Systematic review

Factors influencing the large-scale uptake by households of cleaner and more efficient household energy technologies

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Executive summary

Background

Nearly three billion people worldwide rely on biomass fuels (2.4 billion) and coal (0.4 billion) burnt inefficiently on open fires or simple stoves. These traditional household energy practices have dramatic consequences for health, the environment and socio-economic development. Ensuring access to clean and efficient household energy is therefore a major and urgent challenge faced by low- and middle-income countries. While marked by some successful programmes at both large and small scales, this is generally acknowledged to be a challenging area for policy and implementation. This mixed-method systematic review aims to contribute to this endeavour by identifying those factors which can help ensure more successful delivery of policies and programmes that promote improved solid fuel stoves (ICS) and/or clean fuels.

The main objective of this systematic review was to describe and assess the importance of different enabling and/or limiting factors that have been found to influence the large-scale uptake by households of cleaner and more efficient household energy technologies. These comprise five intervention areas: ICS and four clean fuels, i.e. liquefied petroleum gas (LPG), biogas, solar cookers and alcohol fuels.

More specifically, the systematic review: (i) provides a framework consisting of seven domains of factors influencing large-scale uptake, distinguishing between short-term adoption and longer-term sustained use; (ii) gives a summary of existing knowledge relating to each of these domains, including interpretation of data with respect to equity; (iii) outlines a proposal for a tool to facilitate implementation of these findings in programme planning, and (iv) sets an agenda for essential primary research to better understand how policies and programmes to promote cleaner and more efficient household energy technologies must be designed in order to be successful.

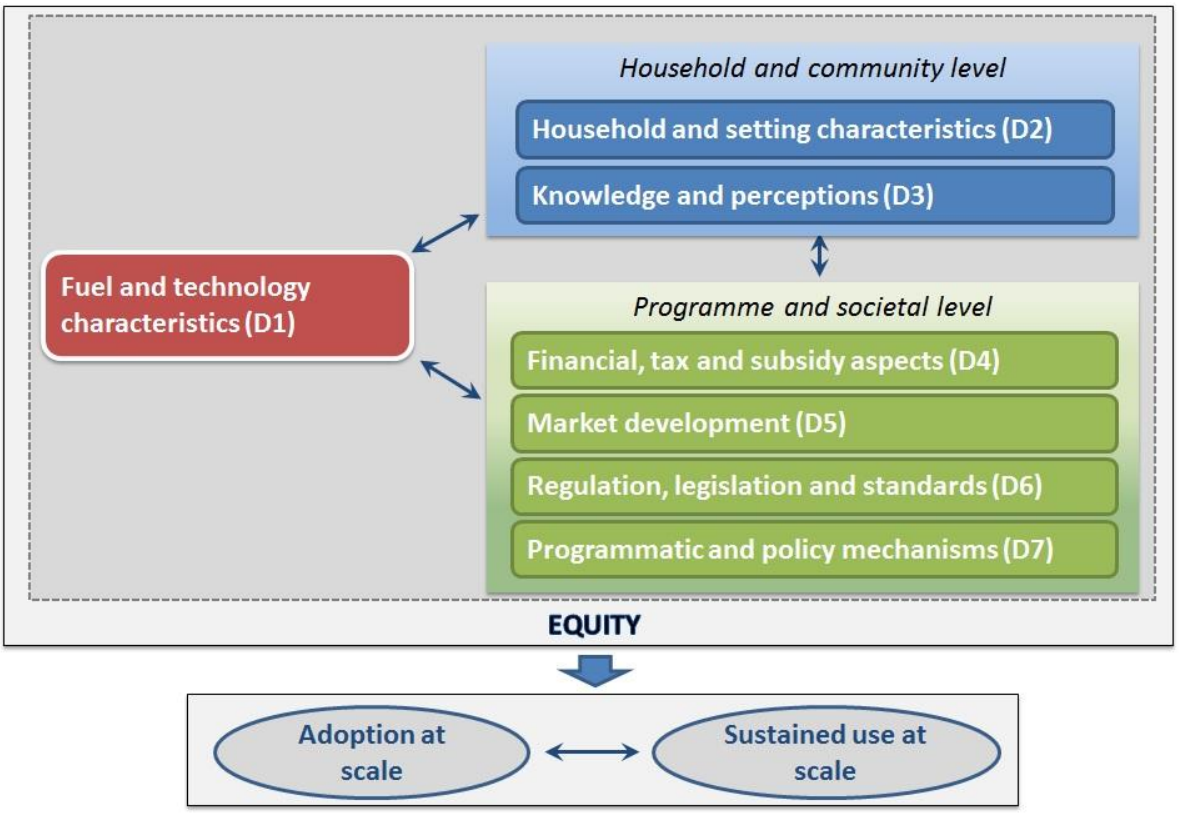
Methods

This systematic review, registered with the Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre) at the University of London, employed a comprehensive search strategy comprising searches in 27 multi-disciplinary bibliographic databases, 14 specialist websites, the grey literature and consultation with experts, covering the period 1980 to 2012. Three types of evidence – qualitative studies, quantitative studies and policy and case studies – were eligible, provided that they related to a direct experience with one of the five types of intervention, and that they reported empirical information on factors influencing adoption or sustained use.

Study selection, data extraction, quality appraisal and a two-stage synthesis procedure followed standardised methodologies and employed a degree of independent verification by two or more authors. Thematic and tabular/narrative syntheses were used for qualitative and other studies respectively, with findings categorised according to seven a priori defined domains relevant to household energy uptake and equity (see Figure ES.1). Domains (D1–D7 on the figure) include: (1) Fuel and technology characteristics, (2)

Household and setting characteristics, (3) Knowledge and perceptions, (4) Financial, tax and subsidy aspects, (5) Market development, (6) Regulation, legislation and standards, and (7) Programmatic and policy mechanisms, with Domains 2 and 3 primarily operating at household and community level and Domains 4–7 operating primarily at programme and societal level. Additional considerations were how the findings related to equity with respect to gender, socio-economic status (SES) and geography (urban/rural location), and the extent to which evidence informed about adoption and sustained use at scale.

Figure ES.1: Framework domains (D1-D7) influencing uptake



Findings

Extent and quality of evidence

Based on nearly 14,000 records identified, this review selected 101 eligible studies across Asia, Africa and Latin America, with 57 studies relating to ICS, and 44 to clean fuels (17 on biogas, 12 on LPG, nine on solar cookers, six on alcohol fuels). Studies included peer-reviewed publications, reports, book chapters, dissertations and conference proceedings, categorised as qualitative studies (19 studies), quantitative studies (22 studies) and policy and case studies (60 studies).

Quality appraisal of individual studies following established criteria found 17 out of 19 qualitative studies, 17 out of 22 quantitative studies and 47 out of 60 policy and case studies scoring moderate or strong quality respectively. It was concluded that this is a moderately strong and consistent set of evidence, and that the identified findings are sufficiently robust to use as a basis for policy planning and evaluation. Although no studies on newer ICS technologies (e.g. advanced combustion biomass stoves which hold promise

of delivering much lower levels of emissions) were identified within the timeframe of this review, it seems reasonable that the findings would also apply to these technologies and the means through which these are promoted.

Overview of findings

For all five types of intervention, a series of factors were identified across all the pre-specified domains. Rather than presenting these factors as discrete enablers and barriers, the systematic review suggests that these can most usefully be seen as operating on a spectrum, so that when present or satisfactory they are enabling, and vice versa.

In terms of relative importance, while factors such as meeting household needs, fuel savings, higher income levels, effective financing and facilitative government action seem critical and necessary for success, none is sufficient in its own right to guarantee adoption and sustained use, and all those relevant to a given setting need to be assessed. Accordingly, these are described as 'necessary but not sufficient'. The nature of the available evidence does not support a more formal prioritisation of factors, and the relevance of most will vary according to context (setting, fuel and technology); indeed some are very specific to fuel type, especially for biogas and solar cookers.

