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## Considering sustainability factors in the development project life-cycle : a framework for increasing successful adoption of improved stoves

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CONSIDERING SUSTAINABILITY FACTORS IN THE DEVELOPMENT  
PROJECT LIFE-CYCLE:  
A FRAMEWORK FOR INCREASING SUCCESSFUL ADOPTION OF IMPROVED  
STOVES

By  
Travis K. Ostrom

A REPORT

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Environmental Engineering

MICHIGAN TECHNOLOGICAL UNIVERSITY

2010

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This report, “Considering Sustainability Factors in the Development Project Life-Cycle: A Framework for Increasing Successful Adoption of Improved Stoves,” is hereby approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE IN ENVIRONMENTAL ENGINEERING.

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## **Preface**

The motivation for this study came from the author's service with the United States Peace Corps from May 2008 through April 2010. The author served as a water and sanitation engineer in Honduras, Central America. Throughout the two years, the author lived in a town of 6,000 people in the Copán department of western Honduras. He assisted the local government and various NGOs on a variety of projects and development efforts, mainly in various small surrounding villages. Most of the author's work consisted of water and sanitation projects, occasionally in remote areas. This caused him to spend a good deal of time in the homes of project participants. As a result the author learned firsthand the situation surrounding fuel use, cooking, and indoor air quality in rural Copán. These experiences culminated in an improved wood-burning cookstove project and the research presented in this paper.

This paper contains some material borrowed and/or adapted from "Applying Life Cycle Thinking to International Water and Sanitation Development Projects: An assessment tool for project managers in sustainable development work," by Jennifer R. McConville (2006) and "Adapting life cycle thinking tools to evaluate project sustainability in international water and sanitation development work," by McConville and James R. Mihelcic (2007). Where this material is used, it has been cited as normal. One exception to this is in the framework developed and presented in the results and Appendix A. There, material from McConville (2006) or McConville and Mihelcic (2007) is combined with new material and presented as an original version.

## List of Abbreviations

|                          |   |
|--------------------------|---|
| <b>M&amp;E.</b>          | Monitoring and Evaluation                                     |
| <b>O&amp;M.</b>          | Operation and Maintenance                                     |
| <b>DALYs.</b>            | Disability-Adjusted Life-Years                                |
| <b>PCV.</b>              | Peace Corps Volunteer   |
| <b>IAQ.</b>              | Indoor Air Quality  |
| <b>IAP.</b>              | Indoor Air Pollution  |
| <b>IDPs.</b>             | Internally Displaced Persons                                  |
| <b>GHG.</b>              | Green House Gas   |
| <b>CO<sub>2</sub>.</b>   | Carbon Dioxide  |
| <b>CO.</b>               | Carbon Monoxide   |
| <b>CH<sub>4</sub>.</b>   | Methane   |
| <b>NO<sub>x</sub>.</b>   | Nitrogen Oxides   |
| <b>SO<sub>x</sub>.</b>   | Sulfur Oxides   |
| <b>PM<sub>10</sub>.</b>  | Particulate Matter with a diameter of 10 micrometers or less  |
| <b>PM<sub>4</sub>.</b>   | Particulate Matter with a diameter of 4 micrometers or less   |
| <b>PM<sub>2.5</sub>.</b> | Particulate Matter with a diameter of 2.5 micrometers or less |
| <b>LIPs.</b>             | Locally Influential Persons                                   |
| <b>UNDP.</b>             | United Nations Development Programme                          |
| <b>DfID.</b>             | Department for International Development (UK)                 |
| <b>LPG.</b>              | Liquid Petroleum Gas  |
| <b>FAO.</b>              | Food and Agriculture Organization of the United Nations       |
| <b>WHO.</b>              | World Health Organization                                     |
| <b>ARI.</b>              | Acute Respiratory Infection                                   |
| <b>ALRI.</b>             | Acute Lower Respiratory Infection                             |
| <b>GDP.</b>              | Gross Domestic Product  |
| <b>NGO.</b>              | Non-Governmental Organization                                 |
| <b>USAID.</b>            | United States Agency for International Development            |
| <b>WASH.</b>             | Water, Sanitation, and Hygiene                                |

## **Abstract**

Indoor air pollution from combustion of solid fuels is the fifth leading contributor to disease burden in low-income countries. This, and potential to reduce environmental impacts, has resulted in emphasis on use of improved stoves. However, many efforts have failed to meet expectations and effective coverage remains limited. A disconnect exists between technologies, delivery methods, and long-term adoption.

The purpose of this research is to develop a framework to increase long-term success of improved stove projects. The framework integrates sustainability factors into the project life-cycle. It is represented as a matrix and checklist which encourages consideration of social, economic, and environmental issues in projects.

A case study was conducted in which an improved stove project in Honduras was evaluated using the framework. Results indicated areas of strength and weakness in project execution and highlighted potential improvements for future projects. The framework is also useful as a guide during project planning.

# 1 Introduction

Development assistance is often offered on a temporary basis and projects typically have finite timeframes. Yet, the impacts of the assistance and projects are intended to be lasting. As a result, a challenge for international development is to achieve long-term sustainability of projects. Historically, many projects have failed to achieve their intended goals (Bishop 2001). Multiple factors contribute to this phenomenon. One key factor is the manner in which projects are planned and executed. It is critical to the success of a project that various elements of sustainability be considered throughout each stage of the project process. This is particularly true where outside involvement is discontinued after project closure, as is the case for much international development work.

Throughout two years living and working in Copán, Honduras the author encountered the after effects of many development projects. While there is evidence of effective development, there is also evidence of failed projects. There are community water systems, designed for a 20 year project life, which fail to provide sufficient water to users just a few years after construction. There are drinking water chlorination boxes and household water filters which sit idle. There are abandoned and overgrown vegetable gardens. There are unused or ill functioning cookstoves.

## 1.1 Improved cook stoves



Figure 1.1: High wood consumption of unimproved stoves



**Figure 1.2: High smoke production of unimproved stoves**

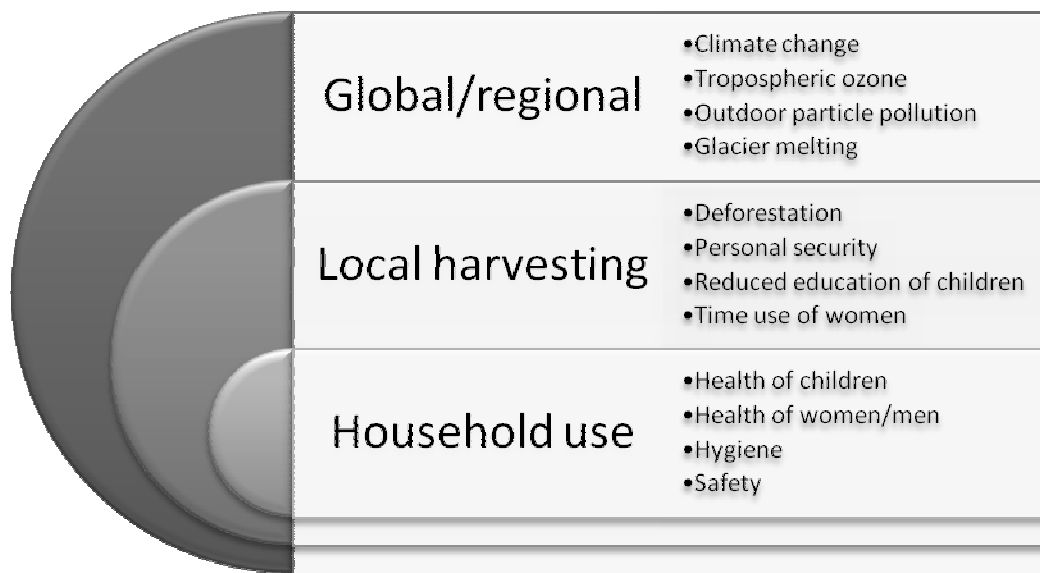
Smoke from indoor combustion of solid fuels causes an estimated 2 million deaths worldwide and loss of 41 million disability-adjusted life-years (DALYs) each year. This accounts for 3.3 percent of deaths worldwide – the most of any environmental factor – and 2.7 percent of DALYs (Mathers et al. 2009). According to the World Health Organization (WHO) (2004), more than half the world’s population uses solid fuels, including “wood, dung, coal or agricultural residues on simple stoves or open fires” to meet their heating and cooking needs. Most of this is in low income countries. Consequently, the disease burden attributable to indoor smoke from solid fuels ranks it fifth among all risk factors and second for environmental factors in low income countries (Mathers et al. 2009). These figures include deaths and DALYs from acute respiratory infections (ARI or ALRI) in children, chronic obstructive pulmonary disease (COPD), and lung cancer. Studies have shown “consistent and strong relationships” between these diseases and indoor air pollution (IAP) from indoor use of solid fuels. Links have also been found to other ill health effects, including tuberculosis and low birth-weight, however studies and evidence in these areas are limited (WHO 2002 and Rehfuss 2006).

These health impacts are a function of pollution levels and exposure. Since over half of a person’s air intake throughout their life is said to occur inside the home, indoor air quality (IAQ) is of vital importance to health (Sundell 2004). Exposure is typically higher for women and children who spend more time in spaces near where solid fuels are used. In fact, it is estimated that, worldwide, 56% of deaths attributable to household solid fuel use occurred in children less than five years of age (WHO 2002). This contributes substantially to making ARI (i.e. pneumonia) the principle killer of children worldwide. Studies have shown that breathing smoke doubles the risk of ARI in children less than five and makes women three times more likely to suffer from COPD (i.e. bronchitis and emphysema). (WHO 2002 and Smith 2006) Levels of IAP from cooking depend on a variety of factors including fuel source, combustion efficiency, and ventilation. Therefore, solid fuel use with simple cooking technologies,

typically with poor ventilation, results in dangerous levels of air pollution within homes. The primary pollutants of concern are CO and particulates (PM<sub>10</sub> and PM<sub>2.5</sub>). Although, NO<sub>x</sub>, benzene, and others pollutants pose threats to health as well (Rehfuess 2006).

Improving household conditions with lower-emission stoves and better ventilation has the potential to substantially improve health. Wilkinson et al. (2009) estimate that installing 150 million low-emission cookstoves in India, over a ten year period, could reduce deaths from ARI in children less than five years of age and COPD in adults by 30%. Beyond addressing the health concerns outlined above, improved stoves are attractive, from a policy perspective, for economic and environmental reasons. Improved stoves tend to be highly cost-effective. Consider an analysis conducted by Mehta and Shahpar (2004), which showed that in high-risk regions, such as Africa and South and Southeast Asia, for a cost per household ranging between (US)\$3 and \$5, “improved stoves could reduce the burden of disease associated with exposures to indoor air pollution for an average yearly cost of \$500-600 per healthy year gained (Mehta and Shahpar 2004).”

Additionally, most, but not all, improved stoves increase efficiency, thereby reducing fuel consumption and emissions. An evaluation conducted by Hutton et al. (2007) modeled the costs and benefits of halving the global population lacking access to improved cooking stoves (a representative chimneyless rocket stove was used for the analysis). It was found that over a ten year period, the intervention produced \$105 billion in economic benefits and a negative net cost of \$34 billion. Fuel cost savings exceeded intervention costs resulting in net negative cost. One of the potential environmental benefits of improved stoves is reduced emissions of greenhouse gases. In the same study by Wilkinson et al. (2009) referenced above, it is estimated that the Indian improved stove intervention could save 0.1 – 0.2 megatons CO<sub>2</sub>-equivalent per million people in 1 year. This is approximately equivalent to an 8% – 16% reduction in the average Indian persons CO<sub>2</sub> emissions (UNSTATS 2010). Improved stoves may also lead to a number of other benefits over traditional stove use. These can include reduced burn risk, decreased vulnerability (during fuel collection), less deforestation and watershed degradation, time savings, and improved domestic conditions (hygiene and pride).

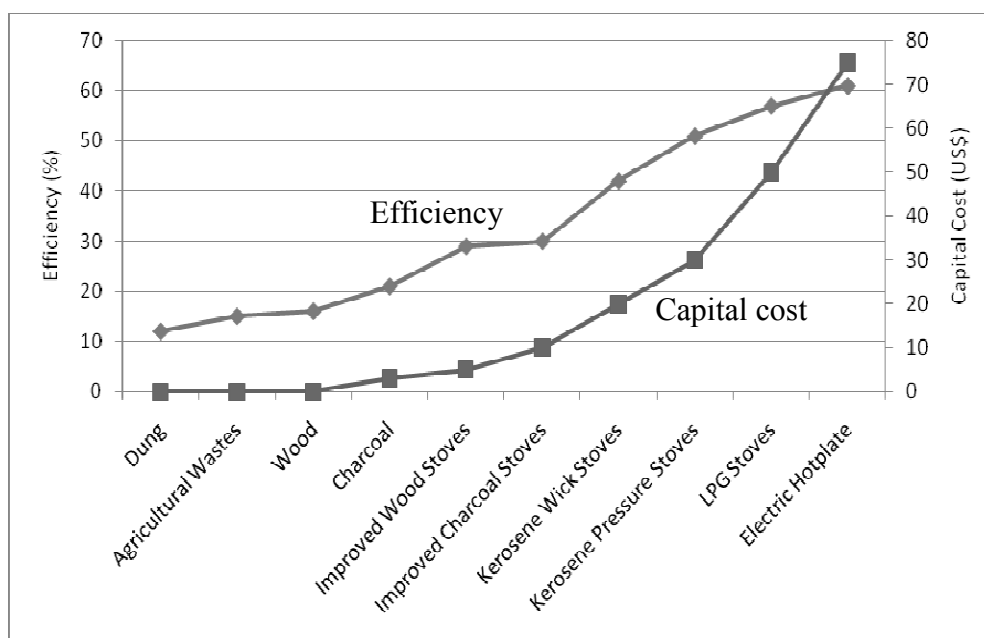


**Figure 1.3: Effects of unimproved stove use**

Adapted from Wilkinson et al. (2009)

Figure 1.4 shows typical efficiency ratings and capital costs for a number of household fuels. The associated hypothesis, commonly referred to as the “energy ladder,” states that as affluence increases, households trend toward use of high-efficiency fuels and stoves. The shift toward use of low-emissions fuels/stoves is also suggested to follow rising affluence. These more-efficient, lower-emission fuels/stoves generally require more capital cost. It is important to note, however, that the concept of the energy ladder is a simplification and generalization of observed behavior. On a country level, the graph in Figure 1.5 supports the energy ladder assertion. It shows that a smaller percent of the population in wealthier countries use solid fuel than in poorer countries.

However at the household level, particularly in developing countries, combinations of different types of fuels and stoves are typically used to meet energy needs. Take, for example, a study by Masera et al. (2000) which found that increasing household wealth led to “an accumulation of energy options” rather than a linear progression from one fuel to the next. The study also found that in four out of five locations there was no significant difference in fuelwood consumption between houses cooking only with wood and those using a combination of liquid petroleum gas (LPG) and wood. Similar results were found for households in Morocco in Najib (1993). This means that more affluent households tend to adopt improved options, but they do not necessarily abandon traditional fuels, or even decrease levels of consumption of those fuels. Masera et al. (2000) conclude that “household fuels, rather than pertaining to a ladder of preferences with one fuel clearly better than the other, possess both desirable and undesirable characteristics, which need to be understood within a specific historical and cultural context.” This historical and cultural context may be the key to understanding complex fuel and stove use choices.



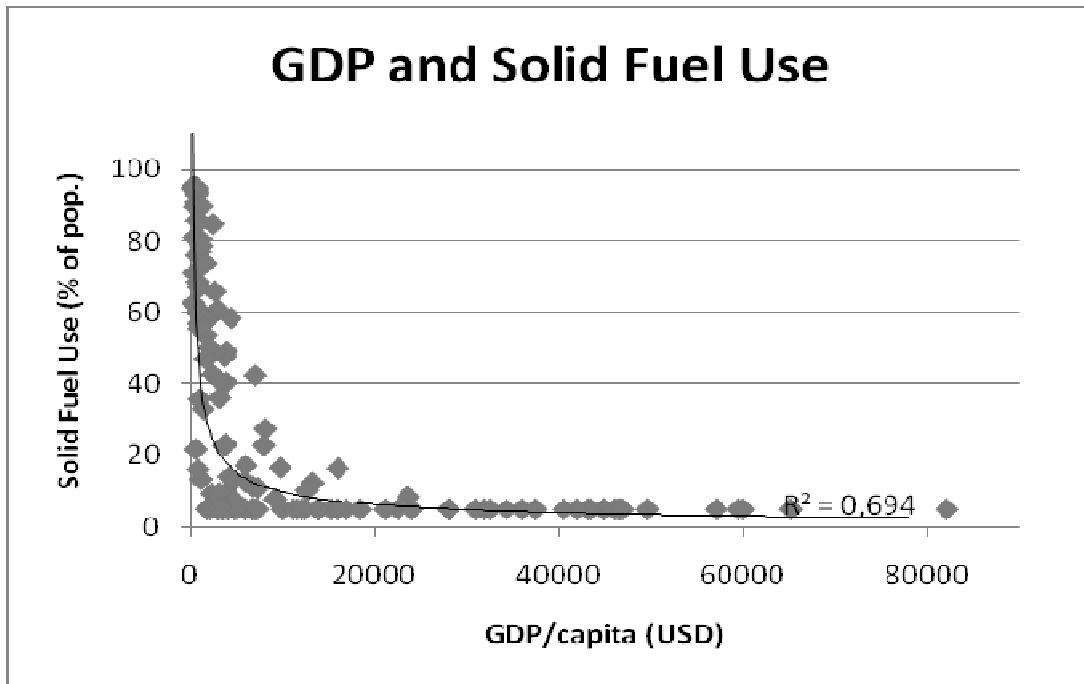
**Figure 1.4: Fuel types ordered according to increasing efficiency, cost, and affluence**

Adapted from Graham (2005)

Additionally, Figure 1.4 places solid fuels toward the low end of efficiency (and high end of emissions). However, this may not always be accurate as Bryan et al. (2009) explain.

“Wood burning know-how has come a long way in the last few years in the industrialized countries as a result of emission quality regulations. If the combustible gas production phase (pyrolysis/gasification) is separated from the high temperature combustion phase for long enough, it is possible to produce emissions of a quality similar to those of a modern gas burner. In actual fact, it is not the fuel but the stove/fuel combination which is dirty. Burning paraffin or ethanol or even liquefied petroleum gas (butane, propane) can result in appalling quality emissions if the technologies and/or stove adjustment are inappropriate.”

Much emphasis in this discussion has been placed on the negative health effects of solid fuel used for cooking. However, this is not meant to imply that solid fuels themselves are dirty or that they are not viable options. In fact, they may be the best options for low income – and perhaps high income – settings due to the costs (economic and environmental) of fossil fuels. Hence, to clarify, when the term “improved stoves” is used in this paper it refers to stove/fuel combinations which have increased efficiency and/or decreased emissions of harmful pollutants.



**Figure 1.5: Wealth and levels of solid fuel use in countries throughout the world**

Source of data: (UNSTATS 2010 and IMF 2010)

### 1.1.1 Stove projects

Recognition of the impact of IAP on health in the developing world has grown in recent years, notably as a result of publication of the WHO's World Health Report in 2000 (WHO 2000). As well, global interest in combating environmental issues, such as deforestation and global warming, has increased. This growing awareness of the problems associated with IAP and the opportunities presented by improved stoves has resulted in increased focus from the development community on these issues. This has included efforts from non-governmental organizations (NGOs), governments, academia, and private enterprises, to further study the issues and increase stove distribution in developing countries. Prominent among these efforts is the Partnership for Clean Indoor Air (PCIA), established in 2002, at the World Summit on Sustainable Development, by a group of organizations committed to reducing exposure to IAP from household energy use (PCIA 2010). Efforts to impact the situation have met with varying degrees of success. A number of studies and reports on past projects were reviewed to assess the range of sustainability levels and glean lessons learned. Two of these are summarized in Table 1.1 and Table 1.2 as examples. For further literature on stove studies see the reference list.

**Table 1.1: A report on a stove project in Peru**

|  |
|--|
| <b>Study:</b><br>Peru Healthy Kitchen/Healthy Stove Pilot Project (Winrock 2008)   |
| <b>Scope:</b><br>Report of a USAID and Winrock International pilot project in 33 rural communities in Peru.  |
| <b>Key findings:</b> <ul style="list-style-type: none"><li>• Stoves installed in 377 households on livestock loan system, plus 36 bought with cash.</li><li>• 27 stove or parts builder entrepreneurs created.</li><li>• 1/3 less wood used.</li><li>• Tests after 12 months showed 80% reduction in PM<sub>4</sub> and CO in most households. Tests after 24 months showed less reduction and some reverse of trends.</li><li>• Awareness was increased.</li><li>• General satisfaction, except in 3% of households, combustion elbows cracked causing many of them to abandon.</li><li>• Project influenced other organizations to adopt parts of approach. Remains to be seen if they will take market approach with loans.</li></ul>   |
| <b>Lessons learned:</b> <ul style="list-style-type: none"><li>• Integrated approach of technology, market-based, multi-media, and strong local promoters is appropriate, but requires more up front effort.</li><li>• Capable local partner and motivated technical manager in the field is essential.</li><li>• Clear, reasonable milestones, and enough time to make adjustments is needed.</li><li>• Training of interested community leaders for local management helps.</li><li>• Field tested promotional materials are important. Reinforcement of messages after time is needed.</li><li>• In-depth and well organized promoter training program is needed to prepare promoters before installation and reinforce and update knowledge after.</li><li>• In-depth stove builder training program prevents flaws. Follow-up technical support may be required to solve problems.</li><li>• Quality materials and local knowledge of them is key.</li><li>• Microloan system is critical.</li></ul> |

**Table 1.2: A report on stove programs in South Africa**

|  |
|--|
| <b>Study:</b><br>Household Energy, Indoor Air Pollution and Health: Overview of Experiences and Lessons in South Africa (PDC 2004).  |
| <b>Scope:</b><br>Overview of household energy and health in South Africa   |
| <b>Key findings:</b> <ul style="list-style-type: none"><li>• Despite electrification levels of 66% in 1999, almost 50% of households use fuels other than electricity, mostly wood and coal, for cooking.</li><li>• A program in the 1970's was unsuccessful, despite good sales, because users modified the combustion chamber.</li><li>• Tests and macro-scale experiments were conducted to inform a new stage of the program. A publicity campaign was included.</li></ul> |
| <b>Lessons learned:</b> <ul style="list-style-type: none"><li>• Cost is a barrier and affordability is key.</li><li>• Capacity building in energy and health is needed in local government.</li><li>• Participatory planning makes projects more acceptable.</li><li>• Viable technologies are rarely commercialized and support is needed.</li><li>• End-user awareness is a challenge.</li></ul>   |

Results from the literature review are largely consistent with the author's findings in Central America. Past projects have experienced varying degrees of acceptance and continued use of installed stoves. However, overall enough improved stove projects have failed that some people hold the idea that "fuel efficient stove programmes always fail (Bryan et al. 2009)." While a number of improved stoves in Copán remained in use, many others had fallen into a state of disrepair or disuse. In fact, some projects experienced difficulties even during planning stages. One organization was unable to find enough households willing to accept the stoves offered, even at a considerable subsidy. Another, more commonly witnessed, problem was alteration of the stoves after installation. Since many improved stove models included a smaller combustion chamber than traditional models, there was a tendency for users to alter the stoves by widening the chamber, thereby decreasing the stove's efficiency. One organization reported approximately 30% of stove recipients altered their stoves in this way (Lara 2010).

