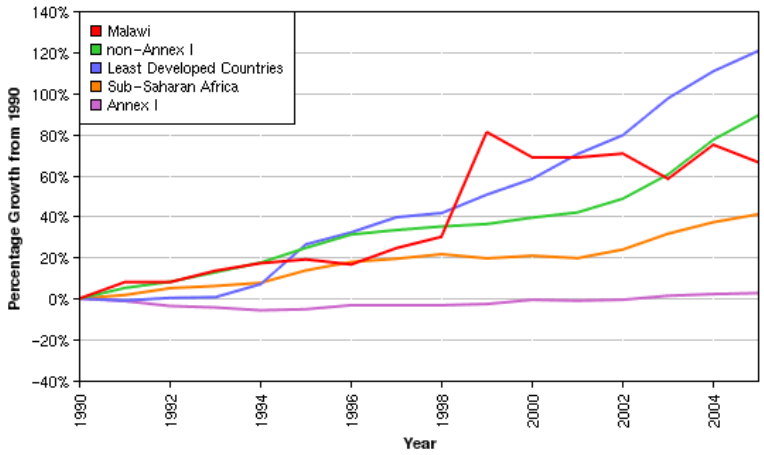
CHAPTER 1: INTRODUCTION AND MOTIVATION

There is international consensus on the need to reduce greenhouse gas (GHG) emissions from industrialized nations as evidenced by ratifications and continuing negotiations around the United Nations Framework Convention on Climate Change (UNFCCC). Specialised studies to estimate the cost of emission abatement have also been conducted in industrialized countries by among others Newell et al. (2006), Jaffe et al. (1999), Manne and Richels (1997), Jorgenson and Wilcoxen (1993), Nordaus (1991; 1993) and the Commonwealth of Australia (1991). However, not much is known about the viability of emission abatement strategies in developing countries of sub-Saharan Africa despite the fact that GHG emissions from developing countries have been rising faster than those from other countries and are projected to match those of industrialized countries by 2018 (Sathaye and Ravindranath, 1998). Moreover, cumulative emissions from least developed countries have been increasing at a faster rate than those from non-Annex I countries since 1990 (figure 1)[1].

Figure 1: National carbon dioxide emissions: 1990-2005



Source: World Resources Institute (2008), Climate Analysis Indicators Tool (CAIT, Version 6.0).

[1] The UNFCCC divides countries into three main groups according to differing commitments:(i) Annex I Parties include the industrialized countries that were members of the OECD (Organization for Economic Cooperation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States, (ii) Annex II Parties consist of the OECD members of Annex I, but not the EIT Parties; and (iii) Non-Annex I Parties are mostly developing countries, including 49 Parties classified as least developed countries (LDCs) by the United Nations (UNFCCC, 2008).

This study focuses on fuelwood and fossil fuel consumption by both producers and households as primary indicators of environmental pressure, while emissions of greenhouse gases are considered as by-products of these indicators. Although greenhouse gas (GHG) emission reductions are at this stage not obligatory for non-annex I countries under the UNFCCC, this study argues that developing countries such as Malawi could achieve better economic and environmental outcomes by implementing voluntary emission reduction strategies that address their local economic development problems. One of the economic problems is that developing countries use fuels less efficiently than industrialized countries because of lack of state-of-the-art technology. Fuel efficiency is also compromised because of the proportionately higher use of coal and biomass which produce more greenhouse gas emissions per unit of energy than do petroleum products and natural gas (Sathaye and Ravindranath, 1998).

Malawi is a typical least developed economy that is heavily dependent on natural resources for energy and livelihood. Economic growth has been accompanied by resource extractions and emissions that could compromise sustainable development of the country. However, there is a risk that current resource extractions have direct and cumulative impacts on ecosystem flows of energy and emissions that often disturb ecosystem equilibrium (Munasinghe, 1993; Adriaanse et al., 1997; Klauer, 2000; Kratena, 2004). For instance, the 1994 Malawi GHG inventory indicated that land use change and forestry contributed 96.3 percent of the Malawi's carbon dioxide (CO_2) emissions, and was a net emitter of 17, 512 Gg kg of CO_2. Agriculture also contributed 25.8 percent and 90.7 percent of methane (CH_4) and nitrous oxide (N_2O) emissions, respectively, while energy-related emissions accounted for 71.9 percent and 91.3 percent of CH_4 and nitrogen oxides (NOx), respectively[2]. It is estimated that currently Malawi emits 747,000 metric tons of carbon dioxide, representing a 25 percent increase in total emissions since 1990 (World Resources Institute, 2006). This however excludes emissions from land use change which for developing countries are a significant source of emissions.

Forest resource degradation in Malawi is attributed to unsustainable use of fuelwood to meet the economy's energy needs. Malawi's growing energy requirements have also resulted in

[2] The 1994 GHG Inventory for Malawi is the most recent available. This is contained in an initial communication to the UNFCCC by Malawi in 2002. This is acceptable since the Kyoto Protocol does not place reporting obligations on non-Annex I countries. However, reporting requirements might change especially after the new round of negotiations following Copenhagen in 2009. In particular, parties to the Kyoto protocol are expected to consolidate their commitments as early as December 2010 at the next round of negotiations in Montreal, Canada.

plummeting imports of oil over the years. Oil is the main source of energy for production activities, accounting for about two thirds of the total average annual energy expenditure by all production activities (NSO, 2001). In 2002, the daily import of refined petroleum products was 5,400 barrels of which 1,700 barrels was motor gasoline and 2,300 barrels distillate fuel oil (IEA, 2003). Demand for oil is so high that imports of petroleum products now exceed 8,000 barrels per day, and might reach 16,000 barrels per day by 2015 (IEA, 2008).

Between 2000 and 2006, the country's primary energy consumption per dollar GDP averaged 2021.1 British thermal units (Btu) per year, with energy intensity increasing at an average of 2.5 percent annually (IEA, 2008). Despite growing energy requirements, Malawi has been utilizing less than a quarter of its installed hydroelectric generation capacity (Livuza et al., 1997). Recent data shows that out of 1,453 GWh of electricity generated, only 30 percent is absorbed by domestic consumers while 1.2 percent is exported (UNESCO, 2008). Studies conducted in developing countries like China, Brazil, Mexico, India, Thailand and Vietnam generally conclude that abundance of domestic hydroelectricity is important for reducing CO_2/energy elasticities whereas scarcity of renewable energy sources is associated with non-declining CO_2/energy elasticities (Sathaye and Ravindranath, 1998). Malawi therefore has a clear opportunity for shifting the energy base of the economy from fuelwood and carbon-intensive fuels to hydroelectricity.

