



CEE review 11-004

WHAT ARE THE MAJOR BARRIERS TO INCREASED USE OF MODERN ENERGY SERVICES AMONG THE WORLD'S POOREST PEOPLE AND ARE INTERVENTIONS TO OVERCOME THESE EFFECTIVE?

Systematic review protocol

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1. Background

Although there is no simple definition, modern energy services are often identified in terms that contrast them with traditional energy services such as those derived from the burning of biomass in open fires (UN-Energy 2005; Brew-Hammond 2010). As such, the notion tends to combine both energy carriers and associated technologies, together with the benefits to users that these afford: lighting, cooking, heating, transportation, and so forth (UNDP 2005). Examples of modern energy services, therefore, include (among others) electricity from solar home systems (SHSs) for lighting, natural gas burned in modern stoves for cooking and petroleum-based engines for motive power to enable agro-processing (Modi et al. 2005; Practical Action 2010).

A lack of access to modern energy services among the world's poor is widely recognised to have negative impacts on their health, education and quality of life, further deepening and entrenching their poverty (DFID 2002; Modi et al. 2005; UNDP-WHO 2009; Bazilian et al. 2010). However, despite the long-standing efforts of many national and international organisations to improve the accessibility of the poor to modern energy services, progress has been slow (Modi et al. 2005). A notable exception to this pattern is the case of China's electrification programme, which has achieved about a 99% electrification rate (although 1% of the Chinese population is still a large number of people) (Urban 2009). Nevertheless, the record in China is not entirely one of success: there are significant problems with, for example, the reliability of China's electricity supply (Cherni and Kentish 2007). If progress elsewhere continues along current trends, the world's energy-poor will remain so, with the current 1.4 billion without access to electricity only falling to 1.2 billion by 2030 and the 2.7 billion who rely on traditional biomass today rising to 2.8 billion over the same period (OECD-IEA 2010). Some interventions have had limited beneficial impacts, while others have worsened the situation for the energy-poor (Karekezi and Sihag 2004).

Given this uneven record of interventions over many years, there is a large body of literature that attempts to identify what is preventing success, and what policies might be implemented to realise widespread access to modern energy services for the world's poor. One of the abiding concepts in these analyses is that of barriers to access or to the adoption of technologies that can deliver modern energy services. The UK Department for International Development (DFID) has commissioned this systematic review in order to "neutrally collect, critically appraise and synthesise" the evidence provided in the literature on barriers to the use of modern energy services among the world's poorest people, and interventions to remove those barriers, as part of its drive for evidence-based policy making (DFID et al. 2010:1). The final review will provide a robust evidence base to inform DFID's policy and practice. DFID has asked the review team to focus on sub-Saharan Africa, but we will conduct our searches in as broad a manner as possible in order to capture lessons learned from lower-middle income countries in other parts of the world. This document sets out the research protocol that will be used to collect, analyse and synthesise the available evidence.

2. Objective of the Review

1.1 Primary question

The objective of this review is to address two primary questions: (i) “What are the major barriers to increased use of modern energy services among the world’s poorest people”, and (ii) “are interventions to overcome these effective?”

The following sub-research questions immediately fall out of the primary, overarching question.

- What are the different types of modern energy services, and associated technologies for their delivery and/or use, which are used, or could be used, by the world’s poorest people?
- What are the major economic, technical, political, cultural and social barriers to the use of modern energy services, and associated technologies, amongst the world’s poorest people? What criteria are used to define a ‘major’ barrier?
- What are the different types of interventions that have been used to promote or increase uptake of modern energy services and technologies? What are their characteristics and outcomes?
- What are the different measures of effectiveness which are used to assess the interventions and how do these vary depending on the intervention, the modern energy service and the relevant barriers in different contexts?

There are two issues of focus that should be mentioned at this point. First, DFID have requested that the review concentrates on modern energy services other than cooking, as another research team has been commissioned by DFID to conduct a systematic review to understand the specific issues related to cooking. For example, kerosene or gas are often categorised as modern fuels for cooking; the review will not include these (and other modern cooking fuels) and the associated technologies. The specific list of terms used to exclude such fuels and technologies is given below in section 3. The second issue of focus relates to coverage of the four sub-questions. In order to ensure the review is appropriately focussed, we will undertake a mapping exercise at the abstract stage to ‘take stock’ of the breadth and depth of literature and coverage across the four parts of the question. Further information on this phase is covered in section 3.2. This mapping exercise will also be of use in the synthesis stage.