Another problem involved chimneys becoming clogged or corroded from poor maintenance and/or poor combustion, leading to smoke backing up into the house. In some homes, stove parts had deteriorated from use and were not replaced or stoves did not function as the users desired. These situations were sometimes complicated by a

lack of will or capacity, on the part of the user, to solve such problems. Additionally, implementing organizations rarely maintained long-term involvement in the projects. These are just a few of the barriers to successful dissemination and adoption of improved stoves. The author's experiences and opinion are shared, in part, by Avis and Ballard (2007).

“Many stove programmes have not succeeded because they failed to establish consumer demand for their products, and therefore there was limited uptake and spreading. A successful approach demands commercialisation by removing barriers. This can be done by developing technical skills amongst stove manufacturers or artisans, developing entrepreneurial skills, and marketing improved stoves to the public.”

The author would add that, beyond establishing demand, a successful approach must establish a means of meeting demand. It also must consider the appropriateness of the technologies and approaches used and overcome the barrier of low consumer resources. Additionally, the barriers to successful dissemination and adoption of improved stoves extend beyond market factors. They can also include social and environmental barriers. See Winrock (2008), Polack (2008), and Bryan (2009) for more information on programs that have successfully utilized approaches similar to that described here.

It should also be noted that improved stoves, as a household good, constitute a different type of development situation than projects involving community infrastructure or shared goods. When a household chooses to acquire a stove, or other household technology, it is not typically necessary to involve the rest of the community, government, or development organizations. However, development efforts may be required to build a market ecosystem in which improved household energy options are available and demanded. This could involve local actors such as the community or government as well as outside development support. Therefore, the development focus in improved stove projects should be on increasing local capacity and mobilizing local resources to build the existing market. Programs should not seek to distribute gifts, but rather should be designed to provide more improved options to those without and enable people to make informed decisions about health and energy use.

## ***1.2 Addressing the problem***

### **1.2.1 Project planning frameworks**

In recent decades, attempts have been made to increase project success and strengthen project management through a variety of tools. Examples include the sustainable livelihoods framework and project cycle management (DfID 1999 and Blackman 2003). The frameworks seek to help practitioners understand the project process and consider issues which are important to sustainability. They have been adopted by government and international development institutions such as DfID, UNDP, and Oxfam (IDS

2010). The concepts have also been adapted to specific issues such as environment or gender in development (Bishop 2001 and McDade 2004).

One drawback to the frameworks is that they are not widely used beyond the NGO community. They can also be cumbersome for someone who lacks the training and experience of a United Nations employee, for example. This is important considering the growing number of people and organizations involved in international development, many from fields other than development. These may include practitioners such as smaller NGOs, volunteers, service organizations, religious groups, and more. A key demographic which could benefit from such a framework is engineers, who are often technically capable but may be inexperienced incorporating social considerations into their work. There is growing involvement of engineers in international development. As an example, consider that since 2002 Engineers Without Borders-USA has grown to 12,000 members in over 250 professional and student chapters. It has over 350 projects in over 45 developing countries around the world (EWB 2010).

From personal experience with many such groups, I have witnessed first-hand the need for an easy to use tool for increasing sustainability in development projects. Take for example an experience from a workshop held in Copán, Honduras. Local employees of various national and international development organizations were divided into mixed groups. Groups were asked to rate how they were doing in certain components of projects. For the monitoring and evaluation component, one group gave itself a 5, the highest possible score. When asked why a 5 was deserved in this area, a representative from an organization which claims to support “integrated development processes” responded that they do a great job of monitoring and evaluation because the organizations always check to make sure the project was completed. There was no consideration of project follow-up or post-implementation monitoring and evaluation. In light of the growing trend of NGOs, volunteers, and engineers involved in international development, there is a certain need for sustainability guidance.

McConville (2006) developed a framework targeted at this demographic. The tool integrates project management best practices and sustainability issues into the project life cycle. However, in order to fully understand this framework, one must first understand what is meant by the term “sustainability.”

### **1.2.2 Sustainability defined**

There are many definitions of sustainability and sustainable development and even more interpretations of their meanings. These are terms which are used frequently in development discourse and can be sources of misunderstanding or misrepresentation. As Sugden (2003) states, sustainability “has become one of the most over used and abused words in the development vocabulary”. In the most obvious sense, the term “sustainable” refers to something which can be sustained, or kept going. But, it also refers to resource use and lifestyles which do not damage resources or society (M-W 2010). To clearly understand what is meant by sustainability for the purposes of this

paper, a number of past definitions are presented and key elements from these are noted. These elements are then integrated into a comprehensive definition of sustainable development, as it will be used in this paper. For a more in depth discussion on the various meanings of the terms sustainability and sustainable development, see Lockwood (2003).

**Table 1.3: Definitions of "sustainability"**

|  |   |
|--|---|
| Report of the World Commission on Environment and Development: Our Common Future. The "Brundtland Report." (UN 1987) | <ul style="list-style-type: none"> <li>• "Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future."</li> <li>• "Sustainable development is . . . a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs."</li> </ul> |
| WASH Technical Report no. 94: The Sustainability of Donor-Assisted Rural Water Supply Projects. (Hodgkin 1994)       | <ul style="list-style-type: none"> <li>• "Sustainability is the ability of a . . . development project to maintain or expand a flow of benefits at a specified level for a long period after project inputs have ceased."</li> <li>• "Different participants in the projects (donors, host government, beneficiaries) will have different evaluations of sustainability based on the relative value of achieving the various goals."</li> </ul>                             |
| Sustainability Science and Engineering: Emergence of a New Metadiscipline. (Mihelcic et al. 2003)                    | <ul style="list-style-type: none"> <li>• "Sustainable development is defined as the design of human and industrial systems to ensure that humankind's use of natural resources and cycles do not lead to diminished quality of life due either to losses in future economic opportunities or to adverse impacts on social conditions, human health, and the environment."</li> </ul>  |

Definition 1a:

**Sustainable development** is a process of growth which:

- Meets the needs of the present
- Meets the needs of all concerned
- Continues to meet these needs for an extensive time period
- Does not compromise the ability of current or future generations to meet their needs

Or equivalently,

Definition 1b:

**Sustainable development** is a process of growth which meets the needs of the present, as perceived by all concerned and maintained over a long period after project inputs have ceased, without compromising the ability of current and future generations to meet their needs.

### 1.2.3 Sustainability factors

Table 1.4: Sustainability factors

|                              |                         |  |
|------------------------------|-------------------------|--|
| Social Sustainability        | Socio-Cultural Respect  | A socially acceptable project is built on an understanding of local traditions and core values.  |
|                              | Community Participation | A process which fosters empowerment and ownership in community members through direct participation in development decision-making affecting the community.  |
|                              | Political Cohesion      | Involves increasing the alignment of development projects with host country priorities and coordinating aid efforts at all levels (local, national, and international) to increase ownership and efficient delivery of services. |
| Economic Sustainability      |                         | Implies that sufficient local resources and capacity exist to continue the project in the absence of outside resources.  |
| Environmental Sustainability |                         | Implies that non-renewable and other natural resources are not depleted nor destroyed for short-term improvements.   |

Source: McConville 2006

A number of key considerations have been identified in the literature as critical to achieving sustainability in development, as defined above. These considerations have been grouped in a variety of ways. The UN designates three “pillars of sustainability”: economic, social, and environmental (UN 2002). McConville and Mihelcic (2007) further subdivides the social pillar into three components: socio-cultural respect, community participation, and political cohesion. The result is a group of five factors, containing practices central to achieving sustainability in development. These are summarized in Table 1.4. It should be noted that a number of important factors to sustainability, such as gender or technology, are not grouped into a discrete unit, but

rather integrated throughout the five categories presented. For a more in depth explanation of the factors of sustainability see McConville (2006).

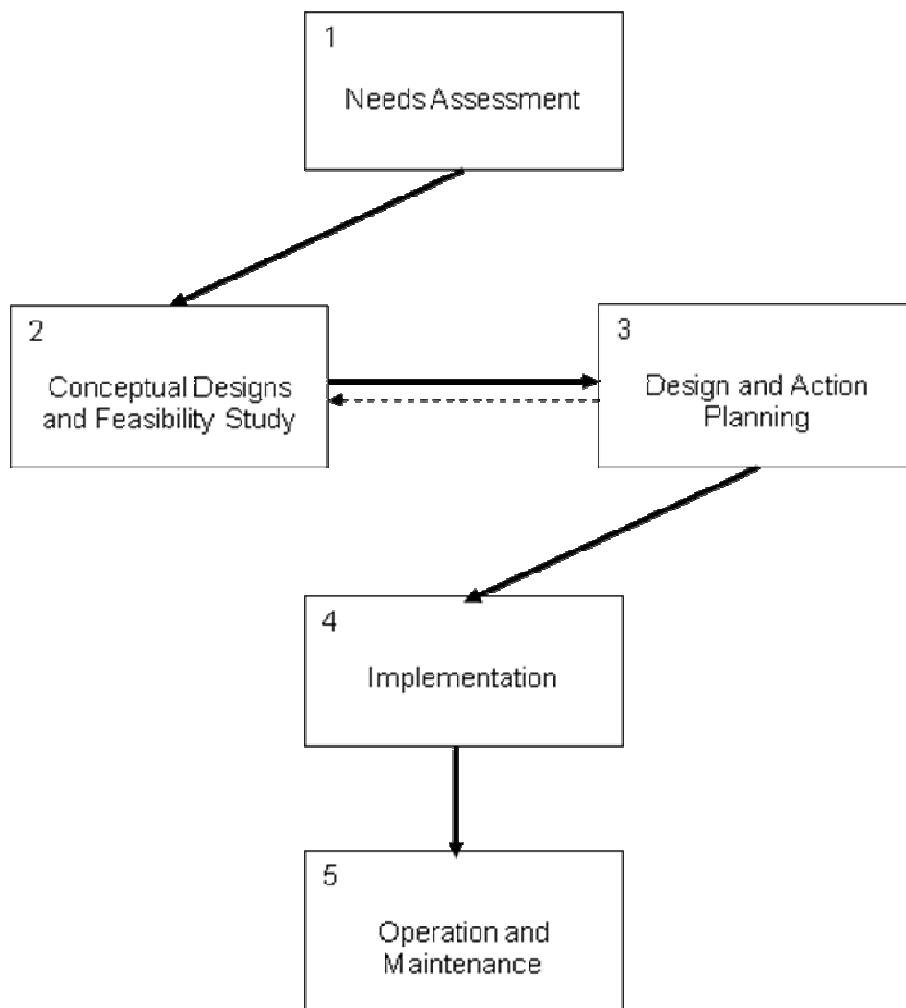
#### 1.2.4 Life-cycle stages

To increase overall sustainability, the above listed factors are considered over the life of a project, from conception through project completion and disposal. In order to create an easy to use procedural tool, the project life cycle is broken down into general stages present in most projects. Although the stages are divided, it is important to note that the divisions are largely arbitrary and there is overlap between stages. The points of segregation between stages can vary by institution. McConville and Mihelcic (2007) describes five project life-cycle stages, shown in Table 1.5. A project progresses through the stages following the sequence shown in Figure 1.6. It is important to take into account the interactions between the stages and how considerations in later stages can affect decisions made in earlier stages. For example, training on operation and maintenance (O&M) will occur during the Implementation stage even though the actual work of O&M will not be carried out until the Operation and Maintenance stage. How this training will be conducted and by whom will be determined in the Feasibility and Design stages.

**Table 1.5: Life cycle stages**

|  |   |
|--|---|
| Needs Assessment                         | Determine demand and gather background information. Generally initiated with request for intervention and ended with decision to proceed or abort.                        |
| Conceptual Designs and Feasibility Study | Alternative plans and technologies developed and assessed. May begin with brainstorming session for solutions across range of improvements and end with design selection. |
| Design and Action Planning               | Design finalized, including schematics and budget, and action plan developed.   |
| Implementation                           | Includes pre-construction, pilot construction, construction, training, and education.   |
| Operation and Maintenance                | Includes use, management, upkeep, continued training and education, monitoring and evaluation, and expansion.   |

Adapted from McConville (2006)



**Figure 1.6: Sequence of life cycle stages**

Source: (McConville and Mihelcic 2007)

One weakness in McConville’s conception of the project life cycle is that it has a beginning and end. However, many projects require an iterative and ongoing process to ensure success. This is particularly true in the case of household technologies which often require refinement or need a market ecosystem in which to proliferate. The Food and Agriculture Organization’s (FAO) “Project Cycle Management Technical Guide” in Bishop (2001) includes a feedback mechanism during the evaluation stage which leads into a new identification stage. Some other frameworks also place greater emphasis on monitoring and evaluation, impact assessment, and gathering of lessons learned in the stage McConville refers to as “Operation and Maintenance (McDade 2004).”

### 1.2.5 Matrix tool

The framework developed by McConville (2006) takes the form of a matrix accompanied by an associated checklist. Each matrix element corresponds to a pairing

of one project life stage with one sustainability factor. Associated with each element is a set of four recommendations based on best practices in project management and issues related to the sustainability factors. Each element, its four sustainability recommendations, and sample rhetorical questions are included in the checklist. The rhetorical questions provide detail and context to the suggestions. Each element is assigned a rating (0-4) based on the number of sustainability recommendations completed. For each of the five project life stages, five matrix elements, with associated sustainability factors, must be evaluated to determine the score for that stage. The highest possible score for each life cycle stage or sustainability factor is 20. The highest possible overall score for a project is 100. By using a matrix format and scoring system, McConville's tool serves as a "point of first entry" for development practitioners new to such approaches. It also makes the framework useful as a post project evaluation tool for individual projects as well as to evaluate and compare similar projects. It can also be used as a guide during project planning and execution. The matrix tool is shown in Table 1.6 followed by a sample recommendation and its associated questions.

**Table 1.6: Matrix representation of framework developed by McConville**

| Life Stage                         | Sustainability Factor  |                         |                    |                         |                              | Total |
|------------------------------------|------------------------|-------------------------|--------------------|-------------------------|------------------------------|-------|
|                                    | Socio-cultural Respect | Community Participation | Political Cohesion | Economic Sustainability | Environmental Sustainability |       |
| Needs Assessment                   | 1,1                    | 1,2                     | 1,3                | 1,4                     | 1,5                          | 20    |
| Conceptual Designs and Feasibility | 2,1                    | 2,2                     | 2,3                | 2,4                     | 2,5                          | 20    |
| Design and Action Planning         | 3,1                    | 3,2                     | 3,3                | 3,4                     | 3,5                          | 20    |
| Implementation                     | 4,1                    | 4,2                     | 4,3                | 4,4                     | 4,5                          | 20    |
| Operation and Maintenance          | 5,1                    | 5,2                     | 5,3                | 5,4                     | 5,5                          | 20    |
| Total                              | 20                     | 20                      | 20                 | 20                      | 20                           | 100   |

Source: (McConville and Mihelcic 2007)

One sample recommendation (worth 1 of the 4 available points) from element (1,1) – (Needs Assessment, Socio-cultural Respect) – is included.

- Recognize differences in gender roles in water and sanitation.
  - How do men use water? How much?
  - How do women use water? How much?
  - Who provides water for the household? Agriculture? Business?
  - How much time do men/women spend per day on water collection?
  - Do men and women follow separate sanitation practices?
  - Are there separate latrines for men and women?
  - Who is in charge of the children's hygiene?

Development projects can take place in a variety of situations. The ideal situation, according to McDade (2004), “would be first to determine the priorities of the people (both men and women) themselves and then to focus the project, or multiple projects, on assisting them in improving their livelihoods and making them more sustainable.” However, many projects are more specifically focused, oftentimes due to the expertise of the implementing organization. This latter situation is typical of improved stove projects. The McDade (2004) describes the two situations, in the energy context, as follows:

- (1) “The **integrated development situation** concerns the type of project that is not primarily concerned with energy but with overall development within a community. Energy is just one of many issues to be addressed, and the project managers are usually not specialists in any particular sort of energy.”
- (2) “In a **single energy technology situation**, projects in fact have a ‘single interest’ character and are promoted and carried out by specialists in the particular technology. In this situation, projects focus on a particular type of energy technology: for example, solar applications, biogas, improved stoves, micro-hydro systems, or mini-grids.”

McConville's framework falls in the space between these two situations. It focuses on a type of project – water and sanitation – but is not specific to a particular type of technology – such as groundwater wells. As a result of the focus on water and sanitation, many of the questions in the checklist are not applicable to improved stove projects. Therefore, a suitable framework for use with improved stove projects remains to be developed.

## 2 Goals and purpose

The goal of this research is to develop a project management and evaluation framework to increase sustainability in improved stove projects. The framework must integrate sustainability factors, including lessons learned and best practices, into the project life

cycle. It should be accessible to NGO workers, volunteers, and engineers with a range of development expertise. The tool should serve as a guide for practitioners to learn from and better execute projects. To accomplish this, it will include a series of checklists used to quantify a project's likely overall sustainability. It will also evaluate key criteria throughout project life stages and across different sustainability factors, enabling practitioners to readily identify specific strengths and weaknesses and correct accordingly. To test the framework's utility for project assessment and that the above conditions are met, a case study will be conducted in which the framework is applied to an improved stove project in San Agustín, Honduras.

### **3 Methods**

#### **3.1 *Initial investigation***

The first stage of this study involved assessing the current conditions in Honduras and Guatemala, based on recognition of problems in improved stove dissemination and adoption. The goal was to learn about issues involving household energy use, indoor air quality, project sustainability, health, environment, and regional technological and organizational capacity. Over the course of two years, many informal conversations were held with residents of a variety of rural communities. These conversations typically took place in the communities and oftentimes in homes. In such cases, casual physical inspections of household conditions were often conducted. Conversations were also held with employees from a variety of organizations active in the region. Some discussions were casual and others were held during visits made specifically for informational purposes. The complete list of organizations and employees consulted is included in Appendix B. The author also participated in a bi-monthly meeting of NGOs and local government in which local environmental issues were discussed and experiences shared.

#### **3.2 *Literature review***

Some literature was reviewed while in Honduras and some upon return to the United States. The most crucial paper consulted was "Adapting Life Cycle Thinking Tools to Evaluate Project Sustainability in International Water and Sanitation Development Work," by McConville and Mihelcic (2007). The framework presented therein served as the basis for the research developed throughout the rest of the study. The framework was first analyzed for applicability to improved stove projects. It was determined that more stove-specific detail would be required to address many of the issues encountered during initial investigation. Therefore, literature on improved stoves and past projects was reviewed in order to extract lessons learned and best practices, and to gain global perspective on issues encountered in Honduras. To better understand the context in which the sustainability framework fit, literature on planning and assessment frameworks, life-cycle thinking, and sustainability was reviewed.

### ***3.3 Collection of knowledge from past experiences***

A number of unstructured, informal interviews were conducted with people identified to have valuable experience with improved stoves. These conversations were held during the final three months of the author's residence in Honduras. They were conducted in English or Spanish, depending on the native language of the interviewee. Around the time the discussions were held, the author was certified to have achieved a Spanish language Oral Proficiency rating of Advanced-High. To begin the conversation, interviewees were informed of the purpose of the interview and asked "what, in your experience, has been found to cause improved stove projects to succeed or fail?" They were encouraged to expand on best practices, outcomes, lessons learned, and suggestions for future projects. Notes were taken by hand and later transcribed to Microsoft Word documents. Visits were made to communities or homes involved in previous projects identified during these conversations. Project impacts were assessed through physical inspections and discussions with stove users and their families. Interviewees are listed in Appendix B.

### ***3.4 Project implementation and analysis***

The author partnered with a fellow Peace Corps Volunteer (PCV), Nesha Francic, to implement an improved stove project in the town of San Agustín, where PCV Francic lived. The author participated in the project throughout all stages over a period of approximately six months. Further information required for project planning and implementation was gathered from local and literature sources with the idea that it could also be used in the research study. Observations were made and noted by hand throughout the project. These observations and the implementation experience were used to provide a basis of comparison for information gathered during research.

### ***3.5 Framework development***

A framework for use with improved stove projects was developed by first editing the recommendations and rhetorical questions in McConville (2006) to apply to stoves. This involved changing terms such as "water and sanitation" to "household energy use," for example. The project life-cycle was re-described, using information from the literature review, to better reflect the improved stove project cycle. Recommendations and questions reflecting the results of research were then integrated into the edited framework by substituting for checklist components deemed less applicable or important. Finally, the resulting framework was analyzed for cohesion, continuity, coherence, and proper weighting of matrix elements.

