERI); and one civil society organization: the Self Employed Women’s Association (SEWA). We also conducted interviews and extended observation in 25 rural households in Haryana state between October 2011 and December 2012, exploring their practices, knowledge and perceptions regarding cooking and the way new technologies of different kinds permeate the rural village setting.

We used their testimony to examine the *structures* and *processes* in the clean cooking sector, and in doing so highlight essential system elements which appear to be either weak or absent. We also took into consideration our own observations of the sector, particularly in relation to the potential users of clean cooking technologies and practices (rural households).

Figure 2. Structural elements of the Indian clean cooking sector



A key limitation of our analysis is that it is based on a relatively small number of interviews, which were concentrated in Delhi (and even though some interviewees came from further afield, most are based in northern India), along with a few villages in Haryana state. In a country as populous and diverse as India, this makes drawing highly robust conclusions about the national context problematic. However, we believe our analysis and conclusions to be broadly indicative of conditions at the national level, and still offer useful insight into some of the key sectoral gaps and needs, and the roles different actors might play in addressing them.

### 3.2 Actors in the clean cooking sector

Figure 2 shows the main structural elements – actors, rules and material and technical elements – of the Indian clean cooking sector, according to the interviewees’ perceptions.

#### Government actors

Within government, the *Ministry of New and Renewable Energy* is the only significant presence. The MNRE is responsible for the design and implementation of the National Biomass Cookstove Initiative, a programme that is intended to catalyse very large-scale growth in the development and dissemination of clean cooking technologies.

Through the NBCI, the MNRE has supported the development of stove performance standards and testing facilities. As of early 2013 the MNRE was supporting a small number of small-scale pilot projects under the NBCI, subsidizing and disseminating particular residential and commercial stove models on a local scale. The ministry intends to expand subsidies to all producers of approved clean stove models, and submitted a Programme of Activities () for clean cookstoves in December 2012, drafted in collaboration with GIZ and the National Institute for Renewable Energy (NIRE), to pursue carbon finance. The POA has been registered by the Clean Development Mechanism (CDM) Executive Board and is awaiting verification.

The MNRE also convenes a Core Committee on Cleaner Cookstoves to discuss emerging issues and strategies. Committee members from within government include the joint secretary

of the MNRE, the director of the NBCI, and a representative of the Planning Commission. Non-governmental members include IIT Delhi and the other testing centres, The Energy Resources Institute (TERI), and several stove producers (who are not voting members).

The central position in the sector occupied by a government entity, the MNRE, rather than for example an industry group, is a reflection of the fact that no functioning commercial market for cleaner stoves and fuels exists, and of the perceived inability of individual entrepreneurs to resource some of the key activities needed to kickstart the sector and encourage growth (see below).

Elsewhere in government, the Planning Commission allocates funds for the NBCI. One interviewee noted that the Five Year Plan for 2013-2018 has set aside resources for scaling up the ambition of the NBCI, pending success in implementing the pilot programmes under the current phase.

Two other ministries were mentioned as starting to show interest in the sector through specific programmes – the Ministry for Human Resource Development had expressed a desire for cleaner stoves in schools, and the Ministry for Women and Child Welfare has a small stove-installation programme in child daycare centres. As mentioned above, the NIRE, an autonomous entity under the MNRE, was involved in preparing the POA for clean cookstoves.

### **Entrepreneurs**

It is unclear how many *clean cooking entrepreneurs* are active in India, since estimates provided by interviewees varied considerably. Some suggested very few (less than 10), others a modest number (anywhere from 20 to 100), while still others suggested that there are in fact a large number of small entrepreneurs many of whom are “invisible” producers fabricating by hand in small rural workshops.<sup>3</sup>

Most clean cooking entrepreneurs were said to work with new stove models, though a few work with alternative fuels such as biomass pellets, and most if not all were said to be small and at a relatively early stage of business development. Some have progressed to the stage of having one or more stove models in specific local markets, but there did not appear to be any with nationwide activities. The more advanced businesses were said to be selling tens of thousands of stoves, which is still a small amount given the potential markets. It was noted by one interviewee that no cookstove currently being marketed in India has achieved commercial viability.

Only a few specific producers were cited regularly in the interviews: First Energy, which was earlier supported by the multinational BP; Envirofit, which was earlier supported by the Shell Foundation; and Philips, which previously marketed an improved stove model but has now withdrawn from India altogether. Predictably, given Simon’s (2010) observation about the distorting role of powerful actors backing individual entrepreneurs, the producers most widely known by name tended to be those linked to larger corporate actors, rather than those who had achieved renown for producing good designs for the Indian context. (However, the Philips

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<sup>3</sup> Stove and fuel entrepreneurs were not distinguished from manufacturers, and it appears at present that designers and producers are often the same people. We therefore use the terms “entrepreneurs” and “producers” interchangeably through the remainder of this paper.

stove does generally have a good reputation among interviewees, and has since been reproduced in similar form by TERI.)