2.2 Secondary questions (*if applicable*)

The following questions are secondary questions. Secondary questions are those that will be used to drive the narrative synthesis (see section 3.6) and will be used to focus and guide our thinking about how to interrogate the data in a way that is meaningful for the analysis.

- Do the different types of modern energy services vary by geographic, temporal or cultural context and how does this relate to the barriers associated with them?
- To what extent and in what ways do *major* barriers *significantly* interact with each other and with their particular contexts?
- What are the different interventions implemented to increase uptake and do these vary in any significant way according to barrier, context or type of energy service?
- How can interventions and services which work in some countries and/or contexts be translated into new countries and contexts in an effective way? (For example, with

decentralised mini-grids how can these be successfully translated into new cultural contexts in Africa?)

- Why do some interventions appear to fail in an African context but are seen as successful elsewhere?
- What are the influences on decisions made by people and/or communities whether or not to adopt more modern forms of energy services and technologies?

3. Methods

3.1 Searches

3.1.1 Search terms and languages

A broad range and combination of search terms will be used. An initial list of search terms, divided according to the four sub-questions, is given below. These will be further refined and/or added to after the initial pilot search (see below). As far as possible, the terms allow for variants of word beginnings and endings. For example, *phone charg* should capture, along with *phone*, *telephone* together with *charger*, *chargers* and *charging*.

List 1a: Modern energy services

- “modern energy service*”
- electric* OR electrif*
- “mobile *phone charg*” OR “cell *phone charg*”
- batt* OR “batt* charg*”
- refrigerat*
- heat*
- freez* OR cool
- light* OR illuminat*
- communication OR radio OR television OR TV or “information and communication technolog*” OR ICT
- “thermal comfort”

List 1b: Modern energy technologies (required to deliver and/or use the services)

- “modern energy technolog*”
- “Platform technolog*”
- “high technolog*”
- “decentrali\$ed grid” OR “modern decentrali\$ed grid” OR “mini\$grid”
- “energy system”
- micro\$hydro*
- pico\$hydro*
- bio\$fuel* OR bio\$gas OR bio\$ethanol OR waste
- photo\$voltaic* OR PV OR “solar home system*” OR SHS
- (“traditional fuel*” OR “traditional bio\$mass” OR bio\$energy) AND (substitut* OR reduce*)
- “solar power” OR “solar energ*” OR “solar panel” OR “solar water heater” OR SWH
- “wind power” OR “wind energ*”
- “wind turbine” OR “wind generat*”

- “renewable energ*”
- energy\$efficien*
- “sustainabl* energy system”
- “gas turbine*”
- “nuclear power”
- “fuel cell*”

List 2: Barriers

- barrier
- difficult*
- challenge
- obstacle
- obstruction
- technical
- access
- poverty
- financ*
- politic*
- polic*
- econom* OR cost
- infrastructur*
- capacity
- cultur*
- social
- awareness
- availabil*
- affordabil*
- institution*
- law
- gender
- “female headed household”
- constrain*
- constrict*
- restrict*
- prevent*
- road\$block OR block*
- enabl*
- facilitat*
- help
- enhanc*
- roadmap

List 3: Interventions

- intervention*
- interference
- investment*
- loan* OR “concessionary loan*” OR concession* OR “soft loan*”

- “market development”
- “public\$private partnership*” OR PPP
- infrastructur*
- subsid*
- micro\$credit OR micro\$finance
- “capacity building”
- “development programme” OR “development program”
- Diffusion
- Adoption
- enabl*
- facilitat*
- help
- enhanc*
- roadmap

List 4: Effectiveness measures

- effectiv*
- useful OR use
- helpful
- success*
- cost-effectiveness
- “economic growth” OR “productive use”
- Health OR “eye disease” OR “eye infection” OR “respiratory disease”
- adopti*
- diffusi*
- uptake
- roll-out
- scale-up OR “scaling up”
- replicat*
- improvement AND (“rate* of access” OR “level* of access”)

List 5: Geographic search terms

- sub-Saharan Africa OR Africa OR SSA
- “developing countr*”
- “southern countr*”
- “global south”
- “low income countr*”
- “least industrialised countr*” OR LDC
- “poor countr*”
- “developing area”
- “developing region”
- “developing econom*”
- “underdeveloped countr*”
- “third world”
- Benin
- “Burkina Faso”
- Burundi