Consistency across different types of evidence, countries and settings supports the robustness of the findings and the general relevance of individual factors. Findings from this review draw on experience from some large-scale programmes including the Indian and Chinese national improved stove programmes, the national mega-conversion from kerosene to LPG in Indonesia and the Brazilian LPG experience, but mainly stem from much smaller-scale projects and programmes.

Factors influencing the adoption and use of improved solid fuel stoves

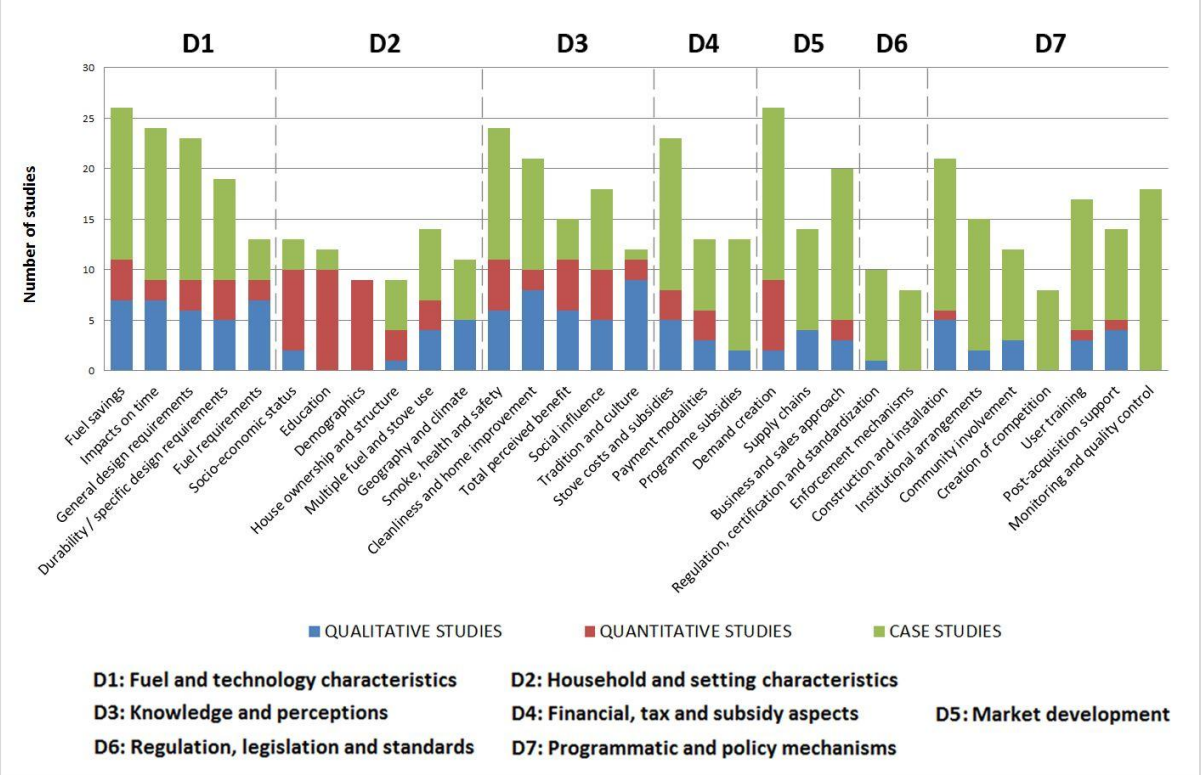
A total of 31 factors spread across all the seven pre-defined domains were identified for ICS (see Figure ES.2) and are further discussed in section 4.2 of this report. Sensitivity analysis excluding weak studies led to little substantive change in the levels of evidence supporting each domain. Based on these findings, the assessment of all factors as relevant to the setting would seem to be important for ensuring the best prospects for success in adoption and sustained use of ICS.

As noted for the overall findings, the nature of the available evidence for ICS does not support formal prioritisation of these factors or domains; all of the factors can be influential, most are inter-related, and many are context-specific. Nevertheless, some appear to be critical to the extent that if these are not met, adoption and sustained use are unlikely. Examples of some of these (note this is not an exhaustive list) include: (i) meeting users' needs, particularly for cooking main dishes and being able to use large enough pots; (ii) providing valued savings on fuel; (iii) offering products of a quality that meets user expectations and ensures durability; (iv) having success with early adopters, in particular opinion formers; (v) guaranteeing support (e.g. loans) for businesses producing and promoting ICS; (vi) ensuring support to users in initial use, and for maintenance, repair and replacement; (vii) developing an efficient and reliable network of suppliers/retailers; and (viii) providing financial assistance for equitable access and/or for more expensive ICS.

Subsidies remain a complex area of policy, and can work for and against adoption and sustained use, depending on how these are applied and managed. Subsidies are likely to be important for equity of access, especially with respect to better-performing and more expensive ICS, but must be managed carefully to avoid adverse effects on markets and on the perceived value of the technology.

Several factors were supported by only a few studies, but this does not imply that they are unimportant for adoption and continuity of use over time. For example, the lack of evidence on standards, testing and certification (Domain 6) is mainly a reflection of the fact that these instruments have not been widely available and implemented, and a concomitant lack of attention in research studies.

Figure ES.2: Factors influencing the uptake of ICS across seven domains (D1–D7), by study type and number of studies



Factors influencing the adoption and use of clean fuels

Several factors are common to all four types of clean fuel intervention. The cost associated with using clean fuels is one of the more important factors determining adoption, the extent to which these fuels are used (that is, the proportion of cooking done with clean as compared to traditional fuels) and sustained use.

Costs include three major components: (i) the initial outlay for the technology, (ii) the ongoing purchase of fuel, and (iii) the maintenance of the technology/system; these vary significantly between fuel types. Ongoing fuel purchase does not apply to fuels such as biogas or solar cookers, but maintenance does and this aspect is very important in

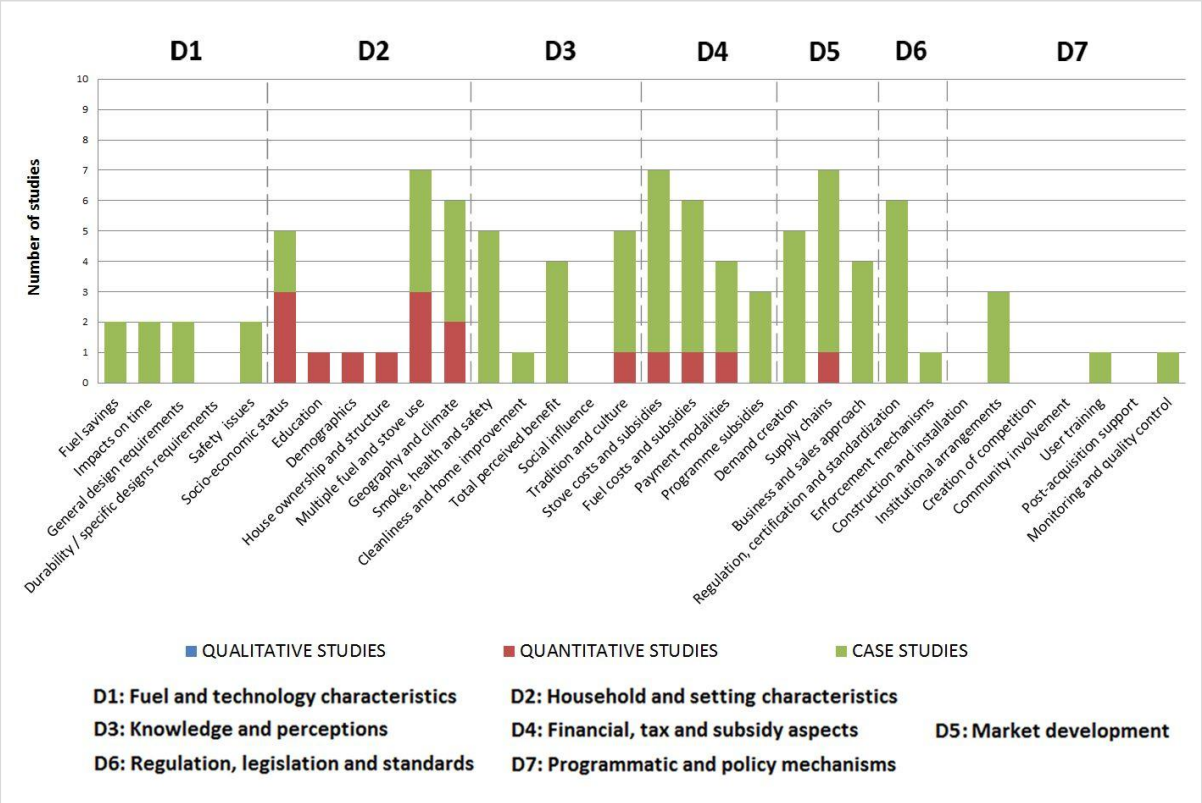
promoting effective use over time. Other aspects relevant to individual clean fuels are further described below.

