Bioenergy in Sri Lanka:

Resources, Applications and Initiatives







WORKING PAPER

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Cover Images:	Main picture: Smiling elderly man sitting next to a biogas gas
	digester, Zul Mukhida, 1/12/2003
	Insert: Man fertilizing crops using the effluent from biogas

digester, Zul Mukhida, 1/09/2009

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Sri Lanka, to this day, suffers from poverty and inequality, with over 23% of the population living below the national poverty line. Being a tropical country however, it benefits from extensive vegetation and biodiversity, making bioresources, bioresidues and biofuels a highly favourable source of energy. Bioenergy has the potential to help meet the country's energy demand sustainably, while reducing the financial burden caused by a 43% dependency on imported petroleum. It would help increase decentralised energy production thus increasing regional and national energy security and would promote decentralised economic development in Sri Lanka.

There is currently a 48% utilization of bioresources, specifically firewood, predominantly for household cooking, although its use in industry is slowly increasing. In 2007 agriculture provided 10% of the country's GDP and employed a third of the workforce, making the use of agricultural bioresidues such as rice husks, bagasse and rubber for energy production a favorable means of producing decentralized energy for local farmers. Furthermore, biogas, produced from agricultural, human, municipal and animal waste has the potential to produce 4GWh of electricity daily, although its decentralized nature prevents it from becoming a centralized, national energy source.

Finally, purpose grown dendro plantations (energy crops) for the production of biofuels, including bioethanol and biodiesel, have the potential to produce 24,000GWh per year in Sri Lanka. Unless these are grown to their full potential on unutilized or underutilized land, they would have serious impact on the country's food availability and affordability. For this reason, the newly established Sri Lankan Sustainable Energy Authority (SLSEA) needs to promote research into the local impact of biofuels and the use of energy crops such as Jatropha as well as providing financial incentives and support for local investment into bioenergy technologies.

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1. Introduction

Country Profile			
Population (million) (2009)	20.3		
Land Area (km ²) (2009)	62,705		
Population growth rate (%) (2009)	0.9		
Life expectancy: (Male, Female years) (2009)	73.1, 77.3		
Unemployment rate (% of labour force) (2008)	5.2		
Literacy rate (Male, Female %) (National Literacy Policies SL, 2005)	97, 95		
GDP per capita (US\$) (2008)	4,300		
Human development index (2007)	0.759		
Gini inequality index (%) (2003-4, CIA)	50		
Household Electrification (%) (2008) (Central Bank of Sri Lanka, 2009)	85		
Biomass share of total primary energy use (%) (2005) (Musafer, 2008)	48		

(Source: Index Mundi, unless otherwise stated)

1.1 Demographics

Despite only recently emerging from a civil conflict, Sri Lanka has experienced a steady average economic growth of 5% over the past 20 years. Although the country achieved considerable success in reducing non income poverty (such as education and health) during this time, success in reducing income poverty has not been as evident. Presently 23% of the population lies below the national poverty line and in 2008 Sri Lanka ranked only 102nd on the Human Development Index (HDI) with an average HDI score of 0.759 and a GDP per capita of 4,300 USD. The country also suffers from high income inequality as indicated by a Gini index of 50%. In contrast Sri Lanka's social indicators such as life expectancy and literacy rate are on par with many developed countries.



As the chart below indicates, the service sector is the main contributor to the economy, while agriculture still plays an important role, accounting for around one-fifth of national output and employing over one-third of the workforce. The Sri Lankan economy is predominantly supported by Small and Medium Enterprises (SME) with over 50% of GDP being produced by the SME sector. The manufacturing base is dominated by the clothing industry and the production of food and beverages, chemical- and rubber-based goods.

Although the economy has grown, the benefits of this growth have not been evenly distributed, with most industries currently located in the Western province. Therefore, regional differences in poverty and economic growth are an ongoing issue. 80% of Sri Lanka's live in rural areas while 5% live and work on estates serving mainly tea and rubber plantations. They live in houses provided by the estate and in most cases do not own land.



Statistical Abstract, Department of Census & Statistics, Sri Lanka, 2007

1.2 Energy

As indicated by the chart below, 57% of Sri Lanka's energy demand is met by indigenous primary sources (biomass, hydro and to a lesser extent solar and wind), however there is still a 43% dependency on imported primary and secondary resources (crude oil, small quantities of coal used for industrial kilns and refined petroleum products).