Interviewees consistently indicated that there are few if any stove-specific *distribution channels*. Each entrepreneur has to find a way of delivering products to local markets. They typically do this through contacts with local energy service businesses and other kinds of urban and rural traders, including “ma-and-pa stores”.

### **Technical and research institutions**

A handful of *technical institutions* are active to some degree in the clean cooking sector, primarily in testing the emissions from new stove designs, although there was also some suggestion of them undertaking modest R&D activities. Among these institutions, IIT Delhi was most commonly identified. Beyond the development of performance standards and the establishment of a stove-testing laboratory, IIT Delhi works closely with the MNRE to advise about issues relating to the NBCI and the sector more generally, both through informal channels and also in its capacity as a member of the Core Committee on Clean Cookstoves.

The visibility of IIT Delhi in the data may be partly related to the fact that the interviews were conducted in Delhi rather than closer to other testing centres, but it also probably reflects the fact that due to its location, IIT Delhi has easy access to national government offices in Delhi, and hence is a more active voice. TERI is also present in both a technical advisory role and as a stove developer. Other stove testing centres are at Maharana Pratap University of Agriculture and Technology (MPUAT) in Udaipur, western India; the Institute of Minerals and Materials Technology (IMMT) in Bhubaneswar, eastern India; and, reportedly, the Indian Institute of Science Bangalore (IISc Bangalore), in southern India.

### **Consumers**

*Consumers* were referred to in various ways by interviewees, mostly as either “users” or “purchasers”, but occasionally as “beneficiaries” of new stoves. The latter was most common among government and institutional interviewees. This chimes with a general observation that among certain categories of interviewee there seems to be a pervasive idea that rural people are “recipients” of new technologies – incapable of affording them and unaware of what they need or want – rather than as actors who will respond once producers bring a stove to market that meets their needs and preferences. In economic terms, it ignores the “agency” of consumers.

An obvious feature of the clean cooking sector at present is the enormous latent demand yet the absence of actual demand – in other words, the difference between a potential market and an actual market – which is discussed in more detail below. From the perspective of other actors, the target consumers range from the rural biomass-using poor (the “bottom of the pyramid”) to urban households using liquefied petroleum gas (LPG) stoves. Most appear to focus on the rural poor.

### **Civil society**

There appears to be very little *civil society* engagement with the clean cooking agenda; or at least respondents did not perceive civil society actors as being of central importance at present. It is difficult to draw a strong conclusion, as their involvement may be localized and hence not easily detected through this study. Nonetheless, at the national level, where lobbying and knowledge sharing are important, there appears to be very limited civil society activity. In this category, SEWA, based in Ahmedabad, is the most visible at the national

level. SEWA's current activity is focused on the dynamics of the market rather than specific stoves or fuels, for example on household financing of stoves and novel distribution channels. In late 2012 it hosted a competition to design improved cookstoves, which reportedly attracted more than 300 entries.

### **Financial institutions**

The very limited involvement of *financial institutions* was often cited as a critical gap in the clean cooking sector. No specific institutions were mentioned as active in financing cookstove entrepreneurs.

Interviewees separated the finance industry into traditional banks, focusing on lending larger sums; microfinance institutions, which lend to smaller borrowers, such as rural households; regional rural banks (RRBs), which have a rural presence and are mostly government owned, and can thus be steered by government directives; and venture capitalists or "investors", which were seen as a potential source of funds for scaling up production.

### **External actors**

International institutions such as the *Global Alliance for Clean Cookstoves* (GACC) appear to have had negligible impact on the Indian clean cooking sector. A spread of Indian actors were sceptical about the GACC. In particular, the GACC Secretariat was perceived as promoting a handful of specific technologies; the Envirofit stove was mentioned on several occasions in this regard, and interviewees claimed that the GACC made financial support to NGOs conditional on their promoting this stove model. Interviewees linked this to a perceived conflict of interest, as several members of the Shell Foundation – the original funder of Envirofit in India – now sit on the GACC's board of directors. However, the GACC Secretariat has been seeking greater engagement in India and the GACC could play a more significant role in the sector, provided it is able to allay the concerns about its approach and activities.

The German development cooperation agency *GIZ* works with the MNRE on a number of clean cooking issues, supporting development of the POA for carbon finance and initiating pilot studies to look at new business models for the sector.

### **"Absentees"**

Interviewees cited some other actors that could play important roles in the clean cooking sector but presently do not. These included several *national government ministries*, notably the Ministry of Health, which interviewees pointed out had run successful nationwide awareness campaigns, for example on polio and HIV/AIDS; the Ministry of Rural Development, whose rural distribution networks interviewees said might be exploited to take clean cooking products to local markets; and the Ministry of Environment and Forests, which has responsibility for both climate change issues and local environmental issues.