Liquefied petroleum gas

A total of 26 factors across the seven pre-specified domains were identified for LPG (see Figure ES.3 and section 5.1). Following exclusion of weak studies through sensitivity analysis, evidence was available for 23 out of the 26 factors, with some representation across all seven domains, although this was very limited for Domains 3, 6 and 7.

LPG is an aspirational fuel for many (if not most) households currently using solid or other liquid fuels (e.g. kerosene), but both the start-up costs and ongoing fuel costs are relatively high. Exclusive use for cooking is limited to higher-income and mainly urban households; where used by lower-income and rural populations, this is almost always in combination with traditional (solid) fuels and stoves appropriate to needs and financial circumstances. Issues of safety (and associated regulation), production vs importation, oil price volatility, subsidy, demand and distribution/availability are critical determinants of the use of LPG and require a strong policy and programme management response.

Figure ES.3: Factors influencing the uptake of LPG across seven domains (D1–D7), by study type and number of studies



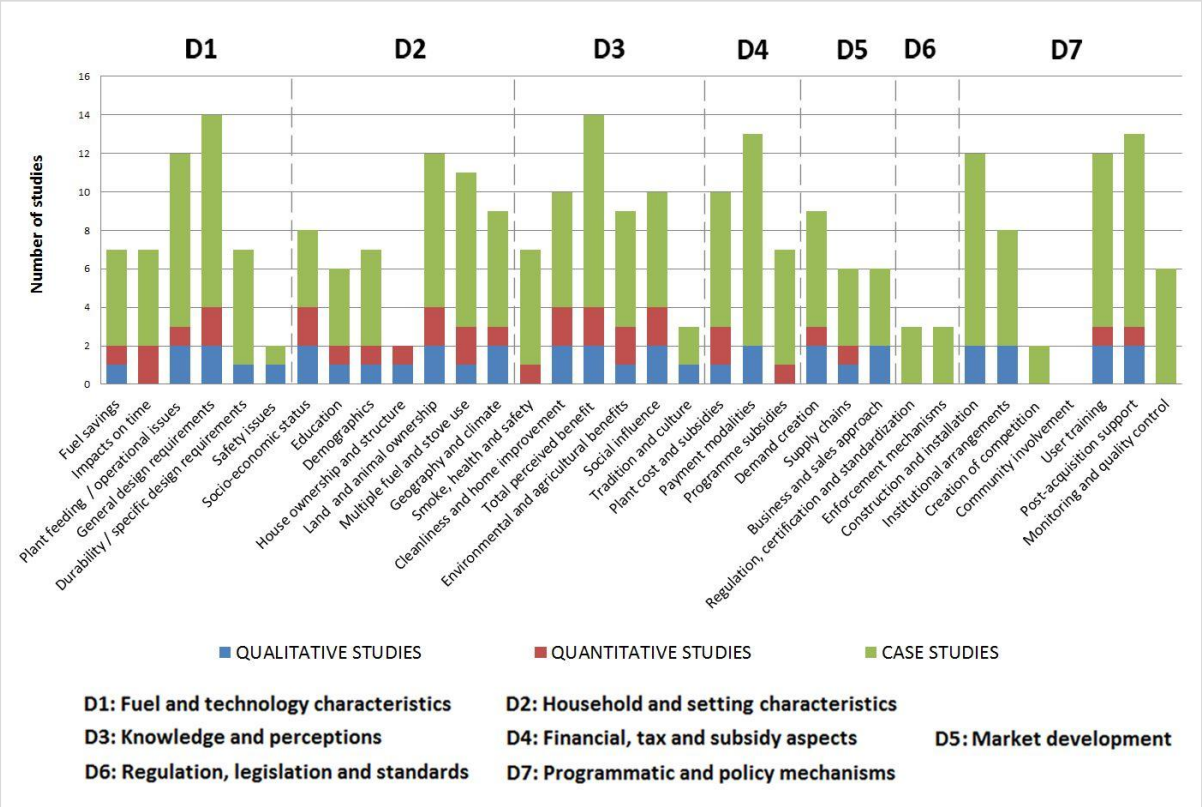
Biogas

A total of 33 factors spread across all seven pre-defined domains were identified for biogas (see Figure ES.4 and section 5.2). Sensitivity analysis made very little difference to the evidence available for each of these factors.

Production and use of this fuel are constrained by a set of necessary conditions, including adequate numbers of livestock and suitable farming practices, water supply, climate (the technology does not function in low temperatures without costly enhancements) and labour to manage the digester. As a consequence, biogas is most suitable for rural households, although urban users are by no means excluded.

Biogas systems are expensive to install (costs range from approximately US$180 to $500 depending on type, etc.), and substantial financial support, mostly in the form of subsidies to users, has been the norm for all programmes reviewed. Maintenance and repair services are also needed if the biogas plant is to function well over many years. When functioning well and appropriately maintained, the fuel is popular in everyday use. It saves on wood collection and/or purchase, provides fertiliser slurry, can be used for lighting and can be linked to a latrine which both improves sanitation and provides additional feed.

Figure ES.4: Factors influencing the uptake of biogas across seven domains (D1–D7), by study type and number of studies



