

What are the enabling or limiting factors influencing the large scale uptake by households of cleaner and more efficient household energy technologies, covering cleaner fuel and improved solid fuel cookstoves?

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December 2011

PROTOCOL

This protocol should be cited as: Puzzolo E, Stanistreet D, Pope D, Bruce N and Rehfues EA. (2011) What are the enabling or limiting factors influencing the large scale uptake by households of cleaner and more efficient household energy technologies, covering cleaner fuel and improved solid fuel cookstoves? A systematic review. Protocol. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London

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List of Abbreviations

AGECC	Advisory Group on Energy and Climate Change
DFID	Department for Social International Development
EAC	East African Community
ECOWAS	Economic Community of West African States
ENERGIA	International network on Gender and Sustainable network
ESMAP	Energy Sector Management Assistance Program
IAP	Indoor Air Pollution
IEA	International Energy Agency
HAP	Household Air Pollution
HEDON	household energy network
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
LPG	Liquefied petroleum gas
UNDP	United Nations Commission on Sustainable Development
UNGACC	UN Foundation Global Alliance for Clean Cookstoves
USAID	United States Agency for International Development
WHO	World Health Organization

1. Background

1.1 Aims and rationale for this review

Ensuring access to clean and efficient household energy is arguably one of the major challenges developing countries face today. Around three billion people rely on solid fuels and traditional, inefficient stove technologies to meet their basic energy needs, including cooking, heating and boiling water (Rehfuess et al, 2006). Unless rapid and effective action is taken, their number will increase over the coming decades (IEA 2004), especially in view of greater vulnerability brought about by climate change, the global financial crisis and volatile energy prices (UNDP & WHO 2009).

Traditional household energy practices have dramatic consequences for health, the environment and socio-economic development. Household air pollution (HAP) (also referred to as indoor air pollution or IAP) from burning solid fuels is an important risk factor for pneumonia, chronic respiratory diseases and several other health outcomes, resulting in more than 1.5 million annual deaths, primarily among children and women (WHO 2006).

The inefficient burning of solid fuels also represents an unsustainable use of natural resources, aggravating deforestation in areas where wood is scarce. It also contributes to climate change, as much of the fuel energy is lost as so-called products of incomplete combustion, including the potent climate warming pollutants methane and black carbon (Pennise 2004; Smith 2000). Finally, much time spent on fuel collection and cooking and/or a disproportionate amount of income spent on securing lower-quality fuels undermines opportunities for education and development. Lack of access to modern energy services therefore contributes to trapping poor households in a cycle of ill-health and poverty.

Several regional and global initiatives, including by the Economic Community of West African States (ECOWAS 2006), the East African Community (EAC 2007), the United Nations Commission on Sustainable Development (Rehfuess 2007), the UN Foundation Global Alliance for Clean Cookstoves (UNGACC 2010), the World Energy Outlook 2010 (IEA 2010) and the United Nation Secretary General's Advisory Group on Energy and Climate Change (AGECC 2010), have emphasised the need to address the cooking energy crisis and to achieve universal access to modern energy. In view of this growing recognition and substantial untapped financial resources in development aid, private sector investment and official/voluntary carbon offset schemes, the large-scale promotion of modern household energy technologies seems more realistic today than ever before.

In working towards this goal, one critical consideration is the effectiveness of interventions in achieving desired benefits for health, the environment and socio-economic development. An ongoing systematic review of the impacts of household energy interventions on IAP and health outcomes, funded by the WHO in the context of work on developing indoor air quality guidelines for household fuel combustion (WHO effectiveness review), is addressing one major question regarding effectiveness. An equally important consideration is how we can achieve the "quantum leap" (WHO 2006) required to result in the sustainable adoption of modern household energy practices by hundreds of millions of households.

Synthesis of insights into the “how to” deliver interventions, the subject of the present review, is becoming more urgent as a result of the recognition that qualitative research has an important role to play in informing policy and practice (Campbell et al, 2003). Both systematic reviews - the WHO effectiveness review and the present systematic review - are complementary and of central importance to policy formulation.

1.2 Policy and practice background

Practical solutions to the household energy problem exist and include (i) switching to cleaner liquid and gaseous fuels, such as liquefied petroleum gas (LPG), ethanol and biogas; (ii) using improved solid fuel cookstoves; and (iii) a variety of measures to reduce IAP concentrations (e.g. smoke hoods, modifications to kitchen location and design). Even though many questions remain with respect to their effectiveness, several interventions have been shown to reduce concentrations of pollutants, increase fuel efficiency and free women’s and children’s time (Bruce et al, 2006), and are good value for money (Hutton et al, 2007). Interventions should be designed to be both more efficient, resulting in fuel and monetary or time savings, and cleaner, leading to reduced pollution levels and better health. In view of current global practices and considerations of acceptability and feasibility (e.g. biogas may only be a suitable intervention for households holding a minimum number of cattle and adequate supplies of water), improved solid fuel cookstoves and LPG are likely to be the most important interventions for large-scale implementation in the near- to medium-term, as they are at least potentially available in all countries around the world.

