Solar Cookers in Bolivia: patterns of usage, social impacts and complexities of enumeration

Plate 1. Mother and children with their solar box cooker

'The study of technology is also a bridge between anthropology and other people's lives because it documents, in a very practical way, the feasibility of inserting and adapting bits of Western technology

into non-Western material cultures, a recurrent issue in the anthropology of development' (Lemonier, 1996: 547).

Abstract

Solar cookers represent one of a host of "technological fixes", promoted by non-governmental organisation (NGOs) intended to lessen the detrimental effects of household biomass fuel use in the less developed world. These concerns centre upon the health effects of indoor air pollution (IAP); the duration of time expended collecting fuel for cooking and heating, which could otherwise be employed in productive enterprise; and the potential deforestation caused by household use of wood fuel. However, many attempts at the promotion and dissemination of improved stoves and alternative stove technologies in the less developed world have experienced a range of problems. This research delves into this process of alternative energy technology promotion in Bolivia, and unpicks the relationship between these grand health, development and environmental narratives, the dynamics of technology promotion, and the social and economic impacts upon the recipients of the

technology. I illustrate that whilst problems of enumerating the extent and effects of solar cooker usage, solar cooker usage is high throughout and significant differences in fuel expenditure exist between households that use and those that do not use solar cookers. A range of confounders over-shadow any identification of significant differences in the time expended cooking and collecting fuels between households that use a solar cooker and those that do not. Such complexities must be taken into account during further enumeration of the impacts of solar cooker usage.

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1 Introduction

1.1 Health impacts of indoor air pollution (IAP) as result of biomass combustion

The global health impacts of IAP resulting from household biomass fuel use are accepted in a broad literature (Bruce *et al*., 2000; WHO, 2002; Ezzati, 2005). The World Health Organisation (WHO) estimated that in the early 1990s, the global burden of disease attributable to biomass fuel use was 1.8 million deaths per year or 4.7% of deaths in the less developed world (WHO, 2002). In Latin America, biomass fuel use was responsible in the same period for 1.0% of mortality and 0.9% of lost DALYs[1] (WHO, 2002). Estimates for 2000 suggest that globally 1.6 million premature deaths were attributable to IAP-related maladies such as acute respiratory infections, chronic obstructive pulmonary disease and lung cancer (Smith *et al*., 2004). Strong epidemiological evidence exists linking acute lower respiratory infections (ALRI), chronic lung disease (a range of disease outcomes encompassing chronic

[1] The Disability Adjusted Life Years (DALY) is a population measure of years of life that are lost due to mortality *and* morbidity due to a range of maladies: they can be seen therefore as productive of active years of life.

bronchitis, chronic obstructive pulmonary disease [COPD] and progressive obstructive lung disease), and lung cancer (the latter albeit associated with coal combustion) with exposure to IAP (WHO, 2002). More moderate epidemiological associations have been identified between exposure to IAP and acute upper respiratory illness (AURI), asthma, nasopharyngeal and laryngeal cancer, tuberculosis, perinatal mortality, low birth weight and cataracts (WHO, 2002; Zhang & Smith, 2003).

Acute lower respiratory infections are the most significant in terms of their contribution to mortality: in Latin America, 71% of the mortality attributable to biomass combustion is attributed to ALRI (WHO, 2002). Globally, ALRI is the single greatest cause of mortality in infants under five years (Zhang & Smith, 2003). Cross-sectional and case control, along with experimental evidence has established an association between indoor air pollution and COPD or chronic bronchitis (Ibid.). There is epidemiological evidence of an association between exposure to particulate pollution resulting from coal combustion (but not from wood fuel) and lung cancer

(Ibid.). However, there are carcinogens present in wood fuel smoke otherwise associated with lung cancer. An association between biomass fuel combustion and tuberculosis was found in a large study in India (Mishra, *et al*., 1999), and hence constitutes an additional risk factor alongside over-crowding, malnutrition and inadequate access to health care (Bruce *et al*., 2000). Evidence from Guatemala (Boy *et al*., 2002) and Zimbabwe suggest a relationship between exposure to IAP and low birth weight, which illustrates the life-long nature of the health effects of IAP (Ezzati, 2005). Evidence from India also indicates that households that use biomass fuels have an increased odds ratio for some cataracts and complete and partial blindness compared to households that use other fuels (Bruce *et al*., 2000).

These health impacts are a result of the gaseous and particulate pollution released during biomass combustion; the most harmful of which are carbon monoxide, nitrous oxides, sulphur oxides (although mainly from coal), formaldehyde and polycyclic organic compounds (such as the carcinogen benzo[*a*]pyrene) (De Koning, 1985). Particles with diameters below ten microns and especially those below 2.5 microns have the potential to penetrate deep into the respiratory passages and have the greatest potential for causing damage (Bruce *et al*., 2000). Due to the incomplete nature of biomass combustion in many households in the less developed world, emissions of such particles are substantial and combined with poor ventilation leads to high pollution levels to which the residents are exposed (Bruce *et al*., 2000). However, the health impact of such particles also depends upon the time spent breathing the pollution, the exposure level. Estimates of morbidity and mortality attributable to indoor air pollution are therefore based upon both estimates of the levels of pollution and duration of exposure and are subject to significant uncertainties (Zhang & Smith, 2003). These uncertainties are compounded by a paucity of extensive studies of pollution and exposure levels (WHO, 2002).

Although there is an apparent relationship between IAP resulting from household biomass combustion, there are also complexities and confounders inherent in the epidemiological evidence. Despite the epidemiological limitations, estimates for excess mortality attributable to household biomass use are consistently between 1.5 and 2.0 million deaths per year (Bruce *et al.*, 2000). Biomass fuel use also indirectly contributes to morbidity (and mortality) due to burns, and for example, where women have adapted cooking times to reduce exposure to pollutants or in the case of fuel shortages, malnutrition as a result of the undercooking of food[2].

1.2 Biomass fuel use, gender and development

The detrimental health impacts of IAP resulting from household biomass combustion are not only severe, but also focussed upon women and children in poor households (WHO, 2002; Warwick & Doig, 2004; Ezzati, 2005). In many contexts, women meet the burden of household labour, including cooking: they spend more time in close proximity to biomass stoves and therefore experience greater concentrations of pollutants and exposure levels (Budds *et al.*, 2001). Throughout the less developed world, women are predominantly responsible for childcare, which forces infants and

[2] There is perhaps a more complex relationship between under-cooking food and malnutrition: some food types such as vegetables may benefit from undercooking whereas others, particularly meat, in an under-cooked form may more likely lead to infectious disease.

children into greater proximity with biomass smoke. This promotes and/or compounds their susceptibilities to a range of respiratory illnesses, owing to the immature nature of their respiratory system. The proposed impact of biomass fuel exposure upon pregnant women resulting in depressed birth weights (Boy, *et al*., 2000) resonates in infant mortality and life-long detrimental health effects.

A body of development literature also focuses upon the burden of household labour surrounding the provision of fuel for cooking and cooking itself, which women almost universally meet (Clancy, 2002; Warwick & Doig, 2004). In rural contexts this time and energy expended foraging for fuel could be otherwise diverted towards income generating activities[3] (Warwick & Doig, 2004). Therefore, lessening the dependency on biomass fuel combustion has the potential for poverty alleviation (Clancy & Kutch, 2003) such that Warwick and Doig (2004) argue that reducing the impact ***of biomass fuel use is essential to achieving seven of the eight Millennium Development Goals. Indeed, it is commonly the

[3] This makes a large assumption about the priorities of rural women of the less developed world: that they are not constrained by other factors that may prevent them engaging in income-generating activities.

poorest households that occupy the lower positions on the so-called energy ladder (using biomass fuels rather than gas or electricity) (Clancy & Kutch, 2003). Poor households expend the greatest amounts of time and effort obtaining fuel, and this hinders any possible escape from the "vicious cycle of energy poverty" (Ibid., see also WHO, 2002). Collecting fuel can also be a dangerous undertaking: the heavy burden of wood fuel (up to 20kg), not only leads to back problems, but during the extended periods of time away from settlement, there is, in some cases, the risk of rape and beatings (Cecelski, 2000a).

1.3 Environmental impacts of biomass fuel use

In the more recent literature concerned with household biomass use, a greater emphasis is placed upon the health and livelihood impacts of biomass fuel use; nevertheless, much of the earlier focus was upon the environmental impact of biomass fuel use (Warwick & Doig, 2004). Household wood fuel use is undoubtedly one of the ***proximate causes of deforestation. However, there is a complex set of synergistic proximate and underlying causes to deforestation throughout the world (Geist & Lambin, 2002). Commonly it is the expansion of agricultural lands and poor forestry practices, rather than the gathering of fuel as such, which are the leading causes of deforestation (Barnes *et al.*, 1994). Therefore, as an indirect or supplementary cause, it is difficult to assess the extent to which household wood fuel use directly affects forestation[4] (Ballard-Tremeer & Mathee, 2000). Some research, from outside of those directly involved with "improved" stove promotion, suggests however, that this previous emphasis upon the environmental impacts of wood fuel use were overstated (Arnold, *et al.*, 2003)[5]. Global biomass fuel use is also responsible for emitting "green-house" gases, however as the proportion of energy utilised in households in the less developed world is relatively small, on a ***global scale, the absolute contribution to greenhouse gases is also minor. The extensive use of animal dung as household biomass fuel, although difficult to quantify, has the potential for decreasing the nutrient quality and productivity of soil.

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[4] It is perhaps more likely that deforestation has a greater impact upon obtaining fuel, increasing the time require, and preventing households from obtaining sufficient fuel (Cecelski, 2000b:3).

[5] Knudson (2002:10-12) who is directly involved with solar cookers takes up an earlier version of this study (Arnold *et al*., 2002), stresses the uncertainty in their findings and describes this study not appreciating the links between fuel wood use and deforestation.

1.4 The success and failure of previous attempts at improved stove dissemination

There are three sets of interrelated factors that influence the health impact of IAP: the emission of pollutants (dependent upon fuel and stove characteristics); pollutant concentration (affected by the living environment); and the exposure (influenced by time spent in proximity to the emission source) (Ballard-Tremeer & Mathee, 2000). Therefore the possible interventions to lessen the impacts of IAP (and biomass fuel use) are wide ranging: from the promotion of alternative fuel types (such as LPG), efficient biomass stoves, heat retainer ("hay box"[6]), solar cooking technologies and modifications to the household environment (such as better ventilation) and promoting behavioural change (Ibid.).

Reviewing the factors surrounding the broader promotion of technologies intended to alleviate the problems associated with IAP and household biomass fuel use supplies some context to solar cooker promotion. Of all the potential interventions intended to

[6] A heat retainer ("hay-box") cooker is an insulated box. Food that has been heated can be placed in the box to continue cooking without using further fuel.

mitigate these problems, improved biomass stoves have received most attention on a global scale. Often however, improved biomass stoves are promoted alongside solar cookers.

The oil price increases of the 1970s prompted a realisation that households in the less developed world would not easily scale the "energy ladder", and pressed the need to invest in "improved" biomass stove dissemination (and in solar cooking technologies). This was compounded by an emphasis upon the environmental impacts (deforestation) of household wood fuel use (Barnes *et al.*, 1994). With this initial focus upon the potential environmental impact of biomass fuel use, early "improved" stoves and their dissemination were conceived with increased fuel efficiency paramount (Ballard-Tremmeer & Mathee, 2000). Since the 1980s programmes of "improved" biomass stove promotion have been undertaken throughout the less developed world and have experienced a range of success and failure (Goldenburg, 2000). India and China both instigated wide spread dissemination campaigns, contrasting greatly in their success: the "top-down" structure of the Indian promotion (compared to the locally focused Chinese programme) contributed largely to its failure (Ibid.).

