Supporting a Transition to Cleaner Cooking Stoves and Fuels in Biomass-Dependent Energy Economies

Introduction

Globally, an estimated 2.4 billion people rely on biomass fuels – wood, charcoal and animal dung – to meet their domestic energy needs. These fuels are typically burned in simple, inefficient traditional stoves or open fires, which creates serious health, socio-economic and environmental consequences, and can also be hazardous and time-consuming to collect.

Catalyzing major changes in energy practices towards more efficient stoves and/or cleaner fuels has been an objective of governments and development organizations for years, but in practice it has been difficult to achieve. Despite more than three decades of interventions in local markets across Africa, Asia and Latin America, there are very few examples of large-scale uptake or true market transformation.

Ingrained social and cultural norms, combined with economic considerations, often provide strong barriers to change. Furthermore, there may be little technical innovation in local stove markets, partly because the livelihood needs and financial limitations of local stove fabricators constrains their opportunity to experiment with stove design: They produce what they know can be sold, which is the local traditional model. Financial constraints also limit experimentation on the household side, discouraging them from purchasing new stoves when their performance is unknown.

In some places, such as in rural northern India (pictured), households make their own stoves from locally available, free resources, which means establishing even a basic a market for new products is difficult. Furthermore, where improved stoves have become available, they are not always well designed with respect to what people actually need and want, limiting user uptake.

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Women in Haryana State, in northern India, make roti (flatbread) in a traditional chulha mud stove, fueled with wood and cow dung.

SEI's role: new knowledge and perspectives

The Stockholm Environment Institute (SEI) and its predecessor the Beijer Institute have been engaged in household energy studies and assessments for nearly four decades. Our goal is to generate new knowledge and analysis that can support successful policy interventions and programmes to expand energy access for the poor, improve livelihoods and reduce environmental impacts from household energy use.

We focus on the kinds of actions likeliest to help households reduce their biomass fuel use and/or switch to cleaner sources of energy. By nature such actions could address a technical gap (e.g. more efficient stoves/fuel production systems), a financial barrier (e.g. micro-finance) and/or a policy need (e.g. changes in government subsidies, or pricing reform in the electricity sector). Below we outline key themes in our research.

Supporting a transformation of energy markets

A central theme in SEI's work is *transformation*, of household behaviour and, consequently, of energy markets for the poor. Transformation implies large-scale change, beyond the project level, to the point that local and in some cases national markets for stoves and household energy have widely embraced cleaner fuels and new practices and technologies, with improved health, financial and environmental outcomes for local communities. It also implies change that is sustainable in social and business terms, meaning it generates its own momentum beyond the scope and one-off financial inputs of any specific intervention.

Although most cookstove projects define their *immediate project objectives* in terms of number of stoves installed, they should also consider how to catalyze wider market change, so that the positive impacts spread far beyond the initial intervention. Without this objective, individual interventions risk being poorly designed, limited in reach and – as many cases have shown – short-lived (because they are socially, financially or technically unsustainable).

Placing users at the centre of the design process

Another key theme in our work is that users should be at the centre of the design process, both for technical innovations such as new stoves (including the business models designed to support their dissemination), and for policy interventions intended to improve energy access or shift consumer behaviour.

Insights from diverse fields such as behavioural psychology, sociology, industrial design, change management and technology innovation all indicate that individual and group behaviour and decision-making are shaped by a complex array of factors. Thus, understanding energy users and how they make decisions and judgements is crucial in determining both *what* interventions are to be pursued and *how* they are designed. Surprisingly, clean cookstove projects do not always appear to take this approach, beginning instead from a technical solution devised without the target users' input. This can result

in, for instance, a new stove model that maximizes energy savings or pollutant emissions reduction *per device* but not necessarily in total terms (i.e. at the community scale), since the latter goal requires consideration of how many people actually use the new stove.

New methods to learn about and from energy users

SEI has developed and applied several methodologies to help practitioners to better understand the driving forces and motivations that influence cooking and energy use decisions at the household and community levels. Approaches used in this field include scenario assessments, transaction cost analysis, pilot or field testing, household surveys, market simulations, and interviews and direct observation of cooking in rural villages. Both quantitative and qualitative methods can reveal important insights useful for designing an intervention in local biomass-based energy economies.

