Supporting the adoption of Clean Cookstoves and Fuels: Why won’t people adopt the perfect stove?

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CASE STUDIES  Supporting the adoption of Clean Cookstoves and Fuels: Why won’t people adopt the perfect stove?

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SUPPORTING THE ADOPTION OF CLEAN COOKSTOVES AND FUELS: WHY WON’T PEOPLE ADOPT THE PERFECT STOVE?

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1. **INTRODUCTION**

Today, 40% of the world population, rely on traditional use of biomass for cooking (IEA n.d.). That means that around 3 billion people, mostly in rural and marginalised urban areas; spend significant household income purchasing fuel or that the women and children in these regions have spend many hours gathering fuel - up to 5 hours per day. Switching from traditional biomass to modern clean, safe and efficient fuels for cooking can enhance welfare for so many people worldwide while helping to reduce the negative health and environmental impacts associated with traditional biomass use; yet, the transition to improved cooking stoves and fuels has largely stalled in many regions, but especially in Sub-Saharan Africa (SSA). Why is it that so often, well designed, efficient and clean stoves fail to penetrate the market in developing countries as expected?

The purpose of this case study is to help students understand the complexity of the problem by summarizing the experiences on the field on different research projects by the Stockholm Environment Institute, to address this knowledge gap.

1.1. **DISCIPLINES COVERED IN THIS CASE STUDY**

Multidisciplinary analysis and thinking; the aim of this case study is to guide the students through the different sides of a very complex issue as it is Energy Access for cooking and reflect and discuss about the barriers for improvement and the possible solutions from different disciplines. In development and human well-being problems the need of a holistic approach is crucial for a successful implementation. The case study promotes teamwork since the two proposed activities are realized in groups of 4 or 5 students.

1.2. **LEARNING OUTCOMES**

As a result of this case study, students are expected to be able to:

- Understand the problem of lack of modern cooking technologies and fuels from different perspectives and disciplines.
• Be familiar with some research methodologies applied by our organization, SEI (stated preference survey and discrete choice analysis, generative methods, open interviews) for understanding decision making around household energy.

1.3. ACTIVITIES

The first activity consists on a Group discussion to explore the different factors that determine the success of a clean cookstove intervention. What is important when planning an intervention to upscale the uptake of cleaner cook fuels and technologies? Are there factors that are more important than others?

The second activity is a simulated intervention. In a group, with the background information and extra material provided, the students are expected to design a project to support the uptake of cleaner cooking technologies and fuels in a small town in central Mexico.
2. **CONTEXT: ENERGY ACCESS**

Nearly one-fifth of the global population has no access to electricity, and two-fifths rely on traditional solid fuels, including biomass, for cooking. 95% of this unmet market is located in sub-Saharan Africa or South Asia (See figure 1), and 84% is in rural areas. In sub-Saharan Africa, only 14% of rural residents have electricity (IEA n.d.) and even having a grid connection does not guarantee a safe, affordable and reliable power supply, or one adequate for productive uses, as blackouts are common in many developing countries.

Energy poverty has serious negative impacts on, human health, livelihoods, and the environment.

![Figure 1 Share of Traditional Biomass in Residential Consumption by Country](image)
2.1.1. **Human Development Health**

According to the World Health Organization (WHO), 4.3 million people die prematurely as a result of disease caused by exposure to smoke from cooking with an inefficient stove (See figure 2). Exceeding deaths attributable to malaria or tuberculosis, exposure to smoke from cooking constitutes the fourth leading risk factor for disease in developing countries.

![Figure 2: Deaths per Year caused by Indoor Air Pollution, by WHO Region](image)

According to the WHO, Exposure to household air pollution almost doubles the risk for childhood pneumonia. Over half of deaths among children less than 5 years old from acute lower respiratory infections (ALRI) are due to particulate matter inhaled from indoor air pollution from household solid fuels.

Indoor pollution is related as well to nearly one quarter of all premature deaths due to stroke (i.e. about 1.4 million deaths of which half are in women) and to approximately a million deaths due to ischemic heart disease.

Women and children exposed to high levels of indoor smoke are 2.3 times as likely to suffer from chronic obstructive pulmonary disease COPD than those who use...
cleaner fuels. Among men (who already have a heightened risk of COPD due to their higher rates of smoking), exposure to indoor smoke nearly doubles (i.e. 1.9) that risk.

Approximately 17% of annual premature lung cancer deaths in adults are attributable to exposure to carcinogens from household air pollution caused by cooking with solid fuels like wood, charcoal or coal. The risk for women is higher, due to their role in food preparation.