Despite the diversity of type of stoves and dissemination, general principles have been drawn from their failures and successes. For example, success is more likely if stoves are designed with assistance from local artisans; if the power output of the stoves can be adjusted; if consumers are paid back their outlay within one to three months etc (see Barnes *et al.*, 1994, for comprehensive review). Along with the shift to greater emphasis upon reducing IAP, more recently such general principles have been supplemented with an acknowledgement of the necessity for awareness of the local context of stove dissemination:

> '…the household energy system and exposure to indoor air pollution are complex processes that vary in crucial details over small distances. This needs to be understood and entrenched into the approach to interventions that "outsiders" …attempt to place on the ground. *A single issue, technology-driven approach to indoor air quality is doomed to failure, as it is likely to try to impose a solution on the ground* ... Such an approach would limit the choices available to the local community and frequently demands of them changes that affect numerous other aspects of their lives.' (emphasis added) (Ballard-Tremeer & Mathee, 2000)

Some authors have also recognized the importance of taking a gendered approach to the promotion of stove technology. Clancy (2002) suggests that, '…in particular many [improved stove promotional programmes] failed because of the lack of understanding of the different roles of men and women in decision making around household energy issues and the interconnectedness with other sectors'. The stereotype of the gendered division of household labour in the less developed world, dictates that women are responsible for cooking food, and often for collecting fuel. Softening the stereotype slightly, Clancy (Ibid.) also suggests that men may become involved in the process of obtaining fuel and particularly in the decision making regarding the type of stove and fuel used. Cecelski disputes this stereotype of men as the prime movers in energy decision-making, in reference to renewable energy technologies:

> '[w]hile women do experience a number of constraints in their involvement with technology, the reality is that women's role in technology has been largely overlooked…"male" roles are not fixed but are increasingly

> being undertaken by women household heads as well as other women.' (Cecelski, 2000b: v).

Women are therefore key actors underpinning the success of alternative stove promotion: potentially women are the chief beneficiaries of alternative energy stoves, and in many contexts women's social networks are potentially important in promoting alternative energy stoves in the less developed world (Herbst, 2000).

1.5 A brief introduction to solar cookers

Despite earlier experimentation on concentrating the sun's heat, solar cooking was first achieved in the eighteenth century: in 1767 Horace de Saussure, a French-Swiss scientist constructed a miniature greenhouse using five glass boxes, one inside another which he used to cook fruit (Buti & Perlin, 1980: 55). The solar box cooker was however invented in the late 1950s by Maria Telkes at the Massachusetts Institute of Technology (M.I.T.) (Knudson, 2002: 3-5): an insulated plywood box with an inclined top of two layers of glass (with a small airspace between) and flared reflectors above (Ibid.: 6). This basic design is in common usage around the world. China held its first seminar on solar cooker in 1973 and its first distribution of solar cookers began in 1981 (Ibid.). Solar cookers were first demonstrated in Bolivia in 1987: two American NGOs sponsored solar cooking demonstrations and taught villagers how to build cookers with local materials (Ibid.: 7).

The history of solar cooker promotion resembles the history of improved biomass stoves, albeit on a smaller scale. Superficially, their appropriateness to mitigating the effects of IAP and biomass fuel use seems obvious: with no emissions, free fuel, and no environmental impact, they are a "logical solution" (Herbst, 2000: 290). Presently a host of multi-national and single-nation NGOs are operating to promote and disseminate solar cookers. Knudson's (2000) comprehensive review of global solar cooker promotion provides a broad overview of the range of organizations engaged in their promotion past and present. This survey indicates that the level of support has been some what mixed particularly in multi-national organizations such as the United Nations (Ibid.: 18-21). Despite the numerous national and small-scale NGOs actively promoting solar cookers, Knudson believes that the potential for solar cooker use has not been realized (Ibid.).

***Some researchers, for example Ballard-Tremeer and Mathee (2000), virtually dismiss the practicality of solar cookers owing to the behavioural changes necessary for their continued usage. Such comments epitomise the so-called "traditional objections" to the feasibility of wide spread solar cooking in the less developed world. Even solar cooker converts concede that there are potential problems with solar cooker use:

> 'There are of course also downsides. The cook must change her long held habits, particularly around the timing of cooking. Food is still expected at the same regular mealtime, which may mean starting in mid morning, rather than waiting until 5:00 p.m. to think about dinner. (Knudson, 2002:16)

Knudson (Ibid.), perhaps naively, describes her perceived benefits of solar cooking:

> '… the pleasure of knowing one is not causing, but rather aiding the earth to recover from deforestation and pollution, hence the reward of making the world of your children and other loved ones safer. Women also have the pleasure of joining in a sorority of women everywhere the world that are,

> through their performance of daily tasks, making a difference in the world.'

Some reports from India indicate that large numbers of solar cookers stand unused after an initial period of use immediately following their promotion. In Gujarat, Philip *et al*. (1986) reported that more than thirty per cent of respondents admitted not using their solar cooker. Hafner (1999) reported that in India as a whole the proportion of use is less than five percent. Anecdotal reports from various countries also suggest that prolonged solar cooker use is difficult to achieve. It is also difficult to find data on usage patterns from promotional programmes as these data are not collected, or perhaps not made available when they suggest low levels of usage. Owing to these reported failures and the scepticism amongst some large NGOs, the advocates of solar cookers have recognised that many organisations require independent and systematic reviews of usage patterns and data collection surrounding the social and economic impacts of solar cooker use in order to promote their technology and support their proposed benefits of solar cooking (Knudson, 2002: 228).

1.6 An anthropology of technology

In the early twentieth century, anthropologists largely abandoned the specific study of technology. Anthropologists in the nineteenth century were interested in the paraphernalia of “primitive” social life, studied as museum collections. This was supplanted by the development of fieldwork and long periods of participant observation as the defining feature of anthropology. Malinowski, considered the father of the modern anthropological method, expressed his belief that the study of ‘technology alone’ was ‘scientifically sterile’ (1935: 460). Anthropology’s shying away from studies of technology is such that Richards suggests:

> ‘Anthropologists are apparently much more willing to "muck in" when it comes to medical subjects, human rights, or conflict resolution, all of which are as future-oriented and value-laden as technology assessment. Is there perhaps an ingrained distaste in the discipline for technology itself?’ (Richards, 2002)

More recently, studies of “material culture” have begun to address some of the issues surrounding technology. This body of literature largely focuses upon how objects reveal and are themselves revealed from the interaction of all spheres of "culture", society and environment. However, Lemonnier (1996: 545) proposes

> '…scholars no longer study the material effects of technical systems *or* the meanings which societies impute them. Instead they focus on the uninterrupted process by which material culture is made part of culture; that is the way in which material culture simultaneously results from and participates in particular socio-cultural characteristics.' (emphasis in original)

This study was conceived with an awareness of this lack: rather than attempting to analyse the social or cultural baggage of an object or technology, I am interested in how a technology is understood in *the local*: how the technology affects social relations, and the nature of technology transfer from innovation to a different social context.

Attempts at unpicking the social relations that surround technology and technological innovation, have been left to what is broadly termed "Science and Technology Studies" (STS). Whilst STS draws upon anthropological theory, it is rare for the methods that have become synonymous with anthropology to be used explicitly in the study of technology. Yet for Pfaffenberger (1992) there are compelling questions such as, ‘what is technology?…How does technology influence technological innovation and how does technological innovation influence culture?’ which he believes only anthropology can begin to answer. Thus anthropology has more readily applied its methods to the study of the “the social construction of scientific knowledge” (see e.g. Latour & Wolgar, 1979 and Nader, 1996), but largely neglected the social construction, and reconstruction of technology.

Ingold (2000) and Pfaffenberger (1992), represent two examples of anthropological insights into technology and its social relations. Ingold (2000: 313-316) argues that technology is a reified concept, a ‘western preoccupation’, which ‘…sets out to establish the epistemological conditions for society’s control over nature by maximising the distance between them.’(Ibid.: 314). This is exemplified etymologically: technology, a compound of two words from classical Greek, *Tekhnē* and *logos*, combined in classical literature to denote an ‘*art of reason*’. However, the contemporary usage is to the converse, commonly relating the ‘rational principles that govern the construction of artefacts' (Ibid.: 294). This etymological slight of hand has therefore distracted attention away from the social connectedness of technology. Underpinning this reified conception of technology is, as Pfaffenberger (Ibid.) describes, 'the standard view of technology', and the dictum, 'necessity is the mother of invention'. The 'standard view', a 'master narrative of modern culture' (Ibid.) has led to a rationalised, deterministic view of technology. The wheel however, first used for ceremonial purposes in the Near East, then amongst the military, *then* as a means of transport, then gradually given up in favour of camels (Basalla, 1988), illustrates that, as for many technologies, 'culture not nature defines necessity' (Pfaffenberger, 1992).

A 'sociotechnical system' is described by Pfaffenberger (1992) as the distinctive technological activity stemming from the linkage of techniques and material culture to the social coordination of labour, including the social, economic, legal, scientific and political context of the technology. With this acknowledgement of the interconnectedness of the social and the technical, it is possible to move away from a deterministic conception of technological dissemination: the distribution of industrial artefacts, of "technology" is often thought of as leading to a social homogenisation, that technology destroys cultures and authenticity. Due to the variety of social, economic, political and scientific factors in which technology is embedded, this deterministic ideal seems unfounded: technology becomes vernacular, influenced by all these spheres, conceptualised and utilised in a host of ways. It is this process, of a technology becoming vernacular, in it usage and understanding, which must be unpicked, in order to gain insight into the promotion and usage of solar cookers.

1.7 Bolivia

Bolivia is often simply known as another *pobre pais*[7] of Latin America, and its reputation as a major cocaine producer proceeds all else. Despite improvement in the last decade of the twentieth century, poverty is still profound in Bolivia (Klein, 2003: 253): Bolivia's Gross National Income (GNI) per capita is less than one

[7] Poor country

third that of Latin America as a whole ($900, compared to the $3260) (World Bank, 2003; 2005). In South America as a whole, less than one quarter of the population (24%) live on less than $ 2 per day, whereas in Bolivia, more than one third of the population (34%) live on less than $ 2 per day (PRB, 2005). The nation's poverty is also disproportionately distributed amongst Bolivia's majority indigenous population (62%) such that almost two thirds of the indigenous population comprises the poorest fifty per cent (Hall & Patrinos, 2005).

Such figures hide the complexity of Bolivian society in the twenty-first century and the wealth of its history, as Klein describes,

> 'For the mass of Bolivians, their culture is a blending of the pre-Columbian and post conquest norms and institutions. Spanish systems of government were grafted onto pre-Spanish kinship organisation…local and state religions were syncretized into new into new folk Christianity highly mixed with the symbols and myths of Mediterranean popular religion. Traditional exchange systems coexist with a highly developed market…' (Klein, 2003: xi)

Bolivia is as diverse topologically as it is culturally: Quechua and Aymarra are the two main indigenous languages, with Guaraní third largerst, followed by more than twenty other languages spoken by ethnic groups dotted around the low lands (Morales, 2004: xxvii-xxix). The highland Altiplano region is contrasted with the low lying tropical regions of Santa Cruz and Beni (Morales, 2004: xxi-xxvii). This varied land is also home to a wealth of natural resources. Yet the Bolivian nation, is a 'beggar sitting on a gold chair' (Osborne, 1964:2), unable to exploit its resources owing to a complex of factors: its lack of a sea port, long periods of political instability that still persists, and the actions of multinational companies that have stripped Bolivia's resources, and continue to do so, without remunerating the nation accordingly. In 1999, foreign aid made up thirty per cent of government expenditure, and more NGOs operate in Bolivia than almost all countries of all Latin American (Klein, 2003: 255). It is therefore perhaps an ideal country in which to study the actions of one particular NGO.

Figure 1. Map of Bolivia

2 Background

These grand intertwining narratives of the negative impacts of indoor air pollution and biomass use, along with an interest in anthropological studies of technology frame this research. I therefore focus upon an NGO, which promotes and disseminates solar cookers in Bolivia, how the cookers are used, and the impacts of these cookers upon the lives of their users.

2.1 The organisation(s)

This NGO, *Cocinas Alternativas Bolivianas* (CAB)[8] promotes a range of "alternative technologies" or "ecological stoves". However, solar cookers remain the primary activity of CAB and associated enterprises. Moreover, although CAB has only existed in its present guise for two years, solar cooker promotion involving its key actors predates the formation of CAB. Hence, the usage and impacts of the solar cookers studied have not been provided by CAB but rather using the same methods and by some of CAB's prominent actors.

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[8] All organisations and informants are anonymised herein for data protection purposes.

The NGO is a small organisation, with four directors, one of whom, Geoff is an executive director. The current organisation was formed following the cessation of involvement between a small business enterprise, *Tecnología Alternativa para el Siglo Veinte Uno* (TA21) and an external NGO, *Solar Cooking Together* (SCT). Geoff and his wife, Charlene, represent the strongest link between the NGO now and solar cooker promotion of the past. Their involvement has ensured that the "methodology" of solar cooker promotion has remained unchanged; and whilst the technology itself has changed only a little in terms of the material used, the basic designs have remained the same.

