

Energy Access and Biomass Resource Transitions in Malawi

Key Findings

- **Malawi gets 88% of its total energy and 98% of its household energy from traditional biomass, while access to modern energy services is less than 10% overall, and under 1% in some rural areas. Combined with agricultural clearing and high population density, this heavy reliance on traditional biomass has contributed to biomass scarcity, land degradation and deforestation. Agro-forestry approaches could improve land management and soil fertility, and provide more effective bioenergy feedstock options.**
- **Land-locked Malawi also faces significant energy insecurity due to its complete reliance on costly imported refined petroleum products – petrol, diesel and kerosene (or paraffin). This imposes additional constraints on transport infrastructure, business development and households. The use of straight vegetable oil (SVO) from smallholder *Jatropha* production for blending with diesel and paraffin is now under way in Malawi and may help address energy insecurity.**
- **Malawi has 30 years' experience with sugarcane ethanol production and blending with petrol; however, existing production capacity is under-utilized and expansion opportunities remain underexploited. Infrastructure improvements and supportive policies are needed to scale up biofuels.**
- **Malawi is vulnerable to climate change impacts due to its high dependence on rain-fed agriculture, hydropower and traditional biomass. Diversification in energy sources and agricultural production therefore should be major priorities. Improved cookstoves and fuel switching to biogas or liquid biofuels are also promising strategies.**
- **In addition, cogeneration of heat and electricity from agricultural residues, especially sugarcane bagasse, offers a cost-effective way to diversify the energy mix; feed-in tariffs or related support mechanisms would help to attract investments.**



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Forested areas are often damaged or destroyed through brush fires or agricultural clearing (Kasungu District, Malawi).

Introduction

Access to modern energy services for households and small enterprises is very limited in Malawi – less than 10% overall, and under 1% in some rural areas. As in many sub-Saharan countries, Malawi's 14 million people rely heavily on biomass, which accounts for 88% of total energy and 98% of household energy use (see Table 1). Rural households rely on firewood for nearly all their cooking needs, while urban households have increasingly turned to charcoal.

Industry use of biomass is dominated by agricultural residues (see Table 2), especially sugarcane and maize residues. Malawi also has 30 years' experience making sugarcane ethanol and blending it with petrol; more recently, the country has also started blending *jatropha* oil with diesel for cars.



Table 1: Energy demand (TJ) by sector and fuel for Malawi (estimated for 2008)

	Biomass	Coal	Petroleum	Electricity	Totals	Sector Share of total	Biomass Share of sector total
Household	122,143	0	644	1724	124,511	83%	98%
Service	419	167	535	457	1,578	1%	27%
Industry	10,135	3,337	3,001	1,927	18,400	12%	55%
Transport	270	14	5407	34	5,725	4%	5%
Totals	132,967	3,518	9,587	4,142	150,214		
Share of total	89%	2%	6%	3%			

Source: Openshaw (2010).

Table 2: Biomass use (thousand tonnes of wood-equivalent) by type and sector (estimated for 2008)

	Fuelwood	Crop Residues	Charcoal	Wood Residues	Totals	Sector Share of Total	Fuelwood share of sector total
Rural Households	6,795	192	152	0	7,140	80.0%	95.2%
Urban Households	681	1	409	0	1,091	12.2%	62.4%
Industrial Sector	256	359	2	9	625	7.0%	40.9%
Transport Sector	0	38	0	0	38	0.4%	0.0%
Service Sector	23	0	7	0	29	0.3%	77.4%
Totals	7,754	590	570	9	8,923		
Share of total	86.9%	6.6%	6.4%	0.1%			

Source: MARGE (2009).

Scaling up modern bioenergy could be a game-changer for Malawi – not only for development, but also to save the country's endangered forests. Yet efforts to expand modern bioenergy production have faced major challenges due to underdeveloped institutions and infrastructure.

On 2 October 2012 in Lilongwe, SEI, the Centre for Agricultural Research and Development at Lilongwe University of Agriculture and Natural Resources, the German Development Institute (DIE), and Malawi's Ministry of Energy and Mining co-hosted a National Seminar on Bioenergy to explore what it will take to transition Malawi from traditional to modern bioenergy. This policy brief draws on that discussion and builds on it, aiming to inform both public- and private-sector actors.