For example, SEI designed a series of choice experiments in studies of energy users in Ethiopia, Tanzania and Mozambique to better understand how households make choices about stoves and fuels, and why seemingly well-designed improved stoves frequently fail to penetrate the local market (see Takama et al. 2011). Survey results were used to construct a discrete choice model to illustrate how consumers make trade-offs between different cookstove and fuel attributes. The data showed the importance of economic factors, particularly up-front capital constraints, but also revealed that medium-and higher-income households were willing to pay a premium for improved stoves and cleaner fuels in exchange for benefits they valued, such as reduced risk of burns or explosions, and reduced smokiness. Such information could be valuable for stove producers interested in targeting particular markets.

SEI has also used ethnographic approaches – combining interviews and observations of people in their home environments – in recent studies of household energy use in Zambia and northern India (Atteridge 2013). These methods are also often used by product designers to study how people judge and interact with different practices and technologies (Lambe and Atteridge 2012). They produce insights about people's needs and desires that go deeper than what they say, by also showing what people do in real life. These insights, in turn, illuminate opportunities for change.

"Generative" exercises can also be useful. For example, talking about an improved stove – a real or imagined one, with specific characteristics relating to cost, shape, colour, functionality, etc. – can be used to generate insights about how the idea of new stoves is understood, interpreted and judged, exploring hypothetical scenarios with households. It encourages people to reflect on specific design aspects or character traits of their traditional practices as well as what possible improved alternatives might look like.

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Several types of advanced cookstoves are tested as part of a project by The Energy and Resources Institute (TERI) in Jagdishpur, northern India.


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A mother in Zambia makes porridge on a traditional mbaula charcoal stove. Production of charcoal, the dominant household fuel here, is linked to deforestation in surrounding areas.

In practice, applying both qualitative and quantitative approaches together can be valuable. In-depth qualitative assessments provide a deep understanding of local dynamics, and this can be used to design specific quantitative methods focused on questions of interest.

Identifying systemic gaps in innovation and dissemination of new technologies

Studies on the enabling conditions needed to support technological innovation and market penetration suggest a range of system "functions" which need to be in place. These include various forms of knowledge across the system, from product developers to market actors and end users; the right economic signals to encourage actors to enter the local market; actual market formation, on both the supply and demand side; space for entrepreneurial experimentation; adequate resources among different actors in the system, and perceived "legitimacy" among potential users.

These insights have been generated mostly in the context of technology diffusion within industrialized consumer markets. SEI is examining how they might apply to developing countries, specifically in understanding what is most needed to support successful innovation and technology dissemination for low-income energy users reliant on biomass. In a study in northern India, SEI conducted interviews with a wide range of stakeholders – from people in villages, to stove designers and

marketers, testing centres, NGOs and national government officials – to examine how this framework helps reveal where policy and financial interventions would best support the emergence and growth of a cleaner cookstove market (Lambe and Atteridge 2012).

Business models: is carbon finance a blessing or curse?

We are also interested in the way business models can support or prevent a widespread transformation of cookstove markets. For example, the use of carbon finance to support cookstove projects is gaining traction internationally, but it is unclear whether this approach will contribute to – or undermine – the goal of market transformation. To help fill this knowledge gap, SEI has initiated a study on this question, focusing on how carbon revenues have been used within business models, and what impacts (positive and negative) this has had on stove projects and on stove and household energy markets more broadly. This will generate lessons that can be help better design future stove projects and programmes.

Carbon finance also raises some challenges regarding greenhouse gas emissions accounting from these kinds of projects. Another SEI study examined some of the methodological challenges in gauging the emissions reductions associated with cookstove projects and proposed several policy improvements (Lee et al. 2013).

The carbon finance work also relates to SEI work on business models more generally, and the wider enabling conditions that can support market development. For example, SEI has previously evaluated over several years the emergence of energy service companies (ESCOs) to support solar photovoltaic (PV) dissemination in Zambia. The project revealed some of the difficulties in creating a market for an "exotic" imported technology and the constraints associated with maintenance, training and the financing of high capital costs.