Although studies like Sathaye and Ravindranath (1998) offer an opportunity for energy and forestry management in developing countries, energy and technology interactions in the results could have been conditioned on erroneous assumptions of free market behaviour (Hyde et al., 1996). While hydropower is the most realistic alternative clean fuel in most developing countries, price effects associated with substitution elasticities among available fuels could be critical to reducing carbon emissions. According to Jaffe et al. (1999) inefficiencies in energy technology markets provide a unique opportunity for exploring inexpensive GHG mitigations through energy efficiency enhancement. However, there is little or no empirical evidence to support this suggestion for developing countries in sub-Saharan Africa region. The underlying question that this study therefore asks is whether Malawi could mitigate GHG emissions through energy efficiency without compromising output growth. In particular, the study seeks to understand the economic, environmental and policy factors that are necessary for successful implementation of GHG mitigation in developing countries.

1.1 Statement of the problem

The energy demand structure in Malawi has serious consequences not only for GHG emissions, but also for sustainable development. The economy's footprint in terms of fuelwood demand is putting tangible pressure on forest reserves and protected areas while rising GHG emissions from energy end users will seriously compromise future wellbeing of the nation.

Despite the gravity of problems caused by the complex interactions that environmental extractions and releases bring to bear on economic development, limited analyses have been carried out to quantify the overall environmental burden exerted by fuelwood demand for energy by economic activities and households. Economywide impacts of fuelwood and fossil fuel use by economic activities and households include forest resource degradation that lead to secondary environmental impacts such as soil erosion and watershed degradation (GoM, 1994a). Therefore, if deforestation and forest degradation continues without corrective measures, the result will be environmental hazards, erosion of biological diversity, deterioration of wildlife habitat and degradation of water quality and quantity (FAO, 2003).

It is imperative to study the effect of shifting the energy demand profile of households and industries from biomass base to more modern and less environmentally damaging energy sources like hydroelectricity and biogas. Previous sectoral analyses of environmental problems mainly focused on impacts of agriculture on soil erosion, forestry and watersheds (French, 1986; Hyde and Seve, 1993; Nankhumwa, 2004). Although adequate for sectoral policies, sectoral analyses often raise recommendations that cause problems of coordinating policies in a large number of different and often non-cooperating government ministries (Munasinghe, 1993). In addition, some sectoral policies may be inconsistent with social goals such as poverty alleviation. Economywide perspectives are critical because poverty and low access to electricity have been linked to over dependency on biomass energy and over-exploitation of forest resources in Malawi (GoM, 2002).

It is therefore crucial to link sectoral policy changes to economywide environmental and distributional outcomes in an integrated framework. A complete and accurate assessment of the human impact on the environment requires a greater understanding of linkages between the environment and economic processes, in addition to the extensive exchanges between

different parts of the economy in the market system. Sustainable development will entail an extensive valuation of environmental resources and damages arising from conventional economic activities (Munasinghe, 1993). There is therefore a need to quantify the material throughput in the Malawi economy in terms of fuelwood and fossil fuel use and emissions linked to their use.

French (1986) projected solid wood demand deficits for Malawi under different policy options aimed at mitigating deforestation. The policy menu included planting new trees to replace the ones cut down, improving efficiency of fuel use and making alternative sources of energy competitive. The study painted a grim future for the energy sector in Malawi in that all suggested policies failed to cut the fuelwood deficit to sustainable levels. However, the study did not explicitly model producer and consumer incentives and how these influenced energy demand over time. Currently, household consumption of fuelwood and charcoal is estimated at 7.5 million tons per year which is 3.7 million tons above sustainable supply (Chagunda et al., 2009).

Among the policy initiatives aimed at changing the energy end-use profile for Malawi is the Malawi Rural Electrification Programme (MAREP). MAREP was launched in 1980 with the aim of increasing the number of people with access to electricity to 10 percent of the population by 2010 (GoM, 2001c). Although the fifth and final phase began in 2003 with a study and development of a Rural Electrification Master Plan, there is no independent empirical study to show the economywide impact of rural electrification on households' and producer energy choices and on the rate of deforestation. In a study of rural households in Bushbuckridge in South Africa, Madubansi and Shackleton (2007) argued for the need to determine changes in biomass consumption rates and harvesting rates before and after introduction of electricity in a longitudinal survey of same households. Like French (1986), Madubansi and Shackleton (2007) did not delineate behavioural factors determining the high proportion of households still using fuelwood 10 years after the introduction of subsidized electricity.

An equally important issue is energy-related greenhouse gas emissions. Carbon dioxide (CO_2) emission from gaseous fuels, cement manufacturing and solid fuels was estimated at 747,000 tons in 1998, representing a 25 percent increase in emissions from 1990 (GoM, 2002). Although GHG emissions reductions are at this stage not obligatory, Malawi could take

advantage of the opportunity to reduce emissions to correct distortions in its domestic energy markets. It is the argument of this study that fuel expenditures by poor households may be reduced by a deliberate policy that supports less environmentally damaging fuels like hydroelectricity and biogas. In addition, reducing energy-related GHG emissions now may be equivalent to averting long-term impacts on the environment (Biesiot and Noorman, 1999). A policy that supports alternatives to biomass and fossil fuels may also benefit the environment by arresting the rampant deforestation that is threatening natural forests in Malawi. However, for such a policy to be relevant there is need to identify factors that determine household and industrial fuel choices apart from the regular price considerations in energy demand analysis.

This study is unique in that it suggests solutions to greenhouse gas emissions within the economic development agenda for Malawi. Literature search reveals that this is the first study in Malawi to analyse the economywide impacts of shifting the energy mix from biomass base to modern fuel sources. This has policy relevance in that the proposed GHG emission reductions are voluntary and yet such emission reduction strategies have the potential to arrest deforestation and improve efficiency of the hydroelectric energy sector. The study will also contribute to the literature on the prospects of a double dividend from implementing voluntary GHG emission mitigation policies in developing countries. In terms of methodological contribution, the study not only estimates energy substitution elasticities in an interfuel partial equilibrium model but also uses an economywide framework to directly estimate the optimal energy mix and implicitly, optimal emissions. This is an innovation in that emission reduction targets are endogenously determined by the model and not arbitrarily by the researcher.

