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Energy access and transition to cleaner cooking fuels and technologies in Sri Lanka: Issues and policy limitations

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ABSTRACT

Easy energy access is a trigger for human, social, and economic development. A research project was undertaken in Sri Lanka to broaden the understanding of human dimension of energy access and technologies. A questionnaire survey, covering 2269 households, gathered data on socio-economic contexts and issues influencing a transition towards clean cooking facilities. The findings reveal that the transition is impeded by four factors: the lack of motivation and the pressure for switching over to cleaner facilities, the lack of modern energy technology options, the financial risks, and the lack of financing and other support. The paper describes the delicate two-way interrelation between women earning wages and the transitions to cleaner cooking fuels and technologies. The findings suggest the need for a policy framework involving the stakeholders, financing and standardised technologies. To make a change it is proposed to introduce a national, integrated policy incorporating financing and energy governance.

1. Introduction

1.1. Country overview

Sri Lanka has made tremendous progress through its policy on household electrification with the aim of providing electricity to all households by 2016. Already 85% of households are provided with electricity. However, the cooking energy domain has not received the same attention. It still depends heavily on biomass, irrespective of the changes in the supply sources and negative effects stemming from the direct combustion of biomass in open hearths for converting solid materials to useful energy. There is a great need for clean-burning fuel for cooking, smoke elimination, drudgery reduction, food security, health, productivity, environmental improvement, and women's welfare. With regards to women's welfare, women, as the cooks, are largely responsible for securing cooking fuel. To date, no political actions have been taken to effect change on energy policy addressing cooking facilities.

In Sri Lanka, the issue of providing cleaner facilities for cooking is rather complex, and the causes of current conditions, such as inadequate access to improved technology and high calorific wood, food habits, household behaviour, competing demand for income, and resource allocation patterns, demand situation specific solutions. The national energy sector is aware of the challenge and the crucial necessity for providing access to cleaner facilities through widening services, linking the UN Millennium Development Goals to energy. The UNDP and others (2005) have stated that there are multiple pathways by which those cooking with solid biomass can benefit from switching to clean-burning cooking fuels. In order to address the technological issues, in 2004, the UNDP provided support for the development of biomass energy technologies in Sri Lanka. This has left a knowledge gap with regards to which areas require improvement and how to transition to new fuels and new technologies. Until now the emphasis placed on switching over to cleaner cooking fuels and stoves has been global rather than local, at least in the context of Sri Lanka.

The advantages of switching to pollution free cooking facilities, particularly the potential contribution to poverty reduction, gender equity, health, and the development process should not be underestimated. Cooking is one of the key energy requirements and changing its model in Sri Lanka has the capacity to reduce spatial energy service gaps and the gaps in development. It has not yet entered the dominant energy paradigm or the sustainable development discussion. However, in many circumstances solutions are addressed locally, particularly by women.

The research and in-depth analysis presented in this paper on energy access and cooking facilities was stimulated by the situation

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Table 1
Indigenous primary sources of energy in Sri Lanka.
Source: ECF, 2006.

Indigenous energy source	Typical user group	Typical applications	Scale of use
Biomass	Household	Cooking	Widespread
	Commercial	Hotels, bakeries	Widespread
	Industry	Tea drying, brick and tile	Widespread
Hydropower	Private power plant	For sale to utility	1 MW power plant
	Electricity utility owned large multipurpose systems	For retail to customers	Major power plants
	Commercial grid-connected	For sale to utility	About 38 power plants
	Village-level off-grid electricity	Household use	About 140 power plants
	Industrial off-grid electricity	Tea industry	Less than 50
	Industrial mechanical drivers	Tea industry	Negligible, one or two remaining factories
Solar power	Solar photovoltaic	Household lighting	About 115,000 units
	Grid connected PV	For sale to utility	One unit
	Solar Thermal	Hot water systems in commercial and domestic sectors	Widespread
	Informal use	Household and agricultural use	Widespread
Wind	Grid connected wind	For retail to customers	One pilot power plant
	Off-grid power plant	For residential use	A few dozens
	Water pumping	Agriculture	A few dozen

pertaining to the energy sector in Sri Lanka as structured in the National Energy Balance (ECF, 2006). The objective was to broaden the understanding of ground realities, to initiate a policy dialogue regarding these issues, and to develop a strategic response. The basic arguments that lead to this research have been raised by the energy sector. Accordingly, rural households use the bulk of firewood and other biomass resources for cooking even though they have access to grid electricity. As shown in Table 1, biomass is strongly connected to cooking applications, while clean energy sources are connected to commercial application and lighting.