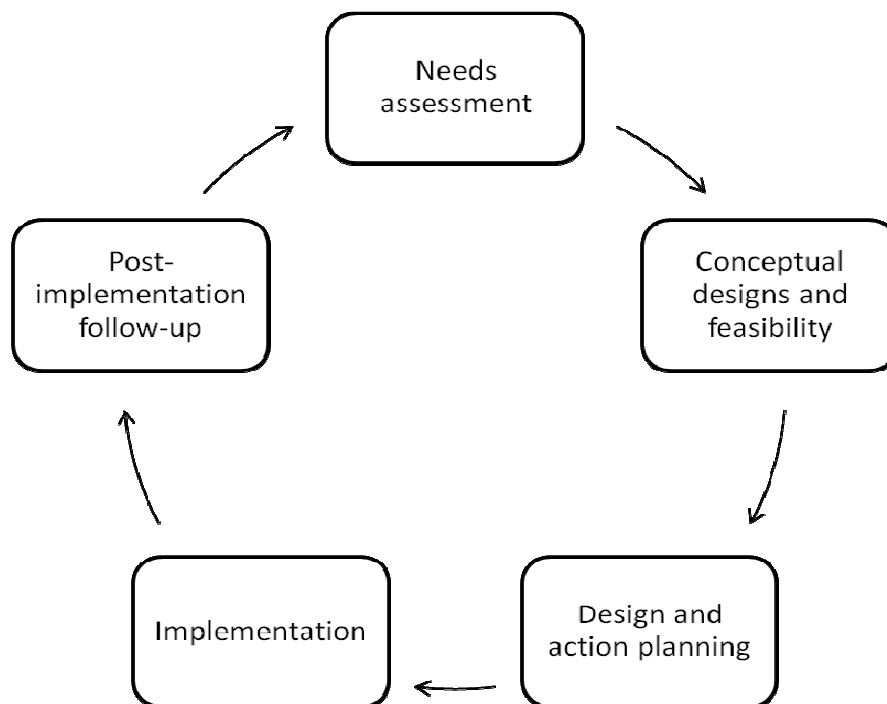
### ***3.6 Framework testing and case study***

In order to test the design and utility of the framework developed, it was applied as a post-project evaluation of the project implemented by the author in San Agustín. The sustainability of the project was assessed by evaluating the checklist components.

Scores for the matrix elements were analyzed to identify strengths and weaknesses of the project. Checklist components were then reworded, regrouped, moved, eliminated, or substituted to make scores better correspond to the author's perception, based on knowledge of sustainability factors, of how well the project should have performed in each area. The project was then reevaluated with the tool and the results were described in a case study. Finally, the framework was corrected for any errors and inconsistencies.

## 4 Results

### 4.1 Sustainability framework



**Figure 4.1: Cyclical life-cycle stages**

Adapted from McConville and Mihelcic (2007)

The developed framework is represented as a matrix accompanied by an associated checklist. Each matrix element corresponds to a pairing of one project life stage with one sustainability factor. Associated with each element is a set of four recommendations based on best practices in project management and issues related to the sustainability factors. Each element, its four sustainability recommendations, and sample rhetorical questions are included in the checklist. The rhetorical questions provide detail and context to the suggestions. Each element is assigned a rating (0-4) based on the number of sustainability recommendations completed. For each of the five project life stages, five matrix elements, with associated sustainability factors, must be evaluated to determine the score for that stage. The highest possible score for each life cycle stage or sustainability factor is 20. The highest possible overall score for a project is 100.

**Table 4.1: Matrix representation of the framework developed in this study**

|                                    | Sustainability Factor  |                         |                    |                         |                              |       |
|------------------------------------|------------------------|-------------------------|--------------------|-------------------------|------------------------------|-------|
| Life Stage                         | Socio-cultural Respect | Community Participation | Political Cohesion | Economic Sustainability | Environmental Sustainability | Total |
| Needs Assessment                   | 1,1                    | 1,2                     | 1,3                | 1,4                     | 1,5                          | 20    |
| Conceptual Designs and Feasibility | 2,1                    | 2,2                     | 2,3                | 2,4                     | 2,5                          | 20    |
| Design and Action Planning         | 3,1                    | 3,2                     | 3,3                | 3,4                     | 3,5                          | 20    |
| Implementation                     | 4,1                    | 4,2                     | 4,3                | 4,4                     | 4,5                          | 20    |
| Post-Implementation Follow-up      | 5,1                    | 5,2                     | 5,3                | 5,4                     | 5,5                          | 20    |
| Total                              | 20                     | 20                      | 20                 | 20                      | 20                           | 100   |

Adapted from McConville and Mihelcic (2007)

The framework is presented here in truncated form. It is presented in full in Appendix A with the complete checklist of recommendations and contextual questions.

*Element: 1,1 (Needs Assessment, Socio-cultural Respect)*

- ☐ Identify past experiences with cooking technologies and attitudes toward them.
- ☐ Identify social preferences and traditions associated with household energy use, cooking practices, and IAP.
- ☐ Determine the level of health education in the community.
- ☐ Recognize differences in gender/age in cooking, fuel collection, and IAP exposure.

*Element: 1,2 (Needs Assessment, Community Participation)*

- ☐ Conduct a participatory needs assessment at the local level to determine local development priorities.
- ☐ Integrate yourself into the community and “accompany” them through the process.
- ☐ Identify stakeholders and community leaders.
- ☐ Determine what community members want from the stoves and expect from the project.

*Element: 1,3 (Needs Assessment, Political Cohesion)*

- ☐ Conduct a situational analysis of regional and national issues such as political structure and stability, government policies, and foreign aid.
- ☐ Ensure the proposed project is consistent with regionally identified development priorities and plans.
- ☐ Research the history of NGO and government projects in the area.
- ☐ Establish communication lines with existing NGO and/or government institutions in the area.

*Element: 1,4 (Needs Assessment, Economic Sustainability)*

- ☐ Understand the local economy and the market for improved stoves.
- ☐ Understand the economic burden associated with cooking, fuel use, and IAP.
- ☐ Identify sources of monetary and non-monetary resources within the community.
- ☐ Assess the general community willingness-to-maintain and willingness-to-pay for fuel and improved stoves, in both monetary and non-monetary terms.

*Element: 1,5 (Needs Assessment, Environmental Sustainability)*

- ☐ Identify local environmental resources.
- ☐ Collect baseline data and data on climate and Determine how environmental resources are used and controlled, and by whom.
- ☐ Identify potential environmental concerns at the local and regional level.
- ☐ Determine local, national, and international understanding of and concern for environmental problems and the willingness to correct them.

*Element: 2,1 (Conceptual Designs/Feasibility, Socio-cultural Respect)*

- ☐ Consider designs which meet the needs and expectations of users and make noticeable improvements.
- ☐ Assess how the proposed stove technologies fit into traditional household practices, including gender roles.
- ☐ Investigate feasibility of health education programs.
- ☐ Recognize why biases exist towards certain technologies by donors and/or locals.

*Element: 2,2 (Conceptual Designs/Feasibility, Community Participation)*

- ☐ The project goals are clearly defined and understood by the community and development workers.
- ☐ Work with leaders who can act as community liaisons throughout the project.
- ☐ Present several technically feasible alternatives for community evaluation and feedback.
- ☐ Community members modify and formally select a design based on their needs, preferences, and an understanding of the constraints involved in the selection process.

*Element: 2,3 (Conceptual Designs/ Feasibility, Political Cohesion)*

- ☐ Develop a working relationship with all interested and pertinent partner organizations, including at least one that is based in the host country.
- ☐ Use lessons learned from the plans and designs of other organizations on similar projects (past and present).
- ☐ Consider ways to provide follow-up to the project.
- ☐ Ensure project fits within local, national, and international context.

*Element: 2,4 (Conceptual Designs/Feasibility, Economic Sustainability)*

- ☐ Consider the logistical feasibility of implementing, operating, maintaining, and replacing each conceptual design.
- ☐ Consider implications for the local economy and stove market and how economic capacity can be built for each conceptual design.
- ☐ Assess the specific willingness-to-maintain and willingness-to-pay for each improved system (how much people value each option).
- ☐ Conduct an economic feasibility assessment to evaluate long-term project viability based on cost estimates, projected operation and maintenance costs, community willingness to pay, the need for outside resources, and the availability of outside funding.

*Element: 2,5 (Conceptual Designs/Feasibility, Environmental Sustainability)*

- ☐ Assess the capacity for sustainable fuel use in the geographic area.
- ☐ Investigate feasibility of environmental awareness and rehabilitation activities.
- ☐ Be sure to select a design which makes a significant and noticeable difference.
- ☐ Conduct an environmental impact analysis for each alternative.

*Element: 3,1 (Design/Action Planning, Socio-cultural Respect)*

- ☐ Plan sufficient time for health education. Empower people to make good choices about exposure to IAP, health, and household energy use.
- ☐ Work with the traditional structure and schedule of community projects
- ☐ Confirm resource contributions and benefits are equitably or acceptably divided.
- ☐ Explore options for increasing gender equity in project roles and capacity building.

*Element: 3,2 (Design/Action Planning, Community Participation)*

- ☐ Community input is solicited in refining the selected technical design.
- ☐ Final technical design is understood and approved through a process of community consensus.
- ☐ Community members are involved in identifying and sequencing tasks that will be incorporated into an action plan.
- ☐ The community members and development workers understand and approve of the timeline and responsibilities laid out in the action plan.

*Element: 3,3 (Design/Action Planning, Political Cohesion)*

- ☐ The roles and responsibilities of partner institutions are defined in a detailed action plan, including financial commitments and a timeline.
- ☐ People in charge of construction and training are qualified and clear on the plans.
- ☐ Follow-up tasks, such as project M&E, are defined and execution of subsequent projects is discussed.
- ☐ Final project design and action plan are presented to and agreed upon by partner institutions and local, regional, and/or national level authorities.

*Element: 3,4 (Design/Action Planning, Economic Sustainability)*

- ☐ Verify costs and availability and develop an action plan for resource procurement.
- ☐ Finalize budget, contributions, and schedule based on demand, local costs, available resources, and commitments.
- ☐ Plan sufficient time for O&M training.
- ☐ Plan actions to build capacity of the stove market and promote stoves.

*Element: 3,5 (Design/Action Planning, Environmental Sustainability)*

- ☐ The final project design minimizes ecological disturbance, energy use, and waste emissions.
- ☐ The project design uses existing, renewable and/or recyclable local resources.
- ☐ The action plan considers the long term availability and seasonality of resources.
- ☐ Finalize an environmental education and rehabilitation plan to address environmental issues.

*Element: 4,1 (Implementation, Socio-cultural Respect)*

- ☐ Conduct health education activities.
- ☐ Encourage the involvement of all participants, particularly women, throughout the construction process.
- ☐ Ensure high quality construction. Be inflexible and precise with critical components of the design, but flexible with non-crucial changes.
- ☐ First implement a small number of stoves. Then use public gatherings to address concerns and build confidence before continuing with the rest.

*Element: 4,2 (Implementation, Community Participation)*

- ☐ Involve the community in revisions of the action plan, program changes, and problem solving.
- ☐ Ensure community members manage and carry out much of the implementation process themselves.
- ☐ Train local leaders in the new techniques and technology that are introduced.
- ☐ Ensure community members are clear on the O&M requirements and schedule.

*Element: 4,3 (Implementation, Political Cohesion)*

- ☐ Supervise work (quality control) and push for fulfillment of responsibilities from all partners.
- ☐ Inform partner institutions of the start of construction, project milestones and major changes.
- ☐ Invite government and institutional representatives to the project and make connections between organizations and the community.
- ☐ Partners are reminded of follow-up responsibilities, future plans are confirmed, and any needed baseline data is collected.

*Element: 4,4 (Implementation, Economic Sustainability)*

- ☐ Conduct training, promotion, and capacity building according to action plan.
- ☐ Recheck the quality of materials and equipment during resource procurement and the quality of the finished project.
- ☐ Monitor and document spending and contributions throughout the project implementation phase.
- ☐ Draft final report on the budget and share with community members and partner organizations.

*Element: 4,5 (Implementation, Environmental Sustainability)*

- ☐ Restore any areas disturbed during construction.
- ☐ Take precautions to avoid and minimize environmental impacts during implementation.
- ☐ Conduct environmental education and rehabilitation activities.
- ☐ Demonstrate the difference the technology has made at the household level.

*Element: 5,1 (Post-Implementation Follow-up, Socio-cultural Respect)*

- ☐ Monitor whether or not the stoves continue to be used as intended. If not in proper use, determine issues.
- ☐ Address immediate issues and potential future ones.
- ☐ Continue health education programs and monitor choices people make about exposure to IAP, health, and household energy use.
- ☐ Reassess how gender/age roles affect the proper use and perceived benefits of the system.

*Element: 5,2 (Post-Implementation Follow-up, Community Participation)*

- ☐ Unite the community to share experiences, provide support, and agree on next steps.
- ☐ The community assists with follow-up activities.
- ☐ Conduct a participatory evaluation to get community feedback and suggestions for improvements.
- ☐ The community has the capacity to conduct O&M.

*Element: 5,3 (Post-Implementation Follow-up, Political Cohesion)*

- ☐ Get feedback from project partners and stakeholders.
- ☐ Invite stakeholders and officials to an opening ceremony. Discuss with them future collaborations and continuation of efforts.
- ☐ Participating institutions carry out agreed upon roles in providing post-implementation follow-up.
- ☐ Share impact and monitoring reports and project evaluations with partner institutions and community.

*Element: 5,4 (Post-Implementation Follow-up, Economic Sustainability)*

- ☐ Continue building the capacity of the local household energy (stove) market.
- ☐ Determine the actual impacts of the project.
- ☐ Monitor fuel use, maintenance, repair, and replacement of stoves.
- ☐ Ensure a mechanism to meet future demand.

*Element: 5,5 (Post-Implementation Follow-up, Environmental Sustainability)*

- ☐ Work to further increase efficiency of technologies.
- ☐ Reassess local awareness of and willingness to address environmental concerns.
- ☐ Reassess environmental concerns and evaluate project impacts.
- ☐ Continue environmental education and rehabilitation efforts.

## 4.2 Case study



**Figure 4.2: Existing stove with poor ventilation (note blackened ceiling)**

A case study is included to illustrate use of the sustainability tool for post-project evaluation. The selected case is an improved cook-stove project the author worked on while in the Peace Corps in Honduras. It was implemented in San Agustín, Copán, where a fellow PCV from the Business program was living. The PCV, Nesha Francic, and the author worked together throughout the complete project process.

Background information on San Agustín and the stove project is provided, followed by a summary of the project execution and results. The elements of the matrix tool were evaluated based on my opinion of how well the recommendations and detailed guidelines (in Appendix A) were met. The resulting scores are presented and analyzed.

### 4.2.1 San Agustín, Copán

San Agustín is a rural town with a population around 3,000 situated in the mountains of central Copán department. Traveling by car or bus along dirt roads, it is accessible in two hours from the department capital of Santa Rosa de Copán. The people of San Agustín depend mainly on agriculture for their food supply and income. Staple foods include corn tortillas, beans, and coffee and to a lesser extent eggs, chicken, cheese, and vegetables such as potatoes. Those with the economic means enjoy a wider variety of foods, local and from Santa Rosa and beyond, including beef, fish, vegetables, and

packaged foods. Coffee and cattle are the major income generators in the area. Most people sell what they produce on their own land or work as day laborers on the farms of wealthier landowners.

Nearly all residents of San Agustín use some form of the traditional wood-burning stove (See Figure 1.1 and Figure 4.2). These can range from simple metal or clay griddles supported by mud (basically a three-stone fire) to well-built brick and concrete stoves with chimneys. Some people have gas or electric stoves, but even those households tend to have a wood-burning stove as well. Cooking is done inside or outside depending on the home and ventilation and efficiency vary depending on the quality and design of the stove. Wood is collected from nearby forests or from the trees which shade coffee plants. For families without wood on their own land, permission is typically required, either from the government or the land owner, to cut trees.

Because nearly all San Agustín residents rely on wood as their main source of cooking fuel, the local government was concerned with the rapid rate of deforestation in the area. In fact, the Mayor's office had programmed improved cook-stove projects into its future development plans. As a result, PCV Francic, and the author began investigating the possibility of implementing improved stoves in San Agustín. Designs were sought and organizations in Honduras and Guatemala, which worked with improved stoves, were visited. Findings were shared with San Agustín residents and government officials. A household survey was also conducted to determine interest, stove associated expenses and problems, and willingness-to-pay. A prototype was even constructed in the home of one municipal employee. Despite the failure of the prototype – the owner dismantled the stove before adjustments could be made – interest was piqued in the project. One woman, misunderstanding the intention of the survey, insisted that she be put on the list to receive a stove, long before such a list existed.

As part of this project and previous research, considerable time was spent investigating feasible designs. A number of designs were encountered from past projects, resources provided by Peace Corps and other organizations, and online sources. We also visited stove businesses and investigated the availability of materials and feasibility of fabricating specialized components. Perceptions of the various options were gathered from residents, government officials, and local and foreign NGO workers. Previous projects were also visited and conversations were held with various people involved in them.

One of the most commonly encountered designs was that of the Eco-Justa. This is an improved stove developed in Honduras by Larry Winiarski of Aprovecho Research Center ([www.aprevecho.net](http://www.aprevecho.net)), an Oregon-based organization, and the Honduras-based Asociación Hondureña para el Desarrollo (AHDESA). The Eco-Justa is similar to traditional Honduran models in size and shape, and also uses wood for fuel. A large metal griddle, with space for multiple pots and tortillas, is supported by bricks cemented together with mortar or clay. A covered metal chimney provides ventilation and the removable griddle and side access port allow for easy cleaning of ash. To learn more

about the Eco-Justa, a representative of Consejo Higuito, the San Agustín environment officer, a community leader, and the PCVs attended a training conducted by Fundación Hondureña de Investigación Agrícola (a Honduran NGO). The main differences between an Eco-Justa stove and a traditional stove are in the combustion chamber and stove body insulation. While traditional stoves typically have a large open space to burn many logs, the Eco-Justa utilizes a smaller “rocket elbow” combustion chamber. The rocket elbow design concentrates heat and improves airflow. It also limits the amount and size of wood that can be inserted at a time. Insulation surrounds the rocket elbow, decreasing heat loss to the stove body or surrounding air. Pumice rock or vermiculite are the recommended insulation materials, however these are not widely available in Honduras – we searched extensively – so clean dry wood ash is used. These changes have been shown to improve efficiency and reduce wood consumption by up to 60% (Bardales 2009).



**Figure 4.3: Inside view of Eco-justa improved stove**

The Eco-Justa’s wide acceptance and familiarity in the region, was one factor to its selection. Another was that there was a small stove business, based in the neighboring department of Lempira, experienced with building Eco-Justa stoves. After a visit to the business and discussion of logistics, it was decided they would implement the stove project. The initial idea was to build stoves in 80 newly constructed houses in an area called La Colonia, just outside of San Agustín. Most homeowners in La Colonia cooked outdoors, under makeshift tin shelters, on basic mud-walled metal-griddle stoves (see Figure 1.1). The organization that financed construction of the houses agreed to fund stoves for all the homes. However, when funding was diverted to aid disaster recovery in Haiti, it became clear that new funding and different homes would

be required. Consejo Higuito, a local organization, had plans to fund improved stove pilot projects in the municipalities in their area, including San Agustín. Therefore plans shifted to install stoves in ten houses in the center of San Agustín.

The mayor selected ten families – all from his political party – to receive the stoves. They were then invited to a meeting where environmental issues were discussed and the stoves were presented. Two of the ten selected were unable to attend and all but one family representative were women. All agreed to participate in the project. After material suppliers were found and prices were set, each contributor's responsibilities were agreed upon. The families provided food and lodging for the contractor and his assistant for five days. They also contributed sand, ash, a table on which to build the stove, and a day of unskilled labor. The municipal government provided rebar, cement, tools, and bricks. Consejo Higuito paid for the griddle, chimney, "rocket elbows," and skilled labor. Consejo Higuito was slow to provide funding, delaying the start of construction, so the San Agustín mayor – a member of the board – put pressure on them.

Each household was expected to have the support table ready by the construction start date. However, the local mason contracted by the families to build the tables made them the wrong size. When the stove contractor arrived, all the tables had to be rebuilt, delaying the project a day and wasting materials. Some women had also disassembled their old stoves, making it difficult for them to prepare food during this time. An introductory meeting was held in which the stove contractor explained how the project would work and addressed questions. Materials, which had been collected and stored beforehand, were distributed and recipients were attentively concerned that they received the same as everyone else. Initially, participants were hesitant to get involved in construction beyond preparing materials, particularly the women. However, by the end of five days, three women and one man were building stoves themselves, under the supervision of the contractor.

The conditions of the houses varied from a one room adobe house with the kitchen section falling down to a multiple room, concrete block, painted house. House furnishings also varied. The above mentioned adobe house had in it a microwave and stereo and the painted house had a new ventilated stove covered with nice tiles. The owner stated that she wanted the Eco-Justa stove for its efficiency (low wood consumption). Another participant was an elderly widow who was thrilled with her new stove because she had to carry wood herself. One person did not want the stove inside her house and the contractor determined it was impossible to install it outside due to wind. So, a new participant had to be found at the last minute. This did not delay construction, but a support table had to be built quickly and was not able to be made as high as the woman would have liked. At the end of five days, an evaluation meeting was held with all participants, the stove contractor, the municipal environment officer, a representative from Consejo Higuito, and the PCVs. The benefits of the stoves were explained qualitatively and quantitatively. Participants were quizzed on maintenance procedures and encouraged to share their experience with neighbors. They were

referred to the environment officer in case of any difficulties. Everyone expressed satisfaction with the stoves and the project process. However, in one home the women operating the stove seemed worried that it was not boiling water quickly.

Funds for La Colonia and additional government funds were expected but pending at last check. Also, just two weeks after project completion, the list maintained by the mayor's office of people wanting an improved stove included 80 households.

## 4.2.2 Scoring

The San Agustín project was evaluated using the matrix tool developed for this research study and the detailed guidelines provided in Appendix A. The results are presented in Table 4.2., which shows the project scores highest in the Needs Assessment phase (20/20) and lowest in the Post-Implementation Follow-up stage (8/20). The high score for Needs Assessment is largely due to the PCVs' long-term presence in the community and the region. In addition, the author acquired experience with stoves and related issues through living in a nearby town and working in many communities in the region. With this contextual knowledge and PCV Francic's specific familiarity with San Agustín, we were able to easily confirm or disconfirm if conditions encountered elsewhere were applicable in San Agustín.