Apart from the large national solid fuel cookstove programmes in China and India, most efforts to date have been small-to medium-scale, including projects/ programmes implemented by the German Technical Cooperation and Practical Action and/or funded by the Shell Foundation and the Partnership for Clean Indoor Air. Independent of scale, some efforts have demonstrated important successes; for example, as a consequence of the Chinese National Improved Stoves Programme most improved biomass stoves now available for sale in the country have flues and other technical features that classify them as improved (Sinton et al, 2004). Enabling factors contributing to the Chinese success story include quality control through the central production of critical stove components and an emphasis on commercialisation (Bruce et al, 2006). Other efforts have not had a lasting impact; for example, ten years after the start of India’s National Improved Stoves Programme improved stoves accounted for less than seven percent of all stoves in use (ESMAP & World Bank, 2001). This limited large-scale impact can in part be explained by insufficient interaction with end users and high subsidies. Similarly, national-level analyses of demand- and supply-side factors in relation to solid fuels in various African countries (Rehfuess et al, 2010), LPG in Brazil (Lucon et al, 2004) and India (D’Sa & Murthy, 2004) and kerosene in Nicaragua (Alberts et al, 1997), as well as sub-national level case studies of New Delhi (Dhingra et al, 2008) or South African townships (Mehlwana, 1997) have provided useful insights into why (or why not) a policy or programme has been successful. Finally, rapid large-scale uptake by households is possible, as is illustrated by the Indonesian experience, where a national policy change, motivated by the government’s pressing need to phase out kerosene subsidies, led several million kerosene-using homes to switch to LPG over the course of approximately five years.

1.3 Research background

Historically, there has been a notable lack of research on factors that enable or hinder the implementation of household energy interventions. In part, this may be attributed to lack of funding available for implementation research, in part it is likely to be due to the division between those who implement interventions (i.e. governmental or non-governmental organisations in developing countries who often lack the capacity to conduct quantitative or qualitative evaluation) and those who conduct research (i.e. researchers that are often more interested in or more likely to receive funding for rigorous research designs focused on health and technical issues that may not inform better understanding or success or failure of implementation).

Broadly speaking, this systematic review is therefore likely to find three types of primary studies (see also section 2.2.1):

- Intervention studies using a variety of epidemiological study designs with accompanying descriptions of factors affecting household uptake (e.g. implementation of the plancha stove as part of the RESPIRE trial in Guatemala; Diaz et al, 2008);
- In-depth qualitative research related to specific household energy interventions, conducted either stand-alone or as part of intervention studies (e.g. focus groups and key informant interviews undertaken in relation to GIRA stoves in Mexico; Troncoso et al, 2007);
- Evaluations of household energy projects, programmes or policies (e.g. Chinese National Improved Stoves Programme; Sinton et al, 2004), impact on consumer choices of fuel prices, etc (Dulgass et al, 2004).

Two systematic reviews are of direct relevance to this current review. As mentioned above, the ongoing WHO effectiveness review is systematically evaluating the impacts of household energy interventions on IAP, exposure and (where available) health outcomes, covering various cleaner fuel options (i.e. LPG, ethanol, biogas), improved solid fuel cookstoves and other measures to reduce IAP. Lewis and Pattanayak at Duke University recently conducted a systematic review of factors that have enabled or limited the large scale uptake by households of cleaner cookstoves and identified a number of potentially important variables (<http://sites.duke.edu/cookstove/research/systematic-review-of-cookstove-adoption/>). We have approached the authors for further details about the scope and findings of their review and have taken these into account during the finalisation of our protocol.

1.4 Conceptual and definitional issues

Focus on cooking with solid fuels

Solid fuel use includes biomass fuels (e.g. wood, dung, crop residues, charcoal) and coal. Cleaner fuel use includes various liquid (e.g. LPG, ethanol, plant oils) and gaseous fuels (e.g. producer gas, biogas) as well as electricity. Kerosene and paraffin occupy a separate category as they are relatively efficient liquid/solid fuels but should not actively be promoted as cleaner fuel options given the mounting evidence on health hazards, including increased risks for tuberculosis (Pokhrel et al, 2010), burns, poisonings and other unintentional injuries.

Solid fuels are used for cooking, heating, boiling water and other tasks, such as brewing alcohol or informal income-generation. Cooking takes place in households worldwide (and is the only household energy task for which comparative information on solid fuel use is available for most developing and middle-income countries), whereas heating is highly climate- and season-specific and many of the other tasks are highly household-specific. This systematic review therefore focuses on cooking as the most important global use of solid fuels but it should be kept in mind that, depending on the setting, interventions may need to meet other household energy needs to be adopted and used by households.

Focus on LPG and improved solid fuel cookstoves interventions

In the short- to medium-term solid fuels are likely to remain predominant among poor households in developing countries, and improved cookstoves will therefore be a critical means of achieving greater fuel efficiency and improved health. Among middle-income households in developing countries and in most middle-income countries, gas and, in particular, LPG has already replaced all or selected cooking tasks and increasingly represents a likely alternative fuel for poorer households. In selected settings, ethanol, biogas or other alternative fuels can provide an efficient and clean source of household energy but are less likely to be scaled up in a large number of countries on different continents. In view of availability, acceptability and feasibility considerations this systematic review therefore focuses primarily on LPG and improved solid fuel cookstoves as the two interventions with the greatest potential for large-scale uptake worldwide. Briefer consideration of other cleaner fuel options will however be included.