- “Central African Republic”
- Chad
- Comoros
- “Democratic Republic of the Congo” OR DRC
- Eritrea
- Ethiopia
- “The Gambia”
- Ghana
- Guinea
- Guinea-Bissau
- Kenya
- Liberia
- Madagascar
- Malawi
- Mali
- Mauritania
- Mozambique
- Niger
- Rwanda
- Senegal
- “Sierra Leone”
- Somalia
- Tanzania
- Togo
- Uganda
- Zambia
- Zimbabwe
- Afghanistan
- Bangladesh
- Cambodia
- “Democratic Republic of Korea” OR “North Korea”
- “Kyrgyz Republic”
- “Lao PDR” OR “Lao People’s Democratic Republic” OR Lao
- Myanmar
- Nepal
- Tajikistan
- Uzbekistan
- Vietnam
- Haiti
- Yemen

To ensure that our search retrieves a manageable number of hits, we also will define the parameters of the search by language and location. Only English language publications will be included, given the skills of the research team members and the resource constraints of the current review. Only studies conducted in low-income countries in Africa, Latin America, South America or Asia as defined above will be included, subject to scope clarifications by DFID. Having said this, there remains the possibility that some studies conducted elsewhere will include important comparators

with sub-Saharan African contexts. In such cases, there is a strong rationale for inclusion of these studies in the review. Further information about geographic coverage of the review is discussed in section 3.2.

Although we have sought to be as comprehensive as possible at the time of drafting this protocol, it needs to be recognised that the development of the list of search terms is an iterative process. We expect to learn more about the relevant topics and key terms from our initial searches and will amend this list accordingly. We expect these amendments to be only minor revisions. Any changes will, of course, be recorded for the final report.

3.1.2 Comprehensiveness and effectiveness of the search

While a systematic review methodology is designed to be comprehensive, it is always possible that relevant articles are missed. In this review, we will use librarians at the RAND Corporation to help minimise this risk. All the librarians are trained in providing customised research support by assisting with development of search strategy, literature searches, citation management, cited reference searches and document delivery. In addition, RAND librarians are knowledgeable in locating and retrieving difficult to find and elusive sources for researchers. All of the searches, including pilot testing, will be conducted by a RAND librarian

In addition, we will take steps to limit the potential for bias of some geographic locations over others. We have been asked to focus specifically on sub-Saharan Africa for this review, but we will conduct our searches in as broad a manner as possible and only apply the geographic exclusion terms from the search at the abstract review stage.

In addition, there is a risk that a literature search will not capture relevant findings in books or edited books where individual chapters are not indexed. Additional searches in a range of academic and non-academic databases, alongside ‘snowballing’ from previously identified literature, can help minimise this risk.

We have run some scoping searches on the Web of Science, GreenFILE, and Academic Search Elite databases using the Search #1 as specified in 3.1.3 to locate papers that identify barriers. The total of the searches was about 6500 hits, with about 5500 from Web of Science, 600 from Academic Search Elite, and 400 from GreenFILE.

The highest relevancy rate came from GreenFILE, which is focussed on energy and the environment. The sample search generated about 400 hits from this database, and after removing most articles referring only to China and India, the total came to about 350. The high number of initial hits from our scoping searches suggests that some refinement of our search terms may be needed and we will be working with the trained librarians to address this.

3.1.3 Search strings and/or combinations of searches

The primary review question is comprised of two parts, with the first part focussed on the barriers and the second part focussed on the interventions. We anticipate papers that are relevant to barriers may not necessarily discuss interventions, but papers that

are relevant to interventions should cover the specific barriers and related energy services which are being addressed.

Therefore, we will undertake three searches, one each to identify barriers, interventions and effectiveness measures. All three searches will include the terms for energy services, technologies and geographic regions. We expect that many of the papers will appear in more than one of the searches and so we will identify these before undertaking the title and abstract review to avoid any duplication in effort.

Search #1 to locate papers that identify the energy services/technologies and barriers in the selected geographic regions:

(List 1a and List 1b search terms “OR-ed” together)
AND
(List 2 search terms “OR-ed” together)
AND
(List 5 search terms “OR-ed” together)

Search #2 to locate papers that focus on the energy services/technologies and interventions in the selected geographic regions:

(List 1a and List 1b search terms “OR-ed” together)
AND
(List 3 search terms “OR-ed” together)
AND
(List 5 search terms “OR-ed” together)

Search #3 to locate papers that focus on the energy services/technologies and effectiveness measures in the selected geographic regions:

(List 1a and List 1b search terms “OR-ed” together)
AND
(List 4 search terms “OR-ed” together)
AND
(List 5 search terms “OR-ed” together)

We anticipate applying the search terms to TITLE-ABSTR-KEY searches, but the appropriateness of this approach will be pilot tested, and may depend on each database searched. We will keep track of the results of this pilot testing and include it as an appendix in the final report. When possible, and at the discretion of a trained librarian, we will narrow our search by broad subject area headings found in some databases in which studies relevant to the question would be found (e.g. energy services or developing countries).