**Table 4.2: Results from evaluation of the San Agustín stove project**

| Life Stage                         | Sustainability Factor  |                         |                    |                         |                              | Total |
|------------------------------------|------------------------|-------------------------|--------------------|-------------------------|------------------------------|-------|
|                                    | Socio-cultural Respect | Community Participation | Political Cohesion | Economic Sustainability | Environmental Sustainability |       |
| Needs Assessment                   | 4                      | 4                       | 4                  | 4                       | 4                            | 20    |
| Conceptual Designs and Feasibility | 3                      | 1                       | 3                  | 4                       | 3                            | 14    |
| Design and Action Planning         | 3                      | 3                       | 2                  | 3                       | 3                            | 14    |
| Implementation                     | 3                      | 4                       | 3                  | 3                       | 3                            | 16    |
| Post-Implementation Follow-up      | 1                      | 4                       | 2                  | 1                       | 0                            | 8     |
| Total                              | 14                     | 16                      | 14                 | 15                      | 13                           | 72    |

Adapted from McConville and Mihelcic (2007)

Post-Implementation Follow-up is susceptible to low scores because many of the recommendations in this stage are based on planning and activities conducted in earlier stages. Also, because it is the final phase of the life-cycle, it can be an afterthought or neglected due to time constraints. The full project timeframe must be recognized early on and planned for accordingly. Deficiencies in planning, which typically focuses more on the implementation stage, are often made apparent during post-implementation follow-up. This was true for the San Agustín project, as shown by the scores for Conceptual Design and Feasibility (14/20) and Design and Action Planning (14/20). Although the scores for these stages are not low, many of the points missed come from unfulfilled recommendations involving planning for follow-up activities. These recommendations are mainly included in the Political Cohesion and Community Participation sections.

It is possible that more of the recommendations for Post-Implementation Follow-up were met. However, this is not known for sure because both PCVs left San Agustín shortly after project implementation. Regardless, the score is appropriate because no solid plans were made to ensure execution of follow-up tasks. Some discussion was held on the topic, but it was left to municipal employees to take any concrete action. This leaves the project in a vulnerable state because without emphasis during the Action Planning, Implementation, and Follow-up stages, needed tasks could easily be left uncompleted. Implementation (16/20) received strong scores in all areas, particularly Community Participation (4), because the project was mainly implemented by the community and local government. Deficiencies in this area stem from tasks which tend to be more feasible in subsequent project iterations, such as starting a local stove business – experience gained with the new stoves during the first iteration is useful. However, better planning could have made up for this - for example, by selecting and organizing potential business members prior to implementation.

The five sustainability factors received similar, good scores (ranging from 13/20 to 16/20), as can be seen in Figure 4.5. Many of these areas were aided, as was true for Needs Assessment, by the PCVs' relatively long-term integration into the community and region. Socio-cultural Respect (14/20), in particular, benefited from awareness of cultural norms gained from nearly two years living and working in rural Honduran society. Many of the points missed in Socio-cultural Respect, as well as in Environmental Sustainability (13/20), came from a lack of focus on health education and environmental awareness promotion. Health and environmental education, including assessment of current levels, account for a total of ten points in the sustainability matrix. Additional points correspond to operation and maintenance training and other capacity building. Reasons for this heavy emphasis on education and training are explained in the discussion section.



**Figure 4.4: Radar plot showing score distribution by life-cycle stage for project case study**

**Figure 4.5: Radar plot showing score distribution by sustainability assessment factor for project case study**

Community Participation (16/20) scored highest among the sustainability factors, largely because PCV Francic's's strong integration into San Agustín made it easy to involve community members in the project. The only stage to receive a low score for this factor was Conceptual Design and Feasibility (1/5). This low score is due to the fact that the PCVs worked relatively independently from the community to find and develop feasible designs. A few community members were involved, to a limited extent, in feasibility analysis. However, these were limited to municipal employees involved in the project from the implementation side, not the use side. No chance was given to project participants from the community to question and modify stove designs. It is important to recognize that "the community" does not refer to just a few local contacts or LIPs, it implies deeper participation involving a cross section of representative community members and project participants.

Political Cohesion (14/20) scored well, again due to the PCVs' connection to the region. Nesha worked in the San Agustín mayor's office during his service and interacted frequently with Consejo Higuito. The author was familiar with a number of government, NGO, and private organizations which worked with stoves, environment, and/or health as a result of my work and research in the area. However, political cohesion suffered in Design and Action Planning (2/5), and consequently in Post-Implementation Follow-up (2/5), as a result of our inexperience with the local system. Economic Sustainability (15/20) scored well because the technology used resulted in substantial fuel cost savings. It was similar to stoves common in the area, which made materials and fuel readily available and accessible. Also, it was produced by an existing local business and funding was plentiful, increasing prospects for future expansion. However, the stoves were subsidized, decreasing the chance that future users would be willing to pay the full stove cost. This could inhibit development of a long-term sustainable market. If a mechanism, such as micro-financing, had been used to overcome the cost barrier, this element would have received a higher score. This deficiency is most apparent in the Post-Implementation Follow-up (1/5) stage. Also, plans for future expansion and checking up on the project were not made.



**Figure 4.6: Finished stove waiting for water to boil**

By applying the tool for post project evaluation, weaknesses in project management were discovered which were not identified during execution. For example, before implementation a meeting was held with community members. The stove design was presented and its importance with respect to health and environment explained. Logistical details of the implementation process were shared, including contributions and responsibilities. At the end of the meeting the community members were asked if they agreed to participate in the project. All agreed. It was clear at that time the approach taken was flawed. The community members were being presented with something essentially free or cheap. Although it happens, people do not often turn down free or cheap gifts, even if they do not really want or need what is offered. A different approach needed to be taken to ensure the technology offered actually fit the community's needs and wants.

While applying the evaluation tool, the needed approach became clear. During the Conceptual Design and Feasibility stage, community members were never presented with design options or given a chance to comment on or modify the design. This was reflected in the low score for element (2,2). Even after a design had been chosen, they were offered no chance to adapt it to their needs and preferences – noted in element (3,2). However, at the end of Design and Action Planning they were asked to approve the design. They were being presented with an all or nothing proposition. At that stage of the project process, it was more feasible to substitute participants than designs. Without the opportunity to modify the design, community members were faced with the option of accepting it as is or receiving nothing at all. This is precisely what happened to the woman who objected to having the stove inside her house during implementation. By breaking down the project into life-cycle stages and sustainability factors, methods to improve subsequent projects were made apparent.

## 5 Discussion

As set out in the goals, this research developed a framework for use in project management and evaluation to increase sustainability of improved stove projects. A number of frameworks exist intended to integrated different issues and increase sustainability in development. However, from review of the literature, this framework addresses an insufficiently met need for a tool that is specifically applicable in situations where it has been determined that a household fuel or cooking technology intervention is needed and desired.

The framework is largely based on that developed by McConville (2006) for water and sanitation projects. It uses the same format of a matrix integrating five sustainability factor groupings into five project life-cycle stages. It is also accompanied by a checklist of recommendations and contextual questions to be evaluated in order to assign scores to each of the matrix elements. Like McConville's tool, these features make it accessible to NGO workers, volunteers, and engineers. They also make the framework applicable as a post project evaluation tool for individual projects as well as to evaluate and compare similar projects. It is also useful as a guide during project planning and execution. One way in which this is done is by making apparent, from the scores, areas of strength and weakness across a range of sustainability factors and project life-cycle stages. In the matrix representation, users can visually see how the project performs overall and in each evaluated component. Adjustments during project planning or in subsequent projects can then be made to account for recommendations in the areas identified as weak. The series of recommendations in the checklist can aid practitioners to consider a variety of critical issues during project implementation. With the expanding involvement of amateur practitioners, and especially engineers, in international development and a number of social, economic, and environmental barriers to acceptance of improved stoves, this framework provides needed assistance for project management and evaluation.

A high score from the evaluation tool does not guarantee long term sustainability, just as a low score does not doom the project to failure. However, incorporating sustainability factors into the project process will likely increase the project's long term impact and success. This assertion is based on the fact that recommendations in the sustainability tool come from lessons learned and analyses of past projects. These are drawn from the author's own experiences as well as those of other development professionals and from the literature. The recommendations address a broad range of factors. This is because there are many potential points of project failure, but also because different elements serve as safeguards to cover for deficiencies in other areas. For example, if no capable local leader is involved in the project and problems arise, it is possible that the project will fail. However, if a capable and motivated leader is involved, it is more likely that the problems will be solved and the project will succeed.

One element which appears frequently across the range of sustainability factors and life-cycle stages is education. This reflects the important role that the participants' education, awareness, and capacity play in project success. By understanding the

negative health effects of IAP or developing concern for environmental issues, participants can become self-motivated to make and maintain positive changes. They can value an improved stove for its impacts on family or environmental health rather than just for its aesthetic qualities. The goal of education is to empower people to make informed decisions about risk exposure and household energy use. The goal of training is to enable people to act on those decisions. For example, a person cognizant of the negative effects of IAP and versed in proper O&M practices may be more likely to keep their chimney from becoming blocked. To account for the importance of education and training in the sustainability tool, over 10% of possible points relate to these factors.

There are a number of important differences between this framework and the one it was largely based on. The most obvious of which is that the sustainability tool presented in this paper is designed for use with improved stove projects, while McConville's was geared toward water and sanitation. One of the consequences of this is that substantial portions of the original checklist were not applicable to the improved stove context. McConville's checklist consists of sets of recommendations for each project element. Nearly all of these recommendations could, theoretically, be applied in an improved stove project with only minor changes to wording, while maintaining the basic structure. For example, Element (1,1) – (Needs Assessment, Socio-cultural Respect) – appears as follows in McConville (2006) (with areas to be changed in bold).

- ☐ Generate a yearly calendar of work and social life in the community.
- ☐ Identify social preferences and traditional beliefs associated with **water supply and sanitation** practices.
- ☐ Determine the level of health education in the community.
- ☐ Recognize differences in gender roles in **water and sanitation**.

In order for this to generally apply to improved stoves, minor changes would be needed as follows (changes noted in bold):

- ☐ Generate a yearly calendar of work and social life in the community.
- ☐ Identify social preferences and traditional beliefs associated with **household energy, cooking practices, and IAP**.
- ☐ Determine the level of health education in the community.
- ☐ Recognize differences in gender roles in **household energy use and cooking**.

However, upon examination of the rhetorical questions and detail under each recommendation, it is apparent that substantial changes would be needed in these areas for applicability. Consider the full text of the second recommendation from Element (1,1).

- Identify social preferences and traditional beliefs associated with water supply and sanitation practices.
  - Are certain water sources preferred over others?
  - Is there folklore or old stories associated with water sources or water use?
  - Are there traditional methods for protection a water source?
  - Do people add things to their water? At the source or at home?
  - Do people consider sanitation issues around the water sources?
  - Are there social caste issues about the use of water from certain sources?
  - Is there a history of filtering or screening water sources?
  - Are there seasonal changes in the quality of the water supply? How are they explained?
  - What is the preferred sanitation method in the community?
  - What are preferred methods of anal cleansing?
  - How do people feel about handling excreta (even when decomposed)?
    - Will people transport it?
    - Will they reuse it?
    - How will this affect maintenance issues?
  - Are the religious constraints to be considered?
    - A traditional rule is that Muslims should not defecate facing or with their backs towards Mecca.
  - Do people believe that excreta are harmful?
    - Many people believe that children's excreta are less harmful than that of adults.
    - Others believe that disease is "an act of God", therefore sanitation and hygiene practices are irrelevant.
  - Are people afraid to use latrines? Why?
    - Snakes, insects, and other animals
    - Black magic
    - Smells
    - Collection of excreta in a single place is "unsanitary"
    - Belief that women using a pit latrine will become infertile
  - Are there taboos associated with washing hands with soap? (In Mali, this practice was believed to wash away a person's wealth)
  - For further examples refer to Pickford, 1995.

As this shows, new sets of rhetorical questions would need to be developed for the new context. Therefore, to adapt the original tool to be generally applicable to improved stove projects, the recommendations could remain essentially the same, but the contextual questions would need to be redeveloped. However, as discussed in the

introduction (see 1.2.5 Matrix tool page. 24) McConville’s framework focuses on a type of project – water and sanitation – while improved stoves constitute a type of technology. Therefore, the general framework, designed for a type of project, did not sufficiently accommodate integration of the lessons learned and best practices researched to the level of specificity desired for a type of technology. An analogous level of specificity would be to adapt the water and sanitation framework to, for example, a general energy or housing project. However, the author did not have sufficient enough experience with a variety of types of energy projects to develop a framework for energy. The author’s expertise and interest was in household fuel use and indoor air pollution. There is also a recognized need for a tool capable of integrating key sustainability factors specific to improved stoves. Therefore, a framework was developed specifically aimed at use in improved stove projects.

An estimated 50% of the framework presented in this paper is new content, not present in McConville’s original. As an example of how the tool has been changed, consider the second recommendation from Element (1,1) in the framework presented in this paper – compared to Element (1,1), above, from the original.

- Identify social preferences and traditions associated with household energy use, cooking practices, and IAP.
  - What are the traditional foods
    - Learn what a user requires from a stove.
  - What are the traditional cooking methods (stove types)?
  - What are the traditional fuel sources?
  - Are there changes in fuel availability? What causes them?
  - Do people add extra materials to their fires?
    - Ex. Dried corn cobs, plastic
  - How do people start their fires?
  - Are certain stove types or cooking fuels preferred over others?
  - Is there a hierarchical view of fuels/technologies (think energy ladder)?
  - What are preferred locations of cooking (indoor, outdoor, separate kitchen)?
  - Is there folklore or old stories associated with food preparation, fuel sources, or IAP?
  - Are there religious ceremonies or festivals to be considered?
    - Ex. Some festivals involve boiling food in large pots. Many “improved” stoves are inadequate for such tasks.
  - Are there possible points of resistance to a new technology or behavior?
    - Ex. People used to cooking on a large open fire may be hesitant to use a smaller, more efficient stove, especially if energy savings come at the cost of slower cook times.
  - Are different devices or fuels used for different activities (cooking, heating, warming water)?
  - Are people afraid to use certain cooking methods?
  - Is the population migratory or temporarily located (refugees, IDPs)?

The two recommendations and contextual questions show similarities in the intent of the recommendation. However, the practical applicability lies largely in the contextual questions. In each case, a number of key considerations, specific to the context and based on research, are presented to encourage the user to evaluate a wide array of potential barriers to success.

Beyond changes to the checklist, two adjustments were made to the project life-cycle, as conceived in McConville and Mihelcic (2007). The first adjustment changed the fifth life-cycle stage from Operation and Maintenance to Post-Implementation Follow-up. This was done to place greater emphasis on continued involvement with the project, beyond implementation. The theory of community ownership insists that the community take responsibility for the project after implementation. This is intended to increase sustainability by encouraging problems to be solved locally. It is an important concept. However, in practice, projects can fail because of a lack of capacity or resources in the community. The author encountered multiple instances in Honduras in which an organization faulted the community in which a project had been implemented for not properly maintaining it. However, upon deeper inspection it was found that a number of factors, beyond the realistic capacity of the community to deal with, led to failure of the project. Among these included a lack of local availability of parts or chemicals needed for operation and maintenance, no source for new or replacement household technologies, no means of training new administrators in the event of death or departure, and a lack of technical capacity. In many instances, it is not possible to build all the needed capacity during project implementation. For example, in an improved stove project in Peru, it was found that reinforcement, sometime after implementation, of messages encouraging good behaviors (and discouraging counter-productive ones) helped to maintain initial levels of impact. Continued technical assistance was also required to address problems encountered after implementation (Winrock 2008).

The second adjustment involved adding a feedback mechanism into the Post-Implementation Follow-up stage and linking it to Needs Assessment for subsequent project iteration. The resulting cyclical life-cycle can be seen in Figure 4.1. This was done to stress that, particularly in projects involving new household technologies, there is often a need to build on past successes and refine, improve, and scale up. Technologies should be developed and disseminated through an iterative process of needs assessment, design, pilot and testing, redesign, and impact and performance monitoring. Often a single iteration of the project cycle is not sufficient to ensure long term sustainability. After completing a single project cycle, lessons learned from monitoring and evaluation should be applied to subsequent iterations by restarting at the needs assessment stage. Through this iterative process the technology and social approach may be improved and impacts assured. This also allows for project scale-up.

Of course, a sustained, ongoing program with multiple project iterations may not be feasible for many organizations or project implementers. Many stove projects are

implemented by outside partners or by partners working with a single community in which the stove project is only one part of their program. In such cases it is recommended that efforts be integrated, to the extent possible, into a larger program with an iterative approach. For example, a local or national NGO, business, or government entity may be disseminating stoves. Individual projects may be able to be incorporated into these efforts and the recommendations contained in this tool used to complement and improve the work.

## **5.1 Limitations**

All recommendations in this framework may not be applicable to some situations. Likewise, all potentially important considerations are not included in the framework. Practitioners must use their judgment in order to determine the best use of the tool and to ensure that it is used as a supplemental aid and not as a crutch.

McConville (2006) describes another limitation of this framework. “By creating guidelines for sequential project steps, there is a danger of planning for each life stage separately.” It is important to not look at each stage only in isolation, but to also consider the project as a whole and the matrix elements as components of a holistic approach. This can be particularly important in regards to the Post-Implementation Follow-up stage. This final stage is heavily influenced by planning and actions made earlier on in the project cycle.

The tool presented in this paper is useful in the assessment and implementation of improve cook-stove projects. However, this paper is limited in scope and does not provide in depth background to stove projects. It is important to have a good understanding of stoves, household energy, and development when implementing such projects. The series of reports prepared by The Center for Entrepreneurship in International Health and Development at the University of California, Berkeley is recommended for an understanding of household energy in a number of countries in different regions. It can be found at <<http://www.pciaonline.org/resources>>.

## **5.2 Future work**

### **5.2.1 Calibration**

Sugden (2003) states, “Organisations often make too many assumptions” about sustainability. This tool also suffers from this flaw to some extent. The weighting of different factors in the framework’s scoring reflects the author’s personal biases toward the perceived relative importance of different issues. Some of this enters in consciously, as described for education and training, while some of it occurs unconsciously or unnoticed. It is possible that another researcher would have weighted certain factors differently. Also, no scientific study was conducted to correlate the various factors to observed effects on sustainability or failure. The ability to do this is limited, as McConville (2006) states, because, “due to the variety of situational factors

present in development projects, it is difficult to introduce additional weighting that would be universally applicable.” That considered, more work could be done to assess the relative importance of different factors to project sustainability. For example, the framework could be applied as a post project evaluation of a number of projects. By gathering lessons learned and long-term results, the framework can then be adjusted to calibrate observed results to those suggested by the tool. However, as McConville points out, “the variety of situational factors in development projects” would require multiple studies to help ensure weighting applies across a spectrum of possible improved stove projects.

### **5.2.2 Case studies**

Utility of this framework has been tested by its developer for one of the three proposed uses. It would be beneficial for a variety of “target users” to apply the tool in cases, including all three scenarios. User feedback could be incorporated into a refined version of the framework.

### **5.2.3 Framework for energy projects**

As discussed above, the framework developed by McConville (2006) focuses on a type of project, namely water and sanitation. Although, the tool presented in this paper was focused more specifically, toward a type of technology, the information contained in it could be used to build a broader framework. For example, a sustainability tool for use in energy projects could be developed by integrating knowledge from this paper, along with lessons from other types of energy projects, into McConville’s framework and more general checklist recommendations.

## **6 Conclusions**

This research developed a project management and evaluation framework to increase sustainability in improved stove projects. This contrasts with previous work by McConville and Mihelcic (2007) that is applicable for water and sanitation projects. The framework incorporates factors of sustainability throughout the development project life-cycle. These factors span a range of areas including social, economic, and environmental issues. It has been found in past development scenarios that considering these issues is critical to long-term project success and sustainability (Bishop 2001: Winrock 2008: DfID 1999: Blackman 2003). A number of barriers exist to large scale dissemination and adoption of improved stove technologies. Historically, projects have often failed to overcome these barriers, resulting in disappointingly low levels of effective use of the technologies. The framework presented in this paper integrates many lessons learned from past improved stove programs, both successful and unsuccessful. These lessons have been collected through extensive research, in the field as well as of the literature.

The framework is represented by a scoring matrix in which the elements are associated with sets of recommendations and questions in a checklist. The tool can be used in post-project assessment to increase understanding of results and gain lessons for future projects. It can also serve as a guide to assist project managers in considering sustainability issues throughout planning and implementation. In a case study included in this paper, the tool was used to assess a completed improved stove project. Strengths and weaknesses of project execution were identified and deficiencies were found mainly in education and follow-up activities. These lessons can be applied to future projects.

The range of possible situations and points of failure in projects is vast and this tool cannot possibly anticipate them all. This leaves the potential for the framework to be improved and further refined through application to more cases and by more practitioners. As it is, however, by considering various factors of sustainability throughout a project's life-cycle, the framework encourages users to appreciate and account for the complexities of development, many of which may not have been apparent without use of the tool. This can be particularly important for practitioners with limited training in non-technical areas, such as engineers.

## 7 Reference list

Avis J and Ballard-Tremeer G. 2007 March 9. Improved Cooking Stoves and the Clean Development Mechanism. Hedon Household Energy Network. [Online Wiki] <<http://www.hedon.info/ImprovedCookingStovesAndTheCleanDevelopmentMechanism>>. Accessed 2010 August 19.

Babcock MD. 2006. The Effects of Traditional Cooking Technologies and Small Control Interventions on Indoor Air Quality in Cayo Paloma, Panama. Houghton, Michigan. Michigan Technological University.

Bardales MT. 2009 May. Construyamos la Estufa Eco Justa. 2<sup>nd</sup> edition. La Lima, Cortes, Honduras. Fundación Hondureña de Investigación Agrícola.

Bishop C. 2001. Project Cycle Management Technical Guide. Rome, Italy. Food and Agriculture Organization of the United Nations.

Blackman R. 2003. Project Cycle Management. Teddington, UK. Tearfund.

Boritt J. 2009. "Cooking to Live." Online Documentary. Project Gaia. <<http://www.projectgaia.com/page.php?page=gallerycookingtolive>>. Accessed 2010 August 11.