In Sri Lanka biomass is a promising source of energy with dominant usage coming from the domestic sector for cooking. In the total energy picture the final energy used by end-users is composed of 58% biomass, 34% petroleum, and 8% electricity. In 2006 households, commercial, and others consumed over 49% of the total energy, the industrial sector consumed 26%, and the transport sector consumed 25%. Of particular note is the heavy consumption of biomass by households, commercial, and others. Nearly 80% of the energy used by the household sector is biomass, with only 10% petroleum and 9% electricity.

2. Cleaner cooking fuels and stoves as a facet of development in general

Cooking with fuel wood and crop/forest residues, though not animal dung, is the common practise throughout Sri Lanka, particularly in rural households. They use biomass due to its availability and free access to reliable sources, specifically of high calorific fuel wood. The number of people, families, and households depending on solid biomass for cooking is increasing due to the increasing population and demographic changes, the increasing cost of alternative commercial sources, the demand competition for family income, and the practical difficulty of switching over to cleaner facilities. As Sri Lanka possesses multiple production systems of agro-forests, it enables a majority of rural residents to secure over 70% of their fuel wood from local sources. Out of the total population of 20 million, 18 million people, living in around 4 million households, rely on fuel wood, locally available materials, and traditional combustion technologies to meet their day to day cooking requirements.

Under these circumstances over 70% of the fuel wood is freely procured by women in rural households. Women obtain cooking fuel as silent service providers, shouldering most of the problems of reaching sources, competition, head-loading, time pressure, etc. They are least concerned about the 'kitchen killer' or the seriousness of the multiple repercussions of direct biomass combustion.

Often the issues facing clean facilities are associated with two domains, fuels and stoves, both lack any technological standards. Policy interventions are required in both areas. The reasons why clean energy sources like electricity, that is accessible to 85% of households, are being used for generating services other than cooking and why clean energy for cooking is not on the agenda of the energy sector need to be understood. Two perspectives are crucial in articulating a discussion. The first is the Millennium Development Goals and Sustainable Development. The second is related to gender justice, rights, health, and environmental and human wellbeing. This paper draws attention to the research carried out on the above questions using field data collected in 2006–2007 from 2269 households in three administrative districts; Badulla, Matale, and Moneragala in Sri Lanka.

3. Field data collection

The primary data for this research was collected using a questionnaire survey, participatory methods, and field observations. The field survey consisted of a three stage procedure. The first stage covered the preparatory work, the second consisted of preparing a questionnaire and templates to guide the key informant discussions and group consultations, and the third was to summarise the field data and produce summary tables. During the preparatory stage 12 field assistants were recruited and trained with an introduction to the subject area. The secondary sources, primarily the information on constituent Divisional Secretariat Divisions (DSDs) of the three districts, were gathered. Two DSDs each were selected from the districts representing the broader agro-ecological zones, along with information on the Grama Niladari Divisions (GNDs), which are the lowest level administrative divisions of the country, and the subdivisions of the DSDs. From each DSD, 20 GNDs were selected at random. Referring to the secondary data; from the lists of the total number

of households in each GND, 14–28 were selected at random to have a 10% household representation in the household survey. In total, the field survey covered 530 households from Badulla, 639 from Moneragala, and 1100 from Matale District.

A questionnaire for field data collection was prepared after one reconnaissance visit to each of the 6 selected DSDs. Questions were structured to gather gender disaggregated data on the socio-economic conditions of the households including:

- income and income sources;
- demography;
- property and asset ownership;
- labour distribution and returns to labour;
- energy use and sources;
- fuel wood supply;
- consumption and technology;
- access to services;
- an open section to record points that emerged during discussions.

Field data collectors were trained, who then tested the questionnaires in the field. Interactive discussions enabled them to learn from each other and sample households before reproducing and adopting the questionnaire for the final survey. 100% of the sample selected responded to the survey, but in 10–15 cases two visits were made to meet the household members. The data collectors worked in pairs and stayed in the respective villages for 3–5 days, enabling them to revisit the households where further discussions were needed or to clarify the points. One group discussion was held in each of the 120 GNDs to clarify the doubts and to construct a general overview of the situation. The field data was entered into the computer database by the same team and tabulations were completed in 2006.

4. Energy use pattern in the study areas

Energy is a multiple service provider in all 2269 households, primarily for meeting two requirements: lighting and cooking. The main source of cooking fuel for all 2269 households is biomass, and only 121 households occasionally use kerosene, electricity, or LPG as supplementary sources of cooking fuel (see Fig. 1). Combustion is done in semi-circular mud-hearths by 2061 households and in improved stoves by 168 with the occasional use of three-stone open hearths when large-scale cooking is needed.