There is also evidence of links between household air pollution and low birth weight, tuberculosis, cataract, nasopharyngeal and laryngeal cancers. Spine and other back injuries due to heavy lifting when transporting wood fuel are common amongst women in poor households.

Burns from open fires and unsafe cookstoves are contributing to a substantial percentage of the estimated 195,000 burn deaths that occur annually. Because burns require prompt and sophisticated medical intervention often lacking in remote areas of the world, such injuries often result in debilitating scarring and loss of movement in their victims (GACC n.d.).

2.1.2. ENVIRONMENT

Unsustainable wood harvesting also contributes to deforestation, reducing carbon uptake by forests. Although depletion of forest cover on a large scale has not been found to be attributable to demand for fuel wood (Arnold et al. 2006). It is known as much as two-thirds of fuelwood for cooking worldwide comes from non-forest sources such as agricultural land and roadsides causing soil degradation. Clearing of land for agricultural development and timber are the main causes of deforestation in developing countries.

Reliance on charcoal for cooking has led to depletion of native forest cover to support charcoal production. In most of the urban or peri-urban areas in developing countries, charcoal is often the fuel of choice. The unsustainable collection of wood for charcoal production can contribute loss to soil erosion, desertification, contamination and loss of watersheds, and loss of productive land, which puts extra pressure on regional food security (GACC n.d.).
Charcoal production is also increasing loss of forest canopy which leads to biodiversity loss, especially in tropical forests while the construction of logging roads damages the environment and exacerbates the declining habitat of endangered species.

In addition to deforestation and air pollution, burning solid fuels releases emissions of some of the most important contributors to global climate change: carbon dioxide, methane, black carbon, and other short-lived climate pollutants (SLCPs). Unsustainable wood harvesting also contributes to deforestation, reducing carbon uptake by forests.

Black carbon, which results from incomplete combustion, is estimated to contribute the equivalent of 25 to 50% of carbon dioxide warming globally, and residential solid fuel burning accounts for 25% of global black carbon emissions, about 84% of which is from households in developing countries. In India for example there are indications that biofuel combustion is the largest source of black carbon (Venkataraman et al. 2005) and in the whole South Asia, more than half of black carbon comes from the use of inefficient cookstoves.

The so called Brown clouds of black carbon can travel long distances and stay in the atmosphere long enough to disrupt the monsoon; then the dark particles deposit on the ice and accelerate the melting of the Himalayan-Tibetan glaciers. As a result, water availability and food security are threatened for millions of people (Ramanathan and Carmichael 2008).
2.2. **Gender, Human Rights and Livelihoods**

Women and children (girls especially) are in charge of collecting fuel and water for the household in most poor countries. Women have an average working day of 11-14 hours, compared to 10 hours on average for men (GACC n.d.).

There are significant socio-economic impacts due to the opportunity costs of spending several hours per day gathering fuelwood (Lambe and Johnson 2009). Spending less time collecting fuel and cooking can enable children to dedicate more time to education and leisure, and women to spend more time with their children, enhance existing economic opportunities, and pursue income-generating or educational opportunities all of which contribute to poverty alleviation.

In Urban and peri-urban areas, where fuel is mostly purchased, the expenditures are significant due to the low efficiency in use, which severely constrains household budgets. Poor households tend to spend a larger percentage of their income on energy than well-off households in Sub-Saharan Africa for example (Figure 3) families with lower incomes are spending as much as 15% of their incomes in energy.

*Figure 3* Percentage of HH income spent on energy

3. CLASS ACTIVITY

Since the launch of the Sustainable Energy for All initiative back in 2011, there has been a global push to rapidly scale up access to clean stoves - The governments of India, China, and Brazil have initiated massive programmes to upscale the uptake of clean stoves for example, and several international organisations such as the Global Alliance for Clean Cookstoves have ongoing programs around the world, however, despite the numerous apparent benefits of fuel switching, the transition to modern fuels has been slower than expected. Indeed, the number of households relying on traditional biomass in sub Saharan Africa is expected to increase in absolute terms by 14% by 2015 although the share will decline slightly to 77% (IEA n.d.).

The promotion of energy efficiency measures and mitigation of the adverse economic, environmental and health impacts associated with the use of traditional biomass is an important policy issue in Developing Countries (Takama et al., 2011).

Get together in groups of 5 and discuss:

- What aspects do you consider are important to guarantee the success of a clean cookstove programme?
- Consider more general aspects like socio economic situation at national and local level, cultural characteristics of the country (e.g. gastronomy), but also particular aspects like stove and fuel cost, stove design, possibilities for financing
- Are there factors that are more important than others? Each group should write a list of the top 5 factors they considered more important and present to the whole group.
- Get creative! There are no wrong answers.