Applying lessons learnt to effective interventions

While this systematic review is not concerned with assessing the effectiveness of cleaner fuel and improved solid fuel cookstoves interventions, the lessons learnt regarding household uptake should be applied to effective rather than potentially ineffective interventions. Critically, effectiveness encompasses a set of features including:

- Good acceptability and capacity for use for all (or at least most) cooking tasks.
- Reduced emissions and concentrations of as well as exposure to pollutants (primarily particulate matter and carbon monoxide)
- Improved fuel efficiency (resulting in monetary or time savings for households).
- Improved safety of children, cooks and other household members

Focus on the household level

Decisions to change practices and adopt, pay for, use and maintain cleaner and more efficient household energy technologies take place at the household level, embedded in the community, but also includes influences from international and national economic factors, for example oil prices and fuel subsidies, respectively. This systematic review therefore applies a household/community perspective in its search for factors that enable or limit household uptake. These factors impacting or modifying household and community decisions can be located at different levels (e.g. programmes, policies and regulations at sub-national and national levels) as detailed in section 2.3.

Explicit consideration of equity

Poorer households tend to be those most dependent on inefficient and polluting household energy practices and, as a result, suffer disproportionately from related health and social impacts. Equity is therefore critical in efforts to scale up interventions at global level (i.e. making sure that the most affected countries are reached) and national level (i.e. making sure that disadvantaged households in poor urban and rural settings are reached). Equity is therefore explicitly considered in the objectives of this systematic review.

Learning for scaling up

To date, experience at scale is limited and we therefore consider factors enabling or limiting household uptake in projects/programmes/initiatives undertaken at any scale in an effort to learn *for* large-scale uptake. In doing this however, careful consideration will be given to the relevance of such experience to likely outcomes at larger scale, for example the stage of development of the project or programme.

A multisectoral approach

Household energy practices are a multisectoral problem and household energy interventions can only be taken forward using a multisectoral approach with the lead taken by different sectors/ministries/agencies (e.g. energy, agriculture, health, development, environment) depending on the country and setting. Consequently, this systematic review will consider enabling and limiting factors controlled or influenced by any of the concerned sectors.

1.5 Objectives of the systematic review

The main objective of this systematic review is to describe and assess the importance of different enabling or limiting factors that influence the large scale uptake by households of cleaner and more efficient household energy technologies.

More specifically, this systematic review will:

- develop a framework for different categories of factors influencing large-scale uptake;
- provide a summary of existing knowledge relating to each of these categories, including interpretation of data through an equity lens; and
- set an agenda for essential primary research (stand-alone research or evaluations of current and future initiatives).

1.6 Authors, funders, and other users of the review

This systematic review will be conducted by a team of researchers based at the University of Liverpool (Dr Elisa Puzzolo, Dr Debbi Stanistreet, Dr Daniel Pope and Dr Nigel Bruce) and the University of Munich (Dr Eva Rehfuess). The review is being funded by the Department for International Development (DFID).

In view of the global momentum that access to clean cooking energy is currently experiencing conducting this review now is most timely. It is critical that global efforts, in particular the ambitious ten-year goal set by the UNGACC that “100 million homes adopt clean and efficient stoves and fuels by 2020” and also the two key goals of the AGECC summary report ‘ensuring universal energy access and reducing global energy intensity’ (AGECC, 2010) proceed in an evidence-based way, and this systematic review can potentially make a major contribution to informing what works and what does not.

The primary users of the proposed systematic review will be decision-makers and implementers involved in the promotion of access to cleaner and more efficient household energy technologies at sub-national, national, regional and global levels. They include national government (e.g. Government of Rwanda, Government of India) and regional governmental organisations (e.g. EAC, ECOWAS), as well as international organisations and partnerships (e.g. UNDP, WHO, International Energy Agency, UNGACC). They also comprise international development agencies and donors (e.g. DFID, GIZ, USAID, European Union) and a variety of non-governmental organisations and networks (e.g. ENERGIA, Winrock International, Practical Action, etc.). The findings of this systematic review will directly contribute to the WHO air quality guidelines on household air pollution in developing countries. Interactions with users are described in more detail in section 2.1.

Review group

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2. Methods used in the review

2.1 User involvement

Broadly, we distinguish between three groups of users (see Appendix 1 for details):

- a) Those making decisions regarding household energy and health interventions, in particular international organisations and partnerships (e.g. UNGACC, WHO, UNDP, UN Energy, Indian National Cookstove Initiative) and current or potential donors (e.g. Shell Foundation)
- b) Those actively engaged with the implementation of household energy projects/programmes at international (e.g. GIZ) or national level (e.g. national governments in India, China, Ghana, non-governmental organisations such as Winrock, GIRA)
- c) Those conducting research on household energy interventions including university researchers (e.g. Sri Ramachandra University (Chennai), Johns Hopkins, Columbia University, UC Berkeley, etc.) and government-related or non-governmental organisations (e.g. Indian Institute of Technology (Delhi), Practical Action)

Different groups of users will be approached at different stages of the review process. Selected individuals will serve as peer-reviewers of the protocol and draft report. A broader purposive sample of stakeholders will be approached to make sure that our approach for this systematic review and the interpretation of the results is “on track”.

Our primary means of approaching users during the design of the review (see Appendix 1) will be email and major questions will be whether they:

- Consider the approach to the research question appropriate?
- Are aware of any specific aspects not currently taken into account?
- Can recommend relevant scientific literature or ‘grey’ on enabling/limiting factors?

When it comes to interpreting the results of the review we will also approach users by email to ensure that our findings makes sense in view of their experience in different countries and settings.