Figure 2. The organisation of the NGOs past and present

2000 to 2003

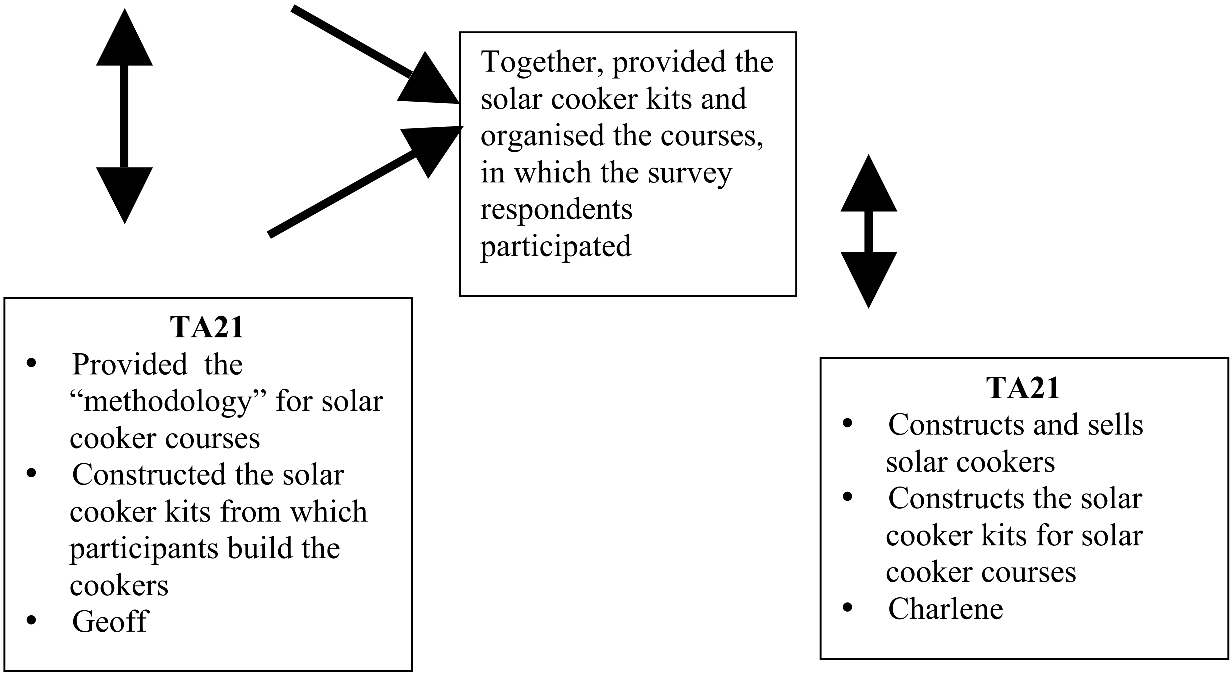
SCT

- Provided funding used for subsidising solar cooker sales
- Funded by external donors
- Provided the logistical support and funding for promotional staff and coordinators (including Charlene)

Present

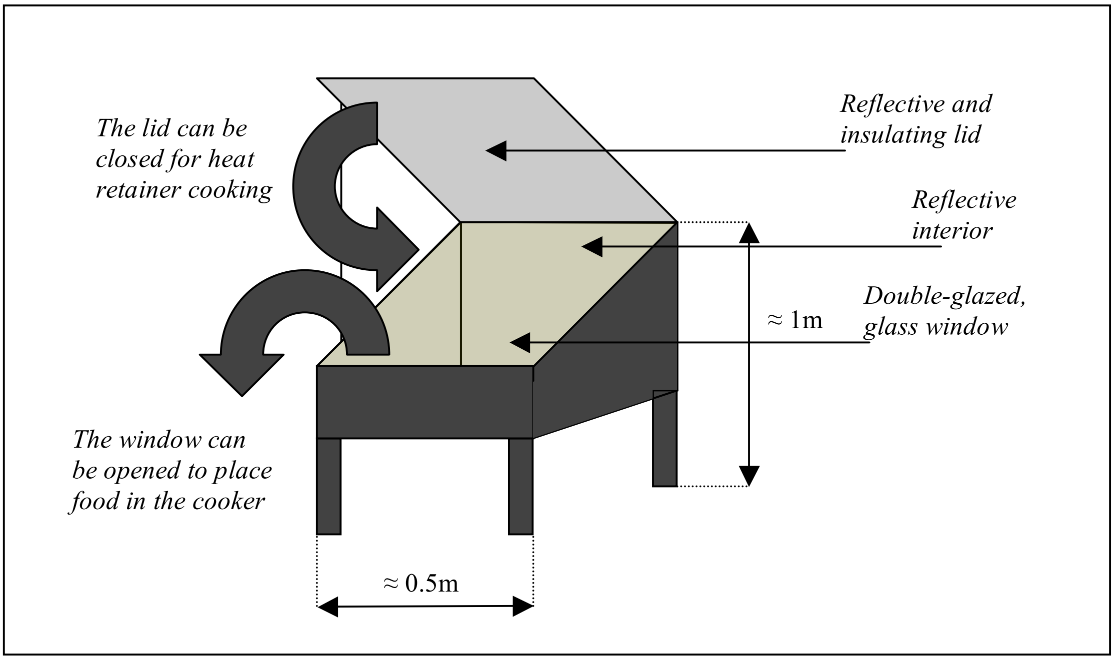
CAB

- Promotes and provides consultancy regarding ecological cookers
- Involved with developing micro enterprise, solar-dried fruit and vegetables …etc
- Run solar cooking courses
- Geoff and three directors
- Presently funded by the directors


Together, provided the solar cooker kits and organised the courses, in which the survey respondents participated
TA21
Provided the "methodology" for solar cooker courses
Constructed the solar cooker kits from which participants build the cookers
Geoff
TA21
Constructs and sells solar cookers
Constructs the solar cooker kits for solar cooker courses
Charlene

2.2 Solar box cookers

Figure 3. Sketch of a solar box cooker as promoted by CAB.



Solar "box" cookers are the primary type of cookers promoted and sold by CAB and TA21. However, they also construct parabolic type cookers, panel cookers, efficient wood-burning stoves and heat-retainer ("hay-box") stoves. The solar box cooker is constructed from wood, glass and a reflective material (aluminium or other type of metal). The open lid acts as a reflector: coated in a reflective aluminium covering, its angle can be altered such as to increase the intensity of radiation entering the cooker. The radiation is incident upon a double-glazed window, which acts to trap heat in the oven beneath it, and covers a square of forty to fifty centimetres, angled approximately 45º to the horizontal. The oven space is covered with a reflective material and tapers to a flat cooking area of around thirty centimetres. The cookers are intended to cook enough food for a household meal, or to supplement the use of other cookers in the same purpose. Cooking times are obviously dependent upon the types of food cooked, the strength of the solar radiation, and the positioning of the solar cooker and its reflector in relation to the incident direction of the radiation

2.3 The "methodology" of solar cooker promotion

Solar cooking courses were undertaken in villages or suburbs, involving around twenty to thirty participants, often contacted through a local coordinator. The courses last six months and comprise of solar cooker demonstrations, participants building their solar cookers, instruction into how to use the cookers and lessons in the benefits of solar cooking. At the start of the course, participants sign a "voluntary contract". This specifies that they will use the solar cookers at least three times a week for the entirety of the course; that they are committed to participate in group meetings every fifteen days, supervised by their local group coordinator; that they agree to supply data for a questionnaire survey, which is completed at the start, mid-point and end of the solar cooking course; and to fill out weekly cooking sheets recording the types of food cooked in the solar cooker and information about the weather on each day of cooking. The participants themselves fill out the latter cooking sheets, using pictorial means of representation to avoid problems of illiteracy.

The local coordinators' roles are to organise these groups and to collect the questionnaire data. The questionnaire used at the outset, after three and six months also contains questions relating to the key variables (fuel expenditure, time expended cooking and collecting fuel, frequency of usage, types of food cooked etc), combined also with questions about educational status, wealth and employment status.

Initially the solar cookers were provided free of charge and the participants' labour (constructing the cookers) was considered to be payment. However, owing to a perceived lack of success of this approach, a subsidised charge was introduced. This subsidy, previously provided by SCT, is no longer available to prospective course participants, which has resulted in a price increase. During the previous involvement with SCT, cookers were priced at around 250 Bolivianos (B.) (31$U.S.). The present price for a solar box cooker kit is 350 B. (39$U.S.) or 400 B. (50$U.S.) for the finished cooker.[9,10] However, all of the solar cooker participants that I surveyed paid a subsidised charge for their cookers and provided the labour to construct the solar cooker kits themselves. This modification however represents the single change made throughout the previous four years of solar cooker promotion: the course has been undertaken in the same format across all of Bolivia.

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[9] Eight B. ≈ 1$U.S. in mid 2005.

[10] This increase in price represents a significant barrier to the prospective users of solar cookers. The constraints upon prospective solar cookers falls outside this study.

2.4 Aims

This study aims to unpick some of the social and economic impacts of solar cooker use, as well as investigating the methods of technology promotion, and the internal dynamics of an organisation that promotes alternative stove technologies.

As outlined above, solar cookers and other improved stoves are intended to reduce the health burden of IAP, time or money expenditure in obtaining fuel, and the environmental impact of wood or other biomass fuel use. In the absence of detailed time-series data regarding the extent of deforestation in the field sites where wood fuel is used, and instruments to assess IAP, this study is limited to analysing the impacts of solar cooker use upon monetary and time expenditure. Therefore, I aim to investigate solar cooker usage patterns, the differences in fuel and time expenditure (for cooking and collecting fuel) between households that use and do not use solar cookers. I am also interested in the nature of solar cooker promotion; how the cookers are used, or why they are not used; if solar cookers are used, by whom (with a particular interest in the gender of the user), how and why, does the particularly method of promotion influence this.

3 Methods

A range of interview techniques were employed to investigate the promotional strategies of CAB, the extent of solar cooker use and the impacts upon solar cooker users. Interviews and further observational data were compiled during a two-month period of involvement with CAB. During this period, I lived and worked along side key actors within the NGO.

3.1 Structured interview survey of solar cooker users and control groups

In order to collect systematic data on key variables of solar cooker usage and their impacts, structured interviews using a questionnaire were carried out with the participants of previous solar cooking courses. These key variables include the usage patterns and energy expenditure, time required to cook and to collect fuel, and the types of food cooked and consumed with solar and other types of cookers. Data were also collected on the household member that cooked and collected fuel, and the size of the household.

A questionnaire was developed and translated into Castilian in the UK. Following discussions with a local anthropologist and Geoff, modifications were made. During the solar cooking courses questionnaire data are obtained from the participants regarding these key variables and I therefore modified the questionnaire such as to enable comparisons to be drawn across time within the course groups. The resulting questionnaire therefore drew upon these efforts at data collection: having reviewed the NGO's course questionnaire, and recognised what I considered to be its flaws, it resembled a hybrid combining elements of both questionnaire (see appendix A).

3.1.1 Pilot study

The questionnaire was piloted in a suburb of Cochabamba where a solar cooker course had been undertaken in 2003. The questionnaire was then modified owing to identified problems with structure and specific questions and to include a greater range of questions regarding attitudes towards, knowledge of, and perceived benefits of solar cooker use. These modifications were intended to supplement the closed questions and to give some indication of the attitudes towards the technology and its means of promotion.

3.1.2 Sample selection

Working in collaboration with CAB, respondents were selected from the courses undertaken in the region surrounding Cochabamba. Respondents were located and interviewed with the assistance of a local coordinator. Sampling therefore followed a modified "snow-ball" type method: the coordinators, acting as gate keepers, had a knowledge of the whereabouts of the participants of the solar cooking courses, familiarity with undertaking questionnaire surveys and were able to provide translation into Quechua when required.

3.1.3 Field sites

Four field sites were visited to collect systematic data regarding these key variables. The first of which was used solely as a site to pilot the questionnaire and identify problems. The field sites were chosen according a range of selection criteria: owing to the ongoing political and social problems, ease of accessibility had to be taken into consideration; the presence of a previous solar cooker course and a coordinator available to act as field guide and translator; the degree of urbanism and the range of fuels used apart from solar cookers. Sites with varying degrees of urbanism were selected in order to attempt to assess the key variables in such varying circumstances. A control sample of non-solar cooking households was also selected randomly from each field location to enable a comparison of these key variables between households that used solar cookers and those that did not. Ten days to two weeks was spent at each field site: one of the field sites, “Broken Hill”, along with the piloting site, were close enough to Cochabamba that I could reside in the city, and make daylong visits to the field sites. However, in the other two sites, “Slight Peak” and “Green Valley”, I stayed for seven days and ten days respectively, and returned on other occasions.

3.1.4 “Broken Hill”

Several solar cooking courses have been held in this large suburb of Cochabamba between 2001 and 2003. The data were aggregated from these courses for statistical analysis. This urban / peri-urban site is located approximately thirty minutes east of Cochabamba.