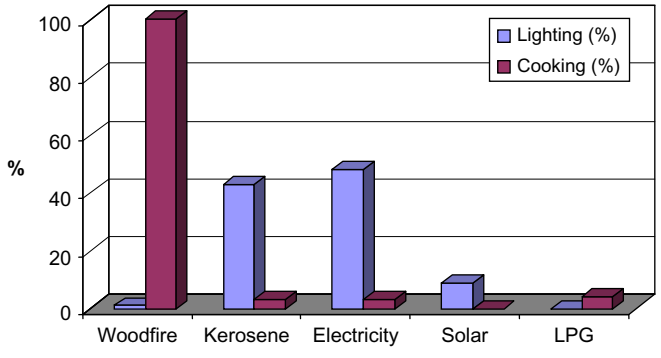

Fig. 1. Sources of energy used in lighting and cooking.

The two services are strongly differentiated. In cooking an unhygienic and harmful traditional source, with no changed technologies, is used. Per Capita consumption of biomass is 1.6 kg per day and with a total population of 95,298 present in the surveyed households, the total daily consumption is around 152,000 kg. In this domain no transition has taken place in adopting clean energy options or combining technology. In contrast, field data confirmed some of the progressive change that had been claimed to occur in securing a clean source of energy for lighting. The percentage of electrified households in Matale is high, observed at 72%. It is 48% in Badulla and only 10% in Moneragala. 4% of the households use wood fires in outer-yards for illumination and to reduce wildlife risks. Socially and economically, Matale is in an advanced position when compared with the other two districts, which are reported as poverty prominent districts of Sri Lanka. In total, the state policy on rural electrification has caused a progressive change in the total picture, enabling 52% of the households to have electricity or solar energy for lighting while 48% use kerosene wick or bottle lamps for lighting in these areas.

With regards to cooking facilities, the situation among the households represented by these three rural districts has undergone no transition; it remains on the lower step in the energy concerns ladder. Essentially no clean or healthy fuels are being used for cooking (see Table 2).

5. Matters beyond access

All 2269 households covered in this study have access to alternative sources of fuels that are capable of replacing the unclean cooking energy and can address the major repercussions associated with the combustion of biomass. The key question that arises is why the clean sources of fuel that are accessible to the households and already used for lighting are not being used for cooking. For example, the households using kerosene for lighting have a keen interest in discontinuing kerosene usage if electricity is made available at an accessible distance. Their readiness to adopt the best source for electricity available in the energy ladder is quite high. This is influenced by their ability to transfer the cost borne in purchasing kerosene to the most beneficial, a healthy and clean source for lighting. Switching over to alternative and clean fuels in cooking is outside the domain of physical access to clean sources. 68% of the responded households indicated that it would be possible to switch over to clean fuel through the adoption of modern technologies for improving or converting the energy generation process.

The responses also showed that the households' behaviour in making decisions over energy sources does not reflect a great variation. The composition of the biomass mix used shows that 92% of the biomass used in cooking is solid wood and 8% is residue primarily consisting of coconut fronds and shells, pods, and stalks.

Table 2
Energy use pattern of households by source.
Source: Field survey, 2006–2007. (Number of households is given in parenthesis).

District	# of Hh.	Lighting			Cooking				
		Elec. %	Kero. %	Solar %	Fuel wood	Kero. %	Elec. %	LPG %	Biogas %
Badulla	530	48 (254)	47 (249)	5 (27)	100 (530)	–	–	–	–
Moneragala	639	10 (64)	72 (460)	18 (115)	100 (639)	–	–	–	–
Matale	1100	72 (792)	23 (253)	5 (55)	89 (979)	3 (33)	3 (33)	4 (44)	1 (11)

Table 3
Reasons for not switching over to clean cooking fuels.

Reasons	% of household reported important			
	Not much concern	To some extent	Significantly	Rank
Lack of personal capacity, confidence, authority, and control over clean fuel	10	25	65	5
Increasing/exclusively high cost of clean energy options that are not affordable	–	–	100	1
Unnecessary burden on family budget	–	–	100	1
Not suitable to meet multiple cooking needs	–	30	70	4
Lack of confidence and unreliability of externally derived sources	–	10	90	2
Risks and unreliable livelihood	–	30	70	4
Necessity to attend to cooking in a consistent way	10	30	70	4
Difficulties incurred in adopting end-use devises	20	10	80	3
Availability of 'fuel wood' from local sources	–	10	90	2
Ability to use biomass without a cost	–	10	90	2
Regenerative capacity and local control over the biomass	5	5	90	2