3.1.4 Databases

A range of scholarly database sources will be searched, including:

- subscription databases including JSTOR, Web of Science, ScienceDirect, WorldCat, Academic Search Elite, Business Source Premier, GreenFILE, Energy Citations Database, and EconLit.
- in particular, we will make sure that individual journals such as Energy Policy, Renewable and Sustainable Energy Reviews, Global Environmental Change,

World Development, and Rural Sociology are included in the subscription databases as these journals will be particularly relevant to our review.

- post-graduate dissertations

We will also search bibliographies of relevant papers (a process known as “snowballing”) to identify additional academic and non-academic articles.

3.1.5 Grey literature

Grey literature will be retrieved through searches conducted in the following non-subscription databases and websites of key stakeholder organisations:

- the International Initiative for Impact Evaluation, the International Energy Agency, UN Statistics Division, WHO, UNDP, UNEP, UNCTAD, UNIDO, UNESCO, US AID and OECD Statistics, World Bank, African Development Bank, REEEP (Renewable Energy and Energy Efficiency Partnership), GVEP (Global Village Energy Partnership); AFREPREN (African Energy Policy Network).

These searches will be conducted by trained librarians who have expert knowledge in rapid searches of internet sources and stakeholder organisations. We will also contact key experts within our institutions for advice on potential sources for relevant grey literature. Similar search terms to those used in the subscription databases will be applied to the internet search. Finally, we will review papers published by research organisations, governments and intergovernmental organisations using Columbia International Affairs Online, the World Bank library and the Global Network on Energy for Sustainable Development.

3.1.6 Literature provided directly by stakeholders

We will seek advice from DFID on an appropriate list of stakeholders to contact. When literature is provided to us by stakeholders, we will include it in the review along with the other articles and evaluate it according to the established study inclusion criteria. If expert input or views are provided to us by stakeholders, we will consider it as a single source of evidence and assess its quality and relevance to the review during the data analysis stage.

3.2 Study inclusion criteria

Criteria for including studies are listed below. The first criterion is any study returned from keyword searches. The remaining criteria are organised by relevance to the subject of the review, by the types of intervention, by the types of comparators in the studies, by the types of outcomes discussed (effectiveness), by the types of the study, and by geographical relevance. The full set of articles will first be reviewed by title according to the first two broad categories of inclusion criteria below. The criteria will be applied in a tiered fashion, that is, if an article passes the first stage of relevance of subject, we will then apply the criteria for geographic coverage. However, we expect many papers may have ambiguous titles. If there is no direct information about barriers in the title, we will err on the side of caution and include the article for further abstract review.

- **By relevance of the subject(s)**

Each article will be reviewed at the title stage for its relevance to the main subjects of the study. If the article does not meet these basic relevance criteria it will be immediately excluded from the review. These criteria are:

- Discussion of modern energy services or energy technologies
- Barriers to using energy services (including but not limited to those listed in List 1a in Section 3.1),
- Barriers to using energy technologies (including but not limited to those listed in List 1b in Section 3.1),
- Population, or subject of the review, as including ‘the world’s poorest people’. Only studies which examine the situation in at least one “low-income country” as defined by the World Bank (WDI 2009) will be included.

- **Geographic coverage**

Each article will be reviewed at the title stage for geographic relevance. If it is not possible to deduce geographic coverage at the title review stage, the article will be included for abstract review, at which point we expect it will be feasible to deduce geographic coverage of the article according to the criteria discussed below.

It is possible that barriers to uptake of modern energy services, and interventions to overcome them, have been studied in one part of the developing world but not another. However, this does not mean that the findings from one context are not relevant elsewhere. So, although the review will focus on sub-Saharan Africa (see below), there could be high value to be gained by including evidence from Asia and Latin or South America, or even articles looking at pockets of extreme poverty in higher-income countries. Asia, Latin America and Africa will all have very different contexts and our review will take this into account by ensuring appropriate search terms for each geographic context are used (outlined in 3.1), as well as keeping track of distribution when extracting data from included studies (outlined in 3.5).