Forest resources, land use change and poverty

In the 1960s, more than half of Malawi's land area was covered by forest. By 1972, the share was reduced to 45% and by 1990 it was 41% (MFNR 1993). The UN Food and Agriculture Organization has estimated forest cover as of 2010 at 34%, but warns that on-the-ground corroboration is needed, because a Forest Resources Mapping and Biomass Assessment for Malawi has not been done since 1990. Considerable forest cover was lost to large estates opened in the 1970s for cash crops,

particularly tea and tobacco. The situation was exacerbated by the increased demand for fuelwood for processing of flue-cured tobacco (Jumbe and Angelsen 2011).

Forest loss also arises through the combination of population growth and poverty, which leads to low-productivity (and/or slash-and-burn) agriculture, while at the same time wood is the only affordable source of energy. Continual agricultural expansion into forested areas is thus accompanied by expanded use of woody biomass.

The fuelwood and charcoal industries are also important employers, accounting for an estimated 133,000 jobs and 2% of the labour force (Openshaw 2010). Reconciling the socio-economic and environmental impacts of biomass use in Malawi is therefore a major challenge. One potential approach for improving both agricultural and forest biomass management is agro-forestry, in which a particular mix of crops and multi-purpose trees are integrated into the same farming area (Bogdanski and Roth 2012).

Energy access and biomass scarcity

Malawi's high population density and uneven distribution of population has resulted in biomass scarcity in some areas. The Northern Region has 44% of forests but only 13% of the population. About 26% of forests lie in the Central Region, which has 42% of the population, while 30% of forests lie in the Southern Region, where 45% of the population lives (Zulu 2010).

Urbanization has resulted in more intensive use of charcoal: between 1994 and 2008, the share of urban households using charcoal rose from 24% to 33%, while the share using firewood dropped from 66% to 56% (Jumbe and Angelsen 2011). Demand for firewood and charcoal exceeds sustainable supply in areas surrounding major urban centres: the catchment areas of Blantyre, Lilongwe, Limbe and Zomba (Yaron et al. 2011).



Fuel shortages at petrol stations have been common in Malawi.

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The spatial imbalance in supply and demand partly explains recent shifts in energy use away from firewood to charcoal and electricity. Households also cope with scarcity through measures such as walking longer distances for wood, planting trees, or changing cookstoves or cooking practices. Measures or policies that ease biomass scarcity in Malawi have been shown to provide clear economic welfare gains (Bandyopadhyay et al. 2012). One such measure in rural areas has been to expand the areas under plantation forests from which fuelwood can be collected, which significantly reduces the pressure on customary forests or reserves (Jumbe and Angelsen 2011).

Biofuels and energy security

Malawi also faces significant energy insecurity due to its complete reliance on imported refined petroleum products – petrol, diesel and kerosene (or paraffin). This not only affects transport and businesses, but also households: A 2010-11 government survey found more than half of households used paraffin as their main source of lighting (National Statistical Office 2012).

Given that Malawi is landlocked in a region with limited transport, distribution and storage infrastructure, fuel imports are costly and a major drain on foreign exchange. Fuel shortages became quite severe during 2011, with long queues and economic disruptions; better management of both energy and financial systems is needed to address these problems (Kampanje 2012).

Yet Malawi is also the only African country that has consistently used liquid biofuels for transport for an extended period – since 1982, with blends ranging from 10% to 24%. Other countries in the region, such as Kenya and Zimbabwe, have used ethanol blends over shorter periods or at lower scales (Batidzirai and Johnson 2012). The high commercial value of sugar and ethanol has brought considerable socio-economic benefits to both small farmers and estate workers. Blending of straight vegetable oil (SVO) with diesel and with paraffin is now also under way in Malawi; the oil is produced by some 25,000 small farmers that plant *Jatropha curcas* as hedge rows around their farms.