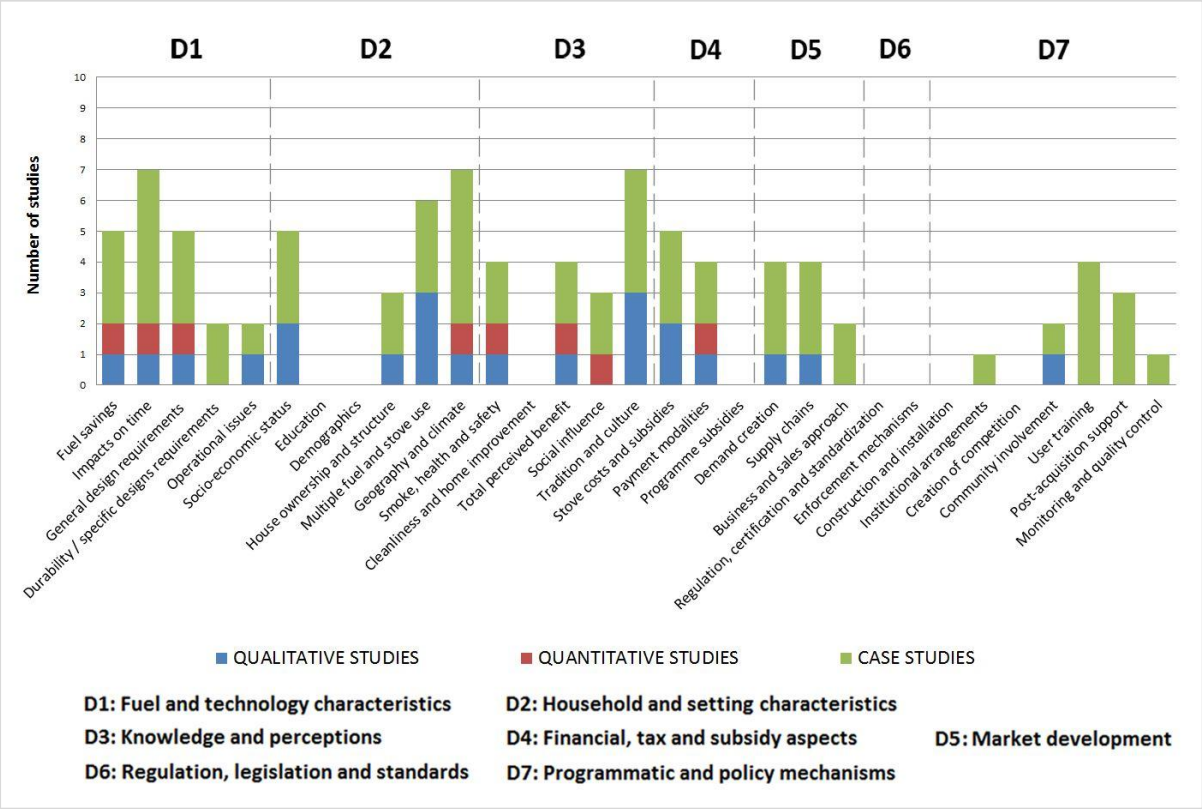
Solar cookers

A total of 23 factors across six of the pre-defined domains were identified for solar cookers (see Figure ES.5 and section 5.3). Most of the evidence pertains to the first three domains, and no study reported on Domain 6. Following sensitivity analysis, 21 factors were retained with at least some supporting evidence, although the factors 'institutional arrangements' and 'monitoring and quality control' were lost.

Solar cooking can be very effective but has restricted potential, as experience shows that even among users familiar with solar cookers it generally only meets around 25–33 percent of cooking needs. It relies on high levels of sunshine and appropriate placement. Users need training to plan ahead for their cooking requirements, in particular because the cooker can be used only during the middle of the day.

It may, however, have more potential than realised as an option complementing other fuels and technologies, not least as it can save on fuel collection and costs, including expensive clean fuels. However, to date production and marketing of low-cost, high-quality solar cookers has been constrained by what would appear to be a piecemeal and poorly co-ordinated strategy.

Figure ES.5: Factors influencing the uptake of solar cookers across seven domains (D1–D7), by study type and number of studies



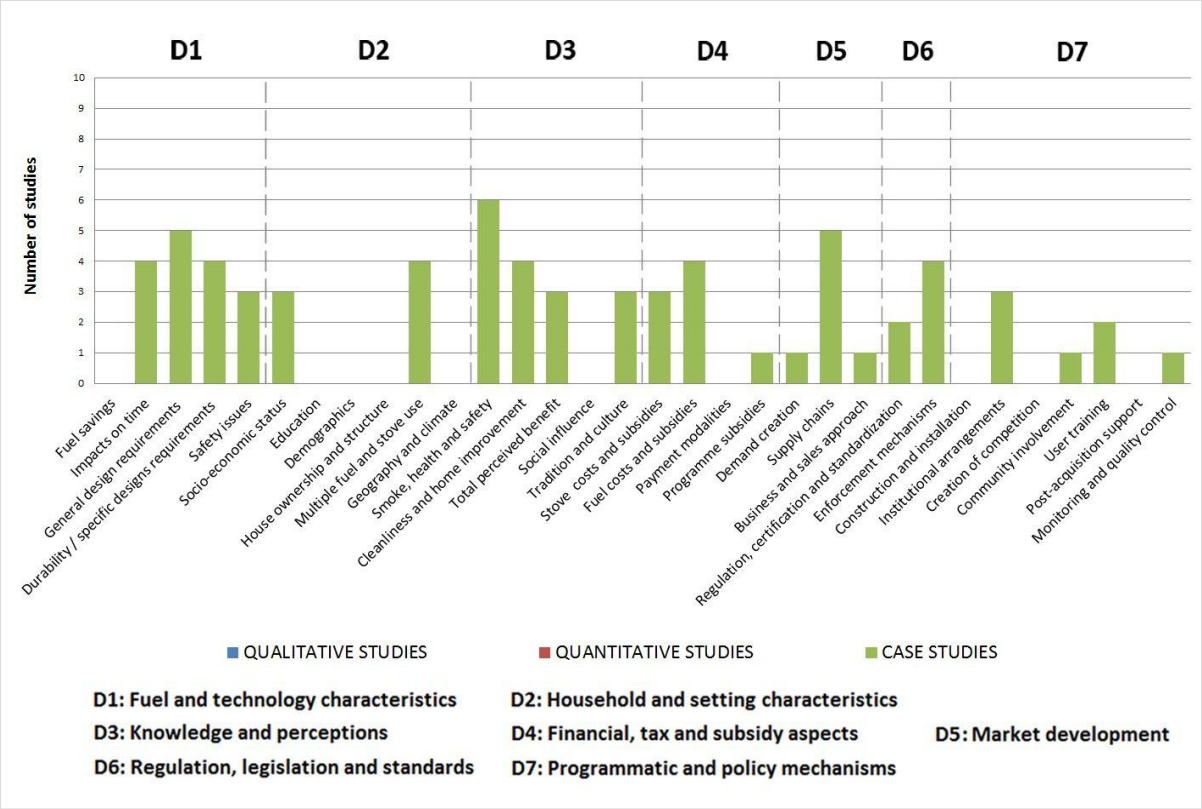
Alcohol fuels

A total of 22 factors across the seven domains were identified for alcohol fuels (see Figure ES.6), with the majority of identified studies (five out of six) concerned with ethanol rather than methanol (section 5.4). All of the available reports were case studies. Also, as most studies were small-scale feasibility studies, special attention was given to users' perceptions of stove design, the advantages and disadvantages of stove use during tests and willingness to pay for the fuel. Following sensitivity analysis, the number of factors with supporting evidence was reduced to 17, with loss of information in Domains 4, 5 and 7.

Ethanol is a relatively new household fuel for which there is less evidence than for the other fuels reviewed here. As a consequence, firm conclusions cannot currently be drawn on the situations and circumstances where it is most likely to succeed. Nevertheless, as a renewable, safe, clean and relatively cheap fuel (compared to LPG, although ethanol costs do vary according to production and taxation arrangements) it may have considerable potential for urban settings and possibly also for rural areas.

Although it can be produced from a wide range of feedstock, land competition with agricultural production and excise (pricing) issues arising from the need to separate its use as a fuel from the legal and illegal alcoholic beverage markets present challenges, and should be priorities for strong and consistent policy.

Figure ES.6: Factors influencing the uptake of alcohol fuels across seven domains (D1–D7), by study type and number of studies



Equity considerations

Inequalities in relation to poverty, urban–rural location and gender are still prevalent and programmes will need to adopt strategies to overcome these.

Evidence suggests that an explicit focus on equity as part of a programme's objective can facilitate the targeting of disadvantaged households in terms of geographic setting (e.g. rural, more remote settings) and SES. While mechanisms to reach families on lower incomes have been employed by some programmes/initiatives, exclusively market-based dissemination programmes usually fail to penetrate beyond a certain level of poverty. Poor people tend to use the limited resources they have on what they regard as more pressing household priorities and hence generate little or no demand for improved stoves and/or clean technologies. However, a gender-sensitive approach may increase success through a better understanding of women's and men's needs and their appropriate involvement in technology development and implementation. Also, use of gender-sensitive promotional campaigns (targeting both women and men) may increase willingness to pay, as it is usually men who exercise the greater control over household expenditure, and control decisions with regards to installing/buying a new technology.