The share of biomass as a primary energy source has gradually reduced from 65% in 1990 to 47.4% in 2007 (even though it has increased in absolute terms) while the share of petroleum has considerably increased, from 22% in 1990 to 43% in 2007 (Sustainable Energy Authority, 2009). This is due to increases in transport requirements and more importantly, the use of petroleum-based fuel for electricity generation. This has placed a heavy burden on the national economy as well as the energy security of the country.

On a smaller scale, grid connected hydro systems are used to add to the capacity of the national electricity grid, while small, off-grid wind systems, micro and pico hydro units, biogas and "dendro*" systems are used on even smaller scale.

As indicated by the 'Energy Consumption by Sector' chart below, 48% of the total energy demand comes from household energy consumption of which 42% is used for cooking. Any change in the biomass consumption patterns of the indusrial sector may affect the commercial price of fuel wood, and in turn its availability and affordability for households.



*Dendro is ther greek word for 'tree', used here to denote energy crop

2. Bioenergy

Sri Lanka, being a tropical country, benefits from sunshine for most of the year and thus enjoys extensive vegetation and biodiversity. Bioenergy has been a primary source of energy for Sri Lanka throughout its history. The country has no known fossil fuel reserves and is therefore a significant importer of energy (in the form of petroleum) resulting in



significant economic dependency on oil exporting countries. Since bioenergy is one of the country's primary indigenous forms of energy, supporting a sustainable bioenergy sector can contribute significantly to long term energy security, increase employment and rural development, and contribute to a low-carbon future.

Until now, a systematic approach to the development of sustainable bioenergy has been lacking. Despite 70% of national bioenergy being consumed in the informal sector for domestic cooking and industrial purposes, it has still not been exploited on a large scale in the formal sector. Instead, the government has concentrated heavily on imported petroleum and hydropower for electricity generation. At the same time however, increase in petroleum prices has resulted in a significant number of agricultural processes (particularly tea production) switching over from oil to biomass for their thermal energy requirements, contributing to the growth of the biomass sector.

Therefore the following sections expand on the current use of bioenergy in Sri Lanka and identify the potential and associated barriers for utilization of bioresources, bioresidues and biofuels for enhancing energy access, promoting sustainable livelihoods and supporting energy security for the country.

2.1 Government Policies

Current progress in Sri Lanka's government policies in promoting the bioenergy sector are discussed and reviewed in detail in the PISCES Policy Brief No. 3 'Policies and Regulations Affecting Biomass-Related Energy Sector Development in Sri Lanka'. Specifically, in the years 2006 and 2007, two significant initiatives were undertaken by the Sri Lankan government: the declaration of the 'National Energy Policy and Strategies of Sri Lanka' and the establishment of the 'Sri Lanka Sustainable Energy Authority (SLSEA)'. The latter focuses on promoting indigenous energy resources in Sri Lanka, including bioenergy, and increasing fuel diversity through renewable energy development.

Fuel diversification in the transport sector is particularly encouraged, with special emphasis on the promotion of biofuels. Furthermore, the national forestry policy promotes biomass as an energy source; although no specific reference to biofuels is made.

The ten year development framework of the Sri Lankan government for 2007-2016 emphasises the need for the development of sustainable energy sources and delivery systems at competitive prices, through commercially viable institutions. It encourages increase in fuel diversity and security through investment in conventional and non conventional energy sources (i.e. renewable technologies), and both on- and off- grid energy systems, to provide access to electricity to 95% of all urban and rural households by 2016.

2.2 Bioresources

Bioresources refer to plant resources already available within Sri Lanka, such as naturally growing trees and bushes. These can be sustainably exploited if their usage rate is matched with their regrowth rate over the long term. Although it is recognized that trees can also be grown on a large scale in plantations solely for the purpose of energy production, in this report tree energy plantations are considered to be purpose grown biofuels, and their associated potential and barriers are discussed in the Biofuels section.

Firewood

As indicated in the chart below, firewood is the main cooking fuel in Sri Lanka, despite electricity being available to 85% of households. Therefore, cooking accounts for 81% of total biomass consumption (Sustainable Energy Authority, 2003). This is mainly due to the high cost of electricity, in comparison with the relative abundance of wood. Since the alternative energy sources for cooking, such as Liquified Petroleum Gases (LPG) and kerosene, are all imported, wood represents a better option from a national economic and energy security perspective. However, at a household level, burning of biomass without use of a clean and efficient stove can cause local environmental and health issues, something which has been addressed by several initiatives in Sri Lanka over the past decades (see PISCES Working Brief 'Scale-up and Commercialisation of Improved Cook Stoves in Sri Lanka: Learning from the Anagi Experience').