The reasons for the continued use of fuel wood, as reported by the respondents, are multiple. For these households, which already live on a limited income, switching over to cleaner fuels is a forceful creation of additional financial burden. The gravity of the problem varies according to the features of the individual households, but the affordability of alternative fuels and the difficulty to bear the financial burden of switching over to cleaner sources are high (see Table 3). Findings of research carried out in India as part of the Department Of International Development UK (DFID KaR) project showed that the main obstacle to fuel-switching is affordability, and wood fuels are still cheaper (Parikh and Sharma, 2005). The results of the current study similarly show that affordability is a major obstacle to fuel-switching. If a clean source is adopted, the estimated cost of kerosene/electricity or LPG reported to be in the range of Rs. 1200–1400 (US$ 12–14) per month. For around 58% of the households this additional item comes to about 25% of their monthly cash income.

The field data also revealed that there is no pressing desire for the rural households to eliminate fuel wood in cooking. 90% of households reported that they have free access to supply sources or the capacity to regenerate stocks, while keeping them under their control and obtaining financial resources without diverting their income. The concern over adopting 'clean cooking fuel options' is rather low; as a result the discarding of a 'no-cost' source to switch over to a costly source is not a priority. The survey also suggested that some social engineering work is necessary to change the local attitude, and it is crucial to create local demand for cleaner fuels or technologies.

6. Competing cash demand

In selecting energy sources for various services the decisions are made by households in relation to income where the majority live below poverty or marginally above poverty. The field data reveals that the monthly per capita income of 58% of the households is above Rs. 1500, which is marginally above the locally defined poverty line, but this income is reported inadequate to cover major items of expenditure. In allocating household income their behaviour is influenced by the competing cash demand and the possibility to use non-commercial sources for energy needs. A switch to clean cooking facilities is only feasible if the costs do not create an additional burden on the household budget and all other requirements can be met without creating serious financial pressure.

Household decisions on energy are also influenced by the pressing demand for two major services of lighting and cooking. Food is a greater priority than illumination in the household budget. Nevertheless, in allocating household income in the survey, cooking energy is generally not itemised, while electricity or kerosene is listed either as the second or the third place in the budget. In the rural areas considered, fuel wood is a 'no-cost' source accessible to households. Biomass is not considered to be a commodity with a price tag as it does not need to be purchased in a commercial market. In addition to the accessibility of fuel, all 2269 households reduce the expenditure on food by producing as much as possible for subsistence in an ad-hoc manner irrespective of seasonal variations. The greater the engagement in farming the less is spent on purchasing food from the market. In spite of a wide disparity in average monthly income of these households between Rs. 4500 and 20,000, all displayed an interest in having the least-cost cooking fuel. For these reasons and others, the procuring of fuel wood without cost, the access to production sources, the availability of at least a part of required fuel from their own sources, and the practise of collecting fuel wood while attending to other activities, the pressure to switch over to alternative, costly sources is mitigated.

Around 76% of households allocate their income in an inconsistent manner. Decisions are made according to the pressing needs and the immediate situation instead of being restricted to planned expenditures. In allocating income, the total value of energy services is not taken into consideration. All items that are obtainable freely without a financial burden, including water, fuel wood, and food are excluded. A farm family with a monthly income of Rs. 4500–6000 spends 45–65% of the income on food: 10–20% on education; 5–15% on transport; 10–20% on social work; and 10–15% on electricity or kerosene for lighting. 68% of the households feel that spending an additional 20–25% of the total cash earnings on clean cooking fuel is impossible, unwise, and unnecessary. Others consider that recurrent expenditure on clean cooking fuel could be diverted towards better options in improving living conditions via other means and securing services that are not available to them. These circumstances are nurtured mostly by the nature of the livelihood and income sources, rather than the actual amount of income earned by the respective households. Only 12% of households earn a monthly income through regular sources, whereas the others rely on multiple sources, such as casual labour earnings, farm produce, and informal enterprises. The opportunity cost of labour is not taken into account in regard to these supplemental subsistence activities. Often priority is given to regular, unavoidable items: food, clothing, health, kerosene or electricity for lighting, transport, education, and securing household amenities. The household labour is allocated by task enabling the members, specifically men, to grasp market opportunities while women attend to domestic chores, including fuel wood gathering, water fetching, and unpaid farm work.