*State governments* also appear to be inactive, although many have energy departments that interviewees said could play a greater role in awareness raising, among other things. It was noted that the *media* could also play a role in raising consumer awareness, and television and radio advertising were highlighted by rural households as one of the main channels by which they learn about new ideas and technologies.

Some interviewees noted the relative absence of *scientific institutions* besides the technical institutes supporting the NBCI, particularly of institutions that could give scientific input on social and economic or business aspects of the clean cooking sector.

### 3.3 Rules influencing behaviour in the clean cooking sector

The *National Biomass Cookstove Initiative* is the main policy instrument guiding action in the sector. The NBCI currently functions as the channel for the MNRE's activities. However, as a policy structure rather than an actor, the NBCI could be widened to bring in other ministries and develop into a platform for cross-government coordination around clean cooking.

The MNRE, in collaboration with the stove testing centres, is developing a range of *technical performance standards* on emissions and fuel efficiency for stoves. As the intention is to make subsidies available for stoves that meet these standards, the standards themselves act as an incentive for producers to design and market cleaner stoves. Some interviewees suggested, however, that the standards are too narrowly focused on efficiency parameters and therefore that the link between standards and subsidies may also distract entrepreneurs from other design features that are equally important if a commercial market is to be activated and sustained.

The notion of *carbon finance*, including under the Clean Development Mechanism, seems to have had only a minor influence on the sector so far, but could become more influential in future under the POA for clean cookstoves.

The protection of *intellectual property rights* is generally weak in India. There is a prevailing culture of open access to technology, which entrepreneurs said makes it difficult to protect their technologies. They did not cite this as a major constraint, but were concerned that the risk of new designs being copied could deter investors in the long term.

*Culture and tradition* might be described as the dominant set of rules governing the demand side of the market. Cultural and social norms strongly influence household decision making about cooking, and hence in the formation of a market for clean alternatives. This was particularly noted by stove producers, and mirrors our own conclusions drawn from interviews with rural households in this and earlier studies (Lambe and Atteridge 2012).

Government *fuel pricing structures* are of some relevance in guiding decisions by consumers. While they do not cover biomass fuels, the pricing regime for LPG, which keeps LPG prices stable and relatively low, was said to be indirectly influencing market formation and the focus of stove designers, particularly in urban areas.

### 3.4 Material and technical features

Material or technical features of the Indian clean cooking sector most obviously include the dominance of relatively "low-tech" product development by small entrepreneurs, and small-scale production facilities. The traditional clay chulha that is to be found in all rural households is described in Lambe and Atteridge (2012), as are some of the alternative stove designs that have been developed to date.

There is virtually no commercial finance available to entrepreneurs; hence, they rely on funding from non-commercial channels such as aid donors and corporate social responsibility programmes for early-stage development and start-up capital. Finally, as noted above, distribution channels for clean cooking products are virtually non-existent.

### 3.5 System processes

All six of the key system processes introduced in section 2 appear to be weak, causing some major problems and gaps in the functioning of the sector. The most apparent are deficits in knowledge development and diffusion; lack of market formation (particularly on the demand side); a low degree of legitimacy for clean cooking products among target users and within government and the financial sector; and difficulties for producers to mobilize resources, particularly finance and distribution networks.

These essential processes and the gaps are interlinked. For example, if potential consumers do not know what clean cooking products are available, or about the health and other problems that they can mitigate, they will not want to buy them – the products will not be seen as legitimate, and market formation will be suppressed). Similarly, failure to legitimize clean cooking products, and the sector as a whole, within government or the finance sector, makes it difficult to mobilize resources. Conversely, establishment of a stable market can enhance a product's legitimacy.

#### **Knowledge development and diffusion**

*Applied knowledge* of product development is being generated on the ground through the activities of small entrepreneurs. However, these entrepreneurs tend to work independently, and the knowledge is not being aggregated or diffused.

*Scientific knowledge* generation has focused almost exclusively on emissions performance standards and test procedures. One interviewee observed that most stove design was taking place without any rigorous scientific underpinning. Within the sector more broadly there is little input from other scientific disciplines that could add valuable insight, particularly in the social sciences and in business and economics.

A related issue is the lack of a strictly enforced *intellectual property rights* (IPR) regime that could protect technology developers. A more “open source” attitude towards technology prevails in India than is found in than many Western countries. Interviewees also said that the rigorous research documentation needed to register a patent is often beyond the capacity of smaller producers. However, although most producers mentioned difficulties with the IPR regime, none described it as a major problem. Instead, they seek to protect future financial returns through strategies such as strong branding; one suggested that “the trademark is more important than the patent in India”. For now, IPR protection did not seem to be a priority, although it may become so as the market matures.