Bryan S, Vorn V, Rozis JF, Baskoro YI, Madon G, and Brutinel M. 2009. Dissemination of domestic efficient cookstoves in Cambodia. Aubagne, France. Groupe Energies Renouvelables, Environnement et Solidarités.

Buatsi S. 1988. Technology Transfer: Nine Case Studies. London, UK. Intermediate Technology Publications.

Collins D, Morduch J, Rutherford S, and Ruthven O. 2009. Portfolios of the Poor. Princeton University Press.

Cruz EC, León J, Villanueva C, Casanoves C, and de Clerck F. 2010. Ahorro potencial de leña mediante la implementación de la eco estufa "Justa" en la subcuenca del Río Copán y su aporte a la conservación del Capital Natural. Centro Agronómico Tropical de Investigación y Enseñanza (CATIE).

[DfID] Department for International Development. 1999. Sustainable Livelihoods Guidance Sheets. Sussex, UK. Eldis Document Store.

[EWB] Engineers Without Borders EWB-USA. 2010. EWB Homepage. <<http://www.ewb-usa.org/index.php>>. Accessed 2010 August 9.

Goldblatt M. 1999. Assessing the effective demand for improved water supplies in informal settlements: a willingness to pay survey in Vlakfontein and Finetown, Johannesburg. *Geoforum* 30 (1) 27-41.

Graham S, Bailis R, Charron D. 2005. Household Energy, Indoor Air Pollution and Health: Overview of Experiences and Lessons in China. Berkeley (CA). Clean Energy Group at Winrock International.

Hernandez M. 2010 April 12. Conversations with the Hernandez family. El Zapote, Honduras.

Hodgkin J. 1994. The Sustainability of Donor-Assisted Rural Water Supply Projects. Washington, D.C. United States Agency for International Development. WASH Technical Report No. 94.

Hutton G, Rehfuess E, Tediosi F. 2007 December. Evaluation of the costs and benefits of interventions to reduce indoor air pollution. *Energy for Sustainable Development*. Volume XI No. 4.

[IDS] Institute of Development Studies. 2010. Livelihoods Connect. Eldis. <<http://www.eldis.org/go/livelihoods/>>. Accessed 2010 August 16.

[IMF] International Monetary Fund. 2010. World Economic Outlook Database. <<http://www.imf.org/external/pubs/ft/weo/2010/01/weodata/index.aspx>>. Accessed 2010 May 10.

Lara C. 2010. Conversations with Claro Lara. San Agustín, Honduras.

Masera OR, Saatkamp BD, and Kammen DM. 2000. From linear fuel switching to multiple cooking strategies: a critique and alternative to the energy ladder model for rural households. *World Development* 28: 12, pp. 2083-2103.

Mathers C, Stevens G, and Mascarenhas M. 2009. Global Health Risks: Mortality and burden of disease attributable to selected major risks. Geneva, Switzerland. World Health Organization.

McConville JR. 2006. Applying Life Cycle Thinking to International Water and Sanitation Development Projects: An assessment tool for project managers in sustainable development work. Houghton, Michigan. Michigan Technological University. <<http://cee.eng.usf.edu/peacecorps/Resources.htm>>. Accessed 2010 August 19.

- McConville JR and Mihelcic JR. 2007. Adapting life cycle thinking tools to evaluate project sustainability in international water and sanitation development work. *Environmental Engineering Science*, 24(7):937-948.
- McDade S. 2004 December. Gender and Energy for Sustainable Development: A Toolkit and Resource Guide. New York, NY. United Nations Development Programme.
- Mehta S, Shahpar C. 2004 September. The health benefits of interventions to reduce Indoor air pollution from solid fuel use: a cost-effectiveness analysis. *Energy for Sustainable Development*. Volume VIII No. 3.
- [M-W] Merriam Webster. 2010. Online Dictionary. <<http://www.m-w.com>>. Accessed 2010 May 20.
- Mihelcic JR, Crittenden JC, Small MJ, Shonnard DR, Hokanson DR, Zhang Q, Chen H, Sorby SA, James VU, Sutherland JW, Schnoor JL. 2003. Sustainability science and engineering: emergence of a new metadiscipline. *Environmental Science & Technology*, 37 (23), 5314-5324.
- Najib AB. 1993. Household energy consumption behaviour in a pre-Saharan small town in Morocco. Research report No. 2 from Environmental Policy and Society, Uppsala University.
- Osorto I. 2010 April. Conversations with Ignacio Osorto. Tegucigalpa, Honduras. Asociación Hondureña para el Desarrollo (AHDESA).
- [PDC] Palmer Development Consulting. 2004 October. Household Energy, Indoor Air Pollution and Health: Overview of Experiences and Lessons in South Africa. Berkeley, CA. Clean Energy Group at Winrock International.
- [PCIA] Partnership for Clean Indoor Air. Resources. <<http://www.pciaonline.org/resources>>. Accessed 2010 August 11.
- Pickford J. 1995. Low-Cost Sanitation, A Survey of Practical Experience. London, UK. Intermediate Technology Publications.
- Polack P. 2008. Out of Poverty: What Works When Traditional Approaches Fail. San Francisco, CA. Berret-Koehler Publishers Inc.
- Raje DV, Dhobe PS, and Deshpande AW. 2002. Consumer's willingness to pay more for municipal supplied water: a case study. *Ecological Economics* 42 (3) 391-400.
- Rehfuess E. 2006. Fuel for Life: Household Energy and Health. Geneva, Switzerland. World Health Organization.

Simanis E, Hart S, DeKoszmovszky J, Donohue P, Duke D, Enk G, Gordon M, and Thieme T. 2008. The Base of the Pyramid Protocol: Toward Next Generation BoP Strategy. 2<sup>nd</sup> Edition. Ithaca, NY.

Smith KR, Shuhua G, Kun H, and Daxiong Q. 1993. One hundred million improved cookstoves in China: how was it done? *World Development* 21(6): 941-961.

Sugden S. 2003. Indicators for the Water Sector: Examples from Malawi. London, UK. WaterAid.

Sundell J. 2004. On the history of indoor air quality and health. *Indoor Air*. 14 (s7), 51-58.

[UN] United Nations. 1987. Report of the World Commission on Environment and Development: Our Common Future. Published as Annex to General Assembly document A/42/427.

[UN] United Nations. 2002 September 4. Report of the World Summit on Sustainable Development (Johannesburg, South Africa, 26 August-4 September 2002). New York, NY. United Nations. <<http://www.johannesburgsummit.org/>>. Accessed 2010 August 16.

[UNSTATS] United Nations Statistics Division. 2010. Millennium Development Goals Indicators. <<http://mdgs.un.org/unsd/mdg/Data.aspx>>. Accessed 2010 May 10.

Whittington D, Briscoe J, Mu X, and Barron W. 1990. Estimating the willingness to pay for water services in developing countries: a case study of the contingent valuation method in Haiti. *Economic Development and Cultural Change* 38 (2) 293-312.

Whittington D, Lauria DT, and Mu X. 1991. A study of water vending and willingness to pay for water in Onitsha, Nigeria. *World Development* 19 (2/3) 179-198.

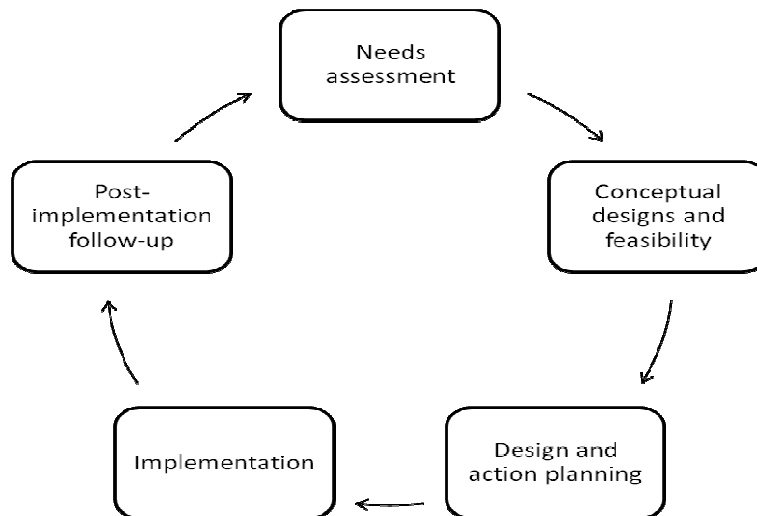
[WHO] World Health Organization. 2002. World Health Report: Reducing Risks, Promoting Healthy Life. Geneva, Switzerland.

Wilkinson P, Smith KR, Davies M, Adair H, Armstrong BG, Barrett M, Bruce N, Haines A, Hamilton I, Oreszczyn T, Ridley I, Tonne C, Chalabi Z. 2009 November 25. Public health benefits of strategies to reduce greenhouse-gas emissions: household energy. *The Lancet. Health and Climate Change Series*. Issue 1.

Winrock International. 2008. Peru Healthy Kitchen/Healthy Stove Pilot Project. Washington, D.C. United States Agency for International Development.

## 8 Appendix A

### Matrix Elements with Rhetorical Questions and Supporting Detail



**Figure 8.1: Project life-cycle stages**

Adapted from McConville and Mihelcic (2007)

From McConville (2006):

“The following is a list of rhetorical questions and explanatory statements to clarify the scoring guidelines of the sustainable life cycle matrix. The examples and questions are certainly not exhaustive nor will they all be relevant for every project. They are meant to guide practitioners and stimulate discussion on a sustainable project process. Not all of the questions following a sustainability recommendation need to be answered in order to obtain a positive score. Instead, the questions and statements are meant to provide the project manager a sense of the depth and scope that each guideline encompasses. If the reader feels that the general essence of the guideline has been addressed in project planning then a positive score can be given. To determine the score of a project, assign a rating (0-4) to each matrix element, depending on the number of sustainability recommendations (check boxes) that are completed. If none of the recommendations are met the matrix element is 0 (poor evaluation). If all of the recommendations are met the matrix element is 4 (excellent evaluation). The potential score for each sustainability factor or life stage is 20, while the total possible score is 100.”

**Table 8.1: Matrix of sustainability factors and life-cycle stages**

| Life Stage                         | Sustainability Factor  |                         |                    |                         |                              | Total |
|------------------------------------|------------------------|-------------------------|--------------------|-------------------------|------------------------------|-------|
|                                    | Socio-cultural Respect | Community Participation | Political Cohesion | Economic Sustainability | Environmental Sustainability |       |
| Needs Assessment                   | 1,1                    | 1,2                     | 1,3                | 1,4                     | 1,5                          | 20    |
| Conceptual Designs and Feasibility | 2,1                    | 2,2                     | 2,3                | 2,4                     | 2,5                          | 20    |
| Design and Action Planning         | 3,1                    | 3,2                     | 3,3                | 3,4                     | 3,5                          | 20    |
| Implementation                     | 4,1                    | 4,2                     | 4,3                | 4,4                     | 4,5                          | 20    |
| Post-Implementation Follow-up      | 5,1                    | 5,2                     | 5,3                | 5,4                     | 5,5                          | 20    |
| Total                              | 20                     | 20                      | 20                 | 20                      | 20                           | 100   |

Adapted from McConville and Mihelcic (2007)

*Element: 1,1 (Needs Assessment, Socio-cultural Respect)*

- Identify past experiences with cooking technologies and attitudes toward them.
  - Have stove projects been implemented previously in the area?
  - Can the results of these projects be investigated?
  - What successes and failures can be identified from previous projects in the area?
  - Are there people who were left out of previous projects, but would now like an improved stove?
  - Are there sections of the population which were missed by previous projects (low income, geographically isolated, cultural or racial minorities)?
  - How do people view “improved” stoves?
  - What concerns are there regarding “improved” stoves or development projects?
  - What is the level of satisfaction with the existing cooking methods/fuel sources?
  - Does the community have knowledge of options for improved cooking methods/fuels?
  - What are the preferred options?
  - What technical, financial, and capacity building assistance does the community need to reach these solutions?

- Identify social preferences and traditions associated with household energy use, cooking practices, and IAP.
  - What are the traditional foods
    - Learn what a user requires from a stove.
  - What are the traditional cooking methods (stove types)?
  - What are the traditional fuel sources?
  - Are there changes in fuel availability? What causes them?
  - Do people add extra materials to their fires?
    - Ex. Dried corn cobs, plastic
  - How do people start their fires?
  - Are certain stove types or cooking fuels preferred over others?
  - Is there a hierarchical view of fuels/technologies (think energy ladder)?
  - What are preferred locations of cooking (indoor, outdoor, separate kitchen)?
  - Is there folklore or old stories associated with food preparation, fuel sources, or IAP?
  - Are there religious ceremonies or festivals to be considered?
    - Ex. Some festivals involve boiling food in large pots. Many “improved” stoves are inadequate for such tasks.
  - Are there possible points of resistance to a new technology or behavior?
    - Ex. People used to cooking on a large open fire may be hesitant to use a smaller, more efficient stove, especially if energy savings come at the cost of slower cook times.
  - Are different devices or fuels used for different activities (cooking, heating, warming water)?
  - Are people afraid to use certain cooking methods?
  - Is the population migratory or temporarily located (refugees, IDPs)?
- Determine the level of health education in the community.

“[Low health education] makes it more difficult for them to understand the health effects of indoor air pollution. This in turn limits their ability to make good choices with regards to fuel selection, stove design and placement, and flue installation and ventilation.” (Graham 2005)

- What is their educational background?
- What is the educational background of the leaders?
- What is the literacy rate?
- What health education issues are covered in schools? What is received from other sources?
- What awareness-raising activities or campaigns have been conducted?
- What is the level of awareness of IAP-related issues?
- Who receives education? Men, women, boys, or girls?
  - Note: there may be discrepancies between who receives education and who makes choices regarding household health risk.

- Do people report any of the following health issues (household surveys and data from health centers may be useful here)?
  - Back pain or hernia from gathering fuel
  - Accidental burns
  - Acute Respiratory Infection (ARI)
  - Asthma
  - Tuberculosis
  - Stillbirth or low birth weight
  - Chronic obstructive lung disease
  - Heart disease
  - Lung, oral, nasopharyngeal, or laryngeal cancer
  - Eye irritation

Note: ARI is very strongly associated with exposure to IAP from solid fuels, but the other illnesses have varying degrees of association. Also, people may not report these illnesses by name, but may indicate chest pain or coughing, for example.

- Why do people get sick? (According to them)
  - Do people connect any of these illnesses with IAP (smoke)?
  - What are the leaders' attitudes toward IAP?
  - Is health a motivation for improved cooking technology?
  - Is smoke a motivation?
  - Are there health care facilities available?
  - How is the household IAQ (ideally from measurements)?
  - How is IAQ perceived in the community?
- Recognize differences in gender/age in cooking, fuel collection, and IAP exposure.
- Who suffers most from IAP related illnesses?
  - If fuel is purchased, whose income pays for it?
  - Who is mainly responsible for preparing food (men/women/children)?
  - Who is mainly responsible for collecting/processing fuel (men/women/children)?
  - How much time do men/women/children spend near cooking spaces (IAP exposure)?

Note: Cruz (2010) found that responsibilities varied even between nearby communities.

*Element: 1,2 (Needs Assessment, Community Participation)*

- Conduct a participatory needs assessment at the local level to determine local development priorities.
- Did you use a participatory approach to needs assessment?

There are a range of methodologies based on a participatory approach to evaluate development needs, for example: Rapid Rural Appraisal (RRA), Participatory Rural Appraisal (PRA), and Participatory Analysis for Community Action (PACA). In general, they all aim to identify community problems and to plan solutions with the active participation of the community members (Selener et al., 1999). Each method uses a set of “tools” to assist members in analyzing the characteristics of their community (community map, social calendars), identifying problems (problem lists, priority analysis), and developing possible solutions (solution brainstorming, feasibility matrix). Participatory tools are most useful when a representative group of community members are involved (men, women, youth, elders, ethnic groups, community leaders and organizations). The participatory needs assessment must take place in the community itself. In depth literature can be found on all of these methods. It is not necessary that all techniques be used during the needs assessment. In fact, development workers should select the tools that are the most applicable to the community. Whatever tools are used the result should still be the identification of the top community needs.

- Is the group involved in the needs assessment representative? Are they influenced by local power groups?
- Can the following types of questions be answered by community members?
  - What are the general characteristics of this community? (employment, services available, ethnic groups, community history)
  - What are the strengths of the community?
  - What are the problems in the community?
  - What are the causes and effects of these problems?
  - Which problems have priority for the community?
  - What can be done to address the problems?
  - What is the population of the community?
- Integrate yourself into the community and “accompany” them through the process.
  - Can an extended stay in the community be arranged?
    - Ex. Peace Corps Volunteers (PCVs) live 2 years in a community; the “Base of the Pyramid Protocol” from Cornell University uses week-long homestays. (See page 18 of Simanis et al. 2008)
  - Do you speak the local language?
  - Is there another outsider, such as a PCV, integrated into the community that can assist?
- Identify stakeholders and community leaders.

Note: Capable and motivated local leaders can correct for overlooked elements and solve problems which may arise. This can highly impact project success or failure.

- Who will be directly affected by project intervention?

- Who will be indirectly affected?
  - Are both genders considered?
  - Are all age groups considered?
  - Are the people responsible for cooking related tasks involved (including fuel collection)?
  - Are there ethnic groups with varying needs? Can they be equally or proportional represented in the project process?
  - Who are the community leaders?
  - How capable are community leaders?
  - Who are the local influential people (LIPs)?
  - Are there people with veto power? (mayor, village chef)
  - Are there influential people without official titles who will affect how others accept the project? (leading scorer on the soccer team, favorite old man, people of wealth or connections, landowners, employers)
  - Are there any existing related committees?
  - Are there CBOs or directive groups such as parent's association, youth organization, board of community directors?
  - How is the community governed?
  - Who are the decision makers in the community? Official? Unofficial?
  - How representative is the community government?
  - What is the level of participation in community decision making?
  - Who implements the decisions?
  - What are the rules and procedures governing community action?
  - What is the level of participation in community activities?
  - Are all stakeholders behind the project? What will make them agree? Are leaders motivated to assist with the project?
- Determine what community members want from the stoves and expect from the project.
- What specific needs must the stoves fulfill?
    - Ex. Boil rice, have room for multiple pots
  - What specific expectations do participants have for the stoves?
    - Ex. It must have a chimney, it must be portable
  - Is there a perceived need for intervention within the community?
  - Do community members understand the project possibilities?
  - Do they understand the limitations?
  - What are the motivations for wanting improved cooking technologies?
  - Is the community aware of the capabilities/limitations of the development workers?
  - Are community priorities in line with development workers' area of expertise?
  - Is there agreement within the community to participate in project intervention?
  - What is the level of commitment to the project?
    - Note: Partner communities should be selected not just based on need but also on desire and capacity to execute.

*Element: 1,3 (Needs Assessment, Political Cohesion)*

- Conduct a situational analysis of regional and national issues such as political structure and stability, government policies, and foreign aid.
  - Are there any overwhelming local/regional issues that may affect the project?
    - War
    - Drought
    - Disease (AIDS and other epidemics)
  - How stable is the national government?
  - What is the financial situation of the country?
    - Debt levels
    - Inflation rates
  - What is the structure of the national government?
  - What do community members think about the government?
  - How active are government officials in the community?
  - Does the government address IAQ and/or fuel use issues?
  - Are there government programs/initiatives for improved cooking methods?
  - How transparent are government finances and policies?
  - How prominent are foreign aid projects?
  - Have potential information sources been consulted, such as: UNDP Human Development Report, local interviews, government and NGO reports?
  - Are there regulations, proposed or in force, which would affect stove or fuel choice and use?
    - Ex. The Gambian government in 1980 banned use of wood-based charcoal. Traditional stoves did not accommodate the groundnut briquettes promoted as a substitute, so improved stoves were needed. (Buatsi 1988)
  - Are there any IAQ standards? Stove safety standards?
    - Note: Even if a standard is not well enforced, it is still your responsibility to meet it.
- Ensure the proposed project is consistent with regionally identified development priorities and plans.
  - What are the priorities outlined in the National Poverty Reduction Strategy Papers (PSRPs), National Strategic Plans, and/or Sector-Wide Approaches (SWaps)? These are national initiatives that outline the development priorities for the country. There will be more government funding and institutional support for projects that address these priorities.
  - Are there local development schedules within the community or region? (check with mayor, village counsel, community leaders)
    - Ex. In Copán, each municipality's mayor had a prioritized list of communities and projects based on assessed needs. However, most outside organizations did not consult this when determining projects.

- What funding sources are available for improved cookstoves or projects addressing health and/or environment/deforestation?
  - What are all the stakeholders' motivations for the project?
    - Ex. Ministry of Health may be motivated by reducing respiratory illness, Environmental NGO by conservation, and users by reduced smoke and fuel use or cleaner house.
  - What national or regional programs are there which could affect the project?
    - Ex. National program to combat deforestation
  - Is long term M&E a priority in the area?
- Research the history of NGO and government projects in the area.
- What NGOs work or have worked in the area?
  - Have there been programs for improved stoves in the area?
  - What other work or projects have been done in the community before?
  - Who executed the projects – government, NGOs, CBOs?
  - Has M&E been carried out for past projects?
  - Are past project reports available?
  - In what ways were projects successful? In what ways did they fail? What lessons were learned?
  - How was the community involved in the project implementation?
  - What is the community's opinion of past projects?
  - How do nearby communities, government, NGOs view past projects?
  - What pitfalls should be avoided in future projects?
  - Are any projects on-going?
- Establish communication lines with existing NGO and/or government institutions in the area.
- Have government officials, CBOs, and NGOs in the area been contacted?
  - What entities/organizations work in the field of household energy, health, environment, business development, or marketing?
  - Is there an experienced development professional which can mentor and guide the project?
  - Are there research institutions that can assist with design development, market research, testing, and/or monitoring?
  - Are they receptive to your organization?
  - Are they open to collaboration or support?
  - What support can they offer?
  - What initiatives/projects are they currently working on or do they have planned in the area?
  - What advice do they have for working in the area?
  - Is there an agreement among organizations for geographical division of efforts?
  - Is there a mechanism in place for communication and coordination among organizations, such as periodic meetings?
  - Do potential partners understand the need for post implementation follow up?