3.1. EVALUATION CRITERIA AND FURTHER DISCUSSION

As mentioned before, there are no wrong answers, access to clean, modern cooking technologies and fuels is a complex issue. However, around the world there are
many examples of clean cookstove programmes that failed because their approach does not consider consumers’ preferences when designing the programme.

From our experience at SEI, the preferences of the consumers regarding the fuel and design of the stove, and how they trade-off between these to make a choice are as important as consumer’s income, gender or level of education. Failing to acknowledge stove users as consumers that make choices and have preferences and desires, no matter how modern or efficient the stove is, is not likely to support the switch towards sustainable energy.

3.1.1. Previous Research

Previous research on the determinants of stove choice at the household level has focused mainly on socioeconomic factors, such as income, age, gender and education, disregarding the role of product specific factors such as usage cost, stove price, safety, indoor smoke, etc.; or the cultural and ethnological factors surrounding consumer’s choice:

- Energy ladder approach: A number of studies have been conducted to understand the factors that affect cooking stove choices and fuel consumption patterns. Many studies have pointed to income or wealth as a key factor, with increased income, households climb the “energy ladder” towards cleaner, more modern alternatives (Leach 1992) (Douglas F. Barnes 1993) 1987 (Pachauri et al. 2004)

- Fuel stacking approach: Other research has suggested that households don’t entirely switch to more efficient options but change between different options (“fuel stacking”) (Masera et al. 2000). The observed diversity in fuel-switching patterns is due to the presence of various non-cost factors such as local food habits and cooking frequency (Ouedraogo 2006) ethnicity (Heltberg 2005), local traditions and institutions (Hiemstra-van der Horst and Hovorka 2008) and food taste preferences.
The findings of these studies have illuminated the roles of socio-economic factors and few product specific factors (such as stove price) as determinants of fuel and stove, however, they have failed in understanding the relative strength or trade-off among the factors affecting stove and fuel choices at the household level (Odihi, 2003; Pundo and Fraser, 2006). Although many factors have been identified and evaluated, the relative strength of key factors (e.g. stove price, fuel price) in influencing fuel/stove choices remains poorly understood.

Besides, socioeconomic factors tend to be fixed in the short-term for most individuals and it takes time for an intervention to have an impact on them, whereas product-specific factors can be influenced quickly based on the availability of new products or alternatives (e.g. a new stove design that to save fuel, subsidies on fuels or stoves, etc.) and on individuals’ changing (e.g. by supporting informed decision taking).

3.1.2. POLICY IMPLICATIONS

The gap of knowledge regarding how consumers choose a stove and fuel, and what factors are important while making that choice have leaded to poorly designed intervention programmes that fail in delivering a technology that will be adopted and embraced by consumers.

In India for example, the central government subsidized stove producers so that stoves would be affordable to consumers, yet it is apparent that many producers did not consider consumer preferences when designing and marketing stoves,(Bhattacharya and Jana 2009) And many households discarded the new stoves within a matter of months. The government was also been criticised for failing to ensure that the stoves, which were made by networks of trained local artisans, met minimum quality standards, at the end the programme was cancelled few years after it started. The lessons learned from this programme influenced new improved cookstove programmes across India over the past decade initiated by domestic and international non-government organizations and by business organisations at the grassroots level, these generally adopted a more commercial and bottom-up approach, based on demand-driven marketing techniques in rural communities (Lambe and Atteridge 2012)(Greenglass and Smith 2006). However, to date these
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initiatives have also failed to significantly transform the rural household energy market (Balachandra 2011)

3.1.3. CONSUMER AT THE CENTER

To tackle this gap on knowledge, since 2008 the Stockholm Environment Institute (SEI) has conducted a series of studies using an innovative approach to better understand the most important influences over household energy choices, in order to identify practical ways to support communities shifting to a cleaner and more efficient energy use.

The study involved a stated preference survey to investigate household-level preferences of cooking fuels and stoves; researchers polled 200 households in Addis Ababa, Ethiopia, 564 in Dar es Salaam, Tanzania, and 402 in Maputo, Mozambique. The research team applied an alternative methodology to commonly used techniques in the energy field, named “discrete choice analysis” (DCA), which is commonly used in transportation studies, to assess the trade-offs among attributes affecting household cooking choice. There were focus group discussions as well as individual interviews.