The government has taken steps to promote knowledge development and diffusion within parts of the clean cooking sector. In addition to generating learning in and around the communities hosting NBCI pilot projects, the MNRE's Expression of Interest call for the pilots apparently requested producers to explain how they would generate learning that could be useful at the national level. The government has also supported the development of the emissions performance standards, procedures and facilities by technical institutes such as IIT Delhi.

Interviewees indicated that consumers, most of them in rural households, learn about new technologies from print and, particularly, radio and television advertising; demonstration showrooms in local markets; neighbours and friends; and from village leaders and other prominent community members. This last group were said to shape how other people in their

community interpret new ideas and technologies, and hence affect not only knowledge but also perceptions of legitimacy.

There are also some specific critical gaps in knowledge and perceptions visible in the sector. *Comprehensive information* about the clean cooking market has never been compiled, which makes it difficult for any actor to get a clear overview of either the current situation or the barriers facing other actors. This is illustrated by the wide range of estimates of numbers of entrepreneurs that are active in the sector.

It is also evident in the suggested priorities different actors offered for stimulating the market. The government sees the main need as certification of technical performance, as a way of establishing the legitimacy of clean cooking products, especially among consumers, while entrepreneurs and civil society organizations stress the need to raise awareness among consumers and overcome distribution challenges, at least in the immediate future. Several interviewees indicated that awareness raising is to be a future focus of the NBCI and has been budgeted for, but said that the government wants to ensure there is a supply of high-quality improved stoves available beforehand – “otherwise what will they raise awareness about?”

Another gap in perceptions between different actors could be settled by research: the need for price subsidies for clean cooking products. In general, public-sector actors – the MNRE, IIT Delhi and TERI – tended to stress the need for subsidies to make the products affordable and attractive. Conversely, entrepreneurs and SEWA saw subsidies as unnecessary or even a hindrance because they distort the market. Even the few entrepreneurs who were in favour of price subsidies did not describe affordability as a major issue. In the household interviews, respondents said that products received for free were not valued, which also speaks against the use of heavy subsidies.

One reason for the discrepancies in understanding may be that the MNRE receives only limited input from entrepreneurs and the target consumers. Most entrepreneurs do not have the resources or connections to engage with the ministry. Furthermore, although several producers are in the Core Committee on Clean Cookstoves, they are probably too few to reflect the range of perspectives and needs across the whole sector, especially given India’s regional diversity. Similarly, civil society – which might otherwise represent smaller producers and consumers – is not strongly engaged, although SEWA participates in the Core Committee. Instead, the MNRE seems to rely most heavily on information and advice from a few technical institutes. These institutes generally do not look at the social or business sides of technology development and, further, most have a regional focus on northern India.

Some interviewees suggested that producers have a poor understanding of consumer decision making around cooking, which has resulted in products being brought to market that are not necessarily attractive to households. It was widely recognized among the interviewees, including entrepreneurs themselves, that clean cookstove design has been supply-driven, shaped by producers responding to a range of potential difficulties they see households might have with traditional practices (e.g. smoke, inefficient fuel use). The lack of interaction between producers means there is little opportunity for them to share their insights and experiences on this matter. Based on the interviews, it appears that producers nevertheless have a reasonably consistent beliefs about consumers’ capacities and constraints (e.g. about their financial capacities).

It was observed that many entrepreneurs lack expertise in developing and managing a small business. Venture capitalists may be able to offer business guidance, but they are unlikely to engage in the sector until the market is stronger.

All of the non-household interviewees said that rural households lacked knowledge about the health and environmental impacts of traditional biomass-based cooking practices and of the available alternatives. In our household-level interviews and observations, it was clear that, while households saw soot emissions as a nuisance – making them cough, blackening walls etc. – they did not see them as a serious health or environmental concern. Most also had little awareness of alternatives to traditional cooking practices. Even those households that were aware of some alternatives – usually electric or LPG stoves, rather than improved biomass stoves or fuels – they had little or no experience of them.

### **Strategic direction and goals**

Entrepreneurs indicated that the main attraction of the clean cooking sector was the size of the *potential market*. Humanitarian and environmental motivations were also evident to a lesser degree. However, while this has motivated some small entrepreneurs the absence of an actual market probably diminishes the incentive for major players to enter the market.

The lack of consumer demand, coupled with limited access to resources, has in the past motivated some producers to focus on selling stoves to the government and NGOs, rather than on developing commercial markets. However, this appears to be changing, at least among respondents in this study, who all stressed a more commercial approach and some of whom argued strongly against intervention in the form of price subsidies.

As described, among consumers there appears to be no strong incentive to enter the market, and as yet no major efforts by government or other actors to activate demand (for instance by raising awareness). Consumers do not describe a need for new cooking practices or technologies and are generally satisfied with traditional practices, despite the fact they do describe factors such as smoke as a nuisance and health problem.