Here, the assisting course coordinator had primarily worked one particular course but had some knowledge of the whereabouts of the participants of the other courses.

3.1.5 "Slight Peak"

At around forty-five minutes north by bus, "Slight Peak" is slightly more distant from Cochabamba than "Broken Hill", and therefore slightly less urbanised. It could however also be classified as peri-urban. Two solar cooking courses have been undertaken here since 2001.

3.1.5 "Green Valley"

The most rural of the four field sites, "Green Valley", sits two to three hours by bus west of Cochabamba. One solar cooking course was undertaken here in 2003.

3.2 Semi-structured interviews and field observations

To explore the nature of technology transfer from the perspective of the NGO semi-structured interviews were undertaken with a number of the key actors who work within or alongside CAB. These interviews investigated motives for involvement with solar cookers, their role within CAB, the activities and underlying principles of CAB, further details about solar cooking courses, how they came to be involved with solar cookers and CAB, the history of their solar cooker promotion and their perception of success. These interviews, varying in length from twenty minutes to one hour, were undertaken in English and one in Castilian, recorded and transcribed.

Field observations including conversations with key actors within CAB and particularly previous solar cooker courses coordinators were recorded to give insight into the nature of CAB's promotional techniques. These conversations were undertaken in Castilian and on an *ad hoc* basis during my involvement with CAB. They were recorded as field notes alongside further observational notes made regarding solar cooker use and during the time that I spent working alongside CAB. Owing to political unrest at the time of my study, my movement was restricted by blockades, and hence the time spent in each field site was reduced. A greater proportion of time was consequently spent working alongside, and observing the working practices and internal dynamics of the NGO.

4 Findings

4.1 The social and economic impacts of solar cookers

4.1.1 Summary of structured interview data

Table 1. Summary of survey data from "Broken Hill".

	Frequency	Percent		Frequency	Percent
Male	8	9.3	No solar cooker	18	20.9
Female	78	90.7	Solar cooker	68	79.1
Total	86	100.0	Total	86	100.0

Table 2. Summary of survey data from "Slight Peak".

	Frequency	Percent		Frequency	Percent
Male	8	16.3	No solar cooker	14	28.6
Female	41	83.7	Solar cooker	35	71.4
Total	49	100.0	Total	49	100.0

Table 3. Summary of survey data from "Green Valley".

	Frequency	Percent		Frequency	Percent
Male	5	14.3	No solar cooker	11	31.4
Female	30	85.7	Solar cooker	24	68.6

Total	35	100.0	Total	35	100.0

Table 4. Summary of all survey data.

	Frequency	Percent		Frequency	Percent
Male	21	12.4	No solar cooker	43	25.3
Female	149	87.6	Solar cooker	127	74.7
Total	170	100.0	Total	170	100.0

4.1.2 Levels of solar cooker usage

Results from the survey indicate that solar cooker use in the dry season is high amongst course participants: in the entire data set, mean daily frequency of usage is greater than one (table 5), 62.4% of course participants using their solar cookers once a day or more, and 92.7% of course participants use their solar cooker in the dry season (table 6). As one would expect, solar cooker use in the wet season declines significantly. Nevertheless, although less than one percent of solar cooker users report using their solar cooker at the same level as in the dry season, over forty percent of participants use their cooker for some purpose (including heat retention cooking) in the wet season (table 7).

Table 5. Daily solar cooker usage (dry season): summary statistics.

N	Valid	123
	Missing	4
Mean		1.2474
Median		1.0000
Mode		1.00

Table 6. Daily solar cooker usage (dry season): frequencies.

Mean daily frequency of usage	Frequency	Percent
.00	9	7.3
.03	2	1.6
.07	1	.8
.15	4	3.3
.30	13	10.6
.35	2	1.6
.40	5	4.1
.50	9	7.3
.60	1	.8
1.00	33	26.8
1.50	1	.8
2.00	26	21.1
2.50	5	4.1
3.00	8	6.5
4.00	2	1.6

5.00	2	1.6
Total	123	100
Missing	4	

Table 7. Solar cooker usage (wet season).

	Frequency	Percent
Not at all	75	62.5
when sufficient there is sun	14	11.7
Sometimes	3	2.5
as a heat retainer	5	4.2
same as dry season	1	.8
1 or 2 times a month	6	5.0
3 times per week	2	1.7
1 or 2 times per week	2	1.7
1 or 2 times per day	11	9.2
much less than in the dry season	1	.8
Total	120	100
Missing	7	

4.1.3 Limitations of solar cooker usage data

There are several possible problems to consider concerning the accuracy of the solar cooker usage data: surveys in each of the field sites were undertaken alongside a field assistant, a local course coordinator, with whom most of the respondents were familiar, and familiar with their involvement with CAB. In some cases, one might suspect that this association would foster a tendency to exaggerate solar cooker use. Nevertheless, prior to each interview, a paragraph was read out as part of gaining consent for the responses to be used, which stressed my independence from CAB (which was reiterated when questioned, as I frequently was). I also designed the questionnaire to provide an alternative measure of solar cooker use: enquiring into types of cooker used yesterday indicated that 43% of respondents used a solar cooker yesterday alone or in combination with another type of cooker (table 8). This perhaps indicates that respondents may have slightly exaggerated the frequency of solar cooker use, perhaps owing to the presence of the course coordinator. However, the presence of the course coordinators was unavoidable in order to locate the course participants.

Table 8. Types of cooker used yesterday (all data): frequencies.

	Frequency	Percent
solar	1	.6
solar and gas	57	34.5
solar and wood	3	1.8
solar, gas and wood	10	6.1
gas	62	37.6

wood	13	7.9
gas and wood	19	11.5
Total	165	100
Missing	5	

There is a further problem regarding how solar cooker usage ought to be quantified: in this case, usage was enumerated according to the daily frequency of use, "*how many times per day in the last week did you use your solar cooker?*" (A mean daily frequency of usage was calculated in the cases where cookers were used less than once per day.) But how does one define a single use? Some respondents would indicate that they used their solar cooker once, but all day, whereas other would simply use the solar cooker for a single dish or to heat water for two to three hours. In this study, the two cases were treated as equal. This particular means of quantification was chosen owing to concordance with the method used by CAB in the solar cooking course questionnaires and enables some comparison to be made between this study and the data extracted during the solar cooking courses. In some cases, an additional, open question was added regarding the duration of use per day, which could be considered as an alternative measure (table 9). There are also apparent circumstances where this means of quantification is also flawed: duration of usage may be strongly affected by the type of food consumed, contributing further variation into the analysis.

Table 9. Open question 4: each day, for how much time do you use your solar cooker?

	Frequency	Percent
all day	12	60.0
all morning	4	20.0
1 to 2 hours	2	10.0
2 to 3 hours	2	10.0
Total	20	100
Missing	150	

4.1.4 Fuel Expenditure

In the dry season, the complete fuel expenditure data set reveals some significant statistical difference between households that use solar cookers and those that do not. There is however, no statistically significant difference in the complete wet season data set, as one would expect, as solar cooker usage is much lower (tables 11 and 12).

Figure 4. Histograms of monthly fuel expenditure per household member (dry season, all data).

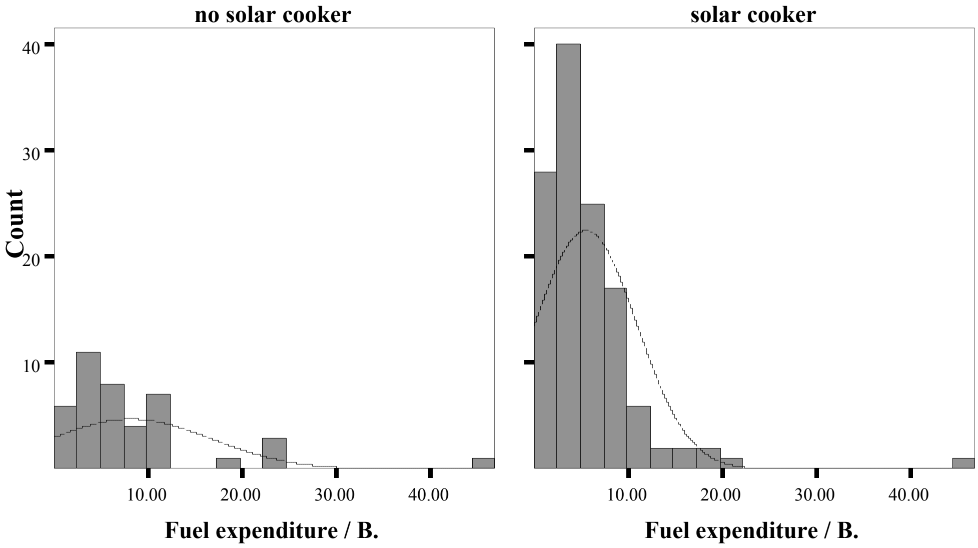


Figure 5. Histograms of monthly fuel expenditure per household member (wet season, all data).

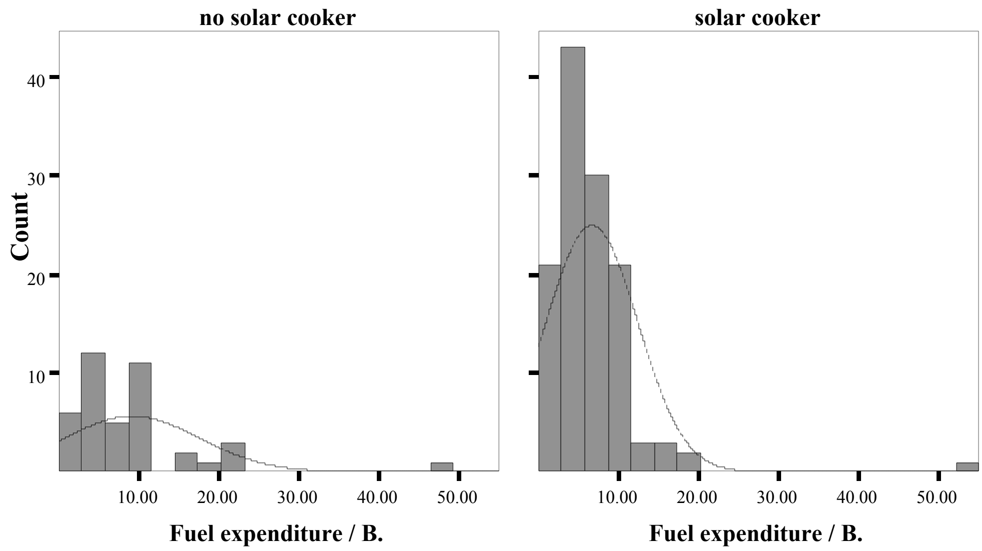


Table 10. Monthly fuel expenditure per household member (all data): summary statistics.

		N	Mean	Std. Deviation
Monthly fuel expenditure per household member / B. (dry season)	solar cooker	124	5.5386	5.44529
	no solar cooker	41	8.2390	8.55890
Monthly fuel expenditure per	solar cooker	124	6.6933	5.73963
	no solar cooker	41	9.1629	8.41014

household member / B. (wet season)

Table 11. Monthly fuel expenditure per household member (all data). Parametric test of means: independent sample t-test.

		t-test for Equality of Means			
		t	df	Sig. (2-tailed)	Mean Difference
Dry season	Equal variances not assumed[11]	-1.897	51.125	.063	-2.7004
Wet season	Equal variances not assumed	-1.750	52.861	.086	-2.4696

Table 12. Monthly fuel expenditure per household member (all data). Non parametric test of medians: Mann- Whitney tests (test statistics).

	Dry season	Wet season
Mann-Whitney U	1983.500	2059.000
Wilcoxon W	9733.500	9809.000
Z	-2.107	-1.822
Asymp. Sig. (2-tailed)	.035*	.068

* Significant at 95%.

[11] One cannot assume variances are equal as Levene's Test for Equality of Variances P<0.05 for both dry and wet season expenditure.

4.1.5 Limitations of fuel expenditure data

Despite the significant difference in monthly household fuel expenditure in the dry season (table 11), there are numerous factors that influence fuel expenditure per household member: duration of gas or wood stoves use, and the associated influence of the type of food cooked, number of meals cooked at home, and the amount of food cooked (some households may cook for other households or sell food in the street). None of these factors have been entirely controlled for in this analysis and they are particularly difficult to enumerate, quantify and hence to factor into analysis.

There is also an interaction between the use of collected fuel and purchased fuel: households that do not use a solar cooker, which have relatively low fuel expenditure may utilise large amounts of collected fuel, and hence may expend significant time collecting fuel. This relationship may interfere with identifying any possible significant difference in fuel expenditure per household member.