1.2 Objectives

The main objective of this study is to evaluate the implications of voluntary reduction in energy-related emissions on the environment and on economic welfare in Malawi.

To achieve the above main objective, the study will pursue the following specific objectives:

1) Estimate interfuel substitution elasticities.
2) Analyse the partial equilibrium impacts of alternative fiscal policy regimes that taxes high carbon fuels and subsidizes alternative low carbon substitutes on energy and carbon intensities.

3) Estimate elasticity of substitution among fuels in the energy aggregate input and elasticity of substitution between energy and non-energy aggregate inputs.
4) Analyse short-run and long-run structural adjustment parameters of substitution in production.
5) Analyse economywide impacts of alternative fiscal policy regimes that taxes high carbon fuels and subsidizes alternative low carbon substitutes.
6) Analyse environmental gains/losses in an economywide framework of alternative fiscal policy regimes that taxes high carbon fuels and subsidizes alternative low carbon substitutes.
7) Determine the optimal fiscal policy regime and thereby the optimal energy mix for the country.

1.3 Hypotheses

The study hypothesizes that:

For industrial energy demand analyses:

1) All fuels in the energy aggregate are Morishima substitutes for each other.
2) Capital, labour and energy input aggregates are Morishima substitutes for each other.
3) The rate of long-run adjustment in intensity of energy use is faster in low capital economic activities and vice-versa.

For the economywide analyses:

1) The economic impact of a fiscal policy regimes that taxes high carbon fuels and subsidizes alternative low carbon substitutes would be negative for capital intensive sectors but positive for labour intensive sectors
2) The positive impact of fiscal policy regimes that tax carbon-intensive fuels and subsidizes alternative low carbon fuel substitutes on labour intensive sectors would be offsetting their negative impact on capital intensive sectors resulting in a positive overall net economic impact (gains).
3) Simultaneous environmental and welfare improvements (double dividend) are feasible from a fiscal policy regime that taxes high carbon fuels and subsidizes alternative low carbon substitutes.

1.4 Organization of the thesis

This thesis is organized in 7 chapters. Chapter 2 provides an overview of energy supply and use in Malawi. Chapter 3 is a theoretical background of the study and discusses the literature. Chapter 4 describes the study approach. Chapter 5 presents estimates of interfuel substitution and dynamic adjustments in input demand. The general equilibrium implications of voluntary reductions in energy-related are evaluated and discussed in chapter 6. Chapter 7 summarises findings and concludes the thesis with policy recommendations.

CHAPTER 2: ENERGY SUPPLY AND USE IN MALAWI

This chapter provides an overview of the energy supply and use in Malawi. The first section discusses the structure of the economy of Malawi. The second section discusses the aggregate energy supply and use and presents the energy balance for Malawi. The third and fourth sections discuss the composition of energy demand by production activities and by households. The fifth section discusses the impact of biomass energy use on forest resources and cover. The Malawi national environmental policy framework is discussed in section six. A conclusion section summarises the chapter.

2.1 Economic structure

The Malawi economy is driven by agriculture which contributes an average of 35.8 percent to GDP, and about 86 percent to export revenues annually. The agriculture sector has the highest employment with over 68.72 percent of the total labour force directly engaged in agriculture, fishery and forestry (NSO, 2000). For the last decade ending in 2004 the macroeconomy was characterised by an annual GDP growth rate of 4.15 percent. This was achieved mainly through growth in non-agricultural sectors such as mining, construction and financial and professional services. The only traditional sector where growth has been significant over the years is small-scale agriculture (RBM, 2006).

The agricultural sector is organized in a dual structure consisting of large-scale commercial estates with vast landholdings and small-scale farmers with small land ownerships. Typically, estates have legal and institutional rules regulating land tenure, crop production, and occasionally their marketing and pricing. There are about 30,000 estates occupying over 1.2 million hectares and about 2 million households operating as smallholder farmers on 6.5 million hectares of freehold land. Approximately 25 percent of smallholder farmers cultivate less than 0.5 ha on average, 55 percent cultivate less than 1.0 ha, 31 percent cultivate between 1.0 and 2.0 ha and 14 percent cultivate more than 2.0 ha (FAO, 2003).

Economic growth in the whole economy is largely influenced by changes in small-scale agriculture, the contribution of which to agricultural value added for the preceding decade

averaged 77.5 percent. Smallholder farmers contribute about 80 percent of the national agricultural production, and about 20 percent of agricultural exports, while estates account for 20 percent of the agricultural production and 80 percent of the exports (FAO, 2003). Small-scale agriculture registered an average annual growth rate of 11.3 percent between 1995 and 2004. In contrast, large-scale agriculture registered an average annual growth of 4.5 percent while the entire agricultural sector grew by 9.4 percent annually[3].

Malawi exports comprise mainly agricultural products. The countries that import from Malawi by order of importance are South Africa (15%), United States of America (9%), Germany (9%), Netherlands (7%), and Japan (<5%). Tobacco account for an average of 59 percent of the country's exports while manufactured and other products together account for 19 percent (Table 1). The composition of exports has remained stable for the last decade and there is no real movement towards non-traditional exports. Mulaga and Weiss (1996) found that about a third of manufacturing activity is based on the processing of agricultural goods for export, while the majority of the remainder is production of light consumer and industrial goods. Currently non-agricultural manufactured exports account for about 12 percent of total merchandise exports while tobacco and beverages account for 56 percent of exports (UN COMTRADE, 2009).

Furthermore, the economy faces unfavourable shifts in the terms of trade with falling prices for the traditional exports like tobacco, tea and sugar (Mulaga and Weiss, 1996). Export prices declined by 44 percent between 1995 and 2002, with the exception of 1998 when export prices were higher than average. This is in contrast to rising unit prices of imports averaging 31.9 percent annually between 1995 and 2002. Consequently the value of imports rose by an annual average of 35.9 percent for the period 1994- 2002. Transport costs account for about 30 percent of the total import bill. Oil, intermediate manufacturers and transport equipment are major imports. The main import sources by order of importance are South Africa (38%), Zimbabwe (18%), Zambia (8%), and Japan (4%) (NSO, 2002).

Since independence in 1964, the economy's trade strategy was to develop manufacturing capacity driven by strong primary export capacity in tea, tobacco, and sugar (Mulaga and Weiss, 1996). However, the performance of manufacturing has not impressed much on the

[3] Calculations of sectoral contribution to GDP and growth rates are based on National Accounts data from the Reserve Bank of Malawi, www.rbm.mw.

economy in recent years. For instance, the contribution of all sub-sectors in manufacturing contributed less than 30 percent to GDP in 1998. During the preceding decade up to 2004, manufacturing was the third largest sector after agriculture and distribution services, contributing an average of 12.97 percent annually to GDP.