Our primary means of communication and dissemination of review results with users at large will be (i) incorporation in the new WHO indoor air quality guidelines for household fuel combustion (ii) presentations at relevant conferences and meetings, in particular those of the UNGACC, (iii) scientific publications and (iv) the internet through organisations, such as the HEDON household energy network, and listserves.

2.2 Identifying and describing studies

2.2.1 Defining relevant studies: inclusion and exclusion criteria

Types of studies

In view of an evidence base that we expect to be quite limited in many respects (in particular with respect to consistency and breadth of any specific type of study design and methodology), this systematic review will need to be inclusive with respect to types of studies. A large variety of study types could potentially provide relevant information. We will therefore consider in-depth qualitative research studies conducted at a very local scale (e.g. focus groups, key informant interviews), community- or district-level case studies, process evaluations of programmes or project reports and national-level analyses of demand- and supply-side factors.

Types of participants

Lack of access to cleaner cooking energy is primarily a problem of developing and middle-income countries. We will therefore include all projects/programmes/initiatives of relevant cooking fuel and technology options conducted in developing or middle-income settings.

Types of interventions

We will consider projects/programmes/initiatives targeting the household setting (rather than public or commercial settings) undertaken at any scale. Cooking fuel and technology options will be assessed with a focus on the following two broad categories:

- cleaner fuels, focusing on liquefied petroleum gas
- improved solid fuel cookstoves

Studies dealing solely with modern biofuels (e.g. biogas, ethanol) and solar energy will be excluded but stored separately for future reference.

Types of enabling and limiting factors

As a means of structuring the review and for identifying entry-points for intervening on relevant factors, this systematic review aims to develop a comprehensive framework for likely enabling and limiting factors. This framework includes factors in broad domains:

- (i) knowledge and perceptions;
- (ii) fuel and technology characteristics;
- (iii) financial, tax and subsidy mechanisms;
- (iv) regulation and legislation;
- (v) market development;
- (vi) programmatic and policy mechanisms and at different levels, i.e. household,

community, national (including government and implementing organisation) and international levels.

All projects/programmes/initiatives reporting relevant information under one or more framework domains will be subjected to quality appraisal (see section 2.3.1). The subtopics listed under each domain heading will be further refined as the review progresses. Please see section 2.3.4 for our detailed approach to analysis.

2.2.2 Search strategy

This systematic review is being conducted in tandem with the above mentioned WHO effectiveness review and will take an exhaustive approach followed by purposive sampling (if needed; see evidence overview below), covering a range of programme types (e.g. market-based versus central government-implemented or led). As described below, our search strategy will combine new systematic searches with assessing the relevance of all studies included in the database of the WHO effectiveness review (see below). All studies will be recorded and managed through the EPPI-reviewer version 4 software, to keep track of where and when studies were identified, reasons for excluding studies. Criteria for inclusion and exclusion will be allocated and applied accordingly.

During a preparatory phase involving three reviewers (EP, DP, DS) we will work on a sample of approximately 100 hits obtained through databases in different sectors (e.g. health, energy, development) to assess the comprehensiveness and feasibility of our search terms, and to refine our inclusion/exclusion criteria as specified below.

Multi-disciplinary electronic databases

We will conduct systematic searches using the following databases:

- African Journals Online (<http://www.ajol.info/index.php/index/search>)
- African Women Bibliographic Database (<http://www.africabib.org/women.php>)
- Applied Social Sciences Index and Abstract (ASSIA)
- British Library for Development Studies (<http://blds.ids.ac.uk/>)
- Campbell Library
- Cochrane Library
- Conference Proceedings Citation Index (part of Web of Knowledge)
- Environmental Sciences and Pollution Management
- Global Health Database (EBSCO)
- International Encyclopedia of the Social & Behavioural Sciences (IESBS)
- Latin American and Caribbean Health Sciences Information System (LILACS)
- Ovid (MEDLINE)
- Pollution Abstracts
- Proquest Dissertations & Thesis (PQDT)
- PsycINFO

- Pubmed
- Research for Development
(<http://www.dfid.gov.uk/R4D/SearchResearchDatabase.asp>)
- Sanitary Engineering and Environmental Sciences (REPIDISCA)
- Scientific Electronic Library Online (SciELO)
- Scopus (EMBASE)
- Social Science Citation Index (part of Web of Knowledge)
- Social Science Research Network (SSRN)
- Social Services Abstracts
- Sociological Abstracts
- Sustainability Science Abstracts (SAS)
- Web of Knowledge
- 3ie - International Initiative for Impact Evaluation
(http://www.3ieimpact.org/database_of_impact_evaluations.html)

Specialist websites

The following website of key stakeholder organisations will be independently searched:

- HEDON: <http://www.hedon.info>
- USAID: <http://www.usaid.gov/index.html>
- Global Alliance on Clean Cookstoves: <http://cleancookstoves.org/>
- World Bank Energy Sector Management Assistance Program: <http://www.esmap.org/esmap/>
- The Partnership for Clean Indoor Air: <http://www.pciaonline.org/>
- Global Village Energy Partnership (GVEP): <http://www.gvepinternational.org/en>
- Ashden Awards for Sustainable Energy: <http://www.ashdenawards.org/>
- Renewable Energy and Energy Efficiency Partnership: www.reeep.org/