Demonstrating and evaluating the feasibility of new fuel and stove combinations

Introducing new *fuels* in addition to new stoves poses several more challenges. SEI is working with a women's cooperative in Addis Ababa, Ethiopia, and other partners to demonstrate the technical, environmental, social and financial feasibility of ethanol micro distilleries (EMDs). This initiative, the first of its kind in sub-Saharan Africa, will look at the viability of an EMD using locally produced sugar cane molasses, and potentially other agricultural residues, as feedstock to produce ethanol for household cooking.

Crucially, the project aims to identify key enabling factors for the successful implementation of such schemes in terms of local acceptance of technology, as well as governance needs at the municipal and national levels. It will generate lessons that can help improve the technical and business viability of small scale, community-run ethanol plants, supporting wider replication of this type of renewable energy system as a means of improving energy access and reducing the negative effects of current household energy practices.

Using co-benefits as leverage for action: health improvements

A new area of SEI research is exploring synergies that can result from integrating household energy interventions with programmes and technologies targeting other goals, in particular health. It also links with another area of interest, that of the importance of framing new technologies and other interventions in terms that people respond to.

For instance, by better understanding how households themselves perceive health and safety risks associated with biomass collection, processing and use, these – rather than long-term chronic health benefits, which may be less immediately tangible to stove users – might stimulate user interest in new cooking technologies.

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A local tinsmith in Zambia makes small cookstoves by hand. Low-cost local production can help improved cookstove projects' chances of success.

Awareness-raising on energy access

In addition to research and analysis, SEI has also led some outreach projects to raise awareness about household energy issues. A recent example is *Energy for All 2030* (ENFORSA), a cross-European project which aims to raise the public and political profile of the energy access agenda at the European Union (EU) level and ensure its place within future efforts to achieve the Sustainable Development Goals (SDGs) in sub-Saharan Africa.

To highlight the leadership role that the EU can play in achieving the Universal Energy Access goals, SEI has for instance organized informational meetings with political and policy actors, including the EU Development Commissioner, the EU Energy Facility and Members of the European Parliament (MEPs), a visit by a delegation of MEPs to Kenya to witness first-hand the difference that access to energy can make to the lives of the poorest, and several high-level events at the European Parliament. One outcome of these activities was the preparation by an MEP of an Own Initiative Report outlining future energy access priorities for EU support, which was submitted to the Development Committee and ultimately passed by the EU Parliament in February 2012.

Learn more:

Explore SEI's research on household energy, including the studies discussed above and dozens of publications, at **www.sei-international.org/household-energy**.

Key insights from our research

- **Cookstove projects need to strive for market transformation.** There are limited funds to support cookstove projects, and even the most ambitious initiatives will only replace a fraction of the stoves in any given market. That is not enough. The goal needs to be market transformation. It is essential that projects catalyze wider market change – that innovation spreads beyond project participants. This has implications for many other aspects of a stove project, from technology design, to the business models used to produce and market stoves, to the usefulness of carbon finance. The most successful projects will engage local producers and distributors, and generate widespread market demand for improved stoves and cleaner fuels – even without subsidies.
- **Stove design should enable market replication.** Clean cookstove technologies and business models should be designed explicitly to enable replication across the market. Too often, projects use stoves made outside the countries where they are distributed, often by large corporations. This means they may not be easily replicated by other local manufacturers. While this may be optimal for stove manufacturers (since protecting intellectual property rights and building a viable business is their individual goal), internationally supported initiatives should focus on those which seek to achieve wider transformation rather than limited dissemination.
- **It is crucial to understand user needs, and the wider social and cultural contexts.** This applies both to designing new stoves, and to new policies intending to change behaviour. People's needs, resources and decision-making vary between urban and rural contexts and from place to place. Promotion of "generic" clean cookstove models that have been designed in isolation from local user needs and contexts should be avoided.
- **Improve knowledge-sharing across the household energy sector.** Despite decades of projects targeting behaviour and technology change among households, there is a lack of readily available, comparable data on how these efforts have been designed, what they have achieved, and why they have met with only limited success. This could be addressed by international partners putting resources into a comprehensive public database on cookstove interventions, as a platform for researchers, project developers, funders and communities to learn from the successes and failures of the past. Although project developers may be reluctant to openly share details on their failures, these insights about what challenges were faced and why projects were not effective in transforming markets are crucial to evolving better models in the future.

Further reading:

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