

Improved Cookstoves Assessment

Mike Clifford



PHOTO: A community testing out an improved cookstove in India. Practical Action.



CASE STUDIES **Improved Cookstoves Assessment**

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IMPROVED COOKSTOVES ASSESSMENT

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1. INTRODUCTION

The Global Dimension in Engineering Education (GDEE) is a European Union funded initiative involving the collaboration of development NGOs and Universities with an aim to integrate sustainable human development as a regular part of all technical university courses.

Part of the initiative is the development of a set of case studies based on real project experiences. The case studies cover a broad range of topics directly related those studied in engineering, science and other technology/environment/development-related courses. They give a background to the subject, a look into real life projects, and offer students hands on learning by various class and homework activities.

This case study looks at improved cookstoves, drawing from project experiences of the organisation Practical Action, with additional input coming from The University of Nottingham. Many stoves with which people cook are fuel inefficient and a health hazard (e.g. smoke inhalation). Improving cookstoves is a vital aspect to improve the health and wellbeing of both people and the environment. There is a lot of innovative research and implementation work being carried out in this field around the world by affected communities, governments, NGOs and academics. Many “improved” cookstoves have been tried and tested; the type will differ case by case depending on a number of factors.

We will examine some different types here from engineering, social, health and safety angles. Thus, this case study document can be seen as flexible and can be modified to suit the class you are teaching. Further resources throughout will provide extra material on different aspects of cookstoves which you can further study. The primary aim is to engage students with these issues and integrate more of a global development outlook into their studies.

1.1. DISCIPLINES COVERED

Mechanical Engineering, Social Sciences, Health Studies, Civil Engineering, Environmental Engineering, Design Engineering, Building/Construction Engineering, Sustainable / International Development, Engineering with Management / Business, Sustainable Design courses, Safety Engineering, Development Studies and more.

1.2. LEARNING OUTCOMES

By learning about different “improved” cookstoves that have been implemented around the world, and by evaluating some of these from engineering, social science and health and

safety perspectives, learners are expected to develop an appreciation of the challenges surrounding cooking in an efficient, safe and environmentally sustainable way.

1.3. ACTIVITIES

Activities include a class exercise evaluating an improved cookstove project, and a homework exercise involving the design and construction of a simple cooking stove and the production of a simple meal.

2. DESCRIPTION OF THE CONTEXT

In economically rich countries, we often take for granted the instant and constant availability of clean cooking fuels and stoves which do not harm our health, and are affordable to us. However, it is estimated that 2.7 billion people worldwide rely on burning biomass fuels like wood, charcoal and animal dung, and many cook on open fires inside their homes. This way of cooking is fuel inefficient and dangerous, with women and children in particular exposed to harmful levels of wood-smoke; a major cause of lung disease and early death (an estimated 4 million people die each year from indoor air pollution). Traditional 'open' cook stoves are also estimated to contribute to deforestation and around a third of global carbon monoxide emissions, with the black carbon particles and other pollutants in biomass smoke thought by many to exacerbate climate change.

Improved cook stoves, designed to burn biomass fuels more cleanly and efficiently than traditional stoves, have been promoted by charities, governments and private institutions in many poorer countries since the 1970s. A variety of approaches have been tried, including "build-your-own stove" projects, community-focused participatory schemes, manufacturing stoves in remote villages and market-based commercial activities. In some countries, these new stoves have been well-received. For example, in Kenya, 80% of urban families use a metal "jiko" charcoal stove for cooking, which uses 50% less fuel and also decreases cooking time. The cost of the stove can be recovered in fuel savings in just a few months. It is estimated that the widespread uptake of the jiko stove in Kenya saves 206,000 tonnes of wood or 570,000 hectares of trees per year.