The second largest consumer of fuelwood is the industrial sector (tea, coconut, rubber, brick, lime and pottery industries), followed by the commercial sector (hotels and restaurants, bakeries and local food vendors). Firewood is mainly sourced from rubber plantations and jungle clearings although some estates are also growing wood lots to furnish their own energy needs.



Principal Type of Cooking Fuel by Sector

Energy Balance, Sri Lanka Sustainable Energy Authority, 2003

Firewood Availability

So far, the usage of firewood for cooking has not created a threat to the forest coverage, mainly because it is sourced from shrub jungles, branches or pods of coconut and other palm trees which grow throughout the island and can die naturally.

However, despite its widespread availability, firewood cannot always be collected from household compounds, especially in urban areas where nearly 80% of the firewood has to be purchased, as indicated by the graph below. This is one of the drivers for promoting Improved Cook Stoves which have higher efficiencies and hence are more economical.



Firewood Sourced By Area

Coconuts

Sri Lanka is a country which grows coconuts for domestic consumption and also for export in industrial plantations. Coconuts are the seeds of coconut palms and have multiple applications although they are predominantly used for their oil - a lucrative source of energy. For example in 2005, Sri Lanka produced 2,515 million coconuts from a land area of 395,000 hectares. By 2006 this had increased by 6.7%.

Key issues

The current abundance of firewood and coconuts in Sri Lanka means that bioenergy requirements pose little threat to the country's bioresources. However if bioenergy production in the form of biofuels is expanded to meet the demand of a growing bioenergy industry, this will impact on land and food availability in the future. There are also inherent problems associated with the use of firewood, mainly regarding the generation of soot and smoke; and also related to the difficulties of transport and use in small spaces. This is especially the case when using firewood for cooking, which is why Improved Cook Stoves are important not only in increasing stove efficiency but also in reducing indoor air pollution, caused in conventional stoves by incomplete combustion.

Central Bank of Sri Lanka, 2007

Technologies and initiatives

At present, both Traditional Cook Stoves and Improved Cook Stoves are used by the domestic sector in Sri Lanka. The most widely used Traditional Cook Stoves are the three-stone stove and the semi-enclosed mud stove called "Sinhala Lipa" (similar to the U-Chulah stove), while the Anagi stove is the most popular Improved Cook Stove used.

Improved Cook Stoves could play a big role in reducing overall expenditure on firewood, saving around 41% of the fuel wood currently used in Traditional Cook Stoves (Musafer N., 2008). Research shows that only 12% of fuelwood in the domestic sector is currently being used in Improved Cook Stoves, hence there is still great potential for savings.

On a larger scale, there are currently 5 major fuel-wood installations in Sri Lanka with a total capacity of 7.18MWth, consuming a total of 56 tonnes of wood per day (Jayasinghe P., 2004). These include wood gassifiers for generation of hot air for product drying, for firing rotary kilns and for thermal incineration. However, such large scale installations have struggled to develop reliable supply chains.

Planned Biofuel Projects

#	Installation	Institution	Capacity (MW)
1	Grid Connected Dendro Power Plants using SRC wood and Rice Husk using Steam Turbine Technology	Ceylon Electricity Board	10
2	Captive Power Plant using wood gasification	Talawakele Tea Estates Ltd	0.3
3	Grid Connected Dendro Power Plants using SRC wood and Rice Husk	70 MW (13 projects of 1-10 MW)	
4 Plans for a dendro power plant with wood supplied by cultivation of 2,500 acres of Gliricidia plants in uncultivated land of 3,000 families		Labunoruwa Youth Organisation, Divisional Secretariat (Thirappone)	1.5 to add to national grid

The following is a list of planned biofuel projects in Sri Lanka:

(Source: Jayasinghe P, The Biomass Energy Sector in Sri Lanka, Successes and Constrain)

2.3 Bioresidues

Bioresidues are residues from existing agricultural or industrial processes and forestry. They include exhausted rubber trees, rice husks, fallen palm fronds and bagasse and biogas (methane fuel produced from the anaerobic digestion of agricultural, human, livestock and municipal waste).

