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

EVIDENCE BRIEF

A broad range of factors across seven domains interact to determine uptake of improved solid fuel stoves (31 factors), LPG (26 factors), biogas (33 factors), alcohol fuels (22 factors), and solar cookers (23 factors).

About this brief

This paper summarises evidence from a systematic review by Puzzolo et al (2013), entitled *Factors influencing the large-scale uptake by households of cleaner and more efficient household energy technologies*. It was produced by the Universities of Liverpool and Munich, and funded by DFID's Research and Evidence Division.

The purpose of the systematic review was to describe and assess the enabling or limiting factors that have influenced the large-scale adoption and sustained use of improved solid fuel stoves (ICS), liquefied petroleum gas (LPG), biogas, solar cookers and alcohol fuels.

How to use this brief

This brief is designed to provide an overview of the key evidence included in the systematic review, to assist policy-makers and researchers in assessing the evidence in this field. It summarises key findings, and provides links and references to the included studies. The evidence is deeply contextual and this brief provides only a broad overview. It is not designed to provide advice on the choice of household energy interventions or on how to implement these in particular contexts.

Methodology

A comprehensive search of 27 bibliographic databases, 14 websites, grey literature and also consultation with experts was carried out, covering the period 1980-2012. This identified nearly 14,000 records. Qualitative, quantitative, and policy and case studies were included in the review, provided they related to direct experience of one of the identified technologies and reported empirical information on factors influencing adoption or sustained use. Screening, data extraction, critical appraisal and two-stage synthesis followed strict standards, with findings categorised in relation to equity issues plus seven pre-specified domains. This yielded 101 eligible studies (57 ICS, 12 LPG, 17 biogas, 9 solar cookers, 6 alcohol fuels, 55, 23 and 19 from Asia, Africa and Latin America respectively.

Key findings

For all five types of intervention the review found a series of factors that influence uptake. These are categorised according to seven a priori defined domains: (i) Fuel and technology characteristics, (ii) Household and setting characteristics, (iii) Knowledge and perceptions, (iv) Financial, tax and subsidy aspects, (v) Market development, (vi) Regulation, legislation and standards, and (vii) Programmatic and policy mechanisms. In terms of relative importance, factors such as meeting users' needs, fuel savings, higher income levels, effective financing and facilitative government action seem critical for success. However, none are sufficient in their own right to guarantee adoption and sustained use, so all factors relevant to a given context need to be assessed.

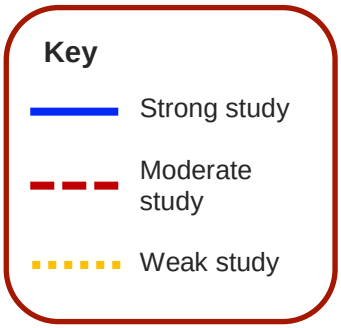
Some factors are supported by only a few studies. This does not mean that the factors are unimportant; only that they have been given less attention in research studies, particularly where technologies or factor-related practices are not yet widely available or implemented.

Research gaps

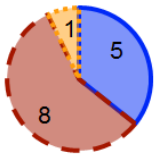
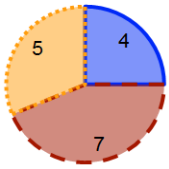
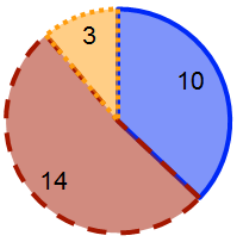
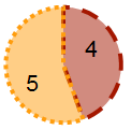
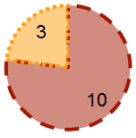
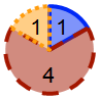
- Studies investigating uptake should clearly distinguish between and investigate adoption, initial use and sustained use
- No relevant studies were available on advanced combustion biomass stoves, which deliver lower emissions
- More empirical evidence on adoption and use of clean fuels (other than biogas) is needed, particularly on multiple stove use and factors influencing transition to exclusive use of clean fuels.

Summary map of evidence

The summary map below outlines the quantity of studies included in the systematic review according to type of technology, type of study and quality of study. Quality appraisal found 17 of the 19 qualitative studies, 17 of the 22 quantitative studies and 47 of the 60 policy and case studies were of moderate or strong quality respectively. Note that the quality score for individual studies (i.e. strong, moderate and weak) should not be considered equivalent across the three study methodology groups as it is design-specific. The size of the pie chart represents the quantity of studies though the pie charts are not exactly to scale. Please refer to the systematic review for information about study quality assessment and an overview of the countries covered by the studies. Overall, this is a moderately strong and consistent set of evidence, with findings consistently identified in different countries and regions, and in different types of study. Findings can be considered sufficiently robust to use as a basis for policy planning and evaluation.



Summary of included studies by type of intervention, study type and quality

Study type	ICS	LPG	Biogas	Solar	Alcohol
Qualitative	Total = 14 	Total = 0	Total = 2 	Total = 3 	Total = 0
Quantitative	Total = 16 	Total = 3 	Total = 2 	Total = 1 	Total = 0
Policy and case study	Total = 27 	Total = 9 	Total = 13 	Total = 5 	Total = 6 
Total studies	Total = 57	Total = 12	Total = 17	Total = 9	Total = 6

Outline of evidence

The table below outlines the factors influencing uptake and/or sustained use, which are categorised according to seven domains. Rather than presenting these factors as discrete enablers and barriers, the systematic review suggests that these can most usefully be seen as operating on a spectrum, so that when present or satisfactory they are enabling, and vice versa. Common and distinct factors influencing uptake of ICS and clean fuels are reported in the table below. For each factor, only key examples of the findings are noted. Please refer to the systematic review for a complete synthesis of the findings.