Common and distinct factors across interventions

The majority of factors are common to all or most of the five interventions reviewed, although there are also some important differences, which usually reflect specific requirements for one or more of the clean fuels (in particular for biogas and solar cookers, where unique factors apply). Lack of evidence for some of the listed factors however – especially among the clean fuels – does not necessarily mean a factor is unimportant. This could partially reflect limited research into some of these aspects. Therefore the summary table (Table ES.1) provided here should be considered as a synthesis based on the knowledge gained so far from the available studies, and not necessarily as a definitive account of all factors important to adoption and use of each of the fuels and technologies reviewed (see Chapter 6).

For example, among the common factors identified, initial stove cost and ongoing fuel costs play a crucial role in influencing uptake, as well as the characteristics of the fuel and cooking technology itself. Design and construction includes a set of very important aspects such as the use of well-designed technology with quality materials and careful construction in order to meet users' needs and ultimately to significantly reduce emissions and improve safety.

Time saving can be an important enabler and improved stoves and fuels can save time in two main ways, first in reduced fuel collection time and second through more efficient cooking. With respect to time saving, the issue of opportunity cost also emerges as a common theme across both ICS and clean fuels: where time saving is valued (e.g. where fuel is paid for and labour is more limited or it is possible to engage in paid employment), this acts as an enabler, but where not or less valued (e.g. in rural areas with more abundant labour, especially where education levels are low) this enabling function seems less apparent. Programme planning should include assessment of how time and fuel savings are valued, and should be followed up by engagement with prospective users to see whether and how appreciation of the opportunity costs of inefficient fuel collection and cooking can be increased. By contrast, households that purchase rather than collect

wood or other commercial fuels are more likely to adopt an improved stove with demonstrably better fuel efficiency, as monetary savings are directly experienced and more highly valued by those already paying for their fuel.

Table ES.1: Common and distinct factors influencing uptake of ICS and clean fuels

Domain	Factors influencing uptake	ICS	Clean fuels			
			LPG	*Biogas*	*Solar cookers*	*Alcohol fuels*
Fuel and technology characteristics	Fuel savings	✓	✓	✓	✓	-
	Impacts on time	✓	✓	✓	✓	✓
	General design requirements	✓	✓	✓	✓	✓
	Durability/specific design requirements	✓	-	✓	✓	✓
	Fuel requirements	✓	-	-	-	-
	Operational issues	-	-	✓	✓	-
	Safety issues	-	✓	✓	-	✓
Household and setting characteristics	Socio-economic status	✓	✓	✓	✓	✓
	Education	✓	✓	✓	-	-
	Demographics	✓	✓	✓	-	-
	House ownership and structure	✓	✓	✓	✓	-
	Land and animal ownership	-	-	✓	-	-
	Multiple fuel and stove use	✓	✓	✓	✓	✓
	Geography and climate	✓	✓	✓	✓	-
Knowledge and perceptions	Smoke, health and safety	✓	✓	✓	✓	✓
	Cleanliness and home improvement	✓	✓	✓	-	✓
	Total perceived benefit	✓	✓	✓	✓	✓
	Social influence	✓	-	✓	✓	-
	Tradition and culture	✓	✓	✓	✓	✓
	Environmental and agricultural benefits	-	-	✓	-	-
Financial, tax and subsidy aspects	Stove costs and subsidies	✓	✓	✓	✓	✓
	Fuel costs and subsidies	-	✓	-	-	✓
	Payment modalities	✓	✓	✓	✓	-
	Programme subsidies	✓	✓	✓	✓	✓
Market development	Demand creation	✓	✓	✓	✓	✓
	Supply chains	✓	✓	✓	✓	✓
	Business and sales approach	✓	✓	✓	✓	✓
Regulation, legislation and standards	Regulation, certification and standardisation	✓	✓	✓	-	✓
	Enforcement mechanisms	✓	✓	✓	-	✓
Programmatic and policy mechanisms	Construction and installation	✓	-	✓	-	✓
	Institutional arrangements	✓	✓	✓	✓	✓
	Community involvement	✓	-	-	✓	✓
	Creation of competition	✓	-	✓	-	-
	User training	✓	✓	✓	✓	✓
	Post-acquisition support	✓	✓	✓	✓	-
	Monitoring and quality control	✓	✓	✓	✓	✓

Conclusions and recommendations for research and practice

The breadth of factors identified across domains may appear to present a challenge for focused and efficient policy-making, so the question of which are most important is critical.

This review has reported on the enabling and limiting roles of a wide range of factors under seven domains, and found that, although some are critical for success, none guarantees this and therefore it is important to consider all those factors that are relevant to a given setting, technology or fuel.

Consequently, it is recommended that a policy planning tool incorporating the findings of the review work be developed and tested. Given that specific policy and programmatic actions are dependent on the choice of intervention and setting, the tool needs to incorporate an element of flexibility in order to allow adaptation. A proposal for the content of this tool is described in Table ES.2, covering seven key components; this would be applicable to both programme planning and in the evaluation of programmes that have already been implemented.

Interactions are noted as important, and may operate at the level of individual factors (within and between domains), but also between sets of domains. Thus, it is important to recognise that some factors primarily act at the household or community level (e.g. Household and setting characteristics; Knowledge and perceptions) whereas other factors primarily act at the regional, national and international level (e.g. Financial, tax and subsidy aspects; Regulation, legislation and standards). Since all domains impact in a significant way on whether programmes reach their intended populations and whether they achieve sustained adoption and use, this suggests that the connection between local and national levels is important, if programmes are to be successful at scale and over extended periods of time. Given the structure and function proposed for the policy planning tool, such interactions can be highlighted, although the most useful method and format for doing so will need to be refined through development and testing.

In addition to the development and testing of a policy tool, two general recommendations for research and practice emerge. First, future and ongoing intervention programmes or initiatives should – in addition to ensuring the technology/fuel meets needs and expectations – establish the effectiveness of the stoves and fuels, in particular in relation to reducing emissions and exposure to household air pollution, but also in relation to fuel efficiency and safety, prior to embarking on large-scale dissemination. Second, such programmes should be accompanied by robust monitoring and evaluation efforts and, in selected cases, by research studies designed specifically to strengthen the understanding of which factors are most important for securing adoption and sustained use, including maintenance and replacement. Such research studies will need to draw on a combination of quantitative and qualitative scientific approaches.

Table ES.2: Key components of the proposed policy planning tool

Section	Component	Explanation
I	*Programme information*	A preliminary section to record key information on the setting, fuel and technology (single or multiple), delivery mechanisms, etc., being assessed.
II	*Framework covering all factors in the seven domains, and key aspects for equity*	The tool would be structured to allow assessment of all domains and factors. This can be prepared within a suitable software program with each domain represented by a separate section, and structured to facilitate assessment of factors, summarising findings, and highlighting interactions between domains, as described in sections III–VI below.
III	*Method for assessing the relevance of each factor*	This component would assist in determining the relevance of each factor to the setting, technology and fuel under consideration (section I above). Based on the information in section I, certain factors may be given more or less emphasis. In addition, guidance would be provided for making further assessment of relevance in the setting.
IV	*Data collection to assess each factor*	Survey instruments and examples of other sources of information would be provided to assist in assessing the status of each (relevant) factor. It is expected the survey forms would mainly be in outline form to allow adaptation to local circumstances, although more complete sections would be provided where appropriate.
V	*A scheme for assessing how each factor is operating*	Based on the information collected on each factor in section IV, a scheme will be provided to assess whether each factor is acting as a barrier or enabler and (if possible) the extent. A scoring system will be developed to simplify this and allow comparison, while preserving important information on direction and strength of effect.
VI	*Guidance for compiling results for individual factors by domain, and highlighting inter-relationships*	A facility will be built into the tool to compile and display the results for each factor, and to summarise these by domain. In addition, important interactions can be highlighted, some of which can be 'built-in' within the tool to draw attention to common or expected interactions, but also with a component that is user-defined.
VII	*Guidance on application of results*	The final component will provide guidance to users on reviewing the results by factor, by domain, and overall for the purpose of programme planning and evaluation. This guidance will be developed and improved during testing and initial piloting of the tool with programme partners.