7. Labour issues

Not all rural and urban households are similar. 11% of the households use clean cooking fuels, mainly LPG and electricity, as supplementary sources, and these households are worth considering separately because they demonstrate the factors that have already facilitated a transition. The behavioural patterns of these 11% of the households are different from those who rely completely on biomass for fuel. Women of these households spend comparatively less time cooking, nearly 2–3 h per day in a structured manner. The detailed analysis revealed that they select items, which are easily prepared as much as possible. The decisions made on selecting food items and choosing to switch to clean energy options are driven by labour opportunities available to women and the increasing difficulties of allocating labour and time to procure and process fuel wood and cook. The need to switch over to clean cooking fuels is influenced by the women's enhanced financial capacity to pay off the additional cost of energy through alternate labour. Two features differentiate this category of household from the others regarding energy decisions. The first feature is that women who have conventionally spent 3–4 h a day on procuring and processing fuel wood have replaced the biomass with costly and cleaner sources of cooking fuels. The second feature found in the field situation is an increase in time used in regular employment and a reduction of time allocated for energy related activities, primarily in procuring and processing. The work patterns of the women in these households are structured around their employment and income, not procuring cooking fuel, attending to hearths, and cleaning and tidying the kitchen. Women who are regularly employed spend around 3 h cooking two meals per day, one in the morning prior to travelling to work and the other after their return. In contrast women, performing conventional chores spend around 6 h cooking three meals per day, in addition to engaging in various other unpaid tasks informally in between cooking-related activities (Table 4).

Women estimated that in total, at least 10 labour days per month traditionally spent on gathering and processing fuel wood could be made available to allocate on other productive work. The opportunity cost of this time, is estimated to be Rs. 2500 per month while the financial benefits gained by providing biomass for fuel with no direct cost was Rs. 1200–1400 per month. This suggests that if remunerative employment is available for women, they become financially capable of switching to clean fuels. In this connection two transitions are needed; the first is the deviation of women's unpaid family labour towards paid labour or income earning enterprises. The second is the replacement of traditional biomass conversion or combustion technology for saving the end-user's labour time substantially. This points-out the needs for examining secondary benefits of energy technologies through a comprehensive cost benefit analysis. The findings of research carried out in China and other parts of rural Asia (Kelkar and Nathan, 2005) showed that a low opportunity cost of women's labour limits the adoption of improved stoves, while women's entry into income earning activities promotes a fuel transition. Based on the same research, the authors emphasised that the lower the income or production the lesser the incentives to adopt clean technology. So long as opportunities for women's engagement in income earning activities are limited, there will continue to be a heavy reliance on collected rather than purchased fuel, and a rural fuel transition is unlikely to occur.

Table 4
Employment status of women using supplementary sources of cooking fuels.
Source: Field survey, 2006/2007.

Fuel type	Total number of households	Households with women in outside waged employment	Households with women in unpaid agriculture	Households with women in casual work
Kerosene	33	22	06	05
Electricity	33	31	00	02
LPG	44	42	02	00
Biogas	11	00	11	00

The research carried out in Sri Lanka suggests that there is no one single solution to a wide range of situations. On one hand the labour constraints experienced by women in paid employment illustrate the difficulty of continuing to bear the responsibility as biomass providers, and on the other the enhanced financial capacity to pay for better options and cleaner sources would facilitate such a transition. Rapidly evolving labour markets in urban areas and industrial zones have expanded opportunities for young women to secure paid employment. The women's migration for work has directly transformed the traditional lifestyle, influencing the decision to adopt easy and convenient cooking technologies. The households producing biomass also have indicated a desire to select clean technologies rather than exclude biomass from their energy domain. It is interesting to note that the high income receiving households who can afford a transition to a clean source of cooking fuel (electricity or LPG) still prefer to use fuel wood. Unlike poorer households, this is associated with a concern over maintaining the preferred taste in food by slow-cooking in clay pots on wood hearths. Like poorer households, for them it is also a way to save energy expenditure and utilise the biomass that they produce on their own lands and the high calorific wood available throughout the year.

8. Technological issue

A variety of technologies are available to convert solid biomass into cleaner and convenient energy forms such as gases, electricity, and liquids. Yet, in the rural areas considered here the use of improved biomass combustion technologies is limited to cook stoves (see Table 5). Three types of stoves are being used. The locally made semi-circular stoves are the most popular type. When compared with the three-stone hearths, these require less fuel wood, and compared with open hearths, consumption is 50% of total fuel. In addition the stove emits a relatively low amount of smoke, it fits easily into narrow spaces, it is easy to maintain, and women have the capacity to establish and manage the stoves with full confidence. Three-stone hearths are the oldest type. Their relative advantage is the capacity to use un-split logs and unprocessed wood. They are used for processing food, including rice parboiling, and in large-scale cooking for festivals and ceremonies. Improved cook stoves are purchased from the market, fixed by male artisans, release less smoke, and are easy to clean. Fuel wood consumption is lower by 20% when compared to the semi-circular type, but the use of residues (coconut shells and fronds) is reported to be risky because they easily damage the stoves. More than one type of stove is used by 58% of the households using improved stoves and half of the households using semi-circular stoves. They occasionally use three-stove hearths. A comparative analysis of the combustion technologies was a difficult task because rural households often use more than one type very flexibly.