Controlling for this interaction, and analysing households that do not use collect fuel indicates a statistically significant difference between mean monthly fuel expenditure per household member between solar cooker users and non users in the dry and wet season (tables 14 and 15).

Figure 6. Histograms of monthly fuel expenditure per household member (excluding household that collect fuel, dry season).

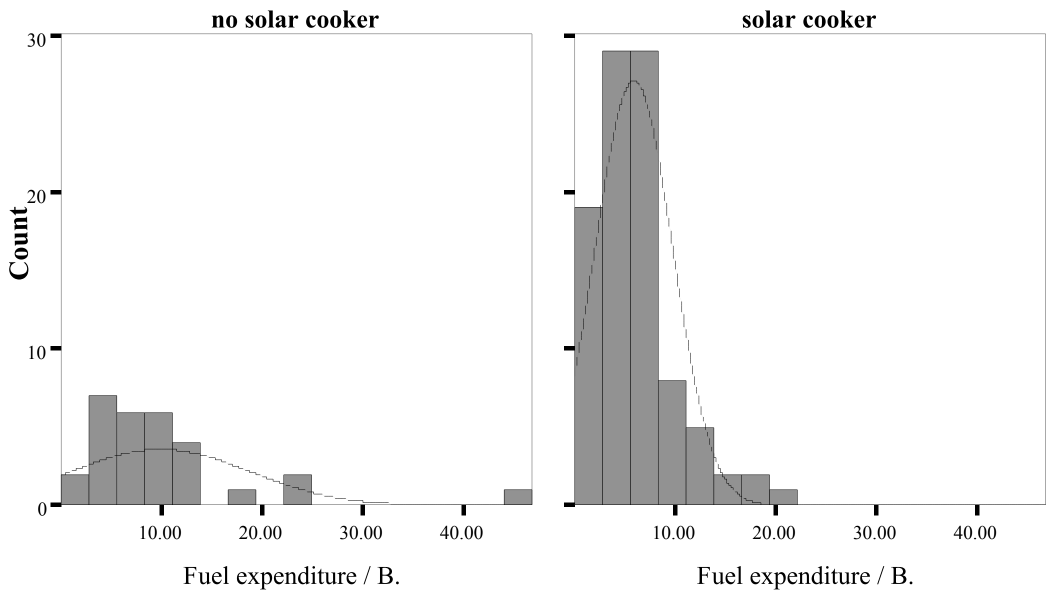
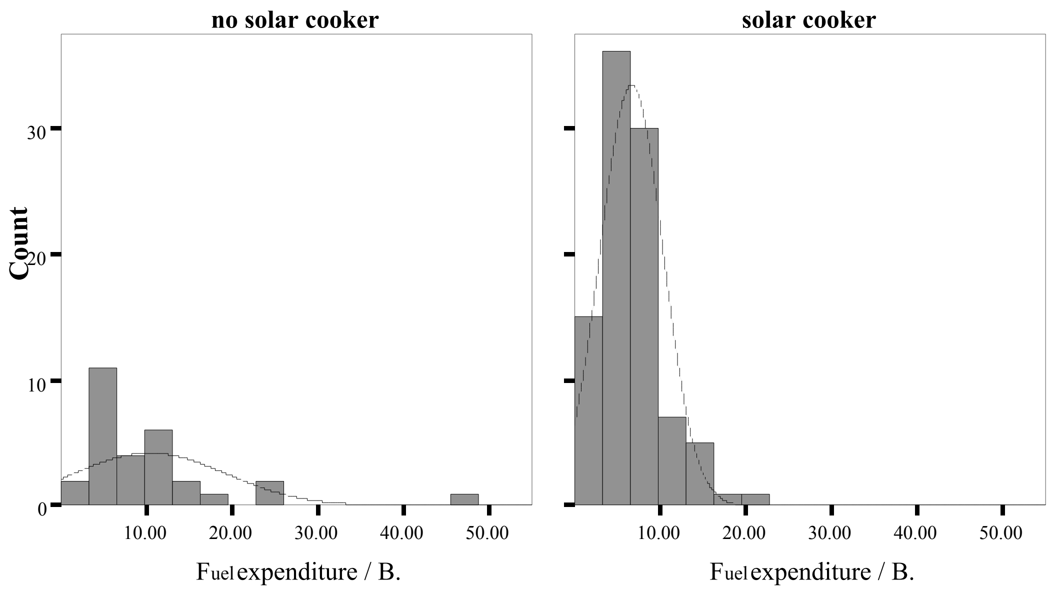


Figure 7. Histograms of monthly fuel expenditure per household member (excluding household that collect fuel, wet season).



no solar cooker
solar cooker
Count
0
10
20
30
10.00
20.00
30.00
40.00
50.00
Fuel expenditure / B.
Fuel expenditure / B.

Table 13. Monthly fuel expenditure per household member (excluding households that collect fuel): summary statistics.

		N	Mean	Std. Deviation
Monthly fuel expenditure per household member / B. (dry season)	solar cooker	95	5.9492	3.86267
	no solar cooker	29	9.9431	8.86450
Monthly fuel expenditure per household member / B. (wet season)	solar cooker	95	6.6988	3.67689
	no solar cooker	29	10.3867	8.94274

Table 14. Monthly fuel expenditure per household member (excluding households that collect fuel). Parametric test of means: independent sample t-test.

		t-test for Equality of Means			
		T	Df	Sig. (2-tailed)	Mean Difference
Dry season	Equal variances	-2.35	31.309	.025*	-3.9939

	not assumed[12]	9			
Wet season	Equal variances not assumed	-2.166	30.940	.038*	-3.6880

*** Significant at 95%**

Table 15. Monthly fuel expenditure per household member (excluding households that collect fuel). Non parametric test of medians: Mann- Whitney tests (test statistics).

	Dry season	Wet season
Mann-Whitney U	884.000	987.000
Wilcoxon W	5444.000	5547.000
Z	-2.914	-2.306
Asymp. Sig. (2-tailed)	.004**	.021*

* Significant at 95%
** Significant at 99%

One might also hypothesize that the more a household uses its solar cooker, or of all the cooker use, the greater proportion that is solar, would result in decreased fuel expenditure. Indeed there is a significant negative relationship between the proportion of daily solar cooker usage [13] and monthly fuel expenditure per household member when households that collect fuel are excluded (figure 8;

[12] One cannot assume variances are equal as Levene's Test for Equality of Variances P<0.05 for both dry and wet season expenditure.
[13] Mean daily frequency of solar cooker use divided by mean daily frequency of all stove types.

table 16). This analysis therefore confirms that the higher proportion of cooking which is comprised of solar cooking, the lower the monthly fuel expenditure per household member (amongst non-collecting households).

Figure 8. Scatter graph of proportion of daily solar cooker use against monthly fuel expenditure per household member (dry season, excluding households that collect fuel).

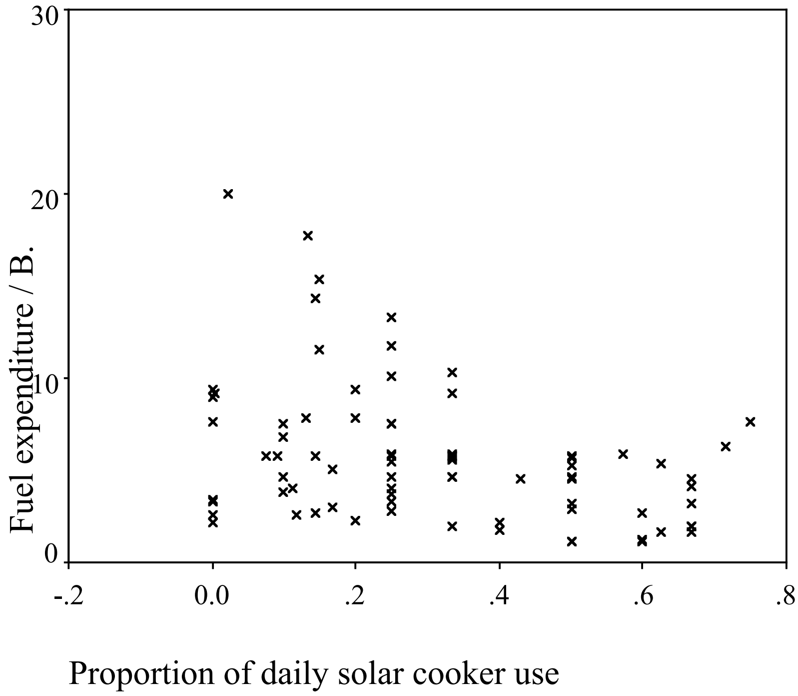


Table 16. Proportion of daily solar cooker use against monthly fuel expenditure per household member (households that collect fuel excluded): non parametric correlation coefficient.

			Monthly fuel expenditure per household member (dry season) / B.
Spearman's rho	Proportion of daily	Correlation	-.360**

solar cooker use	Coefficient	
	Sig. (2-tailed)	.001
	N	78

** Correlation is significant at the .01 level (2-tailed).

The situation is perhaps more complex than simply indicating the impact of solar cooker usage on fuel expenditure: the significant difference in fuel expenditure remains in the wet season when respondents used their solar cookers much less frequently than in the dry season (tables 14 and 15). This may be a result of the range of possibly confounding factors detailed above.

Despite the complexities of calculating expenditure per household member, I believe that the reported levels of fuel expenditure at a household level to be accurate. I encountered high levels of interest surrounding fuel expenditure, particularly gas (Liquefied petroleum gas [LPG]) expenditure: the price of LPG was widely perceived to have increased greatly over the previous few years and represented a significant monetary outgoing for many households. Respondents readily knew how much they spent on fuel and responded quickly to questioning. The interest in gas prices also reflected the nation-wide interest in the situation surrounding the ownership and allocation of profits from Bolivia's hydrocarbon resources (see e.g. Crabtree, 2005).

The use of the household as the unit of study also heralded complications with regard to quantifying differences in fuel use and time expenditure. Whilst there are many factors, which undoubtedly influence fuel expenditure, the size of the household is clearly one factor that influences the amount of fuel consumed. Therefore, all comparisons of fuel expenditure were controlled for household size. The variable composition of households adds a further level of complexity that may undermine this simplistic scaling method: each household member was treated as equal in terms of fuel use irrespective of age, gender and time spent in the household. However, fuel consumption is particularly influenced by age. Yet, this is not as straightforward as might be assumed. It is possible, in some cases that young infants may consume more fuel that older children, as water is heated for bathing, and therefore unwise to scale upwards with increasing age. The length of time that household members spend and number of occasions they eat in the house is of importance to the fuel expenditure: in some cases household members only spend the weekends at the household, yet the recorded size of the household did not incorporate this. In many cases, it is unlikely that this could be achieved accurately without a long period of study. Further to this, it is unlikely that cooking a meal for ten people for example, requires five times more fuel than cooking a meal for two people: each additional person added to a meal, is likely to require a decreasing proportion of the total fuel budget. Therefore, it is very difficult to scale per household member fuel expenditure accurately, and a simple single unit scaling was used.

4.1.6 Time expenditure

No statistically significant differences were identified in the time expended cooking between households that use solar cookers and those that do not (table 17). Nor were significant differences identified in the time expended collecting wood in households that collect wood, between solar cooker users and non users (table 18).

Figure 9. Histograms of household daily time expenditure for cooking.

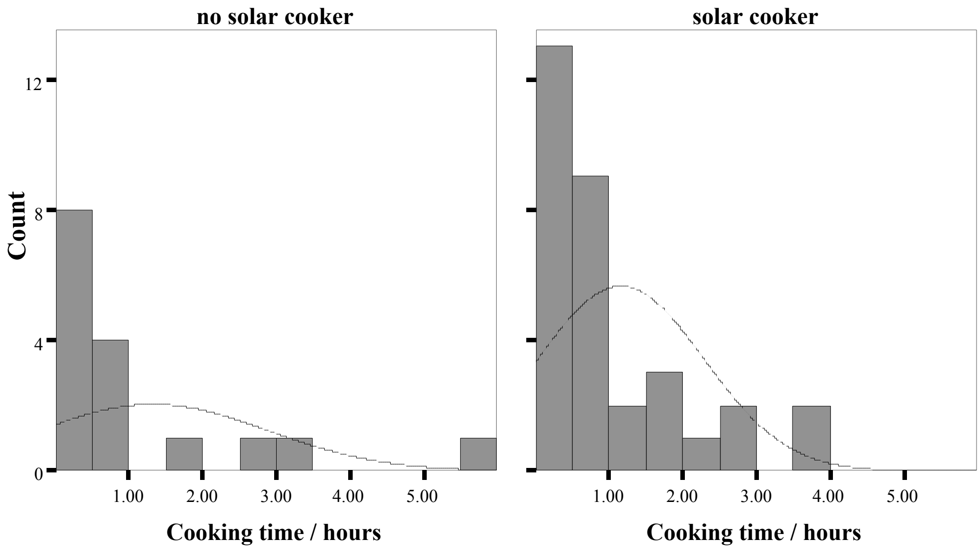


Figure 10. Histograms of yesterday's household time expenditure for cooking.