Table 1: Domestic exports shares by product category: 1998-2006

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	Annual Average
Total Exports (MKW million)	15770.3	18360.9	23370.0	29913.2	29406.6	39944.9	52300.1	59227.3	73374.3	37963.1
Agric. products	**88%**	**87%**	**86%**	**81%**	**83%**	**75%**	**78%**	**78%**	**75%**	**81%**
Tobacco	65%	66%	63%	61%	61%	50%	54%	56%	54%	59%
Tea	8%	9%	9%	9%	9%	9%	10%	10%	9%	9%
Sugar	10%	6%	10%	8%	12%	12%	8%	8%	9%	9%
Coffee	1%	1%	2%	1%	1%	1%	4%	3%	2%	2%
Cotton	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Rice	2%	2%	1%	1%	1%	1%	0%	1%	0%	1%
Pulses	1%	2%	1%	0%	1%	1%	1%	1%	1%	1%
Maize	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other products	**12%**	**13%**	**14%**	**19%**	**17%**	**25%**	**22%**	**22%**	**25%**	**19%**

Source: Balance of Payments Accounts from the National Statistical Office.

In 1998, the manufacturing sector contributed 31.6 percent to the domestic supply, compared with 17 percent services and 6.2 percent agriculture. However, the domestic sales of non-agricultural manufactured goods averaged 42 percent of total sales between 1999 and 2001 (NSO, 2003). The high dependence on agricultural processing is one of the reasons manufacturing has been weak. This exposes the manufacturing sector to the same risks that agriculture is facing. There is also a high import content in intermediate inputs used by the manufacturing sector. For instance, the share of imported inputs to manufacturing in 1998 was 65.7 percent compared with 26.5 percent to services and 7.8 percent to agriculture. This trend is contributing significantly to the growing import bill which has quadrupled in 6 years from MKW27,414 million in 2000 to MKW143, 406 million in 2006 (RBM, 2008).

The macroeconomic performance of the economy determines the microeconomic outcomes such as production efficiency and income distribution. In general, agro-based sectors are crucial in determining macroeconomic aggregates and microeconomic outcomes. Depending on which source one is quoting, poverty headcounts in Malawi varies from 54 to 65 percent of the national population, and between 66.5 and 89.7 percent of rural population (NEC, 2000;

World Bank, 2008; Chen et al., 2009)[4]. At district level, Ntcheu, Ntchisi, Zomba, Thyolo, Mwanza and Phalombe have poverty headcounts of over 75 percent (NSO, 2000). The poverty incidence and severity are a reflection of the sources and distribution of income in the economy. About 78 percent of the income accruing to rural households is from agriculture labour, 12 percent from land, 5 percent from enterprise and 4 percent government. Urban households on the other hand get most of their income from enterprises (i.e., 55% from capital ownership), followed by labour (33%), land (10%) and government (2%).

Since smallholder agriculture is the economy's growth engine, there are indications that the economy's growth will continue to put pressure on forest resources and cover as a result of biomass energy use and conversion of forests to agricultural land. It is also expected that as manufacturing expands, there would be an increase in fuelwood demand because of the large agro-processing component (especially of sugar, tea and other food products) in manufacturing. This might be followed by a surge in demand for electricity since manufacturing is also a leading user of hydroelectricity among production activities.

For households, biomass will remain the most important source of energy for the foreseeable future. Apart from the high incidence of poverty which typically means that most households cannot afford modern sources of energy, the other reason for the pervasive reliance on fuelwood is that it is available at no fee or restriction on most customary lands. In urban and semi-urban areas however, high tariff of electricity is a contributing factor, as many people cannot afford to use electric power, hence there is lack of appropriate alternatives technologies to substitute firewood and charcoal (FAO, 2003).

2.2 Aggregate energy supply and use in Malawi

The energy needs of the Malawi economy are almost entirely met from biomass sources. Biomass energy consists mainly of fuelwood and charcoal produced from open access forest resources within Malawi. Other biomass sources include fuelwood from private forests or from farms, public forests and from protected lands owned by government. It also includes crop residues, weeds and animal droppings (GoM, 1994a; UNESCO, 2008). Fuelwood and

[4] A re-evaluation of progress towards achieving millennium development goals (MDGs) by World Bank shows that poverty levels have declined. However, this progress depends heavily on a re-calibration of poverty lines from $1/day in MKW at 1993 purchasing power parity to $2/day, which is equivalent to cost of basic needs (World Bank, 2008). A more rigorous discussion of recalibration of poverty lines for Malawi is provided by Chen et al. (2009).

charcoal account for about 93 percent of total energy consumption by Malawian households (UNESCO, 2008; Chagunda et al., 2009). The agricultural sector and households are the main users of biomass fuel accounting for over 90 percent of their energy requirements. Other production activities mainly rely on hydroelectricity and fossil fuels (NSO, 2000; NSO, 2005).

Electricity Supply Corporation of Malawi (ESCOM) is the sole generator and distributor of hydro-energy with an installed capacity of 308.5 Megawatts. It has three power generating stations on Shire River in southern Malawi namely, Tedzani, Nkula and Kapichira that account for 98.5 percent of the installed capacity. Wovwe is the only other power generating plant further north on Rukulu River. At maximum use, household demand for electricity accounts for less than 2 percent of installed capacity whereas industrial demand accounts for 21 percent of capacity. An additional 1 percent is being exported to neighbouring Mozambique, implying that only a quarter of the installed capacity is being utilized (Livuza et al., 1997). Recent estimates put peak domestic demand at 31.2 percent of installed capacity, including 17.4GWh export to neighbouring countries (UNESCO, 2008).

Malawi does not produce energy balance data. However, the International Energy Annual (IEA) published by the United States Department of Energy has some energy production and use data that could be used to produce the energy balance for Malawi (Table 2). The IEA of 2003 shows that except for hydroelectricity, Malawi's energy requirements are met from imports. This excludes fuelwood from total energy supply as biomass sources are not captured in the IEA. As pointed out above, fuelwood and charcoal are the only sources of energy for most households in Malawi. The major energy import is oil consisting of mainly petroleum and diesel, except about 3 percent (18 million litres per annum) of the requirement which is met by locally produced ethanol (NSO, 2002). However, ethanol production is far short of the required 20:80 petrol-ethanol blend as the current annual production translates to 12:88 petrol-ethanol blends (NORAD, 2002).