In other countries, the progress has been less spectacular. Schemes have failed for a whole range of reasons which are only partially understood. Reasons for failure include: cost of the new stoves, cultural resistance to change, negative experience with previous "development" projects, lack of fuel, failure to understand users' needs and so on. Some stove initiatives have relied solely on the attraction of new technologies rather than taking a more holistic approach which learns from past mistakes and also from successful intervention projects.

Here we consider seven examples of improved cook stoves:

1. The Household Rocket Stove:

Fuel: Wood

The cylindrical stove is clad around an elevated ceramic liner that forms the burning chamber. There is a receptacle opening into the base for placing the fuelwood. The burning chamber is fitted with a grated metal that is elevated slightly for holding and organising the pieces of fuelwood to prevent them from falling off during burning process and to let air circulate beneath the fuel shelf.



Advantages:

- Efficient stove with high performance
- Heat loss is minimal as a significant amount of heat generated in the burning process is concentrated within the shield that encircles the pot; this is a technique that delivers high amount of cooking energy per cooking task
- Portable
- Uses less fuelwood than other cookstoves, as the fuel intake receptacle is designed to restrict the amount of wood able to fit in at any given time

Disadvantages:

- Concern over urban household use, where fuelwood is not readily available
- Concern surrounding the promotion of a fuelwood cooking device when there is also a clear need to protect our natural resources and biodiversity from further exploitation
- Stove cannot be left unattended while in use as flames from the fallen embers could potentially pose risk of being ignited

Further resources:

- Rocket stoves in Tanzania <http://practicalaction.org/rocket-stove-options>
- How to build your own rocket stove <http://www.rocketstove.org/index.php/household-stoves>

2. The Rwandan Improved Canamake (RIC)

Fuel: Charcoal

The Rwandan Improved Canamake stove is being promoted under a Practical Action East Africa project in Rwanda. It is a conical, ceramic-lined stove with two



variants of pot rest – the metal pot rest, and the clay pot rest. Two models are available – the standard RIC and the small RIC. It has many features of the existing Canamake portable stove, but with several improvements. The stoves cost 6.5 USD each, and are built by local cooperatives whom Practical Action have helped establish. Local workers/artisans have been trained to make the kilns/moulds.

At Private Sector Development events, the RIC was lighted and used to either cook dry beans or potatoes (two staples in the Rwandan diet), and attracted a large audience, proving very successful. Using these stoves instead of the common cookstove in Rwanda has resulted in a 35% reduction in indoor air pollution and a 40% reduction in charcoal use where they have been implemented.

Further resources:

[Article on the Canamake](#) in The Rwandan Focus

3. The Gasifier Stove

Fuel: Wood, straw or grass

The cylindrical metal stove is clad around an internal vacuum that forms the burning chamber through which the fuelwood is vertically fed from the top of the stove. A detachable metal ring that is easily fitted to the upper part of the stove serves as the pot support. The bottom part of the stove is fitted with a wooden knob that serves as the air-intake valve, controlling the air flow ratio and aiding the internal gasification process. Both sides of the middle part of the stove are fitted with firm wooden handles that enhance its portability.



Advantages:

- Efficient with high performance
- Heat loss is minimal, as a significant amount of heat it generates in the burning process is concentrated at the base of the pot; this is a technique that delivers high amount of cooking energy per cooking task
- Portable
- Can convert wood instantly into charcoal at the completion of the burning process, giving the unique advantage of producing charcoal fuel that can be used in a Rwandan Improved Canamake stove. This is a unique way of fuel recycling process that is unmatched by most fuelwood burning stoves

Disadvantages:

- Difficulty in refilling fuel immediately after the initial fuel input burns out. This often occurs in the middle of cooking, and apart from the drudgery involved in culling fuelwood and termination of the cooking process midway, such effort usually results in copious smoke emissions and inefficiency
- Fuelwood needs to be cut to a certain size to fit to the combustion chamber of the stove; an additional task for stove users
- The height of the stove in relation to its light mass makes it liable to tipping
- Concern over urban household use, where fuelwood is not readily available
- Concern surrounding the promotion of a fuelwood cooking device when there is also a clear need to protect our natural resources and biodiversity from further exploitation

Further Resources:

- Practical Action technical brief <http://practicalaction.org/gasifier-stoves-advanced-biomass-stove>

4. The Charcoal Beehive Briquette Stove**Fuel:** Briquettes

This is a metal stove that has a clay-lined burning chamber in which perforated briquettes that are pre-heated in another stove, are placed as fuel. The pre-heated briquettes eventually glow until they are able to radiate energy in the glowing process.