References

8.1 Reference list of included studies on improved solid fuel stoves

Agurto-Adrianzen M (2009) The role of social capital in the adoption of firewood efficient stoves in northern Peruvian Andes. MPRA Paper No. 15918. Munich: Munich Personal RePEc Archive. Available at: mpra.ub.uni-muenchen.de/15918/1/MPRA_paper_15918.pdf (accessed 1 August 2013).

Amarasekera RM (1989) Sri-Lanka - status of improved woodstove dissemination in Sri-Lanka. In: Cáceres, R (ed.) Stoves for people. Proceedings of the 2nd International Workshop on Stoves Dissemination, Antigua, Guatemala, 4-10 October. Exeter: IT Publications, pages 118–121.

Anderson ZC (2007) Reducing indoor air pollution on developing countries: a case study investigating the utilization of improved stoves in rural India. Available at: http://www.hedon.info/docs/Acasestudyinvestigatingtheutilizationofimprovedsto%5B1%5D..pdf (accessed 1 August 2013).

Barnes DF, Kumar P, Openshaw K (2012) Cleaner hearths, better homes: new stoves for India and the developing world. New York: Oxford University Press.

Barnes DF, Kumar P, Openshaw K (2012a) Maharashtra – commercial approach. Chapter 3 in: Cleaner hearths, better homes: new stoves for India and the developing world. New York: Oxford University Press, pages 24–35.

Barnes DF, Kumar P, Openshaw K (2012b) Haryana – women's involvment approach. Chapter 4 in: Cleaner hearths, better homes: new stoves for India and the developing world. New York: Oxford University Press, pages 36–49.

Barnes DF, Kumar P, Openshaw K (2012e) Andhra Pradesh – interagency coordination. Chapter 7 in: Cleaner hearths, better homes: new stoves for India and the developing world. New York: Oxford University Press, pages 78–94.

Barnes DF, Kumar P, Openshaw K (2012f) West Bengal – nongovernmental organisations. Chapter 8 in: Cleaner hearths, better homes: new stoves for India and the developing world. New York: Oxford University Press, pages 95–113.

Barnes DF, Kumar P, Openshaw K. (2012c) Karnataka – technical innovation and institutions. Chapter 5 in: Cleaner hearths, better homes: new stoves for India and the developing world. New York: Oxford University Press, pages 24–35.

Barnes DF, Kumar P, Openshaw K. (2012d) Gujarat – rural development approach. Chapter 6 in: Cleaner hearths, better homes: new stoves for India and the developing world. New York: Oxford University Press, pages 64–77.

Bensch G, Peters J (2011) Combating deforestation? – Impacts of improved stove dissemination on charcoal consumption in urban Senegal. Ruhr Economic Papers No. 306. Essen: Rheinisch-Westfälisches Institut für Wirtschaftsforschung. Available at: http://en.rwi-essen.de/publikationen/ruhr-economic-papers/ (accessed 5 July 2011).

Chowdhury MSH, Koike M, Akther S, Miah MD (2011) Biomass fuel use, burning technique and reasons for the denial of improved cooking stoves by forest user groups of Rema-Kalenga Wildlife Sanctuary, Bangladesh. International Journal of Sustainable Development and World Ecology 18(1): 88–97.

Christoff J (2010) Benefits and barriers: exploring complete and sustained ecological stove usage in rural Mexico. MPhil thesis, Yale University, New Haven, Connecticut.

Damte A, Koch SF (2011) Clean fuel saving technology adoption in urban Ethiopia. ERSA Working Paper 229. Pretoria: University of Pretoria.

George R, Yadla VL (1995) Factors affecting perception of beneficiaries of National Programme on Improved Cookstoves regarding cost-benefit of adoption of Mamta stove. Procedeedings of Solar 95, Annual Conference of the American Solar Energy Society, Minneapolis, Minnesota, pages 361–366.

GERES (2009) Dissemination of domestic efficient cookstoves in Cambodia. Renewable Energy, Environment and Solidarity Group GERES edition. Available at: www.geres.eu/images/stories/publis/publi-nls-en.pdf (accessed 2 April 2013).

Gordon JK, Emmel ND, Manaseki S, Chambers J (2007) Perceptions of the health effects of stoves in Mongolia. Journal of Health Oganization and Management 21(6): 580-587.

Inayatullah J (2011) What makes people adopt improved cookstoves? Empirical evidence from rural northwest Pakistan. Governance of Clean Development Working Paper Series 012. Norwich: University of East Anglia, School of International Development.

Jagoe K, Bromley H, Chengappa C, Bruce NG (2006a) Standard monitoring packages for household energy and health field projects. Evaluation of the health and socio-economic impacts of development alternatives pilot project 'Energy Services for Village Households and Rural Enterprises in Bundelkhand - India'. Final Report, December 2006. Qualitative findings. University of Liverpool unpublished report. Personal communication.

Jagoe K, Bromley H, Chengappa C, Bruce NG (2006b) Standard monitoring packages for household energy and health field projects. Evaluation of the health and socio-economic impacts of development alternatives pilot project 'Energy Services for Village Households and Rural Enterprises in Bundelkhand - India'. Final Report. Quantitative findings. University of Liverpool unpublished report. Personal communication.

Jagoe K, Bromley H, Dutta K, Bruce N (2007a) Standard monitoring packages for household energy and health field projects (ARTI – India). Final report, July 2007. Qualitative findings. University of Liverpool unpublished report. Personal communication.

Jagoe K, Bromley H, Dutta K, Bruce N (2007b) Standard monitoring packages for household energy and health field projects (ARTI – India). Final report, July 2007. Quantitative findings. University of Liverpool unpublished report. Personal communication.

Kürschner E, Diehl E, Hermann-Friede J, Hornikel C, Rosenbusch J, Sagmeister E (2009) Impact of basic rural energy services in Bangladesh. SLE Publication Series – S238. University of Berlin. Available at: http://edoc.hu-berlin.de/series/sle/238/PDF/238.pdf (accessed 2 August 2011).

Levine DI, Cotterman C (2012) What impedes efficient product adoption? Evidence from randomized variation in sales offers for improved cookstoves in Uganda. Working Paper Series, Institute for Research on Labor and Employment. San Francisco: University of California at Berkeley.

Masera O, Díaz R, Berrueta V (2005) From cookstoves to cooking systems: the integrated program on sustainable household energy use in Mexico. Energy for Sustainable Development 9(1): 25–36.

Mounkaila (1989) Niger - The Promotion and Dissemination of Improved Stoves. In: Cáceres R (ed.) Stoves for people. Proceedings of the 2nd International Workshop on Stoves Dissemination, Antigua, Guatemala, 4–10 October. Exeter: IT Publications, pages 46–50.

Muneer ETS, Mohamed MEW (2003) Adoption of biomass improved cookstoves in a patriarchal society: an example from Sudan. Science of the Total Environment 307(1–3): 259–266.

Mwangi A (1992) Analysis of wood energy production and consumption strategies among small-scale farmers in central Kenya. PhD thesis, Michigan State University, East Lansing.

Namuye SA (1989) Survey on dissemination and impact of Kenya Ceramic Jiko in Kenya. In Cáceres R (ed.) Stoves for people. Proceedings of the 2nd International Workshop on Stoves Dissemination, Antigua, Guatemala, 4–10 October. Exeter: IT Publications, pages 40-44.

Osei RD (2010) Toyola charcoal stove: improving the environmenet and health of the poor in Ghana. GIM Case Study No. B095. New York: United Nations Development Programme.

Pandey S (1989) Some factors determining level of use of improved stoves by Brahmin and Chhetri women in Central Nepal. PhD thesis, Case Western Reserve University, Cleveland, Ohio.

Pandey S, Yadama GN (1992) Community development programs in Nepal: a test of diffusion of innovation theory. Social Service Review 66(4): 582–584.