Coal and natural gas are also imported, albeit in smaller quantities compared with oil. Currently, the country imports as much as 0.1 trillion Btu of primary coal and metallurgical coke to supplement annual production of 65,000 metric tons (IEA, 2008; Nationmaster, 2009). Coal production in 2007 represents only 59 percent of total annual demand of over 110,000 metric tons in 1992 (GoM, 1994a). For the last four years, expenditure on oil

products averaged 998.5 million Kwacha per annum (7.8 percent of GDP) while expenditure on coal by industries averaged 54 million Kwacha per annum, representing 0.4 percent of GDP (NSO, 2002) [5].

Table 2: Production and consumption of some primary energy sources

	Consumption			Production
Year	Petroleum ('000 barrels per day)	Coal (Million short tons)	Electricity (Billion KWh)	Hydroelectric net installed capacity (MW)
1998	5.0	0.02	1.00	308.5
1999	5.0	0.02	0.96	308.5
2000	5.3	0.02	1.00	308.5
2001	5.3	0.02	1.02	308.5
2002	5.4	0.02	1.14	308.5
2003	5.5	0.02	1.15	308.5
2004	6.0	0.02**	1.27	308.5
2005	7.0	0.02**	1.37	308.5
2006	7.0	0.02**	1.10	308.5
2007	7.0	-	-	308.5
2008	8.0	-	-	308.5

Notes and sources: IEA (2003).*http://www.indexmundi.com ; **UNData Energy Statistics Database; - No data

The discussion that follows in section 2.3 is based on energy use and supply data extracted from the Annual Economic Survey (AES) conducted by the Malawi National Statistical Office. The AES is by design a panel of companies that reflects the current economic situation in the industrial sector, and does not necessarily focus on energy issues. The variables in AES include sale of goods, stocks, purchases of intermediate materials and supplies used in production, employment, capital investment in fixed assets, and profit.

2.3 Energy consumption by production sectors

Oil (diesel, petroleum and other lubricants) is the main source of energy for production sectors, accounting for about two thirds of the total average annual energy expenditure by all production activities (Table 3). Hydroelectricity is the second important source accounting for an average of a third of the total annual energy expenditure by all production activities between 1998 and 2001. Coal and fuelwood are major alternatives to hydroelectricity and oil. Natural gas is also an alternative source of energy in Malawi although its use and supply is still minor. Virtually all gas supplies are imported from South Africa (NSO, 2002).

[5] The annual average exchange rate (Kwacha per dollar) for the period was K56.70.

Table 3: Share (%) of total energy expenditure by industry and source between 1998 and 2001

Industry/Sector	Electricity	Fuelwood	Oil products (petrol, diesel and other lubricants)	Coal	Gas
percent of the total annual energy expenditure by all production activities	32.6	1.5	61.7	3.3	0.8
Manufacturing	60	48	28	100	100
Services	21	-	48		
Distribution	9	-	13		
Water and Electricity	5	-	4		
Agriculture	3	52	3		
Construction	1	-	2		
Mining	1	-	2		
Total	100	100	100	100	100

Source: AES (NSO, 2002).

There are important differences in sources and requirements of energy by production sectors. To a large extent, the nature of products produced and the technology employed determine the type of energy that would be appropriate for an activity. Electricity is mainly used by manufacturing and services (Table 3). Fuelwood is used by agriculture and manufacturing sectors only whereas oil products (petrol, diesel and other lubricants) are mainly used by the services sector. Among production activities, gas is used by four sub-sectors of the manufacturing industry only. Among these, fabricated metal production is the major user contributing 82 percent to total demand for gas. Ethanol is used by the activity of retailing auto fuel (distribution) for blending with petrol. Molasses, which is a by-product of sugar manufacturing, is also used by bakeries and confectioneries. However, the volume and value of molasses are negligible.

"Tobacco and sugar growing" dominate energy demand by all agricultural sub-sectors. The sub-sector is the main user of fuelwood and hydroelectricity in agriculture, and only second in ranking to "tea, coffee and macadamia growing" for its demand for oil products (Table 4). Tobacco farmers are the largest consumers of industrial wood, both for posts and for curing tobacco. It is estimated that estates alone use about 84,826 m^3 of firewood for curing tobacco per annum (GoM, 1998a). However, "tea, coffee and macadamia growing" and "tobacco growing" are almost at par in proportional terms for fuelwood demand within agriculture.

Table 4: Agricultural sub-sectors contribution (%) to total expenditure on various energy sources

Agriculture sub-sector	Fuelwood	Hydroelectricity	Oil products
Dairy farming	0.9	1.3	0.6
Fishing		2.6	11.4
Horticulture		0.9	2.1
Poultry farming		4.8	10.3
Tea, coffee and macadamia growing	5.0	42.3	52.2
Tobacco & sugar	94.1	48.1	23.5
Total	100	100	100

Source: AES (NSO, 2002).

Among distribution sub-sectors, "wholesale on a fee or contract basis and wholesale of agricultural raw materials" and "retail sale in non-specialised stores" are the main consumers of hydroelectricity. "Wholesale on a fee or contract basis and wholesale of agricultural raw materials" is also the main consumer of oil products among distribution sub-sectors. Ethanol on the other hand is only used by the activity of sale of automotive fuels (Table 5).

Table 5: Distribution sub-sectors contribution (%) to total expenditure on various energy sources

Distribution sub-sectors	Hydroelectricity	Oil products	Ethanol
Retail sale of hardware, paints, and glass	2.4	3.5	0.0
Maintenance of motor vehicles	3.1	1.5	0.0
Other retail sale in non-specialised stores	8.2	17.9	0.0
Retail sale of automotive fuels	9.5	21.5	100.0
Retail sale in non-specialised stores, pharmaceutical and toilet articles	31.6	5.2	0.0
Sale of Motor vehicles	12.7	6.5	0.0
Wholesale on fee and of agricultural raw materials	32.6	43.8	0.0
Total	100.0	100.0	100.0

Source: AES (NSO, 2002).

The manufacturing sector's demand for energy from oil, hydroelectricity and fuelwood is consistently dominated by the production of "tea and other food products" (Table 6). The bulk of the demand for electricity by manufacturing is from the sub-sectors of "rubber tyres and plastic products" and the manufacturing of "tea and other food products". For oil products, the productions of soft drinks and of "tea and other food products" are the major users of oil. For coal, the productions of "soaps, detergents and toiletries", "malt liquor and malt" and of "soft drinks" are the main users. Gas is mainly used in the productions of "fabricated metal" and "batteries and motor vehicle trailers". Fuelwood on the other hand is mainly used in the production of "tea and other food products" and sugar.