Briquettes are made out of wood, leaves, twigs, branches and any other kinds of agricultural and forestry residue. These are converted to char by carbonising in a charring drum, grinding into powder, mixing with bentonite clay and water, then filled compactly into a mould and dried in the sun for 2 or more days.



Advantages:

- Well-designed stove with aesthetic quality
- Heat loss is very minimal, as a significant amount of heat it generates in the burning process is concentrated at the base of the pot; this is a technique that delivers high amount of cooking energy per cooking task
- Portable
- Practical for slow cooking practices as it has low fire power
- Once ignited it doesn't need any attendance by the user to function
- Does not produce much smoke

Disadvantages:

- Pre-heating the briquettes takes a lot of time
- Igniting the fuel also takes some time. To make it easier one can use another fuel to ignite it (wood or charcoal). Once it is ignited it will remain so until the briquette is completely burnt out or extinguished by water
- From the experience of the Netherlands Development Organisation (SNV) in implementing this type of stove in Nepal, some of the problems faced were high cost of collection of raw materials, wear and tear of screw and barrel, localised environmental impacts due to emission of CO, CO₂, SO_x, air pollution during production, and lack of government commitment to technology

5. Solar cooker

Fuel: None (uses sunlight energy)

Solar cookers use the sun's rays to cook food without the need for additional biomass fuel. A parabolic dish focusses the rays onto a cooking pot, generating very high temperatures. These have been most successfully implemented and used in China and Tibet.



Advantages:

- No fuel costs
- No need to collect fuel
- No smoke / pollution
- Good for cooking food that needs a constant temperature

Disadvantages:

- Can be difficult to use
- Safety concerns regarding pointing the stove towards the sun
- May need to be adjusted during cooking to follow the sun
- Food might taste different
- Can only be used when the sun is shining

Further resources:

Practical Action's technical briefs on [Solar Cooking](#) and on [Solar Cooking and Health](#)

6. Biofuel stoves

Fuels: Agricultural or crop waste

Biofuel stoves such as the Cleancook stove use alternative fuels derived from agricultural produce or crop waste to cook food.



Advantages:

- Lower levels of pollution (PM2.5 / smoke)
- Faster to cook food than wood

Disadvantages:

- Expensive
- Fuel vs food issues
- May not be appropriate to cook certain foods (flatbreads like injera for example)

Further resources:

Practical Action - [Ethanol Stoves in Madagascar](#)

7. Jiko Stove

Fuel: Charcoal

The jiko consists of a ceramic liner fitted inside a metal case. It burns 25 to 40 per cent less charcoal than the traditional stoves on which its design was based.

Read the story of Benson in Kenya, who used Practical Action's book on "Appropriate Mud Stoves in East Africa" to begin a career in his local community of making and supplying jiko stoves with smokehoods.

<http://practicalaction.org/mud-stoves-in-kenya-1>

**3. CLASS ACTIVITY**

The class activity is for the students to evaluate a real life improved cookstove project (chosen by the lecturer or by the students from one of the above examples, or another type). Students, in groups of approximately 4, are to produce a poster and carry out a 5min group presentation to show their learning outcomes.

The project / technology should be evaluated using the following criteria / questions:

Technological: how does the stove work? What fuel does it use? How efficient is it at boiling water? How much fuel would be used to cook a typical meal? What materials are used in the construction of the stove? How is the stove manufactured? Will the stove be able to be used to cook all of the meals required every day?