The MNRE's attempts to set strategic direction and goals for the sector have to date mainly taken the form of the technical performance standards.

### **Entrepreneurial experimentation**

The breadth of entrepreneurial activity in the clean cooking sector, including experimentation with design and business models, is somewhat difficult to determine. It is clear that entrepreneurs are mostly small in scale, and as noted, they do not always have technical or scientific knowledge. There is no activity among big players (such as Philips or BP, both of whom formerly experimented with clean stoves in India) who have the resources to really experiment and support methodical, dedicated innovation.

It was commonly stated that entrepreneurs' product design activity has so far been influenced by supply considerations such as the MNRE's focus on technical performance standards, and not on meeting real consumer needs. There has been little consumer-oriented market analysis or research.

Interviewees said that financial constraints make experimentation difficult for small-scale producers. As a result, most entrepreneurs "try one product only" rather than develop a range of products that could appeal to different market segments.

For its part, the government is encouraging stove entrepreneurs to team up with technical institutes like IIT Delhi to improve the technical aspects and emissions performance of their current models, and under the NBCI covers half the cost of this work.

### **Market formation**

Interviewees provided no examples of strong markets for clean cooking products, and it is difficult to find any solid examples anywhere in India. Weak consumer demand is a consistent feature across the sector. Entrepreneurs are thus working to develop products for a future market, but generally lack the capacity or resources to catalyse demand by themselves. How to do this, and what the government should be doing in particular, is one of the central questions in the sector at present.

One interviewee noted that in India, innovations are often first introduced in the southern states, partly because consumers tend to be more open to trying new products and partly because women – who are still overwhelmingly the main household cooks – have more financial independence than they do in other parts of the country.

### **Legitimation**

Clean cooking products suffer from low legitimacy among the target *consumers*. Stove models that have been brought to market in particular locations have often failed to meet consumers' preferences and needs. Stove producers cited users' interest in factors such as "comfort of use", portability, purchase cost, colour, shape, not blackening walls the way traditional practices do, faster burning (which can conflict with fuel-efficiency goals), and economic savings.

An additional problem cited is that stoves are seen as a product for women, while it is the men who make major purchasing decisions in most households – although one interviewee said this would be less of a problem in the south of India, where women often have their own bank accounts and are more financially independent. Interviewees from the MNRE and technological institutions stated that performance testing and certification might help to legitimize stoves, reassuring purchasers that they will meet their expectations.

The clean cooking sector seems to suffer from a legitimacy gap within *government* too. Although the NBCI has an ambitious target, its structure suggests relatively low government commitment. Other energy issues such as solar energy and energy efficiency have been made so-called national missions, cross-government policy priorities. In contrast, the NBCI is essentially a one-man programme within a single ministry. This is a problem because MNRE has only limited capacity in some key areas, such as rural distribution networks and national awareness campaigns. Other ministries have these capacities and – given the broad socio-economic and environmental benefits of more efficient biomass fuel use – relevant interests.

The sector's legitimacy among *financial institutions* is also low. Interviewees noted that financial institutions are reluctant to lend against clean cooking technologies, not least because there is a lack of experience that could help establish the viability of such loans. This makes it difficult for producers to access commercial finance. The weakness of the market makes it unattractive to venture capitalists.

Finally, there are signs of a legitimacy deficit in relation to some *international* actors that might otherwise be well placed to support domestic efforts. The GACC, in particular, is perceived by some as being too "top-down" in its approach, and is also accused of supporting specific technologies which interviewees argue is a role it should not be playing.

### **Resource mobilization**

Both producers and the MNRE clearly suffer from resource constraints. *Producers* struggle to access working capital needed to establish production moulds and to develop a "proof of

concept”, which is needed to attract commercial finance for expansion. Producers indicated that charitable assistance and the money provided through corporate social responsibility programmes were not a sufficient basis to create a viable market, and that they need access to loans. The large response to SEWA’s 2012 stove design challenge suggests not only that there is significant latent entrepreneurial interest but also that these actors have no resources of their own to finance product development.

Besides product development, entrepreneurs need resources (and capacity) for marketing. The huge knowledge gaps among consumers mean that product marketing in the clean cooking sector must establish the legitimacy of clean cooking products as a category, as well as differentiating and promoting individual products.

Producers also face constraints in the lack of distribution networks for getting their products to the consumers. The low awareness about clean cookstoves among other potential distributors means that entrepreneurs must spend their own limited time and resources building up local networks, making “last-mile delivery” costly. In a vibrant market, where sales are more assured, retailers and distributors are more likely to take the initiative to source clean cooking products themselves.