Table 6: Manufacturing sub-sectors contribution (%) to total expenditure on various energy sources

Manufacturing sub-sector	Oil	Hydroelectricity	Fuelwood	Coal	Gas
Bakeries and confectionaries	3.9	1.0			
Batteries & motor vehicle trailers	0.4	0.3			11.4
Cement, lime & plaster	1.8	5.9			
Dairy products	2.4	2.1			
Distilling spirits	1.9	0.7			
Fabricated metal	1.1	0.9			84.9
Fertiliser & plastics	0.2	0.6			
Footwear (leather)	0.8	2.2			
Furniture & other wood products	5.4	4.0	2.4		
Grain milling	5.5	4.6			
Malt liquor and malt	8.8	4.5		22.8	
Tea and other food products	13.4	13.0	77.4		
Paper	2.3	1.4	1.0	3.3	
Meat production	0.7	0.6			
Paints Vanishes	2.4	0.6			
Pharmaceuticals	1.6	0.7			
Printing (books, magazines)	0.3	0.1			
Publishing books	0.1				
Publishing newspapers	1.8	0.5	1.8		2.7
Rubber tyres & plastic products	6.8	33.5			
Sawmilling & planning of wood	0.2	0.2			
Soaps, detergent	4.4	3.4	1.9	62.8	1.0
Soft drinks	19.3	6.4		11.1	
Stamping of metal	0.4	0.4			
Structural metals	6.9	2.0			
Sugar	1.9	4.6	15.4		
Textiles and wearing apparel	5.4	5.9			
Total	100.0	100.0	100.0	100.0	100.0

Source: AES (NSO, 2002).

For services, the sub-sector of “banking and other financial services” is the main user of hydroelectricity, while “Water and air transport” is the main consumer of oil products (Table 7). It is also apparent that sub-sectors of “Water and air transport” and “Freight transport” are also significant consumers of hydroelectricity and oil products, respectively. Passenger land transportation also consumes significant amount of electricity, followed closely by national postal services, insurance and real estates, and “restaurants, bars and hotels”. For oil products, telecommunications, other businesses and passenger land transport are other significant users.

Table 7: Services sub-sectors contribution (%) to total expenditure on various energy sources

Services sub-sectors	Hydroelectricity	Oil products
Banking & other financial services	21.5	9.5
Cargo storage	5.2	1.5
Education	3.0	0.7
Freight transport	4.1	21.7
Human health activities	2.4	0.2
Insurance and real estates	8.5	4.5
National postal services	9.0	3.0
Other business	2.4	8.4
Passenger land transport	10.6	6.0
Personal and social services	5.0	0.9
Rail transport	6.2	2.6
Restaurants, bars and hotels	7.1	1.1
Telecommunication	2.8	8.7
Water & Air transport	12.0	31.1
Total	100.0	100.0

Source: AES (NSO, 2002).

2.4 Energy consumption by households

Household energy use data were extracted from the Integrated Household Surveys of 1998 and 2004 conducted by the National Statistical Office. The Integrated Household Surveys are nationally representative, and contain intercensal information on many household indicators. Other reports cited like NEC (2000) and PMS (2000) are based on these and other nationally representative household surveys.

For most Malawian households, access to efficient and modern sources of energy is still limited. Most households still rely on biomass fuels consisting mainly of fuelwood, charcoal and animal waste. Overall, 94 percent of households use fuelwood whereas only 2 percent use electricity as their main source of energy for cooking. In rural areas, up to 98 percent of households use fuelwood whereas less than 0.005 percent uses electricity as their main source of energy for cooking. In addition, only 5 percent of households in Malawi use electricity for lighting, and this include only 0.01 percent of rural households (NEC, 2000).

Markets have naturally responded to the shortage of fuelwood supply by adjusting the price of fuelwood upwards. For instance, between 1985 and 1995, fuelwood prices were increasing by an average of 5 percent annually. Hyde et al (1996) suggest that expenditure on fuelwood may have exceeded 20 percent of the cash income of some subsistence households in rural areas during the same period. According to PMS (2000), poor households in urban areas allocate up to 7.7 percent of their per capita daily expenditures to fuels that mainly consist of fuelwood

and charcoal.

There are low scale initiatives to find alternative energy sources for households. This includes an underground biogas plant developed at Mzuzu University. The technology includes a biogas plant consisting of a digester with a feed capacity of manure from 4-6 cows to produce about $3m^3$ of gas/day when working at 70 percent efficiency. The gas so produced is enough to operate 3 kitchens for 4 hours daily, and it is estimated that 12 biogas plants for cooking could save up to 444 hectares annually of natural forests from which firewood and charcoal are freely collected. In addition, the technology is environmentally sustainable in that the biogas plant captures about 30-40 percent of the total anthropogenic methane emissions, unlike firewood which contributes to emissions directly from combustion and indirectly through land use change (Chagunda et al., 2009).

Charcoal, gas and electricity are other sources of energy for households apart from fuelwood. As indicated above, these sources of energy serve only a small percentage of the population. The 1998 IHS data shows that in 1998, 2.4 percent of households considered charcoal as their main source of energy for cooking, while 0.79 percent and 0.04 percent of the households, respectively, considered paraffin and natural gas as their main source of energy for cooking (NSO, 2000). The recent 2004 IHS data show on the other hand that in 2004, 6.6 percent of the households now consider charcoal as their main source of energy, while 0.16 percent and 0.07 percent of the households, respectively, consider paraffin and natural gas as their main source of energy for cooking. In addition, about 1 percent of the households use crop residues as their main source of energy for cooking (NSO, 2005).

The 2004 IHS data also show that there are substantial rural-urban differences in terms of energy sources. For instance, charcoal is used by 44.3 percent of urban households as their main source of energy for cooking, compared with 43.7 percent that use fuelwood (Table 8). In rural areas, only 1.1 percent of the households use charcoal compared with 97.2 percent that use fuelwood as their main source of energy for cooking. Electricity, paraffin and gas are almost entirely for urban households while crop residues are important to rural households. However, the percentage of households that use paraffin, gas, saw dust and crop residues is negligible.