Agricultural residues

a. Rice husks

The use of rice husks for bioenergy is currently limited, although there is increased use within rice mills and tobacco barns and for cement production as a source of energy during processing (rice husks have an energy potential of 13-19 MJ/kg per kg). Initiatives to introduce rice husk as a heating medium for brick making have not yet made a significant impact. Nonetheless, rice husks could prove to be a valuable source, with 910,500 hectares of rice cultivation and 3,246,000 metric tonnes of rice produced in 2005 (Central Bank of Sri Lanka, 2007).

b. Bagasse

Bagasse is a byproduct of the sugar industry with an energy content of 9.6MJ/kg and is utilised for combined heat and power generation within the sugar factories themselves. In the year 2003, 213,000 metric tonnes of bagasse was utilized (Siyambalapitiya T, 2005).

c. Rubber

Rubber seeds are also a source of bioenergy and can be extracted from existing rubber cultivations, as are rubber trees at the end of their useful life of 20 years, serving as an additional benefit to the rubber plantation industry.

d. Biogas

Biogas is a combustible fuel, consisting predominantly of methane (CH₄) produced by anaerobic fermentation of organic material, with carbon dioxide and traces of water vapour, hydrogen sulphide (H₂S), hydrogen (H₂), and ammonia (NH₃). In Sri Lanka, households, government authorities, industries and livestock and agricultural farms produce a considerable amount of organic waste. Biogas produced from these can be collected and used for cooking and electricity generation. The slurry remaining from biogas production can serve as a valuable organic fertilizer.

Municipal Solid Waste (MSW) in landfills also decomposes anaerobically to produce methane. A ton of land-filled garbage can produce up to 400m³ of methane. In practice, a landfill has around 20 years of useful life during which only 25% of landfill gas can be extracted (Alwis, A 2001).

The figures below indicate the power generation potential of a variety of organic materials through biogas (assuming an average production of 1.25 kWh of electricity from 1m³ of biogas (Alwis, A 2001)), estimating an impressive total electricity production of as high as 4GWh/day. As can be seen, rice paddies have the highest potential for biogas production, paddy straw currently being the most popular.



Potential Power from Biogas

In general, despite its potential, biogas is greatly underused as an energy source. For example, despite possible efficiencies of 80-90%, the use of biogas to run electricity generators is not common, and technologies to achieve this are generally not available locally. Instead, in 2005, Sri Lanka imported 149,000 metric tonnes of LPG at a cost of US\$ 75,000,000; while 252,000 metric tonnes of kerosene was sold in the same year. Kerosene is predominantly used for domestic lighting particularly in un-electrified homes (over 25% of the households in Sri Lanka). Effective promotion of biogas use could meet a significant proportion of the domestic cooking and lighting needs of Sri Lanka. Compressed biogas can also be used as a renewable alternative to petrol for vehicles.

Promoting the production of biogas can have additional agricultural benefits for Sri Lanka's farmers. The Ecosan toilet is an example of a technology which separates human waste into liquids and solids, enabling the former to be used as a fertilizer and the latter to be used as soil conditioner, insect and weed repellent as well as being a source of biogas for meeting household needs. In 2005, Sri Lanka imported US\$135,000,000 worth of chemical fertilizers, a 26% increase from 2004. Aside from being increasingly expensive, chemical fertilizers can pollute watercourses, posing serious environmental and health risks.

An increasing number of Sri Lanka's farmers who grow traditional varieties of crops, practice bio-dynamic farming and are switching to meeting their energy demand from biogas digesters (Sri Lanka Standards Institution, 2008). Bio-dynamic farming is an organic farming system which focuses on the integration of crops and livestock, recycling of nutrients, maintenance of soil and the health and well being of both crops and animals (Diver S., 1999).

2.4 Biofuels

Biofuels generally refer to fuels derived from organic material which is grown predominantly for the purpose of energy production. Examples include bioethanol obtained from the fermentation of sugar cane, rice or sweet potatoes and biodiesel derived from Jatropha oil. Under this category we may also consider woody biomass obtained from plantations of fast growing trees such as Gliricidia.