The Commissioner of this review, DFID, has asked the review team to focus on sub-Saharan Africa. Therefore, we propose using a systematic and transparent approach to reduce the number of papers captured for Asia, Latin America, and other developing countries outside sub-Saharan Africa. For studies in Asia, Latin America, and other developing countries outside sub-Saharan Africa, only studies which examine relevant interventions and their outcomes will be included, while studies which look only at barriers will be excluded. We will also look specifically for other systematic reviews of energy technologies and programmes such as, for example, the rural electrification programme in China, which may synthesise a range of literature and have important evidence for us to draw on for our analysis. Of course, quality criteria as detailed below will apply at these stages. These criteria will allow us to focus on the lessons learned from these non-sub-Saharan-African countries.

Prior to finalising this approach, we will have a detailed discussion with DFID to make sure this fits their needs.

- **By types of intervention**

The intervention must be a public policy intervention or type of involvement to encourage or address increased uptake of energy services. If at least one of the intervention(s) discussed in the article is a public intervention, then the article will be selected for inclusion in the full text review. We take ‘public intervention’ to mean an activity undertaken by an actor (or actors) not working through normal market means. This does not mean that private actors are precluded. Private actors might well be involved but there will be some kind of public dimension to the activity: for example, donor-support, NGO involvement or government role. The rationale for this criterion is that if normal market means are able to deliver modern energy services then there is no need for an intervention to address a ‘market failure’, and so the study will have little relevance to the needs of this review.

- **By types of comparator**

Each article will be reviewed for inclusion of the following comparators. If one of the comparators below is listed, the article will be selected for full text review. The comparators we will use to include studies are:

- *Use of modern energy services before/after an intervention to target barriers to use:* This is the most obvious comparator to select. The presumption would be that the intervention successfully targets the intended barrier (or barriers) and any change in outcome can be attributed to the intervention. However, it might not capture compounding factors (e.g. changes in the broader context that might have had more impact than the intervention), and it would not necessarily capture technology substitution (e.g. if the energy service is new to the user).
- *Use (and associated barriers to use) of modern energy services/technologies versus prior use of traditional fuels:* This could capture technology substitution.
- *Use of modern energy services versus use of traditional fuels used at the same time within a geographical region/community:* This could reveal something about other factors such as individual decision making, or reveal something about the relative importance of different barriers.
- *Analysis of different communities:* This could reveal something about factors in the contexts of different (localised) cultures. If an article looks at interventions in different types of communities this could provide useful analysis and learning for the review.
- *Analysis across different time periods:* Assuming that different time periods are likely to consist of more differentiated broader contextual factors, this could reveal the relative importance of context versus barriers.
- *Use of two or more different types of modern energy services/technologies:* There are potentially many combinations here. There could be two or more modern energy services/technologies being used within the same household; or different modern energy services/technologies used across different households; or the same modern energy service being realised with a range of technologies either within the same household or across different households. In all

cases, the relative importance of barriers could be different across these combinations.

- **By types of outcomes**

We will not exclude studies from the review based on the types of outcomes. The review question is interested in studies looking at barriers to the use of modern energy services, and in the effectiveness of interventions to address barriers. As such we are interested in two outcomes: first, use of modern energy services, and second, effectiveness of interventions. Thus, we will look primarily for studies that include an indicator of the type/level of energy services being used and evidence of increased use.

However, in order to ensure that the data analysis component of the review is appropriately focussed and relevant to the needs of the commissioning body, DFID, we will have more detailed discussions about the types of outcomes and the nature of indicators DFID is most interested in investigating. For example, how does DFID define the concept of “increased use”? Is it through electricity drawn from a national grid, from number of new people connecting to the grid through new access points? If it is the latter, how many new connections count as a substantive increase? Equally, effectiveness of the interventions will need to be defined through a series of indicators. This could be measured through economic productivity, health outcomes of a community, and so on. All of these considerations will require input from both the client and the review team once the initial mapping exercise has been undertaken in order to ensure the review output is fit for purpose. Initial discussions to this effect have already taken place and we expect more will follow as this protocol is finalised. We expect these discussions will be further enabled by the inclusion in our mapping of the outcome measures used by various studies (see 3.5).

- **Types of study**

We will not exclude articles or reports from the review on the basis of study type. We expect both quantitative and qualitative studies will be included in the review. For quantitative analysis, only studies that have controlled for time periods and geographic location will be selected. For qualitative studies, this control criterion would be problematic. In such cases, the review team will assess whether the analysis is appropriately sensitive to contextual factors and the extent to which lessons could be translated to other contexts. These criteria will help ensure that only the highest quality quantitative and qualitative research will be selected for inclusion. This criterion will be applied at the critical appraisal stage, although we do expect to have an overview of the different types of literature once the abstract review stage is completed.