Hand searching

We will also carefully evaluate any literature provided by key stakeholders approached during the early phase of the review (see section 2.1. and Appendix 1) as well as relevant results identified through Google and Google scholar. We will handsearch the bibliographies of all included studies, as well as the bibliographies of selected published reviews and reports (e.g. World Bank report 2011) in order to be as comprehensive as possible. This approach will also allow us to identify papers written in languages other than English (for details see section “Languages” on p 11)

Grey literature

The search strategy for the WHO effectiveness review identified over one hundred projects/programmes and scientific publications. These cover a variety of technologies at different scales, implemented by government (e.g. National Improved Stoves

programme in China), non-governmental organisations (e.g. Practical Action in Sudan) and industry (e.g. Philips Research in India) across all world regions. All studies identified through the original search strategy of the WHO effectiveness review are accessible in an Access database. As grey literature searches are very time-consuming and as a majority of the relevant grey literature is likely to have been identified by the exhaustive approach of the WHO effectiveness review we will scrutinise all studies included in the Access database as to whether they contain information on enabling/limiting factors under the framework and as to whether they meet the inclusion criteria of this systematic review.

Search terms

Search terms reported in Table 1 consist of the relevant cooking fuel and technology intervention options, and a range of terms related to the framework domains defined in section 2.2.1.

The various intervention search terms will be combined with the uptake search terms using the Boolean operator "AND". An inclusive approach will be used for searching. These general search terms will be adapted to the needs of specific databases (e.g. pluralisation, wild cards). In particular, in those databases where forward truncation is not permitted, the following combination will be used for the term **stove*: *stove* OR *cookstove* OR *cook-stove* OR *woodstove* OR *wood-stove*.

All variants of *chulha* (a local name for South-Asian stove type) has been included rather than using a wild card, because of the Chulalongkorn University in Thailand, which has the name in their email address. Where possible, the database searches will be conducted on the "Title, Keyword and Abstracts". When this option is not available, a wider search field will be adopted in the case of small databases (see Appendix 2 for additional information).

Table 1: Search terms¹

Intervention	AND	Uptake
*stove/*stoves		adopt*
cook* AND technol*		accept*
cook* AND fuel*		deliver*
LPG		dissemin*
"LP gas"		implement*
"liquid petroleum gas"		scale
"liquefied petroleum gas"		"scal* up"
"liquefied petroleum gas"		"roll* out"
chulha/chulhas		"tak* up"
chulla/chullas		uptake
chullah/chullahs		
chulas		

¹ Searches will be limited to improved cookstoves and LPG. No specific searches will be carried out to identify other cleaner fuels such as biogas, ethanol and solar energy. Any studies relating specifically to these energy options will be appraised, including for further references.

Timeframe

Our use of the WHO database relies on the timeframe adopted by the WHO effectiveness review, i.e. 30 years for very large-scale intervention programmes and 10 years for smaller scale projects and research studies. For our new systematic searches we adopt a timeframe of 30 years, i.e. all studies published between 1980 (when the first intervention programmes to promote fuel efficiency and save trees were initiated) and 2011 and meeting our inclusion criteria will be included.

Languages

The main search language will be English. We will endeavour not to exclude documents on the basis of language or country. Potentially important studies in Spanish, French, Hindi, German and Italian and can be included directly; for potentially important studies published in other languages (e.g. Chinese) and identified through abstracts in English we will seek assistance with their translation.

2.2.3 Screening studies: applying inclusion and exclusion criteria

Selection of studies

Two authors (EP and DS) will initially consider a selection of abstracts and agree clear criteria for inclusion/exclusion. Subsequently, titles and abstracts of the literature identified by the searches will be checked regarding their relevance initially by one author (EP). Where it is difficult to make a selection decision on the basis of the title and abstract alone, the full text will be independently screened and assessed for relevance by teams of two authors (EP and one of DS, DP and ER).

All decisions and reasons leading to the exclusion of studies will be documented using the EPPI-reviewer software. Random checks on 10% of the abstracts will be carried out throughout the selection process by DS and DP to ensure that the criteria are being applied appropriately.

Studies will be included according to the following inclusion criteria:

- Primary studies/analyses conducted in low- and middle-income countries defined according to World Bank income regions (see Appendix 3 for details).
- Use of solid fuels or kerosene for cooking prior to intervention
- Interventions which include improved solid fuel cookstoves or LPG
- Substantive analysis and interpretation of empirical evidence related to household uptake and/or scaling up.

Evidence overview

The studies meeting the inclusion criteria and including substantive qualitative information will be subjected to thematic analysis. If there are more than approx. 30 studies including such information, the review team will discuss options for purposive sampling with the EPPI Centre policy lead.

The remaining studies meeting the inclusion criteria and containing relevant information on household uptake (i.e. quantitative surveys, case studies and policy analysis) will be mapped using a matrix of framework domains/levels by NB, ER and DP.

2.2.4 Overview of study characteristics

Teams of two authors will independently record key study characteristics for all studies included in the review under the categories reported in Appendix 4.

2.3 In-depth review

2.3.1 Critical appraisal of data quality

Quality will be assessed using a predetermined checklist (Harden et al, 2009) based on criteria suggested in the literature on qualitative research (see Appendix 5). Teams of two authors, involving EP and one of ER and DS will independently appraise studies meeting the inclusion criteria. Any discrepancies in quality appraisal will be resolved through discussion within author teams. Where discrepancies cannot be resolved within author teams, a third author will be involved. Where studies are considered to be of questionable quality, a sensitivity analysis will be carried out.