Combustion of agricultural products

Dendro plantations



Sustainably grown biomass in the form of Short Rotation Coppice (SRC) species has attracted interest as an energy source for power generation. Gliricidia Sepium for example, is a medium sized leguminous tree, with potential to become a low cost indigenous energy supply with local economic and employment benefits. In fact the species has been declared by the Cabinet of Ministers as the 4th national



plantation crop (following tea, rubber and coconut). Other such energy crops include Acacia Auriculiformis and Leucaena Leucocephala. More generally, the national potential for dendro power in Sri Lanka is estimated to be in excess of 4,000 MW, with the potential to generate annually over 24,000GWh. This is nearly 4 times the total hydro power potential in the country and is adequate to meet electricity demand for many decades (Jayasinghe P., 2009). The pie chart (previous page) gives an indication of the land available in 2003 for dendro plantations.

The high availability of short rotation, coppicing tree varieties and 'continuous harvest' crops in Sri Lanka is also becoming attractive to energy investors wishing to invest in the establishment of large scale energy plantations. Additional feasible markets include power plants based on a combination of wood fuels and agricultural residues.

Liquid fuel from agricultural products

a. Biodiesel

Biodiesel is an alkyl ester made from the transesterification of vegetable oils with an alcohol (normally methanol). Coconut, Jatropha, castor, rubber seed, oil palm, soya bean and mustard are some of the crops cultivated in Sri Lanka which could be used for biodiesel production.

Crop yield for production of bioethanol (2005)



b. Bioethanol

Bioethanol produced by the fermentation of sugars or starchy crops and purified by distillation and subsequent dehydration can act as a sustainable substitute to petrol. Among crops grown in Sri Lanka, rice, cassava and maize, with a high starch content and sugar cane, with a high sugar content, can be fermented into bioethanol. Nonetheless, bioethanol production in Sri Lanka is still in its infancy.

Crop yield for production of bio diesel (2005)



Key Issues

The food-versus-fuel debate is a globally controversial topic. On the one hand, biofuel production is a lucrative option for reducing worldwide dependency on petroleum and increasing energy security. On the other hand, as fertile land that is currently cultivated for food products is used instead for energy production, worldwide capacity for food production will decrease as will the affordability of food for households. History can offer many examples of poverty and famine caused by food availability and affordability.

Rice, cassava, maize, sweet potatoes, potatoes, soy beans, mustard and sugar are currently produced in Sri Lanka for human consumption. In 2005 for example, Sri Lanka imported 52,000 metric tonnes of rice compared to 3,246,000 metric tonnes it produced locally; and consumed 472,000 metric tonnes of sugar of which only 54,000 metric tonneswere produced locally, demonstrating that current production does not meet food demand. The sugar industry also produces potable alcohol for local consumption.

In the past Sri Lanka had 4 main sugar factories situated in Pelwatte, Sevenagala, Kantalai and Hingurana, only 2 of which were in operation by the end of 2007, having the combined potential capacity of 117,500 l/day of bioethanol production from molasses. Furthermore, locally-produced castor and neem oil are used for medicinal purposes; but neem seeds contain 40% oil which is used as an insecticide.

Biofuel production in Sri Lanka is in its infancy and the experience gained so far is insufficient to draw any general conclusions. It is certain however, that using existing cultivated land to develop Sri Lanka's bioenergy sector would be a risk to the country's food security. Biofuels should aim to be grown on un- or under-utilised lands. The following table gives an idea of land that could be potentially be used for biofuel production (Musafer N., 2008):

Type of lond	Area/(000' hectares)		Detential for biofuels group
	1997	2010	Potential for biofuels crops
Urban	28	32	No
Agricultural	3,987	4,170	Partly
Natural forests & mangroves	1,909	1,614	No
Planted forests	95	119	No
Wet & Barren land	410	410	Yes
Other open land	86	170	Yes
Total	6,516	6,516	

Initiatives

Initiatives to start biofuel production from Jatropha include:

- A community-based biodiesel processing centre established by Practical Action at the Rasnayakapura Divisional Secretariat area.
- A plot of Jatropha Curcas established by the Department of Agriculture to observe yield performance for biodiesel.
- Studies commissioned by several universities and research institutions on the crop itself: plantation, oil expelling, fuel processing, applications etc. Private sector organisations who have embarked on cultivation of Jatropha and commercialization of biodiesel as a transport fuel; their results however are not yet publicly available.

3. Conclusions

Sri Lanka has considerable potential for meeting a substantial proportion of its energy needs from bioenergy nationwide, from bioresources, bioresidues and biofuels. Until now fuelwood has been the most significant bioresource, used predominantly for household cooking, although its share is in decline as the use of petroleum for transport and electricity generation is increasing.