Through a series of discussions and self-assessments of the advantages and the disadvantages of the biomass combustion technologies available, two sets of technology options were suggested. The first included improved hearths for efficient combustion, and the second dealt with a complete technology drive to convert solid biomass into gas or electricity and supply it as a source of energy for cooking. This indicated the desire for

Table 5
Types of stoves used by the households and employment status of women using the stoves.
Source: Field survey, 2006/2007.

Type of hearths used	Number of households using	Women in informal agriculture (%)	Women in outside waged employment (%)	Women with awareness (%)	Women with management skills (%)
(1) Three-stone open hearths alone	45	98	02	100	100
(2) Semi-circular mud stoves	2065	86	14	100	91
(3) Improved cook stoves	159	12	88	36	04
(4) More than one type	1180	86	100	100 (1 and 2)	91 (1and 2)

technologies that can clean up the whole process and reduce the drudgery of conventional systems. Cleanliness is interpreted by the respondents from various perspectives, particularly by women who are engaged in the biomass cycle from the stage of gathering to post-combustion cleaning. "Free of dirt and drudgery in collecting, portaging and combustion", "free of dirt (ash)", "free of smoke including pollutants", and "free of soot" are the explanations provided by women in regards to cleaner cooking fuel. The conversion of biomass to a pollution free energy carrier is considered by many respondents to be the best solution to pushing the cooking fuel on the energy ladder. However, the field information also revealed that 80% of the respondents are reluctant to adopt alternatives on the basis of cleanliness alone, while 78% consider that switching over to commercial fuels, discarding a freely available type produced primarily in their own lands is unwise and would result in creating additional burdens.

The most crucial question here is what form of conversion is possible and what kind of technologies can improve combustion.

Although the conversion of biomass to a pollution free energy carrier may be the best, in most circumstances the contextual diversity is an obstacle to the adoption of modern technologies. For instance many types of wood and residues of various qualities in different quantities are currently used by individual households. A conversion of these into gas, electricity, or liquid forms is costly and complicated. This becomes possible only through a strong commitment of the state. 80% of the surveyed households reported that up until now there had been no efforts to reduce the repercussions associated with the direct indoor combustion of raw biomass for energy generation. This implies that even technology extensions such as gassifier stoves, improved cook stoves, and biogas systems have not reached the households. These technologies would not necessarily aim to replace the biomass-based energy system with clean cooking fuels, but would instead provide some clean energy solutions with secondary benefits. Any technology shift needs to take into account that the system has the capacity to use locally available raw materials Projects must involve the key stakeholders, with the private sector, state agencies, and households as responsible partners.

Traditionally the development of renewable based energy options in Sri Lanka have focused on electrification. There are multiple potential benefits to village electrification. Its contribution to total development includes improvement in general well-being, gender empowerment, commercialisation of biomass, and land resource restoration. However, the potential for using the same systems to provide cleaner cooking energy for the households as well has not been explored. The lessons from the household cooking energy domain highlight 4 key areas that need to be of focus in new renewable projects as they are developed:

(1) The first is the possibility of diverting the labour invested in procuring biomass to clean energy development. This would enhance labour efficiency and improve health conditions through drudgery reduction;
(2) The second is the potential for integrating clean energy technology to the household energy domain without isolating 'cooking fuels' any further from mainstream energy development and individual projects;
(3) The third is the need for a broader support service to avoid financial and social barriers, thus enabling rural households to adopt low cost technologies to replace fuel wood hearths with cookers or burners. In this connection, field effort is needed to change the attitudes related to two areas. The first is the mobilisation of fuel wood providers to become entrepreneurs or of solid biomass suppliers to gassifier plants. The second is to change cooking practices, enabling women to attend to them in a planned and structured manner.
(4) The fourth is technology extension, information, and awareness on the possible contribution of the wide range of modern biomass-based energy technologies, including improved stoves, biogas, wood gassifiers, etc., to establish clean mechanisms for the household sector. A wider green movement for addressing the issues of climate change could be combined with the efforts to generate cleaner cooking facilities for underserved sectors of the population.