- **Kappa test(s) for consistency of decision regarding inclusion/exclusion, at title, abstract, and full-text level**

The inclusion criteria will be applied to title and abstracts as specified above. For efficiency, in cases where it is clear from the title that the study is irrelevant, the abstract will not be reviewed. After the first review of titles, two reviewers will review the abstracts of all accepted articles and make decisions about inclusion or exclusions. In both stages, reviewers will keep a record of

whether articles are accepted or rejected on the basis of just the title or both title and abstract. Reasons for acceptance or rejection based on the abstract will also be recorded in a template.

At the point of reviewing abstracts and full texts, two members of the review team will make independent decisions on accepting/rejecting a small sample of the relevant articles. The recommended sample size is a minimum of 10% of the full list, up to a maximum of 500 references (CEE guidelines, p. 37). A Kappa test will be undertaken to measure the agreement between the two independent reviewers' decisions. Where disagreements emerge about the decision, the two reviewers will compare their records and discuss their respective reasons. This will help to identify any gaps in the inclusion and exclusion criteria and allow the reviewers to clarify their interpretation of relevance for the remaining articles. If necessary, the inclusion and exclusion criteria may need to be refined.

3.3 Potential effect modifiers and reasons for heterogeneity

We anticipate that the majority of studies will be qualitative in nature and that heterogeneity of study type and output will prevail. Contextual factors of each study will give an idea of the potential modifiers which will need to be taken into account as we review the literature. Difficulties could arise because of many factors in study design and analytical approach. In quantitative research, these problems are usually discussed in terms of reliability and validity (both internal and external). These terms are less appropriate for qualitative research; instead 'equivalents' are suggested to be dependability/auditability in place of reliability, credibility/authenticity in place of internal validity, and transferability/fittingness in place of external validity (Miles and Huberman 1994; Lewis and Ritchie 2003). There are many possible ways to attempt to address these difficulties and we cover many of them in more concrete terms in the next section on how we will assess study quality.

3.4 Study quality assessment

In order to determine which papers should be given a greater emphasis in the final data synthesis, each of the selected papers will be assessed according to their topical and methodological relevance, as well as for their quality and potential risk of bias.

Topical relevance

To assess topical relevance, we will use two sets of criteria, one for studies focussing on the identification of barriers, and the other for studies examining intervention effectiveness. Some of the papers will fall into both categories, in which case both sets of criteria will apply. The two sets of criteria are as follows:

- ***For studies which focus on the identification of barriers***

The first half of the primary question is "what are the major barriers to increased use of modern energy services among the world's poorest people?". The keyword here is "major", and the challenge here is to separate the important barriers from the less important ones and, in the ideal case, systematically rank or group them. We expect each of the papers that fall into this category will provide at least some

information on what are the barriers, so topical relevance will be judged on the basis of whether the study systematically ranks or groups the barriers by their importance. Rankings or groupings determined by quantitative or systematic methods such as the ‘analytical hierarchy process’ or by well-supported qualitative arguments will both be considered to be highly relevant and given a strong emphasis at the data synthesis stage. On the other hand, studies which simply list barriers without providing the reasons why they are presented in a certain order, or how they have been identified, would still be used to provide additional insights although they may be less useful in contributing to the conclusions on “major barriers”.

- ***For studies that examine intervention effectiveness***

The second half of the primary questions is “are interventions to overcome these effective?”. This is a question about whether the policies, programmes or other interventions have achieved the intended outcomes. A highly relevant study for addressing this question has to include the following elements:

- a measurable and appropriate indicator of outcome,
- a measurement of how the outcome has changed, and
- a baseline/counterfactual which the change in outcome can be measured against

We will need to exercise our expert judgement on what is an appropriate outcome indicator, as they are often open to debate. We will also need to take into account the fact that baselines/counterfactuals are difficult to define with qualitative studies and often contentious and that many studies in this field are good and rigorous but do not necessarily include counterfactuals. Therefore, the criteria list above will only be used as a guide rather than a set of rules. We will also draw on the outputs of future conversations with DFID to determine other measures of effectiveness which might be of particular interest to them (see discussion in section 3.2 above). All of this will be recorded during the review and included in an Annex in the final report.