*Element: 1,4 (Needs Assessment, Economic Sustainability)*

- ☐ Understand the local economy and the market for improved stoves.
  - Can a market survey be conducted?
  - How competitive is the market for stove production and sales? What are the barriers for entry?
  - What comparable technologies are available locally? How much do they cost?
  - Are there local producers, installers, and merchants of stoves or similar technologies?
  - What level of capacity do they have?
  - In what areas can market capacity be improved?
  - Are there individuals or organizations capable of providing business, marketing, or management skills training?
  - Is there a source of continual funding for technical assistance?
  - What fuels are available? How consistently? Locally available?
  - Who owns the fuel sources?
  - Who transports and sells fuel?
  - What is the primary source of income and employment?
    - Nationally?
    - Locally?
  - How stable is the national and local economy? And the currency?
  - What materials are locally available for purchase?
- ☐ Understand the economic burden associated with cooking, fuel use, and IAP.
  - Is income lost due to related disease or injury (think DALYs)?
  - How much time is spent on food preparation?
  - What percentage of income is spent on food?
  - How much time/money is spent on cooking fuel?
  - What maintenance costs and tasks are required by current cooking methods?
  - What is the cost to replace current stove technologies? How often is this done?
  - Do families compensate for the loss of children in some way?
    - Ex. Having more children
  - How is loss of productivity due to old age compensated for?
  - Would improved cookstoves provide economic gains or savings in terms of time or money?
  - Does the typical “energy ladder” match historical trends in the region?
  - Where is the community currently on the “energy ladder?”
- ☐ Identify sources of monetary and non-monetary resources within the community.
  - Are income and other resources constant throughout the year or seasonal?
  - What times of the year are incomes and resources more plentiful? What times are less plentiful?

- What are the income levels of people in the community?
- How regular is the income?
  - Does it vary by season?
- How predictable are income flows?
  - Ex. Employers that cheat workers, crop losses
- What access to formal or informal financial instruments, such as credit or savings devices, do people have?
  - Note: Collins et al. (2009) state that the poor often suffer from a “triple whammy”: low incomes; irregularity and unpredictability; and a lack of tools.”
- How do people make money?
  - Paid salary
  - Agriculture
  - Trade
  - Small enterprises (hand crafts, food sales at market, odd jobs, construction)
- Is income dependent on or sensitive to particular factors (tourism, rainfall, commodity price, etc.)?
- Is there a minimum wage? If so, what is it and is it normally met?
- Are there outside sources of income (remittances, pensions, government subsidy)?
- Does income or employment vary by gender or age?
- How is wealth distributed? (ratios of high/low income, inequality in wealth)
- What are indicators of wealth? (livestock, land, vehicle, improved home, multiple wives)
- Can community members contribute labor?
- Are there community members with applicable skills (masonry, welding, etc.)?
- Does the community have the means to transport supplies?
- Are there construction tools or materials available?
- What local fuel resources exist? Who owns them?

Note: Do not assume people are too poor to improve lives without outside help.

- Ex. In Honduras, an improved stove was built in a one room adobe, dirt floor house. The family had very little, but they did have a microwave and stereo.

- Assess the general community willingness-to-maintain and willingness-to-pay for fuel and improved stoves, in both monetary and non-monetary terms.

There are a number of methods in use for determining willingness-to-pay: contingent valuation surveys, estimations based on a percentage of income or current expenditures (Goldblatt, 1999; Raje et al., 2002; Whittington et al., 1991/1990). The community willingness to pay should be determined on more than a “rule of thumb” based on a percentage of household income. It should be voiced by community members themselves, either directly in interviews or indirectly by costs that they currently pay for services.

- What is the average cost of living in the community?
- What do people spend money on? When?
- Are current cooking methods considered adequate?
- How could they be improved?
- Do people rent or own their property or house?
  - It can affect how much they are willing to pay for home improvements and whether portable stoves may be appealing.
- What do people spend on other home improvements or consumables?
- How do community members view their role in stove acquisition?
  - Are stoves viewed as something to be purchased, the duty of the state to provide, or only attainable as a gift?
- Would people be willing to pay for an improved stove?
- How much would they be willing to pay?
- Would people be willing to maintain an improved stove?
  - Monetary costs
  - Time and effort costs
- How much would they be willing to put toward maintenance?
- Are improved stoves seen as a necessity or highly desired?
- Are they a status symbol or a sign of improved domestic conditions?
- What do people pay for fuel?
  - In time
  - In money
- Is fuel scarce?
  - Greater scarcity may correspond to greater demand for more efficient stoves.

*Element: 1,5 (Needs Assessment, Environmental Sustainability)*

- ☐ Identify local environmental resources.
  - What are potential renewable fuel sources in the area (wood, sun, agricultural or animal waste, wind, water, etc.)?
    - How reliable are they?
    - What quantity and quality can they produce?
    - Where are they located?
  - How do fuel needs compare to the supply?
  - Are there any non-renewable fuel resources?
  - What potential materials sources are available?
    - Ex. Clay, river sand, wood, ash
  - Is there data available on these resources (from previous studies, government)?
- ☐ Determine how environmental resources are used and controlled, and by whom.
  - Who controls the resources? (landowners, water rights)

- How do population trends (growth, migration) affect resource use and availability?
  - Are there seasonal variations in resource/energy use? (heating, industry)
  - What is done with agricultural “wastes?”
  - Is there any conflict over limited resources?
    - Ex. Refugees in camps in Ethiopia put greater than normal stress on the productive capacity of the land, causing conflict with local farmers over scarce resources (Boritt 2009).
- Identify potential environmental concerns at the local and regional level.
- Are any of the following current environmental concerns? Is there potential that they will become issues?
    - Desertification
    - Deforestation
    - Erosion
    - Overgrazing
    - GHG emissions
    - Aquifer depletion
    - Ecosystem/watershed deterioration
    - Loss of biodiversity
  - How severe are the impacts?
  - What fuel sources are placing strains on the environment?
- Determine local, national, and international understanding of and concern for environmental problems and the willingness to correct them.
- How does the community perceive the threats to the environment?
  - Can they identify potential environmental concerns?
  - Are the community and/or local and national government concerned about ecosystem loss or climate change?
  - What education concerning environmental problems and solutions have they received?
  - Would they be willing to change their behavior patterns for environmental benefits?
  - Will international treaties or movements influence project efforts (Kyoto protocol, carbon credit trading, pressure to reduce GHG emissions, etc.)?
  - Is environmental impact a motivation for improved cooking technologies?

*Element: 2,1 (Conceptual Designs/Feasibility, Socio-cultural Respect)*

- Consider designs which meet the needs and expectations of users and make noticeable improvements.
- Is it a proven technology?
    - Note: Stoves that do not work can harm the image of “improved” stoves.

- Does it actually do what it is said to do?
- Can this be proven to users?
  - Ex. Some stoves have smaller combustion chambers (smaller fires) than users are accustomed to. If the stove does not cook as needed or if users are not convinced that it can, problems may result in long term acceptance.
- Does the technology significantly improve any of the following?
  - Efficiency/fuel use
  - usability
  - convenience
  - cost savings
  - smoke reduction
  - size/capacity
  - aesthetics
  - social status
  - cooking time
    - Ex. A Guatemalan improved stove user was pleased with his stove because his family could now share beans at the midday meal on Saturdays. With the old stove, the beans would not be ready until the evening.
- Does the design match the needs and preferences identified in the needs assessment? Consider:
  - Number and size of pots
  - Logistics of food preparation
    - Ex. Boiling beans, toasting tortillas, and keeping coffee warm simultaneously
  - Temperatures and heating speeds
    - Ex. Can coffee be heated quickly for people leaving for work early in the morning?
  - Cooking and preparation surface area
  - Taste derived from cooking method
    - Ex. Wood vs. gas, brick vs. metal oven, clay vs. metal griddle
  - Ease of starting
  - Food types accommodated
    - Ex. Boiled, fried, grilled, etc.
  - Location
  - Ventilation

Note: There is likely no one size fits all solution to satisfy all cooking needs for all people. Approach the project from the perspective of increasing available improved options rather than providing *the* solution. Households typically use combinations of cooking devices to meet their needs and transitions in energy use and cooking technologies occur as a result of a complex combination of factors. It is important to remember that regardless of what project implementers determine as the “best” option, it ultimately depends on factors often beyond the capacity of practitioners (especially outsiders) to understand

and account for. Therefore, it may be best to approach the project from the perspective of expanding available improved options.

- Assess how the proposed stove technologies fit into traditional household practices, including gender roles.

Few facets of human life are more determined by culture and tradition than how food is prepared, cooked, and eaten. Considering that much of what comprises “culture and tradition” is essentially what has been found to work over a long time period, it is important to value traditional practices and maintain them as much as possible while reducing IAP and improving energy efficiency. Practitioners must let go of an inclination to think that their “advanced” technology is right and “primitive” traditional methods are wrong.

- Can you brainstorm possible social advantages and disadvantages of potential systems?
- Are all household members involved in the design process, including men, women, and children?
- Will the new system elevate or lower the social status of any group or individual? (By giving them new responsibilities or eliminating their roles?)
- How can designs address these concerns so that the system will be culturally acceptable?
- How will these changes in free time affect the lives of community members?
  - Will increased free time allow for gainful economic employment?
  - Will it affect social time? (Food preparation and consumption can be strongly linked to social or family interaction)
  - Will it affect how children are employed in household chores? (If children no longer fetch fuel, what will they do? Is it reasonable to expect that they will be able to go to school?)
- Will the new system affect political or power roles in the community?
  - Ex. If people no longer depend on powerful land owner for fuel source does that shift the power dynamic in the community?
- Will a new system interfere with the traditional gender power balance?
- What will be the role of men, women, and children for the new technology?
- Will it lead to more, less, or different responsibilities for household members?
  - Ex. Some stoves require wood to be chopped smaller. Therefore, whoever is tasked with chopping must be included to ensure they understand and accept their altered responsibility.
- How can the project encourage ownership by both gender groups?
- Are cultural and traditional preferences and taboos considered and respected?
  - Consider how favorite aspects of the current system can be incorporated into the design. People are most willing to accept something with which they are familiar.
  - Refer to information gathered during needs assessment

Note: Simply because a technology does not fit exactly into current practices does not negate its potential, but these changes must be kept in mind and accounted for in planning.

- Investigate feasibility of health education programs.

Promoting health awareness is a way of increasing demand for efficient stoves and enabling people to make good choices about exposure to risks.

- How can community members learn about IAQ?
  - What assistance can be provided by partner organizations specializing in health education?
  - Can programs in the school(s) be developed?
  - Can broader awareness programs be utilized?
    - Regional radio spots
  - Can the arts be integrated into awareness activities?
  - Ex. Plays, songs, movies
  - Can all household decision makers be included?
- Recognize why biases exist towards certain technologies by donors and/or locals.
    - Are there traditional practices which need to be considered?
      - Ex. Most households in Honduras cook at least some meals with wood, even if they have gas or electric
    - Are certain improved technologies associated with prestige and wealth? (think energy ladder)
    - Are there political pressures/incentives to adopt certain technologies? (organization has relationship with certain supplier or common ownership)
    - Are some systems more acceptable because of their familiarity to either residents or donor agencies?
    - What significance is placed on system convenience, privacy, comfort, or aesthetics?
    - Are there differences in cultural standards of quality or cleanliness that need to be reconciled?
    - Smoke desired to keep bugs away
    - Do certain people stand to gain more from choosing one technology over another?
      - Ex. Stakeholders with masonry skills may gain from brick stoves.
    - What perceptions of utility exist toward different stove characteristics?
      - Is a large fire seen as necessary?
      - Is smoke in the house favored to keep away bugs?
    - Is one technology preferred over another due to appearance?
      - This is an important but often overlooked factor of acceptance. Rural consumer may also seek to imitate urban lifestyles and be more attracted to models similar to those found in urban areas.

Note: Remember that not all biases are negative. Some may be helpful in promoting the use and general acceptance of the system.

*Element: 2,2 (Conceptual Designs/Feasibility, Community Participation)*

- The project goals are clearly defined and understood by the community and development workers.
  - What need had the highest priority?
  - How do community members visualize the expected benefits? How do the development workers?
    - Ex. The implementing organization wanted “ecological conservation” while the stove users wanted “reduced effort searching for scarce firewood” (León 2010).
    - Increased health?
    - Reduced deforestation?
    - Reduction in GHG emissions?
    - Time, cost, and labor savings?
    - Aesthetics and improved domestic conditions?
    - Performance and efficiency?
    - Improved social standing?
  - Who will benefit from the project?
    - Will all members benefit equally?
    - Are all the beneficiaries represented in community discussions?
  - Are community members and development workers in agreement?
- Work with leaders who can act as community liaisons throughout the project.
  - Are the leaders capable of performing (or assigning the responsibility for) the following roles?
    - Assisting in feasibility studies
    - Introducing and explaining proposed designs and plans
    - Gathering community opinions and sharing them with project planners
    - Monitoring and evaluating project progress
    - Gathering household data
    - Organizing community education and events
    - Generating support for the project
    - Providing project follow-up
  - Can a new committee or an existing committee fill this role?
    - Note: there is a danger of too many committees within a community. It can lead to a confusion of roles.
  - Does this group represent all beneficiaries? (men, women, youth, ethnic diversity)
  - Are the leaders respected within the community?
  - Are their decisions and leadership trusted by community members?

- Do they operate according to local customs?
- Present several technically feasible alternatives for community evaluation and feedback.
  - Does the presentation of each design include a technical description, estimated costs, installation time, and operation and maintenance needs?
  - Are users actively involved in discovering and proving the usefulness of the technology?
    - This participation is also critical for spreading the technology through “word of mouth.”
  - Are presentations of alternatives done in a fair and balanced way?
  - Does the community understand the proposed technologies?
  - Are advantages and disadvantages of each design understood and discussed?
  - Does the community think that they can operate and maintain the technologies on their own?
  - What education, training or support services would be necessary for the proposed designs?
  - Are there any concerns not addressed in the conceptual designs?
  - Which designs do community members prefer?
  - Ex. One method employed is to hold a fair at which the stoves are used to cook food so community members could see the stoves in operation, taste food cooked with them, and socialize and share opinions (León 2010 and Boritt 2009).
- Community members modify and formally select a design based on their needs, preferences, and an understanding of the constraints involved in the selection process.

Note: A common cause of project failure is that technologies are chosen by implementing agencies without user feedback. Put forth extra effort to encourage participation and input from community members. This is important because communities may accept gifts they do not necessarily want or need for a variety of reasons. Among these may be a desire to receive more useful gifts in the future, a cultural aversion to saying “no”, fear of receiving nothing at all, or pressure to accept what is offered. It may take extra effort to encourage community members to express their opinions in these cases. They may be afraid to question or criticize the implementing organization or to indicate that something may not be feasible.

- What methods of interaction and sharing can be utilized? Get creative.
  - House visits
  - Community meetings
  - Participatory workshops
  - Town fair
  - Discussion groups

- Can community members think of ways to encourage participation and feedback?
- Can the opinions, needs, and voices of all community members be expressed through the chosen method?
- Are community members allowed to judge the advantages and disadvantages of differing technologies?
- Can they express what they think would be most appropriate for their situation?
- Are they given an opportunity to propose changes?
- Are community members given the opportunity to reflect before selecting a design?
- How is the decision reached? Democratic process? Leader decides? Each household chooses? Each household head decides?
- Is this process consistent with traditional methods of community decision making?
- Is the decision influenced by outside forces?
- Is it possible to judge if the design was chosen on technical merit or political motivation?
- Do community members seem happy with the selected design?
- Are there any lingering concerns that need to be addressed?
- Must the whole community agree on one technology or is it possible to include various in the project, chosen by individual households?
  - It could be useful to recognize that stoves are a household good and therefore adoption may follow patterns similar to adoption of other household goods such as blenders or beds (i.e. the whole community does not buy the same kind of bed).

*Element: 2,3 (Conceptual Designs/ Feasibility, Political Cohesion)*

- Develop a working relationship with all interested and pertinent partner organizations, including at least one that is based in the host country.
  - Does the design meet the goals of all partners?
  - Do partner organizations have compatible programs and agendas?
  - What assistance is required for each conceptual design?
    - Environmental education and rehabilitation
    - Health education
    - Business/market development
    - Research and design testing
    - IAQ monitoring
  - Is there a commitment of support from other organizations or government?
  - What is the expected level of support and interaction from all parties?
  - Do partners have suggestions or feedback on the designs?
  - Are government officials kept informed and/or involved?

- Is there competition for limited resources for project execution (materials, transportation or fuel)?
  - Are there organizations, institutions, or businesses which produce or promote certain stove designs?
  - Can stoves be obtained from these groups?
  - Can government provide support in the project?
    - Note: Stove programs can be appealing to governments because they are relatively low-cost with quick returns in terms of energy savings, health improvements, and conservation.
  - Can the basic goals of the working relationship be written in a Memorandum of Understanding (MOU)?
- Use lessons learned from the plans and designs of other organizations on similar projects (past and present).
- Have points of failure of similar projects implemented in the area been avoided?
  - Have points of success been integrated?
  - Will the project be redundant or in conflict with another project?
  - Is the project consistent with technical designs working in nearby communities?
  - Is it feasible or beneficial to integrate technologies being promoted by government or NGO programs in the area?
  - What constraints did they use?
  - Were there problems? How were they resolved?
  - Will the chosen design complement other efforts, for example by using a standard stove top size?
- Consider ways to provide follow-up to the project.
- Are post implementation M&E plans feasible?
    - Is environment, health, and economic data available?
    - Can all partners agree on the importance of post-implementation follow-up?
    - What partners can assist with M&E?
    - Can partner commitment be expected?
  - Can a locally based institution be involved in project monitoring?

Many organizations consider it sufficient to monitor progress of the project until construction and training is complete. However, this is simply an element of the implementation phase. This is not what is meant by M&E. M&E involves following up with the project to ensure that the construction and training achieved its goals.

- Ensure project fits within local, national, and international context.
- How will planned future development affect long term success of project?
  - Will concurrent programs affect the project?

- Ex. government clean indoor air campaign, health or environment promoters, political promises of free stoves
- Are laws influencing the viability of a technology considered?
- Can new policies be encouraged to promote stove adoption?
  - “For example, in one county a permit for a new home was tied to the installation of an improved biomass stove. In other provinces, permits were not given for fuelwood collection without the installation of an improved biomass stove (Graham 2005).”

*Element: 2,4 (Conceptual Designs/Feasibility, Economic Sustainability)*

- Consider the logistical feasibility of implementing, operating, maintaining, and replacing each conceptual design.
  - How much will materials, equipment, transportation, labor, promotion, and training cost for each option?
  - Can community members provide local cost information?
  - What are estimated O&M requirements?
  - When will the system require maintenance? (Daily, monthly, seasonally)
    - Will people have the time to perform maintenance?
    - Will this vary depending on the season? (seasonality of household composition)
    - Ex: During the harvest people are very busy and will be unwilling to take on any additional tasks.
  - Will food be provided for labor crews? What will it cost?
  - Do community members expect compensation for materials and labor they provide or do they consider it their contribution?
  - Do development workers (partners) expect compensation?
  - Will there be political fees that should be included in the budget?
  - Are proposed solutions within the economic means of users?
  - How will recurrent costs be covered?
  - Will money be saved through the new technology?
  - Will these savings pay for up front and maintenance costs?
  - Will economic benefits such as decreased wood consumption be apparent to users?
    - In resource scarce areas this change is often more easily perceived than in areas where people are not as accustomed to noting their fuel use.
  - Are there funds for long term M&E?
  - What about funding for promotion and education?
  - Are there grants or low-interest loans available? What are the conditions for receiving funding?
    - For agencies?
    - For individuals?
  - What production model will be used?

- Mass manufacturing
  - Local small scale production
  - In home assembly
  - Imported devices
  - Contracts
  - Promotion
  - How will future demand of each option be met?
    - Are new or replacement stoves locally available and affordable?
    - How will future stoves be financed?
  - How much technical knowledge is required to operate and repair the technology?
    - Ex. A wood burning stove is relatively simple to operate and maintain compared to a household bio-digester.
    - Does this knowledge exist within the community?
  - What local materials can be used?
  - How can non-local materials be obtained?
  - Can replacement parts and materials be found locally? Are they affordable?
    - If not, include cost estimates for transportation of supplies or displacement of people to get supplies
  - How often will materials and parts need replacement?
  - Will users be able to repair and maintain stoves on their own or will able providers be trained and/or available?
  - Are traditional fuel sources used or new ones?
  - Is the fuel source affordable and consistently attainable for all households?
    - “Local availability is the primary factor in fuel choice . . . even households that are willing and able to pay will not make the switch from charcoal to LPG if the gas, stove, and gas bottles are not consistently available in a convenient location (Graham 2005).”
  - Are prices subject to fluctuations?
- Consider implications for the local economy and stove market and how economic capacity can be built for each conceptual design.

It is essential to work within the local economy, since it will be in place long after the project ends. Contract with and build capacity of local manufacturers and service providers. If no local manufacturers and service companies exist consider the possibility of creating one.

- Are there businesses or service providers that can be involved in the project, assisted, or created?
- What assistance can feasibly be provided to build the local stove market?
  - Contracts
  - Grants
  - Training
- Can non-local materials be made consistently available?

- Ex. Cement is not a “local” material in many places, but it is often locally available due to consistent demand.
  - How can stove technologies be promoted?
  - Do subsidies of stoves impact local markets?
    - Consumer subsidies should be eliminated as much as possible. There are a number of reasons for this. One is that the local stove industry could be undercut and destroyed by cheap subsidized options provided by development organizations. Indirect subsidies may be a better option.
    - 129 million stoves were disseminated in China with very little subsidy, resulting in low cost to the government. The government funded training, promotion, and administrative costs as well as provided tax breaks to stove businesses (Graham 2005).
  - Is fuel source viable on a large scale?
    - Ex. Is gas available enough in the country to allow for wide spread proliferation? Is there enough biomass to produce the needed charcoal
  - Do people derive and depend on income from supplying current fuel sources?
  - How will the new technology disrupt their livelihoods?
  - Does the fuel distort or impact the local, national, or international economy? (Think corn based ethanol)
  - Considering that as incomes increase, households typically move up the energy ladder (toward greater efficiency/caloric value), does the chosen stove/fuel match that trend?
- Assess the specific willingness-to-maintain and willingness-to-pay for each improved system (how much people value each option).
- What are people willing to contribute for each new stove?
    - Monetary (upfront or in installments)
    - Non-monetary items (labor, supplies, construction material, tools)
  - What are people willing to pay for fuel and maintenance?
    - Monetary cost
    - Time and effort cost
  - Can the stove be promoted as a product, rather than given as a gift?
    - Gifts naturally have the possibility to not be appropriate or valued by the recipient. Whereas, a purchased (chosen) product usually fits the needs of the consumer (or at least is perceived to).
    - The “hand out culture” can exist even when a community contribution is required. (see Element 2,2)
  - Is current fuel scarce?
    - Greater scarcity may correspond to greater demand for more efficient stoves
  - Will people pay for the new fuel if the current fuel is free?
  - Do all members accept the new responsibilities?
  - Can people be trained to operate and repair this system?
    - Do people want to be trained?