Nonetheless, the prohibitive cost of petroleum imports and increasing global concerns about climate change are encouraging the Sri Lankan government to put in place measures for exploring alternative sources of energy, bioenergy being a favourable choice. In addition to fuelwood, coconut oil is a feasible bioresource, while rice husks, rice straw, bagasse and rubber trees are favourable types of bioresidues, due to their high availability.

Furthermore, Sri Lanka has an estimated 4,000MWh per day of biogas energy potential from agricultural, human, municipal and livestock waste. There is also a tremendous potential for biofuels. It is estimated that Sri Lanka could generate over 24,000GWh per year from dendro power alone (both naturally grown and from energy plantations). This is nearly 4 times the country's total hydro power potential and is adequate to meet the country's electrical energy demand for many decades (Jayasinghe P., 2009). In general, there is a need for research to produce more up-to-date data on the energy potential from naturally grown bioresources to justify the need for energy crops.

The use of bioenergy for power generation in Sri Lanka is a relatively novel concept, while initiatives have already been set up for its use in industrial heating. The potential of biofuels to meet the energy demand of Sri Lanka without impacting on the food industry cannot be predicted reliably based on existing studies. The same applies for quantifying the potential of fuelwood in meeting the country's energy demand. Data on biogas production potential is available, but since production would be quite decentralised (with the exception of production from landfills or buildings such as abattoirs or prisons) it does not appear to be a feasible option for centralized energy production.

Energy conversion technologies and efficiencies are currently being studied in Sri Lanka, particularly in the dendro and liquid bioefuels sectors. However further research is still needed on: suitable species for biofuel production, climatic and soil conditions, diseases, nutrient requirements and yield data. Furthermore, due to the absence of sufficient commercial-scale bioenergy plantations in Sri Lanka, their social and environmental impacts are still unknown.

In conclusion, for the sustainable utilization of bioenergy in Sri Lanka, the newly established Sri Lanka Sustainable Energy Authority needs to inform, inspire confidence and provide incentives for local businesses to invest in technologies for utilization of bioresources, bioresidues and production of biofuels. Sri Lankan research institutions should be encouraged and supported to research further into the areas mentioned above and in becoming a point of information and support for local innovators and their pilot projects. The government, with the help of the NGO sector, should strive to extend these incentives and support remote and underdeveloped communities, as well as recognise decentralized bioenergy production as a source of sustainable livelihoods and local development. Despite lacking experience in the bioenergy sector, Sri Lanka can gain confidence by learning from the experience of other countries, such as Brazil, where the sector is better established.

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Executive summary

Sri Lanka, to this day, suffers from poverty and inequality, with over 23% of the population living below the national poverty line. Being a tropical country however, it benefits from extensive vegetation and biodiversity, making bioresources, bioresidues and biofuels a highly favourable source of energy. Bioenergy has the potential to help meet the country's energy demand sustainably, while reducing the financial burden caused by a 43% dependency on imported petroleum. It would help increase decentralised energy production thus increasing regional and national energy security and would promote decentralised economic development in Sri Lanka.

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For over 40 years, Practical Action Consulting has provided development consultancy services as the consulting arm of the international NGO. Practical Action. formerly Intermediate Technology Development Group (ITDG). PAC provides high quality, independent and professional advice to governments, NGOs, aid agencies and the private sector. We work worldwide from regional offices in the UK, Eastern and Southern Africa, South Asia and Latin America. Long standing engagement in technology and developing countries has enabled us to develop a network of local partner organizations and international specialist associates. Practical Action uses technology to challenge poverty by building the capabilities of poor people, improving their access to technical options and knowledge, and working with them to influence social, economic and institutional systems for innovation and the use of technology. Our vision is of a sustainable world free of poverty and injustice in which technology is used for the benefit of all. For more information visit http://practicalactionconsulting.org and http://practicalaction.org/home

Policy Innovation Systems for Clean Energy Security (PISCES) is a five-year initiative funded by the UK's Department for International Development (DfID). PISCES is working in partnership with Kenya, India, Sri Lanka and Tanzania to provide policy makers with new information and approaches that can be applied to unlock the potential of bioenergy to improve energy access and livelihoods in poor communities. The project is being carried out by Practical Action Consulting UK (PAC UK), the University of Edinburgh, PAC Eastern Africa, the African Centre for Technology Studies, M.S. Swaminathan Research Foundation in India, PAC South Asia in Sri Lanka and the University of Dar Es Salam in Tanzania. For more information visit http://www.pisces.or.ke