Methodological relevance

To assess methodological relevance, quantitative and qualitative evidence will both be appraised by looking at methodological quality and relevance and topic relevance, with specific criteria and questions within these broad assessment categories to fit the nature of the evidence. For quantitative studies (which we expect would represent only a small proportion of the relevant papers), we will assess their methodological rigour by considering their study design, including sample size, use of control variables, methods of measuring and assessing different variables, and potential sources of bias. For qualitative studies, we cannot so easily determine the factors which contribute to methodological rigour because of the diversity of disciplinary approaches present in qualitative research. However, we will adapt and refine the recommendations in the Weight of Evidence Framework (Gough 2007) published by the Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre). For example, we will look at the robustness of study design and the defensibility of it against other approaches which might have been used. We anticipate a wide range of approaches to be used in qualitative studies and we will look for evidence that the article defends its particular approach and sample design. We will then look for quality of data collection and whether an adequate sampling was conducted and a clear description of the analysis is given. This would include

identification of appropriate research questions and hypotheses and clear exploration of alternative ideas and explanations, including a full disclosure of key assumptions made in the final analysis. This framework for analysing the methodological rigour of qualitative studies will help us to make explicit the judgements that are being used according to the following dimensions: (a) the generic quality of execution of the study (including coherence and integrity of the evidence in its own terms), (b) the fitness for purpose of the evidence for the review question, and (c) the relevance of the focus of the evidence for the review question. We will establish more specific criteria once we have conducted the searches and been able to map the range of literature available. This will be done in conjunction with the development of the data extraction strategy (outlined in the next section). Until we have a clearer picture of the qualitative studies available to us, it is difficult to anticipate what specific criteria will be most relevant. We will make use of a RAND generic framework for the appraisal of qualitative studies, together with the data extraction template (described in the next section), to develop the criteria through a pilot exercise.

3.5 Data extraction strategy

Information management software (EndNote) helps ensure transparency and replicability throughout the review. This will be used to record bibliographic information for the studies retrieved during the searches. Descriptive information will be recorded for each paper in a separate database, the template for which is:

- Full bibliographical reference
- Publication type (peer review journal article, institution working paper, etc.)
- Study design
- Country or region of the study
- Type of energy service or technology analysed
- Type of barriers assessed
- Characteristics of community assessed (including the reason why the community was selected and how the study subjects were recruited)
- Time period
- Sample size and characteristics
- Outcome/s or type of intervention under investigation
- Effectiveness measures (of interventions to overcome barriers) discussed
- Findings (quantitative and qualitative).
- Biases, effect modifiers/confounding variables identified and/or measured by authors (including in their discussion if *a posteriori* to acknowledge any flaws in their results)

3.6 Data synthesis and presentation

We will confirm the form of presentation of the synthesis after an assessment of the comparability of the evidence. We anticipate that presentation will be a structured empirical narrative alongside several mapping and summary tables (presenting descriptive details of each study included in the review). It is likely that a statistical meta-analysis will be ruled out because we anticipate the majority of studies reviewed will be qualitative.

The synthesis will be structured according to the sub-research questions that fall out of the main review question, as indicated in section 2.1. Within this structure, the secondary questions given in section 2.2 will be used to guide the analysis and develop the synthesis. By doing so, we expect we will maintain transparency and the possibility for repeatability. In addition, in the early stages of the review, after the review of all abstracts but before final selection of the full text articles, we will, to the extent possible as determined by the number of relevant abstracts, build a summary table mapping out the different services, technologies, barriers, interventions and outcome measures which are presented. This will help us to identify the breadth of the material being presented, the potential depth in particular areas where there are many articles published and, as discussed in section 3.4, help us to determine specific quality assessment criteria for selecting papers for full-text review. Equally, it will provide a first indicator of gaps in the evidence base. Such an analysis will form an important input into our synthesis and conclusion stages.

As the evidence is reviewed, we will discuss the strength of the conclusions that can be derived from it based on assessments of the methodologies employed to gather and analyse that evidence, such as the mapping exercise discussed above. The range of comparators included will support these assessments further by enabling a discussion of any effect modifiers, such as contextual factors, and the extent of their influence over outcomes dependent, of course, on whether there are sufficient studies to reveal these factors.

Intervention outcomes were kept purposely broad and inclusive in the search stage of the review; the synthesis will appraise the scope of outcomes analysed in the evidence, and consider any outcome indicators potentially neglected. Dependent on the extent to which the evidence is available, we will discuss variability in outcomes and how such variability might be explained according to different barriers, types of modern energy services, or contextual factors.