9. The risks of switching to clean energy

Respondents are also concerned with the risks that they have to face in switching over from a freely procured biomass to any costly source of cooking fuel. The main reason is that they have no reliable income sources to make the long term financial commitments required to bear the recurrent cost of energy. In the energy market, government agencies have made no special provisions to stimulate a conversion process. For the state agency, the stimulation of the energy sector towards the promotion of clean sources for cooking is risky, and beyond the interest of the national policy. This is due to the heavy external dependence of supply and the vulnerable nature of sources, including electricity, kerosene, and LPG, that are vulnerable to external conditions. For Sri Lanka the electricity, kerosene, and LPG supply depends heavily on imported fossil fuel. 65% of electricity is generated using fossil fuel. The difficulty of using foreign exchange to pay for imported oil, as Sri Lanka does, and the continuously increasing prices of these sources discourage the expansion of these clean sources to cooking at a national level. A new trend in semi-urban areas is reverting to fuel wood by the households which have already adopted LPG in cooking during the last few years. At least a fivefold increase in LPG price had occurred in the recent past, but the trend is reversing. Increasing electricity and kerosene prices force households to minimise their consumption even for lighting, let alone expanding to cooking. For these households, compared to the commercial sources biomass is the more reliable and affordable. The price of fuel wood is reported to be bearable even for the low income receivers in urban and semi-urban areas that

cannot farm or collect their own, and they can supplement fuel wood supplies by burning residues.

The end-users are reluctant to switch to unreliable sources that undergo serious market fluctuations, while the state agencies suffer from the un-affordability of fossil fuel based power systems. The National Energy Policy of Sri Lanka (Ministry of Power and Energy, 2006), while concentrating on its responsibility for providing energy to meet basic needs stated its goal as follows: "Energy requirements to fulfil the basic needs of the people, and to enhance their living standards and opportunities for gainful economic activity will be adequately and continually satisfied at the lowest possible cost to the economy". Two implications have emerged here. The first is the meeting of energy requirements at the 'lowest possible cost', which does not encourage the adoption of high cost sources to replace the 3.1 million TOE of biomass used in year 2006 by the household sector. The second is the contribution of the biomass energy sector to the national economy. As it was estimated by the Regional Wood Energy Development Programme of the FAO, over US$ 440 million worth of biomass is used per annum. This implies that biomass-based energy as a whole is a tremendous financial saving to the country and remains a sustainable way to reduce the burden of costly, imported options. These circumstances are responsible for both the lack of interest of the state to improve access to commercial energy sources and petroleum-based energy for cooking on the one hand and the reluctance of the households with inadequate income to take the risks of switching over to commercial clean energy sources on the other. This situation points-out the necessity for reconsidering the ways by which requirements could be met at a 'lowest cost' to the energy sector and end-users and the necessity of providing multiple technology options.

Any national response to the issues facing biomass energy would need to include protection and enhancing resources to ensure biomass availability, the establishment of dedicated energy plantations, promotion of biomass by elevating it to modern and convenient sources, introducing energy efficient stoves, and promoting concessionary financing for indigenous resources. The state has not yet indicated a direct commitment to promote clean cooking fuels through the adoption of improved technology.

10. Discussion and conclusion

The in-depth analysis of the survey presented in this paper reveals that fuel-switching is not a primary concern of households in making energy decisions. The supply of clean facilities for cooking, irrespective of a policy committed to providing basic energy needs is not part of the mainstream energy agenda. Nevertheless, from the perspectives of improving the application of biomass in the energy system and of improving the health and wellbeing of women and the poor, there is strong incentive to provide cleaner cooking fuels (Wickramasinghe, 2003, 2004a, 2004b, 2006). As to who should lead a transitional process and how to implement better technologies into the political and policy agenda through development projects and programmes, the answer remains elusive.

The national policy on energy demonstrates a commitment for the development of off-grid electricity and the extension of the national grid electricity supply to satisfy basic energy needs and enhance living standards. But this policy does not include any provisions addressing cooking needs. The correlation between cleaner cooking fuels, basic energy needs, and living standards need to be properly defined in policy. The voices raised in regard to 'energy-poverty' have not changed the ideology on clean energy requirements for cooking in particular.

The expanded income earning opportunities made available by labour intensive biomass fuel systems are essential instruments in facilitating the adoption of cleaner cooking fuels and related technologies. Convenience, cleanliness, and saved time and effort are valued realistically by households in relation to alternative opportunities. Multiple technological options could be offered to households, considering the possibilities for fuel wood procurement and the availability of solid wood and other biomass for cooking. Gassifier stoves, improved stoves, community-based biomass energy enterprises, and biogas have great potential. While policy options can be introduced in response to clean cooking needs, planning with well defined targets should be based on regional assessments of biomass resources, local behaviour, and the demand for technology options.