Dealing with missing data

We will contact study authors by email if critical methodological details or results are missing.

2.3.4 Data synthesis

The approach to synthesis will draw on the work of Thomas and Harden (2008), known as thematic synthesis. This approach to synthesis has been applied in a number of systematic reviews that are looking to identify factors with an impact on intervention implementation, and is therefore particularly appropriate for this review.

Data synthesis will be carried out in three stages:

1. During the first stage, data will be coded line by line.
2. These codes will then be used to generate descriptive themes, which will to a large extent reflect the themes generated in the original paper.
3. The final stage will use these descriptive themes to develop analytical themes, which will include the generation of new interpretive constructs or explanations.

All stages will use established principles for analysing qualitative data. Recording of the process of development of themes will be explicit to ensure our methodology is both transparent and rigorous. For an in-depth description of thematic synthesis, see Thomas & Harden (2008).

While our framework domains represent a useful way of organising the findings of the review, the initial approach to analysis will not assume any domains in order to provide an opportunity for the data to speak for themselves, as recommended by Thomas and Harden (2008). In this way we will make sure that codes and themes emerge from the data (which is similar to a grounded theory approach) rather than limiting ourselves to retrieving only those codes and themes that correspond to pre-specified domains. If this approach uncovers additional domains, we will revise our framework accordingly. Subsequently, findings for each framework domain will be summarised in tabular and narrative form. Where possible, findings will be disaggregated by world region, and by other factors if these add value for policy formulation.

In summarising and interpreting findings and drawing preliminary conclusions, we will pay particular attention to the combined effects of different domains and possible interactions between them. We will also specifically consider to what extent these various factors enhance or diminish equitable access to cleaner cooking. This will include evaluating the differential impact of these factors on poorer households, on rural and urban communities and also on women and children.

2.4 The completed review

The completed review will consist of a full technical report, a policy brief and a summary briefing for a web-page feature. The findings of the qualitative and quantitative mapping component will be integrated drawing on the framework domains and potential sub-categories (see Appendix 6).

3. References

AGECC Summary Report. *Energy for a Sustainable Future*. 2010. Available at: <http://www.un.org/wcm/webdav/site/climatechange/shared/Documents/AGECC%20summary%20report%5B1%5D.pdf>

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5. Appendices

Appendix 1: User involvement in different stages of the systematic review process

	Design of review	Interpretation of review results	Communication and dissemination of review results
Those making decisions regarding household energy interventions	<ul style="list-style-type: none"> • Representatives of DFID, USAID and other donors • Representative of UNGACC reaching consumers group • Representative of US State Department • Energy Ministry, Ghana 	<ul style="list-style-type: none"> • DFID representative • Representative of UNGACC reaching consumers group • Representative of US State Department • Energy Ministry, Ghana 	<ul style="list-style-type: none"> • UNGACC meetings • WHO meetings • Scientific conferences/ meetings • Internet platforms and listserves
Those implementing household energy interventions	<ul style="list-style-type: none"> • GIZ • Indian Institute of Technology • Purposive sample of implementing agencies (governments and NGOs) 	<ul style="list-style-type: none"> • GIZ • Indian Institute of Technology 	<ul style="list-style-type: none"> • UNGACC meetings • WHO meetings • Internet platforms and listserves
Those conducting research on household energy interventions	<ul style="list-style-type: none"> • World Bank • Duke University • University of Johannesburg • Purposive sample of Universities/ NGOs involved with research 	<ul style="list-style-type: none"> • World Bank • Duke University • University of Johannesburg 	<ul style="list-style-type: none"> • Scientific conferences/ meetings • Scientific publications

Appendix 2: Search strategy for electronic databases

The search string below will be used to search Scopus (EMBASE) and adapted for other electronic databases. We will combine two main concepts of *intervention* and *uptake*, using the Boolean operator “AND”. These concepts will contain a wide number of terms combined using OR and will be searched on Title-Abstract-Keywords.

Concept 1: Intervention

Free-text terms:

*stove OR *stoves OR lpg OR "LP gas" OR "liquid petroleum gas" OR "liquified petroleum gas" OR "liquefied petroleum gas" OR (cook* AND fuel) OR (cook* AND technol*) OR chulha OR chulhas OR chulla OR chullas OR chullah OR chullahs

In those databases where it not possible to search wildcards at the front of a word we will spell the word out. For example, in the Sustainability Science Abstracts database the following string for *stove will be adopted: *stove OR stoves OR cookstove OR cookstoves OR cook-stove OR cook-stoves OR woodstove OR woodstoves OR wood-stove OR wood-stoves.*

Having trialled our search strategy across different databases, we decided to conduct our search using free-text terms rather than controlled terms because of lack of specificity of controlled terms. For example, in PsycINFO the term “stove” contains, in addition to relevant headings, headings such as “arsenic poisoning”, “adult”, “burns” and “thoracic injuries”.

Concept 2: Uptake

Free-text terms:

adopt* OR deliver* OR dissemin* OR implement* OR scale OR “scal* up” OR “roll* out” OR “tak* up” OR uptake OR accept*

Search Limits

We will include literature published since 1980. Database searches will be conducted of the “Title, Keyword and Abstracts” or “Title and Abstracts”. In some databases, this option is not available and different search field categories will be adopted according to Table 4 and Table 5. In particular, we will be very cautious in searching in “all Fields” or “all Text” in selected databases such as Ovid and PsycINFO in order to avoid including ‘Authors’ (e.g. Cook, Cooke) as a field of search.