Finally, the synthesis will briefly address gaps in the evidence base on the systematic review question. Some of these gaps might be identifiable by making use of literature that is not systematic in itself, such as ‘opinion’ pieces, but is well argued and empirically supported. Considering that there is likely to be a range of opinions expressed in this way, we intend to provide a brief section that sketches the opinion landscape. Of course, no weight can be assigned to such material in terms of evidence of barriers and interventions to overcome them. However, they might usefully point to areas that expert practitioners and researchers believe need further investigation (gaps in the evidence base), or they might provide important rationales for experimenting with particular interventions that have not been tried or have only been piloted before. Such a brief review can serve to ‘complete’ the coverage of the literature. We intend to report the range of opinion as fully and transparently as possible, possibly in tabular form, depending on the complexity of opinion expressed. This will allow

DFID to identify the sources of opinion and to make their own assessments of whether to include them in their programmes.

3.6.1 Selection of studies for synthesis

We intend to select studies for synthesis based on the criteria for study quality and relevance as described in earlier sections. All studies selected will be summarised in some form in the final report, whether it is in tabular form in the initial mapping exercises, or included in the narrative synthesis. We will work in close consultation with DFID and other experts if we find there are too many relevant studies to include in the full synthesis in order to ensure our synthesis remains policy focussed and relevant to the original scope of the research question.

3.6.2 Selection of outcome data for synthesis

As previously mentioned, the definition of effectiveness is broad, and will be refined in consultation with DFID as the review proceeds. The potential range of outcomes of primary studies is thus large. However, not all outcome data from primary studies will be relevant for analysis in this systematic review. Outcome data synthesised in the review will include only those which specifically address how the interventions increase uptake of modern energy services and technologies. This would include both quantitative and qualitative findings, with qualitative findings including, for example, narrative subject reports of outcome differentials of a given intervention effectiveness indicator. We will discuss the outcome indicators considered and not considered in the evidence in the final synthesis.

3.6.3 Process used to combine/synthesise data

The synthesis of data will be guided by the following key questions:

- What is the overall evidence on the barriers to uptake of modern energy services in the developing world?
- What is the evidence on different types of intervention providing differential outcomes?

Following from the steer provided by these two questions, we will use the sub-research and secondary research questions to focus the analysis, as has been discussed in greater detail in earlier sections of this protocol. However, a hypothesis of this review is that the evidence on barriers to the use of modern energy services among the world's poorest people has not been gathered or analysed in any integrative way. Therefore, we anticipate that a 'complete' synthesis of the evidence of barriers and their interactions, together with a similar approach to interventions and their impacts, will be problematic.

3.6.4 Deriving conclusions and implications

Implications and conclusions will be derived from the synthesis of findings from the review and team discussions, a targeted review of academic debates, and consultations with interested policy-makers and academics. Within the review team, we will consider how the question fits within broader development strategies and the key literature identified through the search strategy on modern energy services access and uptake. In the study design, we have chosen to include a wide range of barriers and interventions, including evidence on economic, technical, and cultural barriers and their interaction in different local contexts. Necessarily, then, the conclusions and implications will be emergent and are likely to be context-dependent.

In addition, in order to specifically ensure the relevance of this review to DFID strategies and programmes, we will formally and informally seek the input and advice from policy staff within DFID, as well as more widely. As indicated above, we have already identified and spoken with DFID staff who commissioned this systematic review and they have provided valuable input on their priorities and questions relevant to improved access to modern energy services and technologies in specific geographic contexts. This has helped to shape and tailor the search and review strategy for this study. Continued discussions at the synthesis stage will help to direct the questions asked during the analysis of findings.

4. Potential Conflicts of Interest and Sources of Support

Source of support: Department For International Development (DFID), UK.

One team member, Jim Watson, at the Sussex Energy Group has published widely on the more general topic of energy and development. Relevant publications are listed below. Rob Byrne managed a small solar energy project in Tanzania between October 1997 and October 2000 and was a founding member of the Tanzania Solar Energy Association (TASEA) and served on its interim executive committee for several months before completing a contract in Tanzania (2000). TASEA has now become the Tanzania Renewable Energy Association. It is a membership organisation, involving public and private sector actors, as well as individuals interested in promoting renewable energies for development in Tanzania. In order to mitigate against the risk of biasing our review, we have built in a three-person review process, with additional research oversight by a fourth team member, to ensure objectivity.

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Byrne, R., A. Smith, J. Watson and D. Ockwell (in preparation) “Energy pathways in low-carbon development: from technology transfer to socio-technical transformation”, STEPS Working Paper, STEPS Centre, Brighton.

Mallett, A., D. Ockwell, J. Watson et al. (2009) *UK-India collaborative study on the transfer of low carbon technology: Phase II Final Report*, Brighton and New Delhi, SPRU and TERI.

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