Table 8: percent of households by main source of energy for cooking and location

What is your main source of energy for cooking	Urban	Rural	Total
Fuelwood	43.7	97.2	90.4
Paraffin	1.0	0.0	0.2
Electric	10.0	0.4	1.6
Gas	0.5	0.0	0.1
Charcoal	44.3	1.1	6.6
Crop residues	0.1	1.2	1.1
Saw dust	0.4	0.0	0.1
Total	100	100	100

Source: Calculated by the author from 2004 IHS Data

However, not all households obtain their cooking energy through market channels. About 37 percent of households collect fuelwood from sources that may or may not require a payment of any form. Of these households, 9 percent collect fuelwood from own woodlots, 7 percent from community woodlots, 28 percent from forest reserves, 44 percent from unfarmed areas of the community, while 12 percent did not specify their source. Crop residues and saw dust were also cited by some households as important sources of energy for cooking (NSO, 2005).

2.5 The impact of biomass energy use on forest resources and cover

Historically, fuelwood availability and deforestation were not issues of national importance as energy and natural forest management were not given priority in national policy. At independence in 1964, about 47 percent of Malawi's surface area was classified as forest, against a backdrop of a population density of less than 45 persons per square kilometre. However, because of population growth and rapid expansion of agriculture and other sectors, forest area has since declined to 28 percent by 2000. This figure includes area covered by national parks and wildlife reserves (11.6percent), forest reserves and protected hill slopes (10percent) (GoM, 1996a). Currently wood demand is estimated to exceed supply by at least one third (GoM, 2001b) while national population density is now at 105 per square kilometre. However in some districts in the southern region, population density is over 200 persons per square kilometre (NSO, 2000). This trend is placing a tangible threat to sustainable management of forest resources and the main culprits are agricultural expansion and growing demand for fuelwood energy for both domestic and industrial use.

Forest resource degradation in Malawi could be attributed to unsustainable use of fuelwood to meet industrial and household energy needs. The fact that virtually all energy needs in Malawi are met from biomass sources implies a significant pressure on forest resources and

cover. In the late 1970s to early 1990s, the pressure on forests was compounded by smallholder agricultural expansion which was only checked by supply constraint on cultivable land (GoM, 1998a). However, between 1990 and 2005, the country lost nearly 13 percent of its total forest cover due to fuelwood collection and subsistence and commercial agriculture. In addition, between 2000 and 2005 alone, the country lost almost 35 percent of its primary forest cover (Butler, 2006).

As a result of the extent of past forest resource degradation, the current deforestation rate in Malawi is estimated at 2.4 percent per annum (FAO, 2001; Fisher, 2004), but in some relatively high cover areas like the north of Malawi, the rate is estimated at 3.8 percent per annum (GOM, 1994a). This translates to about 33,000- 50,000 hectares of forests that are cleared every year to meet fuelwood demand (FAO, 2007; FAO, 2001; GoM, 2001a). Demand for fuelwood exceeds sustainable supply, and the deficit is growing at an alarming rate. The Forestry Annual Report of 2000-2001 estimates that the 1999 fuelwood deficit was 5.8 million cubic metres and that at the 2001 annual fuelwood demand growth rate, the deficit would reach 10 million cubic metres by 2010.

If left unchecked, fuelwood demand is eventually going to put pressure on forest reserves and on protected areas since most customary lands have literally been combed bare. Therefore, if deforestation and forest degradation continues without collective measures, the result will be environmental hazards, erosion of biological diversity, deterioration of wildlife habitat and degradation of water quality and quantity (FAO, 2003). It is therefore imperative to study the effect of policy changes especially those that recognise the importance of shifting the energy demand profile of households and industries from biomass base to more modern and less environmentally damaging energy sources like hydroelectricity and biogas.

Currently the government of Malawi through the Department of Energy and Department of Forestry has embarked on a program called Biomass Energy Strategy (BEST) as a response first of all to pressure on forest resources, and second to rural poverty. BEST falls under the European Union Energy Initiative for Poverty Eradication and Sustainable Development (EUEI) that was launched at the 2002 World Summit for Sustainable Development in Johannesburg. The strategy is meant to ensure a sustainable supply of biomass energy (mainly firewood and charcoal) and promote access to modern cooking fuels and efficient biomass combustion technologies by households and small enterprises (GTZ, 2007). BEST

complements older and much broader initiatives such as MAREP, whose main focus was expansion of the national hydroelectricity grid to rural areas.

2.6 National environmental policy framework

Poverty and low access to electricity has greatly contributed to the over dependency on biomass energy and the over-exploitation of forest resources (GoM, 2002). Acknowledging the intricate relationship between economic wellbeing of the people and the environment, the National Environmental Policy (NEP) (GoM, 1994b) has as one of its guiding principles, the profound realization that Malawi's economy is highly dependent on natural resources, and that if these are depleted or degraded, long-term food security and sustainable economic growth would be seriously affected (NEP section 2.3 (e)). Section 2.3 (g) further states that "*Regulation will be complemented by social and economic incentives to influence behaviour for individuals or organizations to invest in sustainable environmental management*".

Malawi has more than forty separate statutes on the environment consolidated by the Environment Management Act (EMA) (GoM, 1996b). According to Part II, Sections 3-7 of the EMA, the custodians of the NEP and the EMA are the National Council for the Environment, the Technical Committee on the Environment, District Environmental Officers and District and Town Assemblies. District/Town Assemblies and City Assemblies are charged with local management of the environment. The assemblies have the authority to levy property taxes, charge fees for services rendered, make bylaws and impose penalties for non-compliance (GoM, 1998a).

The major environmental statutes include laws pertaining to land, forests, water, agro-chemicals, wildlife, and land use planning. The revision of some of the statues leading to the enactment of the EMA revealed major coordination weakness on crosscutting environmental issues. It was revealed for instance that most statutes had limited scope and content, making it difficult to identify parties responsible for environmental damages (GoM, 1994a). The revisions also showed a lack of sectoral policies needed to regulate or guide developments in certain aspects. In particular, there was a need for separate policies for land, water and forests, since the NEP was only a guiding document. A step towards more coordinated environmental policy was the enactment of the new Electricity Act in 1998 and later, the formulation of the

Integrated Energy Policy (GoM, 2003). These two documents, together with the National Forest Policy (GoM, 1996a) have focused on addressing problems in the energy sector.