Some, though not all, interviewees clearly assumed that affordability acts as a constraint for consumers. This is the basis of the NBCI’s price subsidies and of calls for making use of carbon finance as an opportunity to provide further price subsidies. However, as noted above, this idea was contested, especially by some producers and by civil society actors, who argued that the government should not be buying stoves nor subsidizing consumer prices. Similarly, in our household interviews, there was an evident readiness to pay for products that met their needs and preferences (and the presence of expensive items such as LCD televisions in these rural households also indicates a capacity to pay for valued items). Although we cannot claim that these households were representative of all rural households in India, or even of those in Haryana, it does indicate the need for a more nuanced understanding of consumers’ willingness and capacity to pay, particularly financing options such as consumer credit.

While the *government* has allocated resources to the NBCI, many interviewees pointed out that the MNRE has limited capacity and expertise by itself to deliver the major transformation that is envisaged by the NBCI.

## 4. DISCUSSION

The findings presented in section 3 suggest that a number of crucial system processes need to be strengthened in order to support technology development and diffusion in the Indian clean cooking sector. In this final section, we present what we see as the most pressing near-term priorities for the sector, and then suggest what could be done by various actors to achieve those priorities.

### 4.1 Near-term priorities for the Indian clean cooking sector

In general terms, the critical needs of the sector can be categorized as: improving knowledge across the sector; reallocating existing resources and mobilizing additional resources (not only financial but also, for example, distribution networks); and improving the legitimacy of clean cooking products, and of the sector as a whole, among consumers and financial institutions

and within government. In order to accomplish these, there is a need to bring new actors into the sector.

Since the processes are inter-related rather than independent, there is no particular logical order in which these needs should be addressed; likewise, the order in which they are presented below does not imply order of priority. Given the limited scope of this study, any conclusions – particularly those about knowledge gaps – should be interpreted as indicative rather than definitive, and point to areas for further exploration.

### ***Fostering knowledge generation and diffusion***

At present, action by different actors is frequently either inhibited or misdirected because of insufficient knowledge. One specific knowledge gap is reflected in the differing perspectives interviewees had on how far affordability is a barrier for households once clean cooking products arrive to market. The current focus on price subsidies under the NBCI is clearly influenced by strong assumptions on this point on the part of the government and other institutions central to the sector. Entrepreneurs themselves rarely if ever emphasized a need for subsidies. Observations during the household-level survey in Haryana also tend to support the latter view.

Interviewees could not cite any robust study of willingness and capacity to pay in the Indian market, suggesting that none has been made. Such a study could provide crucial evidence for the design of future financial support to the sector, and would provide greater confidence that available public resources are targeting the most critical needs.

Our interview findings suggest that the MNRE's knowledge base may be influenced by two significant biases – technical and geographical – and this observation is worthy of further exploration if there is an ambition to make more of the NBCI.

Another major knowledge gap that needs to be addressed is among consumers: they are generally unaware that clean cooking products exist, or know little about how they work or, crucially, what benefits they offer. This suggests a pressing need for large-scale awareness-raising campaigns targeting rural households. Furthermore, the findings of our household-level interviews and observations suggest that such campaigns should not only share knowledge with consumers about the deleterious effects of traditional practices and the availability of alternatives, but at least as importantly should focus on linking wider aspirational ideas to clean cooking, in order to better stimulate consumer interest. If successful, such campaigns could help to legitimize clean cooking products among rural consumers and help with another crucial process, market formation.

What “aspirational” features should be emphasized by awareness-raising campaigns will vary from place to place. This means that the unique characteristics of local and regional markets need to be understood by both organizations carrying out awareness campaigns and by entrepreneurs.

In our household interviews, we did encounter an example of an awareness-raising campaign focused solely on health that had managed to foster behaviour change. This was a campaign encouraging households to buy bottled, treated water as local water supplies were contaminated. However, drinking contaminated water often causes dramatic symptoms within a short time – making it easier to draw the link – whereas the health impacts of stove emissions can take years to appear.

**Mobilizing resources**

There could be value in reorienting the *allocation of existing resources*. There are strong indications that the current limited public financial support available under the NBCI could be better spent. For example, if, as our findings suggest, price is not an important obstacle to the uptake of clean cooking products by rural households, the use of price subsidies may not significantly boost the growth of the sector, while it risks undermining commercially viable efforts by entrepreneurs. Encouraging more innovative funding models, for instance the bundling of small loans with other financial products used by rural households such as crop loans, might in some cases also reduce the need for a price subsidy framework even where household finances are a genuine barrier.

There is also a need to *mobilize additional resources*. Entrepreneurs need greater access to finance in order to expand production to a commercial scale, whether in the form of seed capital or other loans. To date, they have had to depend largely on grants or concessional finance. However, entrepreneurs indicated that commercial finance would also be viable for them, if financial institutions were willing to lend.