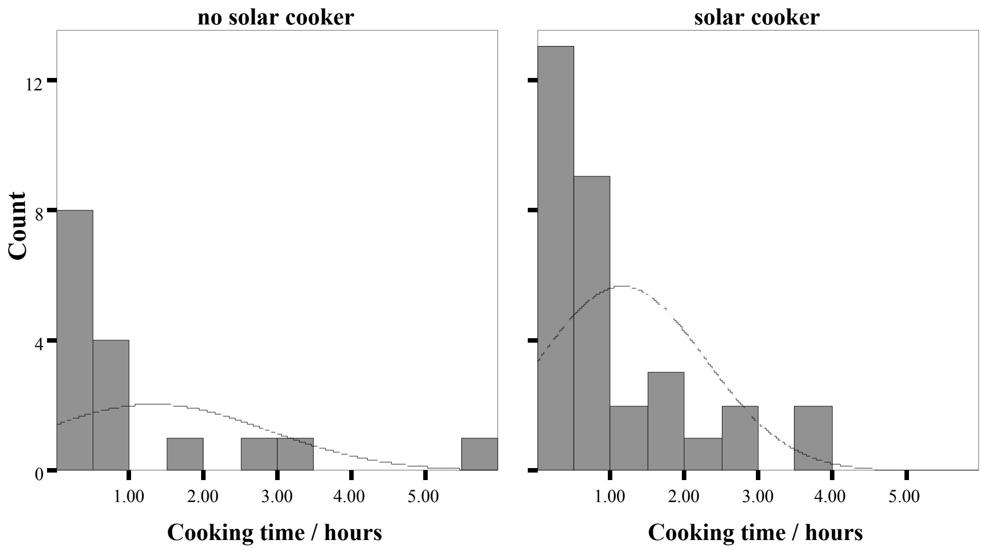


Table 17. Household daily time expenditure for cooking (all data). Non parametric test of medians: Mann-Whitney test (test statistics).

	Daily cooking time / hours	Yesterday total household cooking time / hours
Mann-Whitney U	2376.000	1721.500
Wilcoxon W	10251.000	8162.500
Z	-1.148	-.146
Asymp. Sig. (2-tailed)	.251	.884

Figure 11. Histograms of daily time expenditure for collecting fuel (excluding households that only buy fuel)

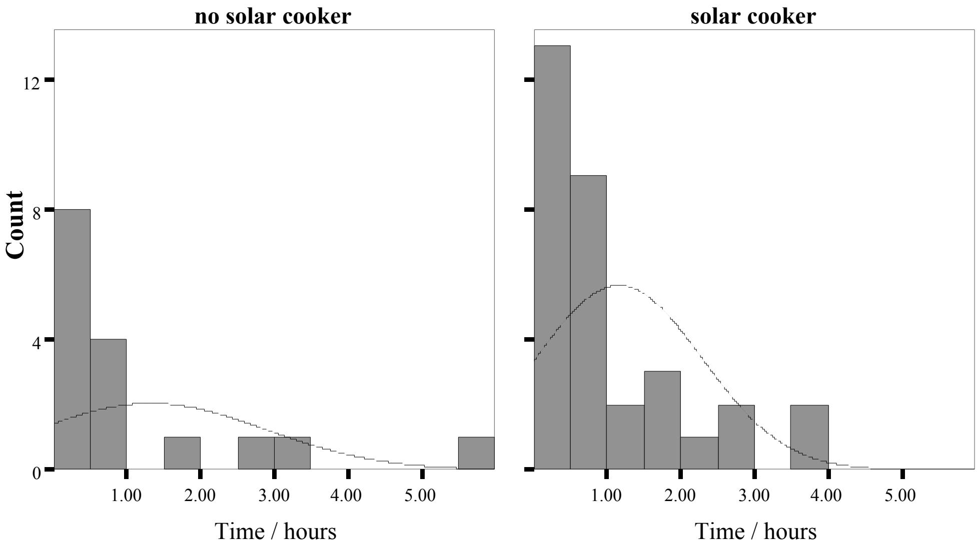

no solar cooker
solar cooker
Count
12
8
4
0
1.00
2.00
3.00
4.00
5.00
Time / hours
1.00
2.00
3.00
4.00
5.00
Time / hours

Table 18. Household daily time expenditure for collecting fuel (excluding households that only buy fuel). Non parametric test of medians: Mann-Whitney test (test statistics).

	Daily collecting time / hours
Mann-Whitney U	246.000
Wilcoxon W	774.000
Z	-.220
Asymp. Sig. (2-tailed)	.826

4.1.7 Limitations of time expenditure data

Enumerating the effects of solar cooker use upon time expended cooking and collecting biomass (wood) fuel is significantly complicated by the difficulties participants had in interpreting the questions put. The question used to survey the time saved through using solar cookers caused considerable difficulty: whilst solar cookers take considerably longer to cook dishes owing to the significantly lower temperature, compared to gas or wood stoves, it is supposed that solar cookers require considerably less supervision, as owing to these much lower temperatures, food never, or at least rarely burns[14]. Therefore enquiring as to how much time one spent

[14] Although generally acknowledged that solar cookers would not burn food, there were scattered reports of dry food burning in a solar cooker.

cooking is meaningless and does not take into account the time require to supervise cooking. So the question was phrased in order to probe how much time is required to *control* the cooking. In my opinion, few respondents understood the question fully, nor could they supply an accurate response. Almost universally, the question had to be rephrased and then was interpreted as how much time was required to cook. As a result, responses tended to be longer for meals cooked with solar cookers. This completely confounds any possible analysis into the time saved on cooking, or supervising cooking in households. A small proportion of respondents also reported that they often did not have time to use their solar cookers: whilst obviously referring to the total cooking time, it highlights perhaps that it is the *perception* of the impacts of a technology that are most important, particularly determining to what extent it is utilised. It is also interesting to note that this problem was not mentioned in a report, produced by CAB relating the time savings associated with solar cookers. The question used in this survey was copied, on the advice of the Geoff, directly from the questionnaire used to enumerate these key variables during the solar cooker course.

Furthermore, as I was attempting to identify which specific household members were cooking (and collecting fuel), rather than simply the total time expended, unravelling the supplied answers was at times difficult. For example, more than one person in a household may cook meals and the time expended by each person may vary greatly over time. Cooking may also be combined with other activities, and hence one cannot say that a given amount of time was given over to this activity, or was perhaps split between multiple household members and hence difficult to apportion accurately the time burden felt by individual members.

In my experience of solar cooker use, the claims of potential time saving are also confounded by the dynamic nature of the heat source, the sun. Solar box cookers (and parabolic and panel cookers) require greater levels of supervision than one might first appreciate: in order to maintain the maximum temperature, the orientation of the solar cooker must track the position of the sun. In order to function most efficiently, the position of the cooker must be altered ever thirty minutes or so. It is however possible to identify the position of the cooker, which on average receives the highest intensity of sunlight, between the start time of cooking and the return, and leave the cooker in this position for the entire time. This is easiest over the midday period and in my experience food cooks well when this technique is used, although obviously not as quickly as using when the sun is being tracked. This technique requires both an awareness of this potential and necessitates calculating the angle of the sun at midday in one's garden. Only one of the ***coordinators reported this possibility and many respondents seemed unaware of the necessity to reposition the solar cooker regularly to maintain maximum heat.

Difficulties were also apparent when trying to enumerate the duration spent collecting fuel, by each household member: this activity in some cases was reported be undertaken extremely seasonally, once or twice per year only, or without any regularity.

Collecting fuel was also combined with other activities in some cases, particularly in rural areas where household members, frequently mothers, spent long periods of time tending to crops or livestock. Difficulties in analysing the differences in time expended collecting fuel between the users of solar cookers and households that do not use a solar cooker are also compounded by the use of multiple fuel sources: gas and wood were combined in some households, the most important of which varies over the seasons, with wood collected and stored to be used in the future. No obvious pattern emerged with regard to which fuel type dominated in a given season. The low sample size of households that collected fuel complicated analysis further.

4.1.8 "Broken Hill"

In this area, on numerous occasions, the course participants were difficult to find, largely due to a large flow of out-migration to Spain and other European countries. Key household members were commonly reported to be undertaking one or two years of work as economic migrants in Spain particularly. This not only affected the sample size of respondents, but also influenced the usage patterns of solar cookers. It was commonly reported if the solar cooking course participant had left the household the remaining solar cooker would remain unused. This perhaps illustrates the importance of the solar cooking course in connecting the user and the technology. The high proportion of out migration combined with the geographically disparate nature of the settlement also engendered an apparently less tightly knit community than experienced in the other field sites.

In this locale, LPG was the fuel used most with 33.7% of participants using wood fuel (table 19), of which less than twenty per cent collected this fuel (table 21). Solar cooker usage in the dry season amongst course participants in this area is high with 90.9% using their solar cooker, and the mean daily usage 1.12 times per ***day (tables 20 and 21). However, around seventy per cent of course participants reported not using their solar cooker in the wet season. At the 95% confidence level significant differences in monthly fuel expenditure per household member were not identified in the total data set and when households that collect fuel were excluded (table 23).

Table 19. Types of cooker used in “Broken Hill”.

	Frequency	Percent
wood and gas	6	7.0
Gas	14	16.3
wood, gas and solar	23	26.7
solar and gas	43	50.0
Total	86	100.0

Table 20. Types of cooker used yesterday in “Broken Hill”.

	Frequency	Percent
solar	1	1.2
solar, gas and wood	3	3.7
gas and wood	4	4.9
solar and gas	31	38.3
gas	42	51.9
Total	81	100
Missing	5	

Table 21. Daily solar cooker usage in "Broken Hill" (dry season): summary statistics.

N	Valid	66
	Missing	2
Mean		1.1282
Median		1.0000
Mode		1.00
Std. Deviation		.90836

Table 22. Daily solar cooker usage in "Broken Hill" (dry season): frequencies.

Mean daily frequency of usage	Frequency	Percent
.00	6	9.1
.03	2	3.0
.15	2	3.0
.30	5	7.6
.40	4	6.1
.50	5	7.6
1.00	22	33.3
1.50	1	1.5
2.00	12	18.2
3.00	7	10.6
Total	66	100
Missing	2	

Table 23. Monthly fuel expenditure per household member in "Broken Hill" (excluding households that collect fuel). Non parametric test of medians: Mann- Whitney tests (test statistics).

	Dry season	Wet season
Mann-Whitney U	275.500	292.500
Wilcoxon W	1653.500	1670.500
Z	-1.723	-1.467
Asymp. Sig. (2-tailed)	.085	.142

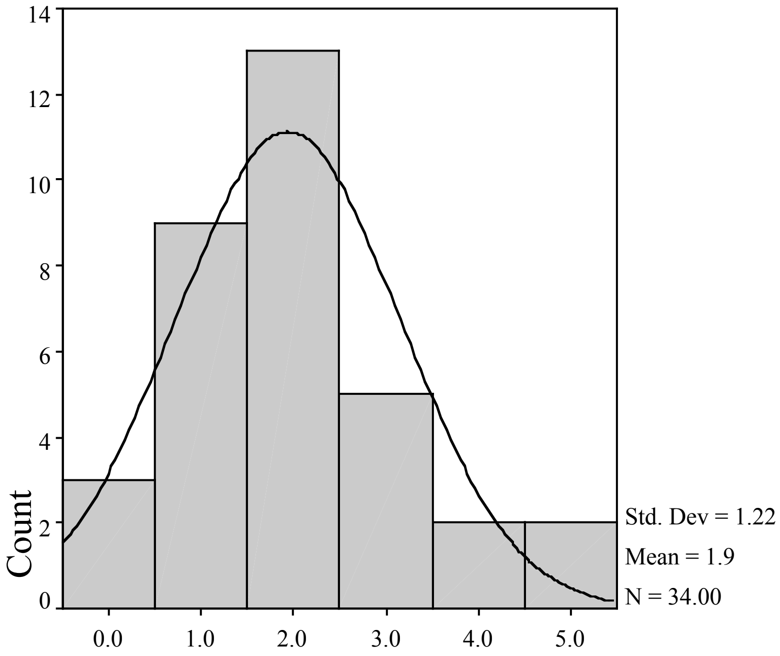
4.1.9 "Slight Peak"

In the second locale 94.1% of participants in solar cooking courses use their cookers, and the mean daily usage at almost twice per day (1.94) during the dry season (table 24, figure 12). During the wet season, 67.6% of course participants use their solar cookers and almost a quarter report using their solar cooker once or twice per week (table 25). In this locale, LPG was also the most important type of fuel used: fifty three per cent of respondents use LPG or LPG and solar energy and 75.5% of respondents used solar and/or LPG yesterday (tables 26 and 27). There is also a slightly higher proportion of respondents that use wood fuel (in combination with other fuels) than in "Broken Hill" (46.8% as opposed to 33.7%) and a slightly higher proportion that collect wood fuel (in combination with buying fuel) than “Broken Hill” (30.6% as opposed to 19.8%) (tables 28). After excluding those that collect fuel from the analysis, there is a significant difference in monthly per household member fuel expenditure in the dry season, however not in the wet season (table 29).