Bioenergy and climate change adaptation and mitigation

Some climate change scenarios for Malawi show hotter and drier conditions that would hurt agriculture and contribute to greater forest loss through fires (MNREE 2011). Already, high reliance on traditional biomass and rain-fed agriculture in Malawi leaves households vulnerable to both food and energy insecurity. These circumstances are common in many African countries, but they are rather extreme in land-locked and densely populated Malawi. Consequently, adaptation measures related to biomass use were included in the country's National Adaptation Programme of Action (NAPA), focusing in particular on biogas technologies and efficient institutional-scale cookstoves (MMNRE 2006). Given that households account for 90% of bioenergy consumption, adaptation measures geared to them should also be considered.

Agriculture, forestry and other land use accounted for 88% of Malawi's reported greenhouse emissions in 2000, the last inventory year. This stands in stark contrast with most developed countries, where forestry and land use represent a net sink (negative emissions), while the energy sector often accounts for more than 80% of the emissions. Malawi has not yet identified any Nationally Appropriate Mitigation Actions (NAMAs), but it is clear that shifting away from current patterns of traditional



The popularity of charcoal has been increasing steadily with urbanization, placing additional pressure on forest resources.

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biomass use and towards modern bioenergy would yield climate mitigation benefits and could attract carbon finance.

There is a proposed Programme of Action (PoA) for improved cookstoves under the Clean Development Mechanism (CDM); emissions savings depend on the specific stove model chosen in a given action, with one specific case estimated as saving slightly under 4 tonnes CO₂ equivalent per stove per year (TÜV SÜD South Asia Private Limited 2012). The savings could be underestimated, however, since they only include savings for non-renewable biomass and also exclude reductions of non-CO₂ pollutants (such as black carbon). Another mitigation measure proposed in legislation and discussed in Malawi's Second National Communication on climate change is to double the use of bioethanol in petrol vehicles, which would save an estimated 80,000 to 100,000 tonnes of CO₂ annually (MNREE 2011).

Infrastructure and institutions

Malawi also needs to upgrade its fuel distribution infrastructure and ramp up biofuel production in the coming years if it wishes to reach blending targets. Fuel blending rates have decreased, production levels of fuel-grade ethanol are far below installed capacity, and expansion opportunities remain under-exploited. Policy and tax incentives remain fairly weak, given the initial start-up costs and the fact that alternative markets for export (e.g., potable ethanol) command higher prices.

As with many countries in sub-Saharan Africa, institutional support related to both traditional biomass and modern bioenergy remains weak; an autonomous Biomass Energy Agency has been proposed in order to build institutional capacity (MARGE 2009). Although such an agency is not yet formed, the Energy Ministry has initiated a task force to develop a long-term bioenergy strategy. At the same time, support for modern bioenergy is constrained by a lack of consistent policies and institutions to provide clear market signals for investors (Jumbe et al. 2009). Nor have policies matured for promoting cogenerated electricity from surplus sugarcane bagasse and cane trash, which could help diversify the future energy mix away from hydropower and traditional biomass. Such diversification could also avoid or reduce the switch to large scale coal-fired electricity that is planned.

Given how rapidly Malawi is losing its forests, synergies between traditional and modern bioenergy should also be explored to combine improved market competitiveness with energy security goals and conservation of forests and land resources. The options include agro-forestry, greater use of agricultural residues and fuel-switching to biogas and ethanol. Improved energy access and use of bioenergy co-products also contributes to rural livelihoods and food security since biomass scarcity often constrains agricultural development.

Policy recommendations

- Energy access and associated economic development goals in Malawi are threatened by the tremendous pressure on forest resources, which will require, first and foremost increasing agricultural productivity. Other important measures include use of improved cookstoves and fuel-switching in the household energy sector.
- High dependence on traditional biomass, hydropower and rain-fed agriculture increases vulnerability to climate change in Malawi. Forest plantations, agro-forestry and diversification in the energy mix could improve both energy security and food security.
- Synergies between expanded biofuels production and reduction in traditional biomass use could be explored through fuel substitution in cooking, heating and lighting for households and small enterprises. Such synergies would promote low-carbon pathways while also improving energy access and stimulating agricultural and rural development.

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Sugarcane being loaded at Dwangwa sugar factory, which also supplies molasses to a nearby ethanol distillery.

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