- Will trained people remain in the community? (Labor forces can be migratory. Educated people tend to be drawn to urban centers where there are better job opportunities.)
  - Is there a means to provide needed assistance consistently and permanently from outside the community?
  - Can maintenance schedules be timed to coordinate with labor availability?
- Conduct an economic feasibility assessment to evaluate long-term project viability based on cost estimates, projected operation and maintenance costs, community willingness to pay, the need for outside resources, and the availability of outside funding.

An economic feasibility assessment is suggested in place of a traditional cost-benefit analysis. In projects affecting human and environmental health, benefits are often hard to quantify. There are data limitations that make it difficult to estimate the health and economic benefits that would traditionally be used to justify costs. The larger question is the sustainability of the project. The measurable benefits will be negligible if the project is not maintained. In fact, some cooking technologies can have negative health impacts if they are not properly cleaned and used (smoke backing up into house from clogged chimney). An economically sustainable project is one that offers long-term benefits (i.e. remains in operation) at an affordable price. The definition of an affordable price will be determined by what beneficiaries and government officials are willing to pay. There are many methods for determining the community willingness to pay (see above). Willingness to pay on the part of the government (or other aid organizations) can be determined based on the amount of grants, subsidies, or other funding currently directed at household energy and conservation projects (see Element 1,3).

In an economic feasibility assessment, the project viability is determined by weighing implementation, operation, maintenance, and replacement cost estimates, versus the willingness of the government and community to pay for it. Decision makers will have to evaluate the constraints identified in the needs assessment (elements 1,\*) along with the analysis conducted in this element to determine long-term viability of the project.

- Does the conceptual design fit within the constraints identified in the needs assessment (see Elements 1,\*)?
- Does it satisfy the first three components of this element?
- What is the total cost to implement the project?
- What funding is available to implement the project?
- What is the estimated up-front cost per household?
- Are up-front costs within willingness to pay?
- What are realistic estimations of operation (fuel) and maintenance costs?

Note the danger of investing more money up front (high technology) to avoid operation and maintenance costs. The high cost of fixing these systems when they do require maintenance (and they will) may be quite inhibitory (Howe and Dixon, 1993).

- Are maintenance and/or fuel costs within willingness to pay?
- What is the cost of replacement?
- Will outside resources be needed for operation, maintenance, and replacement?
- Will these resources be available?

*Element: 2,5 (Conceptual Designs/Feasibility, Environmental Sustainability)*

- ☐ Assess the capacity for sustainable fuel use in the geographic area.
  - Can the fuel source provide an adequate supply throughout the year?
  - Are there seasonal changes to fuel availability or demand?
    - Ex. Agricultural byproducts may only be available around harvest.
    - Heating needs may be the largest driver for change in demand.
  - How will use of the fuel source affect the ecosystem?
  - How will nearby watersheds be affected?
  - Is the fuel source viable on a large scale considering environmental resources?
    - Ex. Does forest growth exceed foreseen wood consumption?

- ☐ Investigate feasibility of environmental awareness and rehabilitation activities.

Promoting environmental awareness is a way of increasing demand for efficient stoves and enabling people to make good choices about their environmental impact and household energy use.

- How can community members learn about biodiversity?
  - What assistance can be provided by partner organizations specializing in environmental education?
  - Can programs in the school(s) be developed?
  - Can broader awareness programs be utilized?
    - Regional radio spots
  - Can the arts be integrated into awareness activities?
  - Ex. Plays, songs, movies
  - Can trees be planted?
  - Can a nursery be built?
  - Can children participate in these activities?
  - Can watersheds be delineated and protected?
  - Can an environmental conservation action plan be developed?
- ☐ Be sure to select a design which makes a significant and noticeable difference.
    - Does the technology result in a noticeable reduction of environmental stress?
    - Is this difference perceptible to community members?

- Ex. The traditional wood burning stoves in one community would burn through 50 sticks in 3 days. The new model of stoves made that same load last 8 days (Hernandez 2010).
  - If not, can it be measured and shared with community members?
  - Does it make a noticeable difference to environmental health (IAP)?
  - Is this difference perceptible to community members?
    - Ex. Users remark that the ceiling above their new stove is clean while the spot above their old stove is black with soot.
  - If not, can it be measured and shared with community members?
    - IAQ measurements taken before and after installation.
    - One possible method is to put a filter (such as a coffee filter) in the chimney to show how much soot is leaving the house.
- Conduct an environmental impact analysis for each alternative.
- How will fuel consumption affect the surrounding environment?
  - How will the operation of the system affect the environment?
    - Waste discharges
    - Disposal of used parts and fuel containers (Where? How?)
    - Ecosystem disturbance
    - Resource consumption (materials)
  - Is the community near a protected area?
  - What is the potential for remediation/mitigation of damage?
  - Does the fuel release emissions that are harmful to human health? Which ones and how much?
    - Ex. CO, toxic compounds found in coal such as arsenic and flourine
  - How will these emissions be minimized or removed from the living/working area?
  - Will environmental impact be improved over current practices?
  - Are invasive species promoted as a fuel source?
  - What is the net GHG production?
  - Are there any potential unintended consequences or side effects to the environment or health?
    - Ex. China executed a large successful stove program which resulted in increased use of coal. Though IAP related illness and death have decreased and biomass resources conserved, cancer levels have risen due to toxins in dirty coal (Graham 2005 ).

*Element: 3,1 (Design/Action Planning, Socio-cultural Respect)*

- Plan sufficient time for health education. Empower people to make good choices about exposure to IAP, health, and household energy use.
- Is there time programmed for health education activities?
  - What health education activities are planned?

- Are IAP and its negative effects explained?
  - Is health education incorporated into school lessons?
  - Do school schedules conflict with extra activities?
  - Are all household decision makers given the chance to learn how to make better decisions about household risks?
- Work with the traditional structure and schedule of community projects.
- Is there a history of community projects? (people working together for the common good)
  - How are community projects traditionally organized?
  - Who determines what projects will require community effort? (Local action planners, leaders)
  - Who directs the work? (foreman, village chief, committee)
  - Who performs the work?
  - Are there culturally determined roles that must be respected?
  - Do all households contribute? How?
  - What are employment schedules like?
    - It is important to disrupt income generating activities as little as possible.
  - Can tasks be adjusted for migratory patterns, planting, harvest, holidays, weather, soccer games, etc.?
  - What household work and activities must be carried out?
    - It is important to disrupt household activities as little as possible.
    - Ex. It may be necessary to dismantle the existing stove in order to build the new one in its place. If so, it is important to schedule activities in a way that minimizes disruption to the household's ability to cook meals.
  - Does scheduling include float time to allow for the unexpected?
  - What are the consequences of not planning for unexpected events?
    - Incomplete project requirements
    - Going over budget
    - Angering people by working through social events
    - Conflicts between development workers and community members
  - What is a typical work day?
  - What time do communal work projects normally start? And finish?
  - What are expectations for breaks and meal times?
  - Are there certain days of the week that work cannot be performed?
    - Religious observances
    - Markets
  - How will the availability of equipment limit work?
    - Ex: How many shovels are there? (It will limit the number of workers at one time.)
  - What is the school schedule?
- Confirm resource contributions and benefits are equitably or acceptably divided.

- Among households?
  - Among ethnic groups?
  - Among areas of the community (neighborhoods)?
  - Among political parties?
  - Among extended family groups?
  - Past projects have found that it is possible and helpful to stratify households according to ability to contribute.
    - However this may require negotiation and documentation of agreement.
- Explore options for increasing gender equity in project roles and capacity building.
- What role do women traditionally play in community projects?
    - Construction projects
    - Communal agricultural efforts (harvest, planting, irrigation)
    - Administration and organization
  - What roles do women feel comfortable playing?
  - Are there ways to increase the involvement of women in the current project?
    - Since women are typically the primary users of stoves, it is essential that they be **centrally** included in the process.
    - Ex: Train them in operation and maintenance
  - Ensure all who will be involved in or affected by use of the new stove are involved in and understand the project.
    - Ex: Some stoves require that fuel wood be cut into smaller pieces. Without involving the person whose traditional role it is to cut the wood, the stove may create conflict in the household.

*Element: 3,2 (Design/Action Planning, Community Participation)*

- Community input is solicited in refining the selected technical design.
- Does the chosen design meet the needs and expectations of users?
  - Are there objections to the design or people who refuse it?
    - In a past project, one household head wanted her stove outside, but the design chosen was not efficient in outdoor use.
  - Are the opinions of all community members expressed?
  - Are they given an opportunity to propose changes?
  - Are community members given the opportunity to experience the technology and reflect before selecting a design?
- Final technical design is understood and approved through a process of community consensus.

A pitfall in projects with new technologies or subsidies is that there is a tendency for beneficiaries to accept what is offered even if they are not fully satisfied with it.

This must be a deeper process than simply presenting the technology and asking “do you want it?”

- Do all participants understand the design, its benefits, and details?
  - Do community members understand the reasons behind the design details?
    - Ex: Changes to key parts of the design may be desired by users, but may negatively affect performance. It is important to understand which elements can and cannot be changed and which are critical to the stove’s function.
  - How is the decision reached? Democratic process? Leader decides? Each household chooses? Each household head decides?
  - Is this process consistent with traditional methods of community decision making?
  - Is the decision influenced by outside forces?
  - Is it possible to judge if the design was chosen on technical merit or political motivation?
  - Are all concerns resolved before full implementation?
- Community members are involved in identifying and sequencing tasks that will be incorporated into an action plan.
- What concrete tasks need to be accomplished?
    - Gathering supplies and finances
    - Storing materials and equipment
    - Recruiting and organizing skilled and unskilled laborers
    - Construction work
    - Construction supervision
  - Who will be in charge of completing these tasks?
    - Community members or someone from outside the community?
    - Are management and labor roles clearly defined?
  - Is there a management system in place?
    - Is there an existing board or committee?
    - Who will monitor and report progress?
  - When do these tasks need to be completed?
    - Develop a timeline
    - Set a schedule for task completion
  - How will the project be promoted in the community?
  - Are influential leaders willing and able to do this?
  - Have community members identified who will receive training on construction and/or administration?
  - Are all users willing to participate in health education and operation and maintenance training?
  - Are assumptions in roles and contributions explicitly stated?
    - Ex: If community members will provide labor, meals for workers, or tools
  - Are plans for post implementation M&E, reporting, and follow-up made?
  - Who will continue subsequent project iterations after the initial round?

- The community members and development workers understand and approve of the timeline and responsibilities laid out in the action plan.
  - Are all participants clear on what they will receive and what their contribution will be?
  - Has this been put in writing?
  - Are expectations met?
  - Are the roles and responsibilities of individuals and organizations explicitly stated?
    - Performing the work
    - Overseeing progress
    - Consulting
    - Informing others of the work
    - Managing resources
  - Are all parties aware of their own roles and responsibilities, as well as, those of everyone else?
  - Are the skills, knowledge and attitude of individuals factored into role assignments?
  - Does the timeline include tasks to be completed by both community members and development workers?
  - Does the timeline include dates for the community monetary contribution paid, resource gathering, start of work, expected progress, completion?
  - Have all participants confirmed their participation?
    - Recipient list
  - Have influential people in the community agreed to adopt the technology?
    - Ex. In one project, the mayor installed one of the first stoves in his home. This enticed neighbors to do so as well and added lasting motivation to continue future projects.

*Element: 3,3 (Design/Action Planning, Political Cohesion)*

- The roles and responsibilities of partner institutions are defined in a detailed action plan, including financial commitments and a timeline.
  - What level of involvement is each organization willing to commit to?
    - Financial support
    - Consulting
    - Sub-contracting
    - Training and Education
    - Direct community involvement
    - Post-implementation follow-up
  - What specific reporting or procedural requirements does each organization need?
    - Progress and monitoring reports
    - Contracts

- Site visits
  - Education or capacity building activities
  - Other paperwork
  - Who needs to be informed of project activities?
  - Who will supervise the project?
  - Who will monitor progress?
  - Who will work directly with the community?
  - Who will recruit skilled laborers?
  - Who will contribute to project financing?
    - How much?
    - When will funds be available?
  - Who will control the project budget?
  - What strings are attached to institutional funds?
    - Earmarks
    - Reporting requirements
  - What are the funding and reporting schedules of the institutions?
  - When will work start?
  - When are progress and final reports due?
  - When will work be completed?
  - Are institutional deadlines respected?
  - Are any delays in funding expected which could negatively affect project implementation?
    - It is important to work closely with funding partners to explain the need for timely delivery of funds and to reach a firm agreement on when funds will be available.
- People in charge of construction and training are qualified and clear on the plans.
- Are people building stoves capable?
  - Do they understand the design fully?
  - Do they understand the need to follow the design rigorously?
  - Do they know who to report to in the event of changes or problems?
  - Are the health and environment education programs satisfactory to all partners?
  - Are the people conducting trainings experienced and qualified to do so?
  - Can they be assisted or trained in any way?
  - Are materials adequate to conduct the planned trainings?
  - Are they in agreement with the project methodology?
    - Ex. Training women
- Follow-up tasks, such as project M&E, are defined and execution of subsequent projects is discussed.
- Who will continue stove proliferation after the initial project?
    - Ex. In one program, government environment officers did not get well involved except in one town, where the mayor built a stove in his house. This officer was the only one assigned to continue with future projects and

as a result future projects were only executed in his town. The other towns lacked the leadership needed to execute subsequent projects.

- It may be difficult to plan subsequent iterations before the first project has been implemented, but it should at least be discussed and tentative plans set.
  - Will a self sustaining market be capable of continuing the spread of improved stoves?
  - Does this market need any support?
  - Who will provide that support?
  - Can a locally based institution be involved in project monitoring?
  - Has a plan for post-implementation M&E been developed?
  - What role do government and donor agencies play in O&M and M&E?
    - Monitoring project status
    - Promotional activities
    - Financial support
    - Providing training and/or payment for training
    - Equipment or support services
    - Business support
  - Who will execute this plan?
- Final project design and action plan are presented to and agreed upon by partner institutions and local, regional, and/or national level authorities.
- Contract signed?
  - Is the contract drafted in such a way to ensure all project goals can be met?
    - Ex. In one project, training was not explicitly included in the contract. As a result, the focus was on meeting the construction deadline and there was not sufficient time left for training.
  - Are all parties aware of their role and the timeline agreed upon?
  - Have all parties seen the finalized design? (Even if they are not directly involved, they appreciate being informed.)
  - Do all partners agree on the implementation methodology?
    - Ex. Having women in charge of or involved in project tasks

*Element: 3,4 (Design/Action Planning, Economic Sustainability)*

- Verify costs and availability and develop an action plan for resource procurement.
- Present an itemized budget for review by community members (they understand the local market).
    - Include all costs:
      - Transportation
      - Labor – skilled and unskilled
      - Training
      - Food
      - Materials

- Administration
  - Follow-up
  - Capacity building
  - Can written price quotes be compared from multiple suppliers?
  - Do prices fluctuate? By how much?
    - Does the cost of labor or materials vary depending on the time of year? (issue of availability)
    - Verify prices as close to the purchasing time as possible.
  - What is the currency conversion rate in the country?
    - Check the rate on the open market as it can differ from the official rate.
  - Can anything be improvised or constructed on site?
  - Can quality be assured and controlled?
    - Ex. Some projects have found that it is easier to control quality of manufactured stoves, rather than home-constructed ones.
  - When will materials be required throughout the construction process?
  - Where will materials be purchased? By whom? When?
  - How will they be transported to the site?
  - Is manufacture of materials required?
    - Ex: making blocks or blacksmithing of parts
    - How long will it take?
    - How far in advance can it be performed?
  - Are skilled laborers required?
    - When are they available?
    - Is a signed contract required?
  - Is there a storage area for tools and construction supplies?
- Finalize budget, contributions, and schedule based on demand, local costs, available resources, and commitments.
- Include a contingency plan for unexpected costs.
  - Can the budget adjust for alternative plans if required materials become unavailable?
  - Has a list of people wanting (and willing to pay for) the stove been compiled?
    - Ex. A common project approach is to attempt to cover the whole community in one go. It is better to follow the demand and install first in the homes of those who have committed. Successful initial installations will likely lead to “word of mouth” advertising and increased demand.
  - Can it be assured that all on the list (and those added later) can receive a stove?
  - Are all participants clear on and in agreement with the installation schedule?
  - Are all contributions specified and agreed upon?
  - Has a price been set for the stove?
  - Do community members understand the initial costs, maintenance costs, and potential savings or costs associated with improved cook-stoves?
  - Are individual contributions consistent with their ability to pay?

- Note: Low income customers tend to be price sensitive and hesitant to try new products.
  - Who will provide the monetary contribution? How much?
  - Who will provide tools and equipment?
  - How many laborers can the community contribute?
  - Will meals be provided for laborers? By whom?
  - Who will provide for food and housing for trainers from outside the community?
- Plan sufficient time for O&M training.
- Is there time programmed for each user to learn how to operate and maintain the stoves?
  - Is there a focus on training how to construct, repair, or reconstruct the stoves?
    - Ex. In one project, a deadline was set for project completion which only allowed sufficient time for construction, but not enough for training. This resulted in the community being unprepared to repair or reconstruct poorly built stoves (León 2010)
  - Are all household users involved?
  - Are the key components of the design made clear?
  - Is it clear what elements of the design can be changed and which must remain exactly as designed?
- Plan actions to build capacity of the stove market and promote stoves.
- Are contracts to be signed with local stove manufacturers, repairers, or parts suppliers?
  - Is funding to be provided to them?
  - Are there any stipulations to the funding and support?
    - Ex. Equipment provided can be taken back if they are not used to build stoves.
  - Are businesses or service providers to be organized or created?
  - Is training to be provided?
  - How can stove adoption be promoted?
  - Can long term support be agreed upon?
    - Ex. Various U.S. university professors made an agreement with AHDESA (stove organization in Honduras) to make trips every two years for technical support (Osoto 2010).
  - Are they to be involved in promotional activities?
  - Is research or testing to be carried out in partnership?
  - Do suppliers need to be consulted about details of the design?
    - Ex. Specific brick sizes, shapes of metal pieces, etc.

*Element: 3,5 (Design/Action Planning, Environmental Sustainability)*

- The final project design minimizes ecological disturbance, energy use, and waste emissions.
  - How different is the final design from the conceptual design? Does the site impact assessment still hold true?
  - Have all environmental impacts been considered during the design process?
  - Have efforts been made to reduce these impacts?
  - Has the impact of disposal of the technology or byproducts been considered?
  - What about emissions such of Particulates, CO<sub>2</sub>, CO, CH<sub>4</sub>, NO<sub>x</sub>, SO<sub>x</sub>?
  - Is energy saved over existing technologies?
  - Can the efficiency and emissions of the final design be tested?
  - Can this efficiency be quantified in a meaningful way?
    - Ex. Reduces wood use from two loads to one load per week.
  - Are there methods for monitoring environmental impacts during the project life?
- The project design uses existing, renewable and/or recyclable local resources.
  - Are local alternatives to imported materials considered during the design development?
  - Are these resources abundantly available?
  - Can existing resources, such as tables supporting current stoves, be used?
  - Can materials be substituted without affecting stove performance?
    - Adobe for concrete blocks
- The action plan considers the long term availability and seasonality of resources.
  - When is the site or resource accessible?
    - Will flooding affect site accessibility; by boat, by road?
    - Sand may only be available when the rivers are low.
    - There may be a certain time of year for making adobe blocks.
  - Will the size, availability, and productivity of the labor pool vary with the season?
  - What time of year is best for construction?
    - Rain
    - Temperature
  - Is a means of fuel procurement in place for the long term?
- Finalize an environmental education and rehabilitation plan to address environmental issues.
  - Does it involve all community members?
  - Does it cover locally important topics, such as biodiversity, long term resource availability, and watershed protection?
  - Does it cover globally important topics such as climate change?
  - Are hands-on experiential activities included?
  - Have partners confirmed their support and participation in specific tasks?
  - Does the plan work with the school schedule?
  - Are events planned with times set?

- Are environmental recovery activities planned, such as reforestation or building a tree nursery?

*Element: 4,1 (Implementation, Socio-cultural Respect)*

- ☐ Conduct health education activities.
  - Can the health concerns identified in the assessment phase be widely publicized?
  - Can other health issues be discussed?
  - Can down time during construction be used for informal education sessions?
  - Are all health education activities in the action plan executed?
  - Is adequate time provided?
  - Can longer term promotional campaigns be developed?
  - Are all project beneficiaries included?
  - Can the project functions and benefits be demonstrated?
  - Can people be trained in health education?
  
- ☐ Encourage the involvement of all participants, particularly women, throughout the construction process.
  - Is each user (typically women) present and actively involved throughout construction process?
  - Are at least one woman and one man well trained in construction and repair? (to the point they can build or repair without outside assistance)
    - Note: In some circumstances, a barrier may exist where men or women may not consult someone of the opposite sex for assistance.
  - Is a special effort made to have women in charge of administration and organization?
  - Are women actively involved in construction?
    - Note: This may require extra effort and encouragement.
    - Ex. At the beginning of a project, one woman was sure she could not build a stove (construction is typically a male job in Honduras). However, by the end of implementation, she was leading a group of women in building stoves under supervision of the contractor. This required persistent encouragement from the contractor.
  - Do all users participate in operation and maintenance training?
  - Do all participate in education activities?
  - Can women bring materials, food, or water to the construction site?
  - Can they fill management roles?
  - Are they included in capacity building exercises? (Including technical and managerial skills.)
  