Table 24. Daily solar cooker usage (dry season) in “Slight Peak”: summary statistics.

N	Valid	34
	Missing	1
Mean		1.9368
Median		2.0000
Mode		2.00

Figure 12. Histogram of mean daily solar cooker use in “Slight Peak”.



Daily frequency of usage

Table 25. Daily solar cooker usage in "Slight Peak" (wet season): frequencies.

	Frequency	Percent
Not at all	11	32.4
when suficient sun	3	8.8
sometimes	2	5.9
as a heat retainer	2	5.9
1 or 2 times a month	5	14.7
3 times per week	1	2.9
1 or 2 times per week	9	26.5
much less than in the dry season	1	2.9
Total	34	100.0
Missing	1	
Total	35	

Table 26. Type of cooker used in "Slight Peak".

	Frequency	Percent
Gas	6	12.2
wood and solar	2	4.1
wood and gas	6	12.2
wood and kerosene	2	4.1
solar and gas	20	40.8
wood, gas and solar	13	26.5
Total	49	100.0

Table 27. Types of cooker used yesterday in "Slight Peak".

	Frequency	Percent
solar and gas	25	51.0

solar and wood	1	2.0
Gas	12	24.5
Gas and wood	5	10.2
solar, gas and wood	6	12.2
solar and gas	25	51.0
Total	49	100.0

Table 28. Method of obtaining fuel in "Slight Peak".

	Frequency	Percent
buy with money	33	67.3
buy with money and collect	15	30.6
Total	48	98.0

Table 29. Monthly fuel expenditure per household member in "Slight Peak". Non parametric test of medians: Mann- Whitney tests (test statistics).

	Dry season	Wet season
Mann-Whitney U	41.500	77.000
Wilcoxon W	341.500	377.000
Z	-2.692	-1.255
Asymp. Sig. (2-tailed)	.007**	.209

**Significant at 99%

In "Slight Peak", the local coordinator was a key factor in promoting solar cookers and particularly targeted the members of a local mother's group whom she perceived as benefiting from solar cooker use. During my presence she was actively promoting solar cookers: selling ready-made cookers and organising a group to construct solar cookers. Many of the respondents reported that they had heard about solar cookers through the coordinator and indeed decided to purchase a cooker on her recommendation.

4.1.10 "Green Valley"

Here, a greater proportion of households used wood fuel and collected their fuel from the surrounding area (table 32).[15] Overall,

[15] See section 4.1.11

the dry season usage of solar cookers was also high here with 95.3% of participants using their solar cookers (table 34). However, the mean daily usage was much lower than in the other field sites at around once every two days (0.57 per day) in the dry season (table 33). Also only forty per cent of participants reported using their solar cooker yesterday, which I suggest is perhaps a measure less open to bias of exaggerated usage (table 31). In the wet season, solar cooker usage almost completely disappeared, with 73.9% of course participants not using their solar cookers whatsoever (table 35).

Table 30. Types of cooker used in "Green Valley".

	Frequency	Percent
Wood	2	5.7
wood and solar	7	20.0
wood and gas	8	22.9
solar and gas	2	5.7
wood, gas and solar	16	45.7
Total	35	100.0

Table 31. Types of cooker used yesterday in "Green Valley".

	Frequency	Percent
solar and gas	1	2.9
solar and wood	2	5.7
Gas	8	22.9
Wood	13	37.1
gas and wood	10	28.6
solar, gas and wood	1	2.9
Total	35	100.0

Table 32. Method of obtaining fuel in "Green Valley".

	Frequency	Percent
buy with money	5	14.3
Collect	7	20.0
buy with money and collect	23	65.7
Total	35	100.0

Table 33. Daily solar cooker usage in "Green Valley" (dry season): summary statistics.

N	Valid	23
	Missing	1
Mean		.5703
Median		.3000
Mode		.30

Table 34 Daily solar cooker usage in "Green Valley" (dry season): frequencies.

Mean daily frequency of usage	Frequency	Percent
.00	1	4.3
.07	1	4.3
.15	2	8.7
.30	8	34.8
.35	1	4.3
.40	1	4.3
.50	3	13.0
.60	1	4.3
1.00	3	13.0
2.00	1	4.3
2.50	1	4.3
Total	23	100.0
Missing	1	

Table 35. Daily solar cooker usage in "Green Valley" (wet season): frequencies.

	Frequency	Percent
Not at all	17	73.9
when sufficient sun	5	21.7
sometimes	1	4.3
Total	23	100.0
Missing	1	

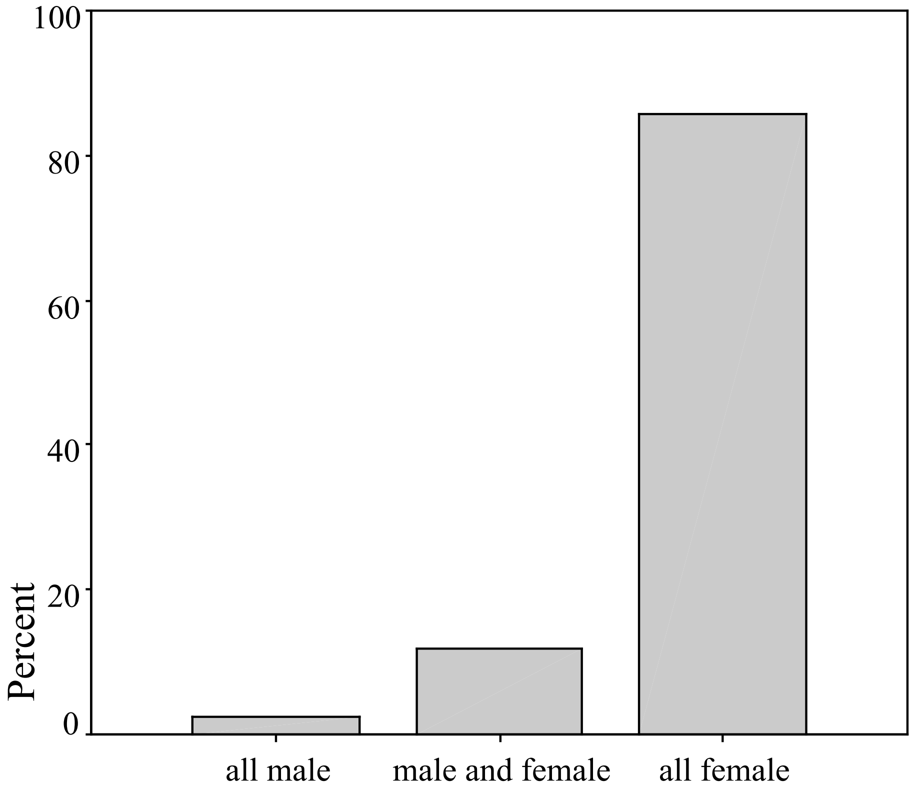
In "Green Valley" a higher proportion of the population spoke only Quechua than in the other field sites. With a greater proportion of questionnaires translated into Quechua and back into Castilian there is a greater potential for misinterpretation and systematic bias. Owing to the linguistically simplistic nature of the majority of the questions (time expenditure aside), I suggest that this had little impact upon overall accuracy. Here the local course coordinator and her husband were of some importance to the promotion of solar cookers: they were well known throughout the settlement and worked closely with a mothers' group. Several members of the mothers' group had participated in solar cooking courses, and several more expressed an interest in the cookers. These members of the mothers' group reported that despite their interest in the solar cookers (and the improved wood stoves) that the prices were too high. Respondents' perceptions of the high price of solar cooker reinforced my belief that this was the poorest of the field sites.

In "Green Valley" a greater focus is placed upon agriculture, with little evidence of formal employment: the village is located in a fertile valley where onions, beans and potatoes are most commonly grown. The emphasis upon agricultural employment, almost universally involving women, also influenced the regularity of solar cooker use: course participants would often respond that they were too busy away from home, working in their fields to use their solar cooker. This is rather at odds with the idea that solar cookers can be left whilst the cook is undertaking other work. Often household members reported how they would not return until dark, in which case any food would be cold. Another rather unexpected factor that ***decreased the potential frequency of solar cooker use was the use of catapults by boys to launch stones at the glass lid for target practice. Some respondents reported that they could not use their solar cooker as frequently as they would like because of this risk.

4.1.11 Gender of solar cooker users and beneficiaries

As one might expect, throughout the study sites, the majority of cooking was undertaken by females (85.6%, n=170 see figure 13). Women were also the primary users of solar cookers. This is not to say that men were not involved, and their prominence may have been more associated with the presence of the female coordinators who accompanied me during the structured interviews, rather than a significant bias. Women were also far more commonly available for interview during the day, indicating their lower levels of formal employment, but also that they were more able to take advantage of solar cooker use.[16]

Figure 13. Bar chart of the gender of household members who cook.



It was reported that in almost eighty per cent of those asked, a female household member chose to purchase a solar cooker (78.5%, n=93, table 36). This contrasts against the stereotype of men being most involved with decision making about energy types. However, this question, *"In your household, who had the idea to learn to cook*

---

[16] The structured interview survey was undertaken in each field location during daylight (office) hours. This was largely due to a perceived lack of safety after dark, and the greater likelihood of encountering solar cooker use and users in each household.

with a solar cooker?" masks the complexity of household negotiation over energy choices: for example, the person who had the idea may have to consult with other household members in order to realise their idea. Some respondents also found this question difficult to answer, which perhaps alludes to a more complex process. Also almost sixty per cent (58.4%) of respondent (table 36) reported that they, the female respondent had had the idea to learn to cook with a solar cooker. This perhaps suggests a bias, by which respondents were exaggerating their importance within the household.

Table 36. Frequency of responses to open question 2: who had the idea to learn to cook with a solar cooker?

	Frequency	Percent
female respondent	54	58.1
Wife	2	2.2
Daughter	4	4.3
Mother	9	9.7
sister-in-law	2	2.2
Sister	2	2.2
male respondent	6	6.5
Husband	6	6.5
Son	3	3.2

Father	1	1.1
Grandfather	1	1.1
all the family	1	1.1
Friend	2	2.2
Total	93	100.0
Missing	77	

The collecting of wood was often shared across the genders as well as the generations, involving children, parents and grandparents. In "Green valley", the most rural of the field sites, in seventy-five percent of households both males and females (table 37) collected wood fuel. In the household, which I joined for an afternoon of wood collecting, the husband and wife travelled together, and whilst she foraged for smaller pieces of wood, he and I used the axe to cut larger, moribund branches. On this occasion, the pace of the work was relatively steady; although prolonged and hot, food and drink was brought along, as was a wheelbarrow to lessen the load. Whilst my male friend pushed the wheelbarrow, his wife carried her *carga* of wood on her back. Women universally carried the *carga*, a strong blanket, folded and thrown of the shoulder, held on the back and used to carry allsorts of items such as wood, babies, groceries, and bags of produce for sale. Generally, in my experience the division of labour in rural areas is as such, where women undertake almost all of the agricultural labour with or without the men, combined with their responsibilities for childcare. The complexities of the gendered division of labour, and how solar cooking interacted with this, were perhaps beyond the time available for this study and this insight represents an overly simplistic analysis. [17]

Table 37. Gender of household members that collect fuel in "Green Valley"

	Frequency	Percent
all female	5	17.9
all male	2	7.1
male and female	21	75.0
Total	28	100.0
Missing	7	

[17] see e.g. Harris (2000)

Plate 2. Returning home with collected wood

4.2 Further complexities of solar cooker use and cooking courses

Previous failures of solar cookers have been explained in terms of so-called "traditional objections": Geoff described how many NGOs complained to him that people simply would not use solar cookers as habits and customs are too difficult to change. He defines his aims as changing habits, although as Charlene described, "[t]he hardest thing in Latin America is to change customs – traditions more than anything. And cooking has its traditional ways." The solar cooking courses, designed to change the cooking habits of participants, and the process of using a solar cooker are however more complex than one might expect.