Social: Where is the stove manufactured? Who benefits from the sales / distribution of the stoves? How does the project take into account the cultural factors surrounding cooking? Are gender issues addressed? How much does the stove cost? What is the pay-back period? What food will be cooked on the stove?

Health / Safety: What levels of pollution are produced by the stove? How do these compare to the pollution generated by an open fire? What are the health impacts? Is the stove safe to use? Are detailed instructions provided? Are people trained how to use the stoves?

Note: Questions and activities can be modified to suit class.

Solution and Evaluation Criteria – the evaluation criteria should be based on how fully students have been able to answer the questions listed above. Additional evaluation criteria could include marks for presentation style (either for the poster or group presentation).

4. HOMEWORK ACTIVITY

The homework activity is a group project (groups of approximately 4) to design and manufacture a simple cooking stove and to (safely) cook and share a meal produced using the stove. Stoves designs could be based on available plans for a rocket stove, or for a solar cooker, depending on the location of the class. Construction should use locally available / recycled materials and simple tools only. A risk assessment should be completed by the students for the activity.

Participation and culture are key to this activity. How will the tasks be divided up? Will the group approach the task from the perspective of the stove or from the perspective of the food? Will gender stereotypes be reinforced – i.e. will female members of the group be expected to prepare the food / cook the meal?

This activity is also open to modification.

Solution and Evaluation Criteria – the homework could be evaluated in a variety of ways, depending on the resources available. Options include: individual reports including a reflective account of the student's role in the activity, or a group presentation could be prepared, with other students asking questions during, or after the presentation. For a more innovative approach, the quality of the meal produced could form part of the evaluation criteria. Did the stove perform as expected? Was the food ready to eat at the allocated time? What governed the choice of stove / meal?

BIBLIOGRAPHY

The Stove Project Manual

By S Joseph, Y Shanahan, W Stewart

ISBN: 9780946688265

Detailed guidelines for project managers interested or involved in stoves programs

<http://developmentbookshop.com/the-stove-project-manual-pb>

Stoves for People

Edited By Roberto Caceres

ISBN: 9781853390197

Firewood shortages, dwindling forests, and the effects on the low income population of the developing world - these are some of the subjects addressed here, together with details of the introduction of fuel-efficient popular stoves for domestic use.

<http://developmentbookshop.com/stoves-for-people-pb>

Kenya Ceramic Jiko

By Hugh Allen

ISBN: 9781853390838

The jiko, a charcoal-burning stove consisting of a ceramic liner fitted inside a metal case, burns 25 to 40 per cent less charcoal than the traditional stoves on which its design was based. This book provides guidance on its production and promotion.

<http://developmentbookshop.com/kenya-ceramic-jiko-pb>

Stove Images: A Documentation of Improved and Traditional Stoves in Africa, Asia and Latin America by Beatrix Westhoff and Dorsi Germann, SFE

<http://hinfo.humaninfo.ro/gsd/genus/documents/s20813en/s20813en.pdf>

FURTHER/SUGGESTED MATERIAL

Health impacts – World Health Organisation

http://www.who.int/indoorair/health_impacts/disease/en/

Practical Answers

Stoves and Ovens – Practical Action <http://practicalaction.org/stoves-and-ovens-answers>

Health impacts – Practical Action <http://practicalaction.org/meningitis-link-smoke>

HEDON

www.hedon.info

Practical Action is a core member of the Household Energy Development Organizations Network (HEDON), set to act as a focal point for those working in the field in household energy. It aims to promote links among the diverse organizations working in this field, including NGOs, government agencies, and consultancies.

GACC - The Global Alliance for Clean Cookstoves

<http://www.cleancookstoves.org/>

The Global Alliance for Clean Cookstoves is a public-private partnership that seeks to save lives, improve livelihoods, empower women, and protect the environment by creating a thriving global market for clean and efficient household cooking solutions.



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