- ☐ Ensure high quality construction. Be inflexible and precise with critical components of the design, but flexible with non-crucial changes.

- Are design components critical to performance, such as the combustion chamber, airway size, etc., constructed exactly to specification?
    - Changes to key elements could affect performance in unpredictable and/or undesirable ways.
  - Has each stove been well constructed and tested for proper function?
    - If not, users and those interested in the project may become disillusioned. Just as word of mouth is important in promoting the project, it could be damning if negative impressions spread from stoves that did not work properly.
  - Do users wish to change non-crucial elements of the design, such as supportable size and position (within reason), color, etc.?
    - Adapting stove characteristics to user preference may increase user satisfaction as long as the changes do not affect the intended function of the stove.
- First implement a small number of stoves. Then use public gatherings to address concerns and build confidence before continuing with the rest.
- Are there doubts or concerns that need to be addressed?
  - Are others able to experience first-hand how the stoves work and their effects?
  - Can participants with stoves allow others into their homes to share experiences?
    - Word of mouth promotion is important.
  - Can a community event, where food is cooked on the stoves, be held?
    - This would allow people to not only see the stoves functioning, but to taste the results (León 2010 and Boritt 2009).
  - Are all project beneficiaries included?
  - Can the project functions and benefits be demonstrated?

*Element: 4,2 (Implementation, Community Participation)*

- Involve the community in revisions of the action plan, program changes, and problem solving.
- Is everyone aware of their responsibilities?
  - Do development workers meet regularly with community leaders to review the action plan and program changes?
  - Are mid-way evaluations and progress monitoring conducted?
  - Is there an open method to share and address community concerns?
- Ensure community members manage and carry out much of the implementation process themselves.
- Are there leaders who can assist fellow community members to resolve concerns and issues which may arise?
  - Can a local representatives help with the following activities?
    - Organize procurement and storage of materials and equipment.

- Manage work crews and daily construction activities.
  - Daily briefing on the task to be accomplished.
  - Monitor and correct public safety concerns.
  - Are community members involved in planning for operation and maintenance?
- Train local leaders in the new techniques and technology that are introduced.
- This is essential to ensure technical problems which arise can be solved within the community.
  - Are there trained people who can take apart and rebuild a stove or build a new stove if needed?
  - Can these people build stoves during the project with only supervision from the trainer?
  - Do people know where to go for spare parts?
  - Can leaders be selected from participants who show the most aptitude for the technology?
    - These may be people who did not stand out as leaders before the project.
  - Is the community given complete specifications for the design, including manuals and specific instructions for operation and maintenance?
- Ensure community members are clear on the O&M requirements and schedule.
- Can public gatherings be held to review benefits of the project and discuss operation and maintenance?
  - Can this be done throughout construction in each household?
  - Can hands on demonstrations be used?
  - Are all project beneficiaries included?
  - Are all required O&M practices explained and their importance understood?
  - Has the community mastered techniques and procedures for operation, maintenance, and repair?
  - Can they be tested?

*Element: 4,3 (Implementation, Political Cohesion)*

- Supervise work (quality control) and push for fulfillment of responsibilities from all partners.
- Do builders follow the design rigorously?
    - Ex. A mason constructed support tables too small for the stoves. The tables needed to be rebuilt, wasting time and money.
  - Have all partners fulfilled their responsibilities as agreed upon in the action plan?
  - What can be done to motivate partners to hold up their end of agreements?
  - Can political pressure be leveraged?
  - Are partner institutions invited to be involved in training exercises?

- Inform partner institutions of the start of construction, project milestones and major changes.
  - Are progress reports and evaluations shared?
  - Is consideration given to how major changes in the design or implementation schedules may affect partner interventions or the government regulatory processes?
  - Are partners able to advise on the implementation process or problems that arise?
  
- Invite government and institutional representatives to the project and make connections between organizations and the community.
  - Are the “right” officials invited?
  - Are efforts made to include everyone that could be interested or have a stake in the project?
  - Can connections between potential future partners be made?
  - Can permanent local actors (NGOs, government, businesses) be connected with the community?
  - Are community members and project partners understand all applicable regulations.
  
- Partners are reminded of follow-up responsibilities, future plans are confirmed, and any needed baseline data is collected.
  - Are all responsibilities understood?
  - Is agency involvement still necessary?
  - Do partner agencies have the capacity to address their roles?
  - Do other agencies need to be recruited to help with follow up issues?
  - Are tentative plans for future projects - made in action planning stage (Element 3,3) - still feasible?
  - Are any data needed to serve as a baseline in M&E or impact studies?

*Element: 4,4 (Implementation, Economic Sustainability)*

- Conduct training, promotion, and capacity building according to action plan.
  - Are energy businesses involved in the project?
  - Is their capacity to be improved in some way?
  - Is promotion used to increase awareness and demand for the project?
  - Are promotional materials produced and distributed?
  - Are trainers compensated?
  - Is training carried out throughout construction process?
  - Are all project beneficiaries included?
  - Are all related tasks listed in the action plan carried out?

- Recheck the quality of materials and equipment during resource procurement and the quality of the finished project.
  - How sturdy are the tools? Can they hold up under strong use?
  - What is the quality of the materials?
  - Are better quality options available? What will they cost?
  - If not, will the design need to be modified?
  - Has each finished product been tested for proper function?
  - Is each user satisfied with the final construction or do changes need to be made?
  
- Monitor and document spending and contributions throughout the project implementation phase.
  - Is someone keeping track of the budget?
  - Is a reliable person or committee in charge of gathering and keeping track of resources?
  - Can a respected community member with accounting experience (i.e. village treasurer) be used?
  - Are they able to keep records of resources, collect receipts, and arrange for the storage of materials?
  - Is a culturally appropriate system of accountability discussed?
  - What is to be done with spare parts after construction?
  - Are procurement and construction schedules processing on-time?
  - Are extra fees required to keep the project on schedule?
  - Can the budget be adjusted to accommodate for changes?
  - Are options to improvise tools and equipment explored when necessary?
  - Are all participants able to contribute the materials, labor, or support agreed on in the planning stage?
  - Can the community improvise and share resources to achieve goals?
    - Ex. One woman was unable to install the stove in her house so she gave the ash (insulation) she had collected to the new recipient. This was viewed as a significant gesture in the community.
  - Are resources (monetary or non-monetary) collected prior to the start of construction?
  - Is labor for construction provided and noted?
  - Is someone keeping track of all contributions? (cash, labor, food shelter, land, materials)
  - Is an audit required?
  
- Draft final report on the budget and share with community members and partner organizations.
  - Can potential savings in fuel reduction or health costs be calculated and shared among participants?
    - Ex. A trip to the health center costs a certain amount in transportation, fees, etc.
  - Are final costs calculated?

- Is an itemized list of community contributions and their cash equivalents included? Is it shared with community?
- Are financial repayment schedules reviewed? (if individual or community loans were used to finance the project)

*Element: 4,5 (Implementation, Environmental Sustainability)*

- ☐ Restore any areas disturbed during construction.
  - Can packaging or other wastes be recycled?
  - Is the site cleaned-up after construction?
  - Are areas affected during resource extraction or transportation restored?
- ☐ Take precautions to avoid and minimize environmental impacts during implementation.
  - Are erosion control methods used during resource extraction (sand, gravel, rock, timber, clay)?
  - How can energy or fuel use be reduced? (transportation, extraction needs)
  - Can the transport of materials (esp. of heavy equipment) be minimized?
- ☐ Conduct environmental education and rehabilitation activities.
  - Can the environmental concerns identified in the assessment phase be widely publicized?
  - Can other environmental issues be discussed?
  - Can down time during construction be used for informal education sessions?
  - Are all environmental education activities in the action plan executed?
  - Are all environmental rehabilitation activities in the action plan executed?
  - Can longer term efforts be developed?
- ☐ Demonstrate the difference the technology has made at the household level.
  - Can an old and a new stove be run head-to-head?
  - Can households monitor their fuel use before and after installation?
  - Can IAQ tests be conducted before and after installation?
  - Can fuel savings be quantified in terms of environmental impact?
    - Ex. Saving a load of charcoal each week saves a certain number of trees each year.
  - Can these changes be publicly displayed or shown to each user?

*Element: 5,1 (Post-Implementation Follow-up, Socio-cultural Respect)*

- ☐ Monitor whether or not the stoves continue to be used as intended. If not in proper use, determine issues.
  - Are stoves still in use? If not, why not?

- Have users adjusted to changes?
    - It may take time for people to adjust to changes in something as highly habitual and cultural as cooking. This may require encouragement for them to believe it is worth the effort.
    - Ex. One user stated it took a week to adjust to her new stove and even more time for her daughter (Hernandez 2010).
  - Has the technology become socially accepted? (Is there a buzz?)
  - Are people properly maintaining their stoves?
    - Cleaning
    - Replacing broken or deteriorated parts
  - Have people modified their stoves? Why?
    - Ex. One common modification made to “rocket” type stoves is to widen the combustion chamber. This allows users to insert more wood and creates a bigger flame. It also prevents the stove from working as intended, eliminating gains in efficiency.
  - Do the stoves meet users’ needs? If not, why not?
    - The above modification may be due to a perception that large fires are needed to cook food, but it also may be due to the fact that the stove actually does not adequately heat.
  - What concerns do users have? How can they be addressed?
  - Have users acquired newer stoves?
  - Can this monitoring be conducted after periods of time?
    - One week
    - One month
    - 6 months
    - A year
    - Many years
- Address immediate issues and potential future ones.
- Do users have concerns or doubts following implementation?
    - User concerns must not be taken for granted. If people do not value the improvements over the drawbacks of new cooking methods, they will not sustain them.
  - Discuss unanticipated problems which may have arisen during implementation?
  - Discuss pitfalls experienced in past projects (as identified in element 1,3).
  - Did all users receive instruction on operation and maintenance?
  - Did all users receive what they anticipated?
  - Are there people still on the list of recipients who have not received stoves?
  - Do all users know where to get replacement parts or replacement stoves?
  - Do all users know who to contact for repairs or can they make repairs themselves?
  - Do any expectations remain unmet?
  - Are there household cooking needs which remain unmet?
  - What can be improved for subsequent project iterations?

- Did people trained in maintenance leave the community?
  - Is performing maintenance seen as shameful or dirty work?
  - Are there traditions, taboos, or fears that were overlooked in project planning?
  - Are costs and benefits are equitably distributed within the community?
- Continue health education programs and monitor choices people make about exposure to IAP, health, and household energy use.
- Do households continue to use their old stoves?
    - Many households will use a combination of technologies to meet their cooking needs, even after introduction of an “improved” technology. Ex. A study in China revealed that 88 of 112 houses visited used an old unvented coal stove in addition to their new improved vented biomass stove (Smith et al. 1993).
  - Are people capable of making good decisions about IAP, health, and household energy?
  - How does their health awareness compare to that encountered in the assessment phase?
  - Can current health education programs be continued or expanded?
  - Which ones were most effective?
    - Promoting health and awareness of IAP issues can increase demand for technologies which improve these conditions.
  - Is there funding available for this?
  - Are there partner organizations willing to participate?
- Reassess how gender/age roles affect the proper use and perceived benefits of the system.
- Are men, women, and children aware of proper operating rules?
  - Have men, women, and children adopted appropriate behavior changes?
    - Ex: A study in Ghana found that men had changed their latrine habits due to a hygiene education program, but women, who were not involved, kept up bad practices (Pickford 1995).
  - Who cleans the system?
    - Ex: Study of latrine cleanliness in Dar es Salaam found that conditions were better when the male head of the household cleaned rather than a wife or child (Pickford 1995).
  - How can differences be addressed?
  - Do all understand and accept their role in operation and maintenance?
  - Who obtains fuel and what work/cost does it entail?
  - Who repairs or replaces parts?

*Element: 5,2 (Post-Implementation Follow-up, Community Participation)*

- Unite the community to share experiences, provide support, and agree on next steps.

- Are community members with stoves willing to share experiences and knowledge with those without?
    - Within their community and with other communities?
  - Are they willing to help them obtain stoves?
  - Are there traditional ways of bringing together communities in the area?
  - Are plans made for subsequent project iterations?
- ☐ The community assists with follow-up activities.
- Is there a community organization or leaders tasked with expanding stove coverage and M&E duties?
  - Is this organization culturally appropriate and composed of traditionally respected people?
  - Is the committee susceptible to elite capture?
  - Can they report achievements or problems to partner organizations?
  - Can they execute future projects?
  - Can the community implement suggestions for improvement?
  - Are they receptive to future outside involvement or monitoring?
- ☐ Conduct a participatory evaluation to get community feedback and suggestions for improvements.
- Is a variety of community members involved in the evaluation?
  - Was the project perceived as a success? Why? Why not?
  - Are all participants satisfied?
  - Are benefits equitable?
  - What can be improved?
  - How can stove adoption be improved?
  - Were their suggestions for improvements taken into account on the existing system?
  - Does the feedback provide suggestions for improving future projects?
  - Can this evaluation be done immediately after implementation as well after some time has passed?
- ☐ The community has the capacity to conduct O&M.
- Is there a community organization or leaders tasked with conducting O&M duties, including assisting others?
  - Can they check on stoves and solve issues which may arise?
    - Ex. People trained in one project were able to take apart and rebuild a poorly constructed stove. They also disassembled and moved a stove to a new kitchen and built new stoves for a community member who purchased materials (Hernandez 2010).
  - Are the operation/maintenance tasks handled locally?
  - Are they aware of sources for replacement stoves and parts?
  - Can they contact other agencies for help if needed?

- Is this organization culturally appropriate and composed of traditionally respected people?
- Is the committee susceptible to elite capture?

*Element: 5,3 (Post-Implementation Follow-up, Political Cohesion)*

- ☐ Get feedback from project partners and stakeholders.
  - What can be improved for subsequent project iterations?
    - In design
    - In procedure
  - Are a variety of stakeholders (government, NGO, donors, etc.) involved in the evaluation?
  - Was the project perceived as a success? Why? Why not?
  - Are all participants satisfied?
  - What can be improved?
  - How can stove adoption be improved?
  - Were their suggestions for improvements taken into account on the existing system?
  - Does the feedback provide suggestions for improving future projects?
  - Can this evaluation be done immediately after implementation as well after some time has passed?
- ☐ Invite stakeholders and officials to an opening ceremony. Discuss with them future collaborations and continuation of efforts.
  - Are all participants included?
  - Are appropriate local and regional officials included?
  - Is credit and thanks given to all who helped?
  - Can contact be maintained and encouraged among participants?
- ☐ Participating institutions carry out agreed upon roles in providing post-implementation follow-up.
  - Is there a mechanism to meet anticipated demand?
  - Are there motivated individuals or organizations which will continue future projects?
    - Do they have the heft to make this happen?
  - Are participants in favor of executing further project iterations or projects?
  - Are agencies still committed to their follow-up responsibilities?
  - Do they double-check/monitor technical aspects?
  - Can they help in refining management structures?
  - Are partners contacted for follow-up and adjustments if problems arise?
  - Do they reach out to regional peers to share knowledge and resources?
  - Can work be done to increase capacity of local stove businesses or community leaders?

- Share impact and monitoring reports and project evaluations with partner institutions and community.
  - Are periodic reports on operations and maintenance shared?
  - Are financial reports shared, if appropriate?
  - Can studies be conducted to determine impacts on health, environment, and economy?
  - Is data available? Are there any noticeable trends associated with stove use?
  - Can studies be conducted over different time periods?
  - Can degree of fulfillment of project goals be assessed?
  - Can impacts observed over time be shared?

*Element: 5,4 (Post-Implementation Follow-up, Economic Sustainability)*

- Continue building the capacity of the local household energy (stove) market.
  - What remaining assistance do local energy companies need to improve their capacity?
    - Financing
    - Access to material markets
    - Access to consumer markets
    - Transportation
    - Administrative/business
    - Technical/design
    - Promotion/advertising
  - What previous assistance has been successful?
  - Has further assistance been solicited?
  - Can this assistance be provided? By whom?
  - Can it be funded? By whom?
  - Are fuel, spare parts, service, and new stoves available?
  - Are they of good quality?
  - Can quality be improved?
  - Are they affordable?
  - Can general promotion of stoves or IAQ and environmental issues be carried out?
- Determine the actual impacts of the project.
  - Can studies be conducted on the impacts on health, environment, and/or economy?
  - Can other impacts be observed over time?
  - Can impacts be expressed in economic terms? (DALYs, cost savings)
  - Can a cost/benefit analysis be conducted?
  - What fuel cost/savings have been experienced over the long term?

- How does this compare to the economic burden encountered during the assessment phase?
  - Can M&E be conducted over different time periods?
- ☐ Monitor fuel use, maintenance, repair, and replacement of stoves.
- Is fuel consistently availability?
  - Are replacement parts consistently available?
  - Are new or replacement stoves consistently available?
  - Can people afford these?
  - Do they have access to them?
  - Are these sources persistent in the long term?
  - Is outside financing or funding needed?
  - Are there mechanisms for obtaining it?
  - Are there options for cost recovery?
    - Ex: Savings from fuel efficiency
    - Ex: Using stoves for income generation
- ☐ Ensure a mechanism to meet future demand.
- Has demand grown?
    - Newly convinced
    - People left out of project
    - Grown children
  - Is there funding to meet anticipated demand?
  - Is funding continual?
  - Are there other potential sources which can be investigated?
  - Is financing (loans) feasible and available?
  - Are market forces sufficient to reach all who want/need stoves?

*Element: 5,5 (Post-Implementation Follow-up, Environmental Sustainability)*

- ☐ Work to further increase efficiency of technologies.
- Can research be conducted?
  - Do community members or partner organizations have suggestions for improving efficiency?
  - Can these be tested?
  - Can newer, more efficient stove models be developed?
  - Can new models be implemented in subsequent project iterations?
- ☐ Reassess local awareness of and willingness to address environmental concerns.
- How have attitudes toward the environment changed?
  - Are people more concerned about environmental issues?
  - Are people motivated to continue to work for environmental improvements?
  - Are people aware of their own role in maintaining a healthy environment?

- How can awareness be increased?
  - Have any initiatives been started by the community?
- Reassess environmental concerns and evaluate project impacts.
- How have environmental issues of concern been affected by the project?
  - Are secondary (possibly negative) impacts considered?
  - Were restoration areas restored properly? And maintained?
    - If trees were replanted, are they growing well?
  - Are long term effects such as forest recovery measured?
  - Are studies conducted?
- Continue environmental education and rehabilitation efforts.
- Are community members aware of improvements since project implementation?
  - Are supporting behavioral changes reinforced?
  - Do people understand the benefits of improved stoves?
  - Were certain educational/promotional activities particularly effective?
  - Can they be continued or expanded?
  - And rehabilitation activities?
  - Is outside support needed for this?
  - Are there partners willing to provide needed assistance?

## 9 Appendix B

To give an idea of the breadth of organizations and individuals consulted during research in Honduras and Guatemala, a list is included below. This list does not necessarily contain every organization or person with which the author interacted regarding this study. Also, the content and contexts of interactions vary. Some consultations produced minor information, while others resulted in substantial knowledge gain.

Organizations and individuals consulted during initial investigation:

Appropriate Infrastructure Development Group (AIDG)

Xelateco

Centro de Investigación Agrícola Maya Chorti

Fundación Hondureña de Investigación Agrícola (FHIA)

World Vision

Peace Corps staff and volunteers

Municipal environment officers from Copán Ruinas and Cabañas

Consejo Higuito

Pure Water for the World

Mancorsaric,

Organismo Cristiano de Desarrollo Integral de Honduras

Rotary Club of Copán Ruinas

Organizations and individuals consulted during collection of knowledge from past experiences in Honduras:

Stove Team International

Claro Lara

Ignacio Osorto from Asociación Hondureña para el Desarrollo (AHDESA)

Josué León from CATIE

Mary and Billy Collins from Centro de Investigación Agrícola Maya Chorti

## 10 Appendix C

Countries included in Figure 1.5.

Algeria  
Angola  
Antigua and Barbuda  
Argentina  
Armenia  
Australia  
Austria  
Azerbaijan  
Bahamas  
Bangladesh  
Barbados  
Belarus  
Belgium  
Belize  
Benin  
Bolivia  
Bosnia and Herzegovina  
Botswana  
Brazil  
Brunei Darussalam  
Burkina Faso  
Burundi  
Cambodia  
Cameroon  
Canada  
Cape Verde  
Central African Republic  
Chad  
Chile  
China  
Colombia  
Comoros  
Costa Rica  
Cote d'Ivoire  
Croatia  
Cyprus  
Czech Republic  
Denmark  
Djibouti

Dominican Republic  
Ecuador  
Egypt  
El Salvador  
Eritrea  
Estonia  
Ethiopia  
Finland  
France  
Gabon  
Gambia  
Georgia  
Germany  
Ghana  
Greece  
Greenland  
Guatemala  
Guinea  
Guinea-Bissau  
Guyana  
Haiti  
Honduras  
Hungary  
Iceland  
India  
Indonesia  
Iran (Islamic Republic of)  
Iraq  
Ireland  
Israel  
Italy  
Japan  
Jordan  
Kazakhstan  
Kenya  
Lao People's Democratic  
Republic  
Latvia  
Lebanon

Lithuania  
Madagascar  
Malawi  
Malaysia  
Maldives  
Mali  
Malta  
Mauritania  
Mauritius  
Mexico  
Morocco  
Mozambique  
Namibia  
Nepal  
Netherlands  
New Zealand  
Nicaragua  
Niger  
Nigeria  
Norway  
Oman  
Pakistan  
Paraguay  
Peru  
Philippines  
Poland  
Portugal  
Romania  
Russian Federation  
Rwanda  
Saudi Arabia

Senegal  
Seychelles  
Sierra Leone  
Singapore  
Slovenia  
South Africa  
Spain  
Sri Lanka  
Sudan  
Swaziland  
Sweden  
Switzerland  
Syrian Arab Republic  
Tajikistan  
Thailand  
Togo  
Tonga  
Tunisia  
Turkmenistan  
Uganda  
Ukraine  
United Kingdom  
United States  
Uruguay  
Uzbekistan  
Vanuatu  
Viet Nam  
Yemen  
Zambia  
Zimbabwe