Table 4 – Main Electronic Databases

Electronic Database	Years included in search	Search categories
Applied Social Sciences Index and Abstract (ASSIA)	from 1980	Title and Abstract
Cochrane Library	from 1980	Abstract, Title, Keywords
Environmental Sciences and Pollution Management	from 1980	Title, Abstract
International Encyclopaedia of the Social & Behavioural Sciences	from 1980	Abstract, Title, Keywords
Ovid (MEDLINE)	from 1980	Keywords ²
Pollution Abstracts	from 1980	Title and Abstract
ProQuest Dissertation and Thesis	from 1980	Title and Abstract
PsycINFO	from 1980	All text ³
Global Health database	from 1980	All text ³
Pubmed	from 1980	Title, Abstract
Scientific Electronic Library Online (SciELO)	N/A	All indexes
Scopus (EMBASE)	from 1980	Abstract, Title, Keywords
Sociological Abstracts	from 1980	Title and Abstract
Sustainability Science Abstracts	from 1980	Title and Abstract
Web of Knowledge	from 1980	Topic

Small databases and those databases where it is not possible to run a combined search (see Table 5) will be searched for each single term falling within the category of interventions (i.e. concept 1), in order to be inclusive as possible.

Table 5: Electronic databases searched only for category of interventions (concept 1)

Small Electronic Database	Years included in search	Search categories
African Journals Online	from 2003	All fields
African Women Bibliographic Database	from 1986	Keywords
British Library for Development Studies	from 1980	All fields
Campbell Library	from 2002	All text
LILACS	from 1980	Words
REPIDISCA	from 1980	Words
Research for Development	N/A	Not specified
Social Science Research Network (SSRN)	All Years	Abstract, Title, Keywords
3ie - International initiative for Impact evaluation	All Years	Keywords

² The search category “Keywords” (.mp.) in Ovid includes a search in title, abstract, subject headings, etc. As these Ovid searches are so broad and in order to avoid a large number of irrelevant hits for authors, terms from concept 1 will only be searched in ‘Abstracts’.

³ Similarly, in PsycInfo and Global Health database, terms from concept 1 will only be searched in ‘Abstracts’.

Appendix 3: List of included countries

Countries meeting our inclusion criteria have been selected according to the World Bank income regions' classification and reported in the following tables (http://data.worldbank.org/about/country-classifications/country-and-lending-groups#Low_income)⁴.

Low-income economies (\$1,005 or less)

Afghanistan	Gambia, The	Myanmar
Bangladesh	Guinea	Nepal
Benin	Guinea-Bissau	Niger
Burkina Faso	Haiti	Rwanda
Burundi	Kenya	Sierra Leone
Cambodia	Korea, Dem Rep.	Somalia
Central African Republic	Kyrgyz Republic	Tajikistan
Chad	Liberia	Tanzania
Comoros	Madagascar	Togo
Congo, Dem. Rep	Malawi	Uganda
Eritrea	Mali	Zimbabwe
Ethiopia	Mozambique	

Lower-middle-income economies (\$1,006 to \$3,975)

Armenia	Indonesia	Philippines
Angola	India	Samoa
Belize	Iraq	Senegal
Bhutan	Kiribati	São Tomé and Príncipe
Bolivia	Kosovo	Solomon Islands
Cameroon	Lao PDR	Sri Lanka
Cape Verde	Lesotho	Sudan
Congo, Rep.	Marshall Islands	Swaziland
Côte d'Ivoire	Mauritania	Syrian Arab Republic
Djibouti	Micronesia, Fed. Sts.	Timor-Leste
Egypt, Arab Rep.	Moldova	Tonga
El Salvador	Mongolia	Tuvalu
Fiji	Morocco	Uzbekistan
Georgia	Nicaragua	Vanuatu
Ghana	Nigeria	Vietnam
Guatemala	Pakistan	West Bank and Gaza
Guyana	Papua New Guinea	Yemen, Rep.
Honduras	Paraguay	Zambia

⁴ Countries from the European and Central-Asia regions, which have a population using solid fuel lower than 10%, will not be included in this systematic review. These countries: Albania, Azerbaijan, Belarus, Lithuania, the Russian Federation, Ukraine and Turkmenistan have been excluded according to the WHO Global Health Observatory latest statistics (<http://apps.who.int/ghodata/?vid=34000>). Countries, for which no information on population solid fuel use is currently available (e.g. Bulgaria, Turkey), will be included.