Discrete Choice Analysis and Stated preference survey

Accurate demand predictions are vital for the uptake of innovative clean cooking alternatives such as ethanol or solar cooking stoves; without this information, stove producers cannot risk producing new stoves, and policy makers are unable to give suitable support to the projects.

SEIs team applied a discrete choice analysis model, often use in the transport sector, in order to evaluate the trade-offs inherent in household choice of cooking stoves and fuels, this model was selected as it allows for the quantitative assessment of both socio-economic and product-specific factors, and because the research team was interested in knowing not only whether a particular product-specific factor is important, but also, how important it is in relation to other factors.
Consumers derive utility not from a cooking stove as such, but from its specific characteristics/attributes such as heat energy delivered, smoke level, safety, convenience to use and so on. Hence, the strength of the factors affecting a stove choice is derived from the weight of the utility that an individual derives from each attribute of a stove and how much they are willing to pay for those attributes. The relative weight of each attribute can be estimated by designing a choice experiment.

The *Stated Preference* (SP) survey technique is crucial for the DCA, researchers asks people to choose alternatives with stated attributes in a hypothetical situation using questionnaires, visual material, telephone interviews, web, etc. For example, preference between ethanol and firewood stoves can be asked using cards as shown in Figure 4.

![Example of SP survey questions](image)

**Figure 4:** Example of SP survey questions

The results revealed that cost – both of the stoves and of ethanol – is a major factor for low-income families; in Ethiopia, for example, *usage* cost is more significant than stove price for the middle and high-income groups. A cheaper usage cost will
reduce the overall cost of a cooking stove in the long term. Therefore, the poor consider initial investment such as stove price to be more significant in the short term but less in the long term. In practical terms ethanol stoves might dominate the market if their price were cut in half.

Similarly, if ethanol is considerably more expensive than charcoal, the cleaner stoves are a tougher sell.

This trade off phenomenon between attributes amongst different socio-economic classes is even more important when non-monetary factors such as smoke and safety are compared. For middle-income households, meanwhile, the key considerations are safety and minimising smoke.

For the low-income group, the smoke coefficient is insignificant indicating that indoor smoke is not important in their choice of fuel/stove. Hence, it can be inferred that the low-income group do not want to pay for a unit of reduction in smoke. However, it is interesting to note that for a unit reduction in the smoke level, the middle-income group want to pay only 64.58 birr, while the rich group is willing to pay almost 9 times more (586.52 birr). As a whole, similar to the usage cost, results show that as the
income level increases, so does the willingness to pay for a unit of reduced smoke level.

In can then be concluded that policy design should depend on the target market; and whenever Africa’s poorest families are targeted, affordability must be the priority. A technologically perfect stove will not be adequate if people cannot afford it, or if the fuel is too expensive. These findings are particularly valuable to stove project operators designing clean cooking stoves and to policymakers setting subsidies for fuels and stoves.
Malinalco is a small municipality in central Mexico with 20,000 inhabitants (6000 households). Even if 89% of its households have access to electricity, still 40% of the population relies on biomass and an open fire (fogón) to cook their meals. The government of the municipality has decided to implement a pilot project using a combination of carbon finance and government subsidies to promote cleaner cooking stoves and fuels to:

1. Reduce health impacts on population
2. Reduce deforestation
3. Generate income supporting entrepreneurs to produce stoves

After a technical and socio economic analysis the government has chosen 4 potential stoves to promote (see figure 8). You and your team have been assigned by the government to advise them on which type of stove should be chosen. You decided that a State of Preference survey and a series of focus groups interviews are necessary to understand the preferences of consumers and where the incentives and subsidies may be of best use.

Your task is to get together in teams of 5 students and:

1. Do some research: What are the gastronomic and cultural traditions and habits around food preparation and eating in México? What are the
traditional dishes in indigenous communities in particular in the State of México? What kind of pots they use?

2. Design a State of Preference survey, using the 4 chosen stoves to:
   a. Understand what are the attributes of the stoves that are important to the end consumer
   b. Understand if/how people are willing to trade off certain attributes

3. Design an open questionnaire for focus group interviews to
   a. Understand how social and cultural and psychological characteristics of population affect choices
   b. Reaffirm the results of the survey

4. Role-play: Back to the classroom, the work of each group will be shared with the rest of the class and tested by means of a role playing game. 2 student of each group will play the role of the surveyors (interviewers to ask the questionnaires developed by his/her their group). 2 students of the same group will act as representatives of the government; the rest of students in the class will act as the families in Malinalco. Each surveyor will apply the questionnaires to a group of families (3-4 depending on how many students there are), then the surveyors will have 10 minutes to discuss general findings to present to the government representatives. Finally the group will discuss what they have learned during this exercise, and present it to the whole class.
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Read our research report for inspiration and ideas:


**Stove information:**

<table>
<thead>
<tr>
<th></th>
<th>Stove cost (USD)</th>
<th>Fuel cost</th>
<th>GHG Emissions¹</th>
<th>In-house pollution (CO/PM2.5)</th>
<th>Risk of explosion</th>
<th>Risk of burning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional stove (fogón)</td>
<td>$3-10.</td>
<td>0</td>
<td></td>
<td>647/13107 (μg/m3)</td>
<td>Very low</td>
<td>high</td>
</tr>
<tr>
<td>Improved stove (aluminium rocket)</td>
<td>$40-80</td>
<td>622g/meal</td>
<td>129/1302/31</td>
<td>624/15 (μg/m3)</td>
<td>Very low</td>
<td>high</td>
</tr>
<tr>
<td>Improved wood stove (plancha)</td>
<td>$60-160</td>
<td>830 g/meal</td>
<td>53/356/6</td>
<td>743/21 (μg/m3)</td>
<td>Very low</td>
<td>Moderate</td>
</tr>
<tr>
<td>LPG</td>
<td>$45-60</td>
<td>.55-.70 usd/meal</td>
<td>89/1022/27</td>
<td>negligible</td>
<td>Relatively high</td>
<td>Moderate</td>
</tr>
<tr>
<td>Ethanol gel</td>
<td>$2-20</td>
<td>.30-.70 usd/meal</td>
<td>Negligible</td>
<td>negligible</td>
<td>low</td>
<td>low</td>
</tr>
</tbody>
</table>

**Table 1:** Types of cookstoves

¹ A tortilla (typical pancake made of maize flour) is used as a reference cooking unit
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**Important facts:**

- In Mexico and Central America the staple food of low income families are tortillas (a flat maize bread), making tortillas on a comal (flat griddle) over a smoky fire is a way of life; women spend nearly four hours a day preparing tortillas.
- An improved cookstove in most parts of Asia or Africa costs about $5-20, but the design will not suit the unique demands of a large surface area for placing multiple pots and making tortillas.
- While stoves 1 & 2 reduce indoor pollution dramatically, the concentrations of CO recorded when using the improved stoves are still very high and beyond the WHO recommended standard air quality in Mexico; this indicates the great health risk to users of improved stoves. Particulate Matter levels are under recommended standards, reducing risk of pneumonia and other respiratory diseases.
• The government is willing to subsidize up to 25% of the price of the stoves and some additional economic incentives may be obtained from carbon credits. Try to design your survey and focus group so that you understand how to better use these incentives (e.g. is people willing to pay for a more expensive stove to save on fuels in the long run? Would people choose a woodless stove if both stove and fuel are subsidized?)

• The LPG stove has two small burners that make it possible to cook two things at the same time, however to make tortillas people will have to use a smaller “comal” as the burner tends to concentrate heat in the middle.

• Ethanol stove is suited for making tortillas and using a smaller pot at the same time.

• It is known that some of the households in Malinalco have more than one stove and use it for different proposes (e.g. one for heating water and making tortillas with larger surface and a smaller one for cooking); think about this when designing your questions for the focus group

• 17.5% of the women in Malinalco can’t read and write, consider that while designing your survey

4.1. SOLUTION AND EVALUATION CRITERIA

The objective of the exercise is to make students reflect about the different disciplines involved in solving the problem of lack of modern energy and discuss the different dimensions of the case rather than make them experts on survey or questionnaire design.

Some of the criteria to evaluate that I consider important are:

• Focus on comparing first the attributes of the two wood stoves and the LPG and Ethanol stoves separately first and in second place the preference between the fuels, to understand the important attributes to switch to a woodless stove

• The questionnaire should cover preferences of non-economic attributes independently and in relation to the economic attributes
• The proposed survey and questionnaires should consider illiteracy levels of the target respondents, hence include pictures and images to help them choose among attributes of the different stoves.

• The questionnaire for the focus groups is used to understand if there are specific preferences influenced by cultural or social (gastronomic traditions, gender factors) factors or individual perceptions (aesthetics, flavour, etc.)

• See attached questionnaires and SP cards from another case for reference
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**BIBLIOGRAPHY**


Supporting the adoption of clean cookstoves and fuels:
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FURTHER/SUGGESTED MATERIAL

- Global Alliance for Clean Cookstoves: http://cleancookstoves.org/Book:
- Video: Saving lives through clean cookstoves: https://www.youtube.com/watch?v=J3Zsj4Lfs_o
http://www.gdee.eu

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