Person B, Loo JD, Owuor M, Ogange L, Jefferds ME, Cohen AL (2012) "It is good for my family's health and cooks food in a way that my heart loves": qualitative findings and implications for scaling up an improved cookstove project in rural Kenya. International Journal of Environmental Research and Public Health 9: 1566–1580.

Pine K, Edwards R, Masera O, Schilmann A, Marrón-Mares A, Riojas-Rodríguez H (2011) Adoption and use of improved biomass stoves in Rural Mexico. Energy for Sustainable Development 15(2): 176–183.

Pushpa K (ed.) (2011) Factors associated with the adoption of improved cook stoves in southern parts of India. Paper presented at: Humanities, Science and Engineering Research (SHUSER), International Symposium 2011, Kuala Lumpur, Malaysia. doi 0.1109/SHUSER.2011.6008490.

Sawadogo A (1989) Fuelwood consumption and improved stoves diffusion in Ouagadougou City. In: Cáceres R (ed) Stoves for people. Proceedings of the 2nd International Workshop on Stoves Dissemination, Antigua, Guatemala, 4–10 October. Exeter: IT Publications, pages 3–9.

Sesan TA (2012) Navigating the limitations of energy poverty: lessons from the promotion of improved cooking technologies in Kenya. Energy Policy 47: 202–210.

Shastri CM, Sangeetha G, Ravindranath NH (2002) Dissemination of efficient ASTRA stove: case study of a successful entrepreneur in Sirsi, India. Energy for Sustainable Development 6(2): 63-67.

Shrimali G, Slaski X, Thurber MC, Zerriffi H (2011) Improved stoves in India: a study of sustainable business models. Energy Policy 39(12): 7543–7556.

Silk B, Sadumah I, Patel M, Were V, Person B, Harris J, Otieno R, Nygren B, Loo J, Eleveld A, Quick RE, Cohen AL (2012) A strategy to increase adoption of locally-produced, ceramic cookstoves in rural Kenyan households. BMC Public Health 13(359). doi: 10.1186/471-2458-12-359.

Simon G (2007) Brokering development: geographies of mediation and energy sector reforms in Maharashtra, India. Ph.D thesis, University of Washington, Seattle.

Simon G (2010) Mobilizing cookstoves for development: a dual adoption framework analysis of collaborative technology innovations in Western India. Environmental Planning 42(8): 2011–2030.

Sinton JE, Smith KR, Peabody JW, Yaping L, Xiliang Z, Edwards R, Quan G (2004) An assessment of programs to promote improved household stoves in China. Energy for Sustainable Development 8(3): 33–52.

Sovacool B, Drupady I (2011) Summoning earth and fire: the energy development implications of Grameen Shakti (GS) in Bangladesh. Energy 36(7): 4445–4459.

Sudjarwo A, Herm UY, Suryaningati D, Sumarni, Sunarno (1989) Indonesia – pottery stoves, their production, dissemination and adoption. In: Cáceres R (ed.) Stoves for people. Proceedings of the 2nd International Workshop on Stoves Dissemination, Antigua, Guatemala, 4–10 October. Exeter: IT Publications, pages 32–38.

Troncoso K, Castillo A, Masera O, Merino L (2007) Social perceptions about a technological innovation for fuelwood cooking: Case study in rural Mexico. Energy Policy 35(5): 2799–2810.

Troncoso K, Castillo A, Merino L, Lazos E, Masera OR (2011) Understanding an improved cookstove program in rural Mexico: an analysis from the implementers' perspective. Energy Policy 39(12): 7600–7608.

USAID/Winrock (2008) Peru healthy kitchen/healthy stove pilot project. Washington, DC: United States Agency for International Development. Available at: http://pdf.usaid.gov/pdf_docs/PDACN009.pdf (accessed 2 August 2011).

USAID/Winrock (2009) Commercialization of improved cookstoves for reduced indoor air pollution in urban slums of northwest Bangladesh. Washington, DC: United States Agency for International Development. Available at: http://pdf.usaid.gov/pdf_docs/pnado851.pdf (accessed 2 August 2011).

Velasco I (2008) More sustainable cooking technologies – a case study in rural kitchens in Michoacan, Mexico. MSc thesis, Lund University. Available at: www.lumes.lu.se/database/alumni/06.08/thesis/Ignacio_Velasco.pdf (accessed 12 July 2011).

Wallmo K, Jacobson SK (1998) A social and environmental evaluation of fuel-efficient cook-stoves and conservation in Uganda. Environmental Conservation 25(2): 99–108.

World Bank (2004a) Case study 1: Tezulutlan project. In: Evaluation of improved stove programs in Guatemala: final report of project case studies. ESMAP Technical paper No. 60. Washington, DC: World Bank, pages 21–44.

World Bank (2004b) Case study 2: social investment fund project. In: Evaluation of improved stove programs in Guatemala: final report of project case studies. ESMAP Technical Paper No. 60. Washington, DC: World Bank, pages 45–68.

World Bank (2004c) Case study 3: Intervida project. In: Evaluation of improved stove programs in Guatemala: final report of project case studies. ESMAP Technical Paper No. 60. Washington, DC: World Bank, pages 69–90.

World Bank (2010a) BCSIR: Improved Cookstove Program, Phase II. In: Improved cookstoves and better health in Bangladesh: lessons from household energy and sanitation programs. Washington, DC: World Bank, pages 15–21.

World Bank (2010b) GTZ Sustainable Energy for Development Program: improved cookstoves component. In: Improved cookstoves and better health in Bangladesh: lessons from household energy and sanitation programs. Washington, DC: World Bank, pages 21–24.

World Bank (2010c) USAID: Reduction of Exposure to Indoor Air Pollution through Household Energy and Behavioral Improvements. In: Improved cookstoves and better health in Bangladesh: lessons from household energy and sanitation programs. Washington, DC: World Bank, pages 24–26.

8.2 Reference list of included studies on LPG

Bates E (2009) Making LPG stoves accessible for low income communities in Kassala, Sudan. In: Rai K, McDonald JU (eds) Cookstoves and markets: experiences and success and opportunities. London: GVEP International.

Budya H, Arofat M (2011) Providing cleaner energy access in Indonesia through the megaproject of kerosene conversion to LPG. Energy Policy 39(12): 7575–7586.

Edwards JHY, Langpap C (2005) Startup costs and the decision to switch from firewood to gas fuel. Land Economics 81(4): 570–586.

Elgarah W (2011) Microfinance for liquefied petroleum gas. GIM Case Study No. B103: New York: United Nations Development Programme.

Heltberg R (2005) Factors determining household fuel choice in Guatemala. Environment and Development Economics 10(3): 337–361.

Lucon O, Coelho ST, Goldemberg J (2004) LPG in Brazil: lessons and challenges. Energy for Sustainable Development 8(3): 82–90.

Pandey J, Morris S (2006) Efficient subsidisation of LPG: a study of possible options in India today (based on a report commissioned by the Petroleum Federation of India). Working Paper 2006-04-0. Ahmedabad: Indian Institute of Management.

Rogers T (2009) Liquid petroleum gas (LPG) as a fuelwood substitute in the Western Ghats of India: Effectiveness and influence of socioeconomic characteristics. MSc thesis, State University of New York, College of Environmental Science and Forestry, Syracuse.

Terrado EN, Eitel B (2005) Pilot commercialization of improved cookstoves in Nicaragua. Energy Sector Management Assistance Programme (ESMAP). Technical Paper Series No. 085. Washington, DC: World Bank.

USAID (2005) LPG market assessment study in Mozambique. Washington, DC: United States Agency for International Development. Available at: http://transition.usaid.gov/mz/doc/misc/moz_lpg_market_assess.pdf (accessed 12 June 2012).

USAID (2010) Assessment of Haiti Alternative Cooking Technologies Program. Washington, DC: United States Agency for International Development. Available at: http://transition.usaid.gov/our_work/economic_growth_and_trade/energy/publications/haiti_cookstoves_assessment.pdf (accessed 2 August 2011).