Upper-middle-income economies (\$3,976 to \$12,275)

Algeria	Gabon	Palau
American Samoa	Grenada	Panama
Antigua and Barbuda	Jamaica	Romania
Argentina	Jordan	Serbia
Bosnia and Herzegovina	Kazakhstan	Seychelles
Botswana	Latvia	South Africa
Brazil	Lebanon	St. Kitts and Nevis
Bulgaria	Libya	St. Lucia
Chile	Macedonia, FYR	St. Vincent and the Grenadines
China	Malaysia	Suriname
Colombia	Maldives	Thailand
Costa Rica	Mauritius	Tunisia
Cuba	Mayotte	Turkey
Dominica	Mexico	Uruguay
Dominican Republic	Montenegro	Venezuela, RB
Ecuador	Namibia	

Appendix 4: Overview of study characteristics (for all included qualitative and quantitative studies)

Study ID _____ Authors, year, title _____

<i>Study design</i>	<i>Study setting</i>	<i>Intervention</i>	<i>Methodology</i>	<i>Domains evaluated⁵</i>	<i>Principal findings and conclusions⁶</i>	<i>Equity considerations (geography, poverty, gender)⁷</i>	<i>Comments</i>
Category ⁸	Country	Implementer	Sampling and number of participants	Knowledge and perceptions			
Using	Rural vs urban	Baseline fuel and technology		Fuel and technology characteristics			
Aim	Region	Intervention fuel and technology	Validity/ repeatability/ trustworthiness	Financial, tax and subsidy mechanisms			
	Population	Time horizon	Data collection	Regulation and legislation			
Theoretical assumptions ⁹	Time period in which the study was undertaken	Scale ¹⁰ and size of programme	Analysis	Market development			
				Programmatic and policy mechanisms			

⁵ Information entered (a) during data extraction for quantitative studies and (b) after thematic analysis for qualitative studies.

⁶ Information entered (a) during data extraction for quantitative studies and (b) after thematic analysis for qualitative studies.

⁷ Information entered (a) during data extraction for quantitative studies and (b) after thematic analysis for qualitative studies.

⁸ Category: qualitative, quantitative, policy analysis, case study.

⁹ Theoretical assumptions: for qualitative studies only

¹⁰ Scale: local, regional, national, international

Appendix 5: Criteria for assessing the quality of a qualitative study¹¹

1) Context of study	
Were the aim and objectives clearly reported?	Yes/Partly/No Aim: Objectives:
Was there an adequate description of the context in which the research was carried out?	Yes/Partly/No Setting: Intervention: Programme:
2) Methodology	
Is the epistemological approach clearly stated?	Yes/Partly/No Approach:
Was the approach to sampling appropriate (including identification and recruitment)?	Yes/Partly/No Description: Sampling method:
Was the approach to data collection appropriate, repeatable (e.g. information about development/content of interview guide, development of interview schedule in line with theoretical approach) and trustworthy (e.g. positionality of research team)?	Yes/Partly/No Description: Data collection methods: Repeatability: Trustworthiness:
Was the approach to data analysis appropriate (e.g. specific approach stated), repeatable (e.g. use of independent coders) and trustworthy (e.g. triangulation, grounded in the views of respondents, positionality of research team, use of independent coders, explicit acknowledgement of negative cases)?	Yes/Partly/No Description: Data analysis methods: Repeatability: Trustworthiness:

¹¹ Adapted from Harden et al, 2009

Appendix 6: Framework domains

1. Knowledge and perceptions

- Health impacts of IAP
- Consumer research on stove design
- Perceptions from previous projects/programmes
- Participatory approaches
- Cost of fuel collection (e.g. time/energy)
- Views of women
- Impact of household characteristics
- Desirability, affordability, convenience
- Perspectives of international donor organisations

2. Fuel technology characteristics

- Choice of newer more efficient stoves
- Choice of wide range of technologies
- LPG related issues
- Pilot programmes to assess performance in practice
- Quality and safety standards

3. Financial, tax and subsidy mechanisms

- New finances linked to climate change monies
- Impact of different financial models
- Lessons from finance models used in small scale energy projects
- Role of financial institutions in administering funds
- Private sector involvement
- Option of spreading cost of stoves over time.
- Impact of short term financing
- Government grants
- Impact of financial model used
- Technical assistance to support cookstove manufacturers
- Indirect subsidies (e.g. stove design/promotion, capacity development)

4. Regulation and legislation

- Cookstove standards
- Quality control
- Relevant lessons from small scale projects
- Role of national institutions

5. Market development

- Use of consumer research and feedback
- Addressing issues of perceived performance and availability
- Views of women
- Role of private sector
- Impact of households characteristics;
- Desirability, affordability, convenience
- Tension of cost vs sophistication

6. Programmatic and policy mechanisms

- Evidence of multi-sectoral approaches (e.g., energy, gender, health, forestry, climate)
- User training
- Use of specific systems (e.g. antenatal care system in India)
- Use of local artisans vs benefits of mass production
- Capacity building
- Role of national co-ordinating agencies

Additional considerations

Within each domain, the following dimensions will be considered:

- d) Equity
 - i) Poverty
 - ii) Geography
 - iii) Gender
- e) Level of intervention / action
 - i) Local
 - ii) Regional
 - iii) National
 - iv) International

Appendix 7: Timeframe

Stage of review	Start date	End date
Completion and submission of the protocol	15.04.2011	30.05.2011
Protocol revision	01.06.2011	15.08.2011
Searching for studies (electronic databases)	01.07.2011	31.07.2011
Screening and assessing study relevance	15.07.2011	31.10.2011
Overview of included studies	15.10.2011	31.10.2011
Critical appraisal of qualitative studies	15.10.2011	30.11.2011
Thematic synthesis of qualitative studies	15.10.2011	15.12.2011
Mapping of quantitative surveys and case studies	15.11.2011	15.01.2012
Preparation and submission of the draft report	15.12.2011	15.02.2012
Peer review of the draft report	15.02.2012	15.04.2012
Revision of the draft report	15.04.2012	15.05.2012
Submission of final report and short summaries	15.05.2012	

First produced in 2011 by:

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