4.2.1 Solar cooking

In the study sites, in the dry season (winter) with temperatures no higher than 25º to 27º Celsius, at altitudes around 2500 metres, watery soup for four to six people takes approximately three hours to cook. Vegetables would cook in around two hours and meat, such as chicken legs, requires four hours of cooking. The internal temperature within the solar box cooker was open to some debate within CAB and TA21. Charlene reported that the temperature of the food reached 150º C in the older cookers, and using a more effective reflective material up to 180º C. The quality of material, and the construction of the solar cooker, has a serious impact upon the attainable temperature: the quality of the reflective material and the integrity of the seals surrounding the glass lid, are particularly important. The attainable temperatures were of some concern to those directly involved with the promotion of solar cookers, who were keen to stress that the cookers were effective. I often ate food cooked with solar cookers that was cooked well and suffered no ill effects.

General remarks and direct questioning revealed that foods requiring a long time cooking at a low intensity, such as soup, are best suited for solar cooking. Such foods are also popular in Bolivia: soup is often consumed at lunch or *almuerzo*, the most important meal of the day. As these dishes require a substantial volume of fuel to prepare they present the possibility of significant fuel savings. It is also perhaps fortunate that the *almuerzo* is the meal most easily cooked using solar cookers, prepared during the times when the sun's intensity is greatest, around midday. Using the solar cooker for meals in the late afternoon was problematic: the Cochabamba region, at around 17º south of the equator, experiences relatively equal day and night lengths with sunset at around 6 pm, and an appreciable decrease in the sun's intensity in late afternoon.

Apart from cooking meals, a range of other uses for solar cookers were reported including preparing jam and preserves, sterilising and heating water, washing clothes, cooking food for pet dogs and heating water for bathing, particularly for bathing infants. Snacks and desserts such as baked bananas can also be prepared using the solar cooker, as well as a popular dish known as *mote*, slow cooked maize or corn. Food for pets was also occasionally cooked in solar cooker.

The most obvious limitation of solar cooking is the necessity for strong uninterrupted sunlight over a period of several hours. During my period of involvement with CAB in and around Cochabamba, the climatic conditions were almost perfect for solar cooking: during nine weeks, I did not experience one day of rain, and only a handful of days of partial cloud. Nevertheless, Geoff acknowledged, other stoves are required for use in the wet season: an "ecological cooker system" that combined a solar box cooker, an efficient wood cooker and a "hay-box" stove, although the solar box cooker can also be used for heat-retention cooking, albeit less efficiently than a specifically designed "hay-box" cooker. There are uncertainties with solar cooking owing to changing weather conditions, and although this uncertainty is relatively low in the dry season here, in other seasons, and other regions.

Cooking meals with the solar cooker, over the required, longer durations, necessitates both an awareness of the principals of solar cooker use and requires foresight when planning of meals. Whist it might be advantageous to be able to leave food cooking and be assured that it will not burn[18], this may not be ideal. It is not possible to return to the household and prepare a meal quickly, but

[18] Some households, when using wood fuel, cooks calculate the required amount of wood according to the cooking time required. Therefore, the meal can be left to cook with some assurance that it may not burn.

for example, the preparation must be completed prior to leaving for a morning of work, and placed in the solar cooker. This leaves less ***opportunity for impulsive cooking. Geoff suggested that promoting a tendency to plan meals ahead of time was therefore an important “habit” that has to be changed so that solar cookers are used regularly[19].

Further to the proposed alleviation of fuel and time expenditure collecting fuel and cooking meals, as well as the decrease in environmental degradation and IAP, Charlene proposed that solar cooking increased nutritional content of food. Charlene, who had previously worked as lead coordinators alongside SCT, reported the reduction in the volume of water required to cook vegetables. She believed fewer vitamins and minerals are lost by water evaporation during the cooking and remain in the food. The taste of food cooked in solar cookers did however pose a barrier on regular use. Very rarely did a respondent report not using their solar cooker because of the changed taste of the food, but a much larger portion

[19] See section 4.1.7

***of respondents reported a dislike of certain foods when cooked in solar cookers. As people are often accustomed to a stronger taste of food cooked with wood, this clearly affected the frequency of solar cookers use.

Solar cookers also require an un-shaded space in which they can be placed in order to receive sufficient sun for sufficient time. Such a space does not however have to be in the exterior, it is possible to use cookers inside a house, next to large windows. Only in a handful of households was there insufficient sun to enable solar cooking throughout the day, and in such cases, the solar cooker was used when possible. I observed that even in the urban locales there was adequate space for solar cooking, which perhaps reflects Bolivia's relatively low population density[20].

[20] With a population density of twenty one persons per square mile, compared to fifty four per square mile in South America as a whole (PRB, 2005).

Plate 3. Family posing with solar cooker

4.2.2 Solar cooking courses

The participants' involvement in construction of the solar cookers during the solar cooking course is of key importance to Geoff's "methodology", as is the extended duration of the course. The former is resonant of Geoff and Charlene's artisanal approach to technology: although not formally trained in engineering, they maintain two small workshops and are actively involved in the construction and development of the cookers. This "hands-on" approach to solar cooking courses was intended, as Geoff recounted, "…to accomplish two things: the people would understand it better, and they would also participate in solar cooker use for a period of time." During the solar cooking demonstration, on the second day of the course, the participants bring their own food, with which they can experiment using the solar cookers. Both these features, constructing the cookers themselves and bring their own food to cook, are intended to promote a stronger connection between the participants and their solar cookers. Participants are also taught the principles of solar cooking such they can understand its limitations and opportunities, also how to maintain and repair their solar cooker. The group meetings, every fifteen days, are used as a forum in which participants can discus any problems or ideas amongst themselves and with the group coordinator. The "methodology" is intended to promote the idea amongst the participants that the technology belongs to them and not imposed from without. Indeed, instruction in the construction of solar cookers during the solar cooking course had a lasting impact for some course participants: I encountered one course participant who was engaged in their own enterprise, building and selling solar cookers, using a design copied from that of CAB; one course participant, who taught at a local orphanage, was passing the skills he had gained during the course onto his pupils, teaching them to build solar cookers; another course participant was adding to his experience in building a solar cooker, and was embarking on constructing a solar shower.

5 Conclusion

***Over ninety-five per cent of participants in solar cooking courses that I surveyed use their solar cookers. The frequency of use is however difficult to assess thoroughly, and clearly varied greatly across households and the three field sites. The reasons for frequent use here are manifold. The dry season climate of the central highlands of Bolivia around Cochabamba is almost perfect for solar cooker use; the propensity of people to prefer large midday meals, often soup based, further promotes daily solar cooker use. ***However, the tendency of solar cookers users to resist daily solar cooking, I suggest was due to their perception that solar cooker require more time and effort. Particularly in the more rural areas, women who spent long periods of time working away from home would use their solar cookers when they felt they had sufficient time.

The solar cooking courses can therefore be considered successful: the involvement of participants in constructing the technology, and in bringing their own food with which to experiment perhaps improved their *relationships* with cookers. The importance of such involvement resonates with the archaic definition of technology as the '*art of reason*' (Ingold, 2000: 294): a more artisanal approach to technology, whereby technology is less disconnected from its users. However, the paucity of respondents who understood how to maintain the optimum temperature in their solar cooker suggests that the courses were quickly forgotten.

These results suggest that, of the areas of potential benefits associated with solar cooking, fuel savings are the most prominent (despite the complexities of scaling fuel expenditure per household member). After excluding households that collect fuel, statistically significant differences were found in monthly fuel expenditure per household member, as was a significant relationship between the proportion of solar cooker use and the monthly fuel expenditure per household member. The complexities of enumerating the time saved by using a solar cooker, however, outweigh any differences between households that use and those that do not use a solar cooker.

In addition, I can only offer anecdotal responses to questions relating to the impact on deforestation and IAP: actors within CAB and solar cooker users informed me of the decrease in forestation and fuel availability particularly in the highland, Altiplano region of Bolivia. The decrease in available biomass fuel, in the Altiplano region, is widely accepted in lay discourse and to many it seems obvious that solar cookers usage could alleviate this stress. The impact of solar cooker use on levels of IAP is difficult to assess without the required instrumentation and constitutes another area of study. However, in the one field site where wood fuel use was high, during the structured interview survey I began to notice that the respondents were cooking outside with wood stoves. After taking note of the location of wood stoves in each household, it became clear that wood stoves were universally used under a small porch structure external to the house, which experienced good ventilation. Technically this negates all occurrence of *indoor* air pollution by definition, but in terms of exposure to carbon monoxide and other harmful smoke-related contaminants, cooking outside with ventilation significantly decreases any potential health impact.

Therefore the problems surrounding IAP that solar cookers are intended to alleviate do not exist in the field sites I visited. Also in this region, Bolivia's central highlands, at around 2500m, owing to the yearlong mild temperatures, no fuel whatsoever is used for heating the insides of homes only to cook food and heat water. These conditions are perhaps very different to those experienced in the highland Altiplano regions, where temperatures in the winter dry season, fall much lower than around Cochabamba and cooking inside is more common, as is space heating. Whilst solar cookers have some benefits in these locales, I was unable to explore fully the benefits of solar cookers use in areas where indoor biomass fuel use was common (and therefore indoor air pollution high).[21]

[21] This was largely due to the social problems which restricted transport.

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Appendix A

Questionnaire (translated back into English)

We are studying the effects of solar cookers on the lives of families in Bolivia.
The responses of this questionnaire will be used only for Christopher Pell's studies.
If you write and send a cheque for fifteen dollars, we can provide a copy of the results.
¿Have you read the above phrases? S N Signed:________

Part A.

1. Gender (i) M (ii) F 2. How are old are you? _____________

Part B.

3. What type of fuel do you use to cook with?

(i) Wood (ii) Grass (iii) Kerosene (iv) Solar

(v) Gas (vi) Animal dung (vii) Other:__________

4. How do you obtain the fuel for cooking?

(i) Buy with money (ii) Buy with credit (iii) Collect it

(iv) Exchange for other things (v) Other:_______________

Part C. Complete the table below

5. Who lives in your house?

6. Of the people that live in your house, who cooks?

7 Last week, each day how much time did they spend controlling the cooking?

<u>If they collect fuel:</u>

8. Of the people that live in your house, who collects fuel?

9. Last week, each day how much time did they spend collecting fuel?

Person in the house	Name	Relation to interviewee	Q. 6	Q. 8
			Hours spent each day last week	
			For collecting fuel	For cooking
1	Interviewee	-		
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

10. Do the people that collect fuel change across the seasons?_____

____

____

11. Does the time spent collecting wood change over the seasons?_

____

____

<u>If they buy fuel</u> (with money or credit) <u>complete the table below</u>

12. In the past month how much have you spent on fuel?

13. How does this change across the seasons?

12.	Past month	
13	Wet	
	Dry	

Part D.

14. Last week, each day, how many times did you use your stove(s) to cook food and heat water? ________________________________

15. Last week, each day, how many times did you use your solar cooker?________

16. How does this change across the season?

16	Wet	
	Dry	

Complete the table below

17. **Yesterday**, What type of stove did you use for each meal?

18. How many people ate these meals?

19. What types of food did you eat for breakfast / lunch / dinner / other

20. How much time was spent controlling the cooking?

		Breakfast(a)	Lunch (b)	Dinner (c)	Other (d)
17	Stove				
18	Number of people				
19	(i) Soup				
	(ii) Meat				
	(iii) Vegetables				
	(iv) Salad				
	(v) fish				
	(vi) Fritters				
	(vii) Potatoes				
	(viii) Rice / noodles				
	(ix) Quinua / wheat				
	(x) tea / coffee / mate				
	(xi) Bread				
	(xii) Cake				
	(xiii) water for drinks				
	(xiv)				

	Other				
20	Time				

Other questions

If possible, can you ask one or two of these questions per interview.

Do you know other people that want a solar cooker? __________

____

____

In your house, who had the idea to learn to cook with a solar cooker? ____

____

What do you think of solar cookers?___________________________

____

____

Each day, over how much time do you use your solar cooker?_____

____

____

How have you come to know about solar cookers?_______________

____

____

In your house, who uses the solar cooker?______________________

____

____

Why have you decided to buy a solar cooker?___________________

____

____

What types of other solar Technologies are you interested in? E.g. solar showers ____

____

____