Viswanathan B, Kumar K (2005) Cooking fuel use patterns in India: 1983–2000. Energy Policy 33(8): 1021–1036.

8.3 Reference list of included studies on biogas

Bajgain S, Shakya I (2005) The Nepal Biogas Support Program: a succesful model of public private partnership for rural household energy supply. The Hague: the Netherlands Ministry of Foreign Affairs. . Available at: www.snvworld.org/en/publications/biogas-support-programme-a-successful-model-of-public-private-partnership-for-rural/ (accessed 26 April 2012).

Bhat PR, Chanakya HN, Ravindranath NH (2001) Biogas plant dissemination: success story of Sirsi, India. Energy for Sustainable Development 5(1): 39–46.

BSP and CEDA (1998) A study on the effective demand for biogas in Nepal - final report. Biogas Support Programme and Centre for Economic Development and Administration. SNV World Publications. Available at: www.snvworld.org/en/publications/a-study-on-the-effective-demand-for-biogas/ (accessed 12 June 2012).

Christiaensen L, Heltberg R (2012) Greening China's rural energy: new insights on the potential of smallholder biogas. World Bank Policy Research Working Paper No. 6102. Washington, DC: World Bank.

Daxiong Q, Shuhua G, Baofen L, Gehua W (1990) Diffusion and innovation in the Chinese biogas program. World Development 18(4): 555–563.

de Alwis A (2002) Biogas – a review of Sri Lankas performance with a renewable energy technology. Energy for Sustainable Development 6(1): 30–37.

Dutta S, Ibrahim HR, Malhotra P, Ramana PV (1997) Biogas: the Indian NGO experience. New Delhi: AFPRO-CHF Network Programme.

Ghimire PC (2005) Final report on technical study of biogas plants installed in Bangladesh. National Program on Domestic Biogas in Bangladesh, a Partnership Program of Netherlands Development Organisation (SNV) and Infrastructure Development Company Ltd (IDCOL). Available at: http://m.snvworld.org/sites/www.snvworld.org/files/publications/technical_study_of_biogas_plants_installed_bangladesh_2005.pdf (accessed 18 June 2012).

iDE (2011) Annual Biogas Users Survey 2010. Final report. Submitted to Infrastructure Development Company Limited (IDCOL), National Domestic Biogas and Manure Programme (NDBMP). Available at: www.snvworld.org/sites/www.snvworld.org/files/publications/biogas_user_survey_2010_bangladesh_2011.pdf (accessed 4 April 2012).

Jian L (2009) Socioeconomic barriers to biogas development in rural southwest China: an ethnographic case study. Human Organization 68(4): 415–430.

Kumargoud V, Mahesha M, Revanna ML, Venkatachalapathy K (2006) Impact of biogas technology on rural women. Environment and Ecology 24S(special 2): 468–471.

Mwirigi JV, Makenzi PM, Ochola WO (2009) Socio-economic constraints to adoption and sustainability of biogas technology by farmers in Nakuru Districts, Kenya. Energy for Sustainable Development 13:106–15.

Planning Commission (2002) Evaluation study on national project on biogas development. Planning Commission, Programme Evaluation Organisation, Goverment of India. SNV Publisher. Available at: www.snvworld.org/node/3108 (accessed 6 July 2012).

Qi Z, Li G (eds) (2010) Contributions and constraints of rural household biogas construction project in northeast China: a case study of Gongzhuling County. Paper presented at: International Conference on Management and Service Science 2010, Wuhan, China. doi: 10.1109/ICMSS.2010.5576785p.

Sovacool B, Drupady I (2011) Summoning earth and fire: the energy development implications of Grameen Shakti (GS) in Bangladesh. Energy 36(7): 4445–4459.

World Bank (2010d) BCSIR/LGED: biogas program. In: Improved cookstoves and better health in Bangladesh: lessons from household energy and sanitation programs. Washington, DC: World Bank, pages 27–30.

World Bank (2010e) IDCOL/SNV: National Domestic Biogas And Manure Programme. In: Improved cookstoves and better health in Bangladesh: lessons from household energy and sanitation programs. Washington, DC: World Bank: pages 30–32.

8.4 Reference list of included studies on solar cookers

Ahmad B (2001) Users and disusers of box solar cookers in urban India – implications for solar cooking projects. Solar Energy 69(suppl.6): 209–215.

Baptista TL, Curnow K, Hiranaga BJ, Magnus BD, Perry D (2003) Solar Household Energy, Incorporated: a market-based strategy for introducing passive solar ovens in Kenya. Ann Arbor: Michigan Business School.

Biermann E, Grupp M, Palmer E (1999) Solar cooker acceptance in South Africa: results of a comparative field-test. Solar Energy 66: 401–407.

Levine DI, Beltramo T (2011) The effect of solar ovens on fuel use, emissions, and health: results from a randomized controlled trial. Draft paper. Berkeley: University of California Available at: http://cega.berkeley.edu/assets/cega_research_projects/24/The_Effect_of_Solar_Ovens_on_Fuel_Use_and_Health.pdf (accessed 15 June 2012)

Otte P (2009) Cooking with the sun – an analysis of solar cooking in Tanzania, its adoption and impact on development. MPhil thesis, Norwegian University of Science and Technology, Trondheim.

Toonen HM (2009) Adapting to an innovation: solar cooking in the urban households of Ouagadougou (Burkina Faso). Physics and Chemistry of the Earth – Parts A/B/C 34(1/2): 65–71.

Sejake S (1998) The impact of an energy intervention: the solar cooker field test in South Africa. Journal of Energy in Southern Africa 9(1): 14.

Sesan TA (2012) Navigating the limitations of energy poverty: lessons from the promotion of improved cooking technologies in Kenya. Energy Policy 47: 202–210.

Velasco I (2008) More sustainable cooking technologies – a case study in rural kitchens in Michoacan, Mexico. MSc thesis, Lund University. Available at: www.lumes.lu.se/database/alumni/06.08/thesis/Ignacio_Velasco.pdf (accessed 12 July 2011).

Wentzel M, Pouris A (2007) The development impact of solar cookers: a review of solar cooking impact research in South Africa. Energy Policy 35(3): 1909-1919.

8.5 Reference list of included studies on ethanol

Couto R (2007) Tapping the potential of proalcool for the household energy sector. Results of Project Gaia's 100 CleanCook Stove pilot study, Minas Gerais State, Brazil. Shell Foundation Project 21316.

Imam D (2011) PPKT: working with the community to grow the business. GIM Case Study No. B086. New York: United Nations Development Programme.

Murren J (2006) User responses - the ethanol-fueled CleanCook Stove's safety, fuel consumption and efficiency. Addis Ababa: Stokes Consulting Group for Project Gaia Research Studies. Available at: www.projectgaia.com/files/UserResponsesCleanCookAddisAbaba.pdf (accessed 2 June 2012).

Obueh J (2008) Project Gaia Nigeria pilot study final report. Results of Project Gaia's CleanCook Methanol Stove pilot study in Delta State, Nigeria. Available at: www.projectgaia.com/files/NigeriaFinalPilotStudyReport.pdf (accessed 6 June 2012).

Practical Action Consulting (2010) Component B: economic assessment of the ethanol household fuel program. In: Ethanol as a household fuel in Madagascar: health benefits, economic assessment, and review of African lessons for scaling-up. Available at:

www.projectgaia.com/documents/Ethanol%20as%20a%20Household%20Fuel%20in%20Madagascar%20Component%20B-%20Economic%20Assessment.pdf (accessed 12 June 2012).

Practical Action Consulting (2011) Component A: analysis of household air pollution interventions in Madagascar. In: Ethanol as a household fuel in Madagascar: health benefits, economic assessment, and review of African lessons for scaling-up. Final report February 2011. Available at: www.projectgaia.com/documents/Ethanol%20as%20a%20Household%20Fuel%20in%20Madagascar-%20Component%20A%20-%20Health%20Benefits.pdf (accessed 12 June 2012).