Factors influencing adoption and/or sustained use of cleaner and more efficient household energy technologies			***Intervention***				
Domain	**Factor**	**Examples**	**ICS**	**LPG**	**Biogas**	**Solar**	**Alcohol**
Fuel and technology characteristics	**Fuel savings**	Impacts on collected/purchased fuel	✓	✓	✓	✓	✓
		Cheaper fuel			✓	✓	
	Impacts on time	Speed of cooking	✓	✓	✓	✓	✓
		Ability of carrying out other tasks while cooking					✓
		Fuel collection time	✓		✓	✓	
		More time for fuel processing or stove cleaning	✓				
		Need for forward planning				✓	
	General design requirements	Design to meet users' needs (e.g. food taste, etc.)	✓	✓		✓	
		Ease of use and efficiency	✓	✓	✓	✓	✓
		Stove cracking	✓				
		Quantity of food that can be cooked	✓	✓		✓	✓
	Durability/specific design requirements	Convenience / portability / warmth	✓			✓	✓
		Aesthetic features	✓				✓
		Functionality			✓		
	Fuel requirements	Limitations in type, size and dryness of fuel	✓				
	Safety issues	Quality of equipment		✓	✓		✓
		Risks of explosions		✓			✓
	Operational issues	Need for sufficient feed and correct water/feed mix			✓		
		Biogas plant daily operation and regular cleaning			✓		
		Lack of familiarity with technology				✓	
Household and setting characteristics	**Socio-economic**	Higher income level	✓	✓	✓	✓	✓
	Education	Years of schooling (for men and women)	✓	✓	✓		
	Demographics	Household size	✓	✓	✓		
		Labour availability	✓		✓		
	Household ownership and	Home ownership	✓	✓	✓		
		Appropriateness of space around house			✓	✓	
	Sufficient land and animal availability				✓		
	Multiple fuel and stove use	Use of traditional stoves or cheaper fuels influence the adoption/exclusive use of the new technology	✓	✓	✓	✓	✓
	Geography and climate	Cold and rainy settings (and altitude for biogas)	✓		✓		
		Increased adoption in urban settings	✓	✓			
		Less adoption in rural settings	✓	✓			✓
		Less adoption in disaster-prone areas	✓				
		Impacts of seasonality/time of day on cooking				✓	

Factors influencing adoption and/or sustained use of cleaner and more efficient household energy technologies			*Intervention*				
Domain	**Factor**	**Examples**	**ICS**	**LPG**	**Biogas**	**Solar**	**Alcohol**
Knowledge and perceptions	**Smoke, health and safety**	Reduced acute health effects	✓		✓	✓	✓
		Reduced burns	✓			✓	✓
		Explosions concerns		✓			
	Cleanliness/home improvement		✓	✓	✓		✓
	Total perceived benefits	Value for money	✓				
		Meeting expectations / convenience	✓		✓	✓	✓
		Prior knowledge of the technology	✓	✓	✓		
	Environmental and agricultural benefits				✓		
	Social influence	Influence of social networks / opinion leader	✓		✓	✓	
		Aesthetic appeal / increased social status	✓		✓		
		Negative impact of cultural taboos			✓		
	Tradition and culture	Importance of food taste	✓	✓	✓	✓	
		Suitability for preparing local dishes	✓			✓	✓
		Stove to be big enough to accommodate large pots	✓	✓		✓	
Financial, tax and subsidy aspects	**Stove costs and subsidies**	Cost to users	✓	✓	✓	✓	✓
		Flexible pricing	✓				
		Subsidies	✓	✓	✓	✓	✓
	Fuel costs/subs	Cost of fuel to users		✓			✓
	Payment modalities	Payment by instalment, loan, credit	✓	✓	✓	✓	
		Inappropriate management of credit or subsidies reported	✓	✓	✓		
	Programme subsidies	Financial support for retailers, rural entrepreneurs or users training	✓	✓	✓		✓
		Lack of financial support for maintenance and awareness	✓		✓		
Market development	**Demand creation**	Promotional strategies	✓	✓	✓	✓	✓
		Word of mouth	✓		✓	✓	
		Coercion, false promises, mis-information	✓				
	Supply chains	Need for efficient supply chains	✓	✓			✓
		Lack of available replacement parts	✓		✓	✓	
		Poor road infrastructure, distance and transport costs	✓	✓	✓	✓	✓
	Business and sales approach	Aspects influencing business expansion	✓	✓		✓	✓
		Shops selling livestock for biogas production			✓		
Regulation, legislation & standards	**Regulation, certification and standardisation**	Need for design standards	✓	✓	✓		
		Policy and legislation		✓			✓
		Negative impacts of fuel price volatility		✓			
	Enforcement mechanisms	Procurement of materials from designated suppliers	✓		✓		✓
		Penalties for non-compliance with standards	✓				
Programmatic and policy mechanisms	**Construction and installation**	Construction / installation by trained personnel	✓		✓		
		Negative impacts of poor construction or installation	✓		✓		
	Institutional arrangements	Co-ordination	✓	✓	✓		
		Strategic government policy and support	✓	✓	✓	✓	✓
	User training	Need for training in stove use and maintenance	✓	✓	✓	✓	✓
		Reported lack of user training	✓		✓		
	Community involvement (e.g. women's engagement)		✓			✓	✓
	Creation of competition (e.g. rewards schemes)		✓		✓		
	Post-acquisition support	Availability / quality of support (e.g. after-sales service)	✓		✓	✓	
		Reported inadequate support	✓		✓		
	Monitoring and quality control		✓	✓	✓	✓	✓

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