Entrepreneurs also need rural *distribution networks* for their products, which are extremely challenging for individual entrepreneurs to establish. The government could supplement the resources available under the NBCI by harnessing other networks and expertise (such as rural distribution networks).

It is important that any resources brought to the clean cooking sector are provided in a way that supports and encourages commercially viable entrepreneurial activity. For example, there is a risk that the proposed subsidy model being pursued through the carbon finance POA could encourage entrepreneurs to shift their focus towards stove models that maximize carbon revenue instead of models that genuinely appeal to the market and that they could produce and market profitably in the long term if carbon finance were withdrawn.

**Legitimacy**

There is a need to address the lack of legitimacy that clean cooking products, and the sector as a whole, suffer among various key groups. The low degree of legitimacy that clean cooking technologies have among *consumers* reduces their incentive to purchase them and thus contributes to the lack of market formation. In the *finance sector*, low legitimacy makes it difficult for entrepreneurs to access commercial loans to finance product development and expansion. The clean cooking issue also appears to suffer a legitimacy deficit within *government*, despite the implementation of the NBCI. This inhibits greater engagement by different ministries and levels of government. With so few dedicated financial and human resources, there are limits to how much the MNRE can accomplish alone.

**Bringing in new actors**

To address the priorities above, there is a clear need to encourage new actors into the clean cooking innovation system. Several *government ministries and levels* have the skills, capacity and reach to overcome critical constraints, including the ministries of Health, Rural Development (particularly for their access to rural distribution networks) and Environment and Forests, as well as state governments.

Technological institutes are relatively well represented in the sector. However, the sector would benefit from the involvement of *scientific institutes* that can develop and share

knowledge about the social and business aspects of introducing new cooking practices and products to rural communities.

The greater involvement of *civil society organizations* could increase the flow of knowledge between government and both smaller entrepreneurs and target consumers. Potential *consumers* themselves could be invited to play a more vocal and active role in the sector, particularly in the design of socially acceptable alternatives to traditional practices.

#### **4.2 The roles of different actors in meeting sectoral needs**

The roles described below are allocated to one actor or another. However, these roles are not mutually exclusive, and some could or should be taken on by more than one type of actor.

##### ***The Indian government***

Most interviewees suggested that the government should take the lead in catalysing the transformation of the clean cooking sector. Based on the findings of our research, there are several possible ways in which the government could do this.

During the early phase of the National Biomass Cookstove Initiative, the main focus has been on technical issues, notably setting up stove-testing centres and procedures. The initiative now needs to broaden its range of activities in order to address the most pressing weaknesses that appear to be holding back the transformation of the clean cooking market.

Major regional and nationwide campaigns should be launched to help raise awareness among target households of clean cooking technologies and their benefits. The earlier polio and HIV/AIDS campaigns could be good models. Most non-household interviewees said this was one of the most valuable roles the government could play in the short term.

An industry group for clean cooking entrepreneurs could be created to facilitate sharing of knowledge, both between entrepreneurs and with other actors such as financial institutions and government policy-makers. This group need not be coordinated by the government; it could for instance be set up by a relevant chamber of commerce. However, the government could still play a valuable role in signaling the need for such a forum and initially in convening the key actors. The focus of such a group should be much broader than technical issues, and it should be able to offer business guidance. It would dramatically improve the flow of information and dissemination of learning within the sector.

The government and others could fund robust studies on the willingness and capacity of biomass-dependent households in different parts of India to pay for clean cooking products. These studies could help entrepreneurs in business planning, as well as establishing objectively how useful price subsidies are in market formation.

The government should direct its financial support for the clean cooking sector towards products that are essentially commercially viable, but which need support to overcome some early-stage barriers. It should not support products that are unviable without subsidies. Although carbon finance rewards delivery of cleaner stoves to consumers, it does not require the stoves to be commercially viable since the stoves can be given away and still earn carbon credits. As an incentive mechanism it thus does not focus entrepreneurial experimentation on developing products for which consumers would be willing to pay a commercial price.

The government should take care to ensure that the NBCI's focus does not narrow down to "picking a few winners" (as the early-stage pilots understandably do). Were it to focus on funding the further development and scaling up of a small number of stove models that meet

emissions standards, this would be unlikely to generate the conditions for market-wide transformation, especially given the need for regional diversity in products and business models.

To unlock lending activity in the sector, the government could issue a formal directive to financial institutions – particularly the regional rural banks – that they should provide loans to entrepreneurs for the marketing and development of clean cooking products. Most of the regional rural banks are publicly owned, but tend to be risk averse and are unlikely to take a chance on lending to the clean cooking sector without a government directive. Access to loans could help entrepreneurs to access the funds they need at different stages of stove development and marketing. It could also build legitimacy more broadly within the finance sector for lending against clean cooking technologies.