The findings of this study show that to make a transition two domains must be addressed: risk and livelihood (see Fig. 2). The prerequisites for this transition include building of local resilience to short term pressure, directed external governance, social capital, and livelihood improvements to assure capacity. In addition, efforts are needed to raise the awareness of technology options and the multiple benefits of clean cooking facilities, particularly those regarding health, gender, and economic implications. Financing a transitional move with technological options for stimulating the households is a challenge. Women, under the prevailing circumstances of primary cooks and homemakers, are the key stakeholders, agents, and beneficiaries of change. Efforts in promoting cleaner cooking facilities need to be coupled with development strategies for progressive advancement. In order to increase the household expenditure on energy, additional income has to be gained through productive engagement of labour and by providing a market for biomass feedstock suppliers to produce and supply fuel wood as an enterprise.

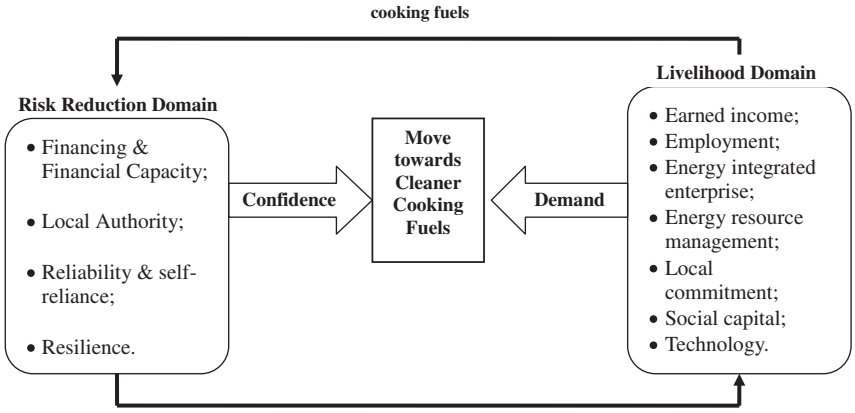

Fig. 2. Potential contribution of the dual domain: risk reduction and livelihood in adopting cleaner cooking fuels and stoves.

The most crucial concern is to move cooking fuels from the free-supply and women's services domain and integrate it into the national energy policy. This has to be strengthened through national machinery for the commercialisation of biomass with quality standards and multiple technology options, enabling the households to make their own choice. The potentials for producing clean energy using biomass as a feedstock would turn biomass into a market commodity, allowing for entrepreneurial opportunities. This transition would enable households to increase their income through the newly emerging market chains, the substitution of inferior by superior fuels, and greater efficiency within the household. Looking at the socio-economic trends in the country where labour demand for productive work and the interest of the rural population to enter into the commercial tracks is increasing, several innovative policy elements could be suggested. The first is a commercialisation of biomass to enable producers to generate an income from biomass and divert that income to an energy transition. To support this innovation a national policy has to be in place to motivate the private sector investments necessary to jumpstart clean biomass energy technologies and subsidise investors for biomass-based clean energy contributions. A subsidy for the producers of capital commitments could also encourage them to improve quality, regulate supply, and organise production. If higher commodity value is introduced for the biomass, end-users will be encouraged to invest in simple energy efficient technologies, primarily improved cook stoves or wood gassifier stoves. For those rural households producing an excess of higher quality wood, supplying wood for the emerging markets would become an enterprise. These could even be introduced in the form of conservation concessions, with government incentives and enhanced financing services to allow the nation to reduce emissions and preserve local habitats. The second element of the policy innovation is a pricing mechanism to meet future challenges. As it has been stated in the National Energy Balance, fuel-switching from biomass to fossil fuels, mainly LPG, continues in the household and commercial sector due to the convenience. This enables the household sector to change cooking practices and relieves the pressure of depending on a diverse biomass mix. However, the high selling price of electricity and LPG has been an obstacle. This tends to discourage fuel-switching despite the need for a convenient form of cooking fuel to cope with labour requirements enabling households in rural areas to expand income earning opportunities. Under these circumstances the national policy should introduce a pricing mechanism with life-time rates whereby low- and mid-income households would be able to get a clean source of cooking fuel, preferably LPG, at a lower, affordable price to satisfy cooking energy requirements. Such policy interventions are crucial to address the issues of affordability of clean cooking fuel and to connect and integrate low-income households. This can address indirectly the needs of women in particular by mitigating of the high cost of energy service supply sources, while recognising the direct and secondary benefits of fuel-switching, as illustrated by the WHO (2002, 2006a, 2006b).

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