The government could also help entrepreneurs to overcome financial constraints by providing seed capital in the form of grants and low-interest loans, and sales tax exemptions at the national or state level, as applicable; and consider alternatives to price subsidies such as negative taxation for clean cookstove producers.

The MNRE and its partners could also reconsider how carbon finance would be utilized. Entrepreneurs did not cite price subsidies as a priority or as especially beneficial in addressing their challenges; hence, more effective ways of using carbon finance might include aggregating revenues as a single revenue source and re-investing these funds so as to address some of the real bottlenecks for all producers, such as funding awareness raising or providing seed funds or low-interest loans.

The government could also signal to entrepreneurs the need to emphasize wider design factors during their development of cookstoves, beyond (but still including) emission performance. This could be facilitated, for instance, through a new industry forum (described above) that enables greater interaction among entrepreneurs.

The government could establish a National Mission on clean cooking, to stimulate action by other government departments and other levels of government (including state governments) whose resources and networks – such as rural distribution networks, education networks, rural health campaigns, or better leverage with rural financial institutions – would be hugely beneficial. This would elevate the government’s level of commitment, raise the legitimacy of the sector, and provide a longer-term policy framework than the NBCI. A National Mission on clean cooking would fit well with the government’s development priorities, as well as its National Action Plan on Climate Change, and by making clean cooking a cross-government issue would act as a platform to stimulate the engagement of both external partners as well as other domestic actors.

Even without a National Mission, the government could support “last-mile” marketing and distribution by promoting the use of existing public distribution networks under various ministries; for instance, government kiosks in each district could be used as an outlet to promote clean cooking products.

#### ***Technical and research institutes***

Technical and research institutes such as IIT Delhi and TERI currently are important contributors to the clean cooking sector, and at present are arguably its main convening agents. They could help to address the sector’s near-term challenges.

Technical and research institutes can develop (or engage, where it already exists) the array of social science and economics expertise needed to understand household needs, desires and capacities. This expertise could be used to improve understanding of the demand side of the market, and thus improve the quality of supply from a consumer perspective.

### **Civil society**

Civil society organizations provide a crucial link between experiences on the ground, in rural India, and the policy realm. Therefore, civil society organizations can help fill knowledge gaps, particularly in government, about the needs and constraints of both households and small entrepreneurs. Civil society advocacy therefore remains a critical activity.

To mobilize new resources for the sector, civil society is often well placed to mobilize international resources, for example by acting as a coordinator of clean cooking initiatives on behalf of a group of entrepreneurs.

### **Entrepreneurs**

Entrepreneurs themselves need to place a greater emphasis on understanding decision making by consumers. Since many rural entrepreneurs are not experienced in designing and marketing consumer goods, they are likely to need support and expert input from other actors, of the sort that can be found within social science research institutions and also in the field of industrial design.

### **International actors**

The support of international initiatives such as the GACC and bilateral development partners would be most effective if directed towards addressing common barriers or gaps across the clean cooking sector, rather than financing the development and diffusion of specific (trademarked) products. In particular, the GACC network and other international actors could use their resources to:

- design and deliver consumer awareness campaigns, in collaboration with the government;
- bring new expertise into the sector, helping to link local actors with clean cooking experience from outside India, and in doing so facilitate information exchange and greater learning, particularly among entrepreneurs; and
- directly fund social science and economics research that focuses on the clean cooking sector, including both the household side as well as on trade and distribution channels.

International actors such as the GACC and GIZ could also help to expand engagement within the Indian government. Increasing coordination and bringing a more cross-government approach to the sector are almost impossible for the MNRE to catalyse by itself. External partners could use their relationships with other government departments to raise the profile of the clean cooking sector and help to mainstream the clean cooking mission into other policy agendas.

In their activities, international organizations must be sensitive to local needs and expectations about their roles. The notion of sovereignty is powerful in India. This may partly explain the negative sentiments expressed almost universally in our interviews with entrepreneurs towards the GACC, as well as towards foreign producers trying to market generic stove designs in India, usually with financial support from donors. The way that external partners engage – not just *what* they do but *how* they frame their own role and purpose – will influence their perceived legitimacy among other parts of the clean cooking

sector. Although they were not found to be a critical gap in India at present, the development of standards and protocols for stove performance was suggested as a platform for engagement with Indian actors, since both the GACC and Indian actors have been working on this issue in parallel.

With the NBCI, the Indian government has shown that it believes the long-held aim of persuading millions of rural households to use cleaner stoves and fuels is both achievable and worth investing in. The government clearly has the central role in structuring and supporting processes that could help to transform the sector, at least until a thriving commercial market emerges. However, several other groups have important contributions to make. Some of them are already recognized and actively engaged, while others are not. Above all, rural biomass fuel-dependent households – the very people whose practices are supposed to change, and who are expected to purchase clean cooking products – need to be seen as key actors in shaping the sector, not just as passive recipients of new technologies.

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