2.6.1 National policies affecting energy supply and use in Malawi

Apart from the NEP (GoM, 1994b), the National Forest Policy (NFP) (GoM, 1996a), the Electricity Act of 1998, and the Integrated Energy Policy (GoM, 2003) are the main policy documents that directly or indirectly address energy problems in Malawi. These documents spell out the sectoral priorities as well as the socioeconomic underpinnings that precipitated the various strategic policy statements that they contain.

Section 5.6 of the NEP outlines some of the guidelines that the government of Malawi is following in implementing the national energy strategy. The policy recognises externalities associated with energy use, especially fossil based energy sources. In particular, the policy states that "*environmental externalities of all energy sources shall be identified and incorporated into policy design and project costing*" (GoM, 1994b: section 5.6 (a)). It also aims at minimizing dependence on imported oil as alternatives are explored, in addition to finding alternative energy systems to fuelwood for both rural and urban communities in Malawi. Further the provision of infrastructure for rural electrification is viewed as a social service since it could significantly arrest deforestation, and improve the quality of rural life (GoM, 1994b: section 5.6 (b)-(f)).

Other policies like the National Forestry Policy and the Integrated Energy Policy equally stress the need to develop alternative energy sources especially for rural communities. The general objective of the NFP is to satisfy people's many diverse and changing needs, particularly those of the rural people who are the most disadvantaged. Specifically the policy aims at "*providing an enabling framework for promoting the participation of local communities and the private sector in forest conservation and management, eliminating restrictions on sustainable harvest of essential forest products by local communities, and promoting planned harvesting and regeneration of the forest resources by Village Natural Resources Committees (VNRC's)*" (GoM, 1996a: Section 2.3.1).

The establishment of VNRC's under the NFP is important because there are vast areas of forests on customary land estimated at about 3.1 million hectares that fall under the jurisdiction of traditional chiefs. At the time the NFP was being drafted, customary land forests accounted for 17 percent of the country's land area under forest cover (GoM, 1996a: Section 1.5). Overall, the NFP envisages a shift in the country's energy mix through institutional changes and economic incentives. Section 2.3.11 for instance outlines the specific objective of the NFP as that of reducing dependence on fuelwood as a source of energy through *inter alia*, (i) promoting "*methods and techniques for the utilization of alternative sources of energy to substitute fuelwood*" (section 2.3.11.1), and (ii) initiating the "*provision of incentives to promote uses of alternative sources of energy*" (GoM, 1996a: section 2.3.11.3).

The first edition of the Integrated Energy Policy (IEP) for Malawi was released for public debate towards the end of 2001. The policy aims at promoting socioeconomic development and contributing to poverty reduction through sustainable provision of "*equitable, efficient and affordable energy service*" (Chilipaine, 2006). The IEP moots rural electrification as a bold step towards addressing both, the energy needs of the rural poor and the environmental consequences of forest resource depletion for energy. Steps towards rural electrification have also included the enactment of a new Electricity Act in 1998, repealing the antiquated Electricity Act of 1965 which established ESCOM as the sole generator and distributor of electricity in Malawi.

Under the new Electricity Act, "Commission" becomes "Corporation", thereby establishing a commercial entity with the same acronym, ESCOM, whose role remains generation, transmission and distribution of electricity. However, the 1998 Act allows for new entrants in the electricity market by establishing a National Electricity Council (NECO) responsible for licensing and regulating power producers. In addition, the revised IEP (GoM, 2003) addresses some of the issues that were not fully addressed by the first edition of IEP of 2001. In particular, the revised energy policy sets procedures for third party access to the national power grid, establishment of a pricing committee, and financing and regulation of investment in alternative energy sources such as fossil fuels and solar energy.

NEP and IEP are therefore in agreement to the extent that both view prices as important in

influencing behaviour of both firms and households. In particular, while establishment of a pricing committee is the mandate given by IEP, chapter 3 of NEP, section 2 lays down the guiding principles for pricing. In particular, section 3.2 (c) states that "*Priority will be given to establishing an enabling economic environment in which market prices provide appropriate incentives for sustainable natural resource use and environmental protection*", and section 3.2 (d) states that "*Prices should reflect opportunity costs and externalities.*" Also section 3.2 (e) states that "*Market failure with regard to the pricing of natural resources will be corrected through the assessment of user fees and taxes or the use of tax reductions and other incentives.*" Finally, section 3.2 (f) gives government departments and local communities the right to revenue generated from sustainable utilization of natural resources on public and customary lands in order to provide positive incentives and self-finance for such continued use.

2.6.2 Expected future developments in environmental and related policies

The Malawi government currently allocates less than 2 percent of its total budget (or less than 1 percent of the economy's GDP) on environmental protection and conservation. In contrast, there is no equivalent revenue collected from environmental regulation activities. Ideally, the government is expected to adjust the costs of environmental management with fiscal revenues generated from taxing activities benefiting from or polluting the environment. It is accordingly projected that future developments in environmental policy would incorporate tax reforms aimed at balancing the environmental fiscal costs and benefits.

Currently, income and profit taxation dominate with an annual average contribution of 42 percent to tax revenue. Taxation of goods and services is the second most important source of tax revenue contributing an average of 41 percent annually, which is an increment from an average of 36 percent between 1995 and 2000. International trade taxes on the other hand are becoming less important for revenue due to SADC, COMESA and other bilateral and multilateral trade agreements. As a result of several international trade agreements, there have been several reductions in maximum tariff rates from 45 percent in the early 1990s to about 25 percent in the 1998/99 budget (GoM, 1999). Currently, the contribution of international trade taxes to tax revenue averages 16 percent annually between 2001 and 2007 (Table 9).

Table 9: Central Government Revenue (%) by source

	2001	2002	2003	2004	2005	2006	2007*	Average
Gross Tax Revenue (Million MKW)	20286.0	23486.0	31749.0	42476.0	55822.8	68177.9	57953.3	42850.1
Taxes on Income and Profits	42%	44%	40%	42%	42%	42%	45%	42%
Taxes on Goods and Services	46%	37%	45%	44%	41%	40%	37%	41%
International Trade Taxes	12%	19%	15%	15%	17%	18%	18%	16%

Source: Ministry of Finance Annual Economic Reports, Note: * Monthly data available up to August 2007.

The tax reforms aimed at incorporating environmental concerns would have to consider the efficiency and distribution effects of such reforms. The imposition of a tax on an activity will, in general, reduce welfare of the taxpayer. The issue that arises is how marginal tax rate increases influence actions of economic agents. Some taxes are particularly distortionary because they impose a burden over and above the revenue that they are supposed to raise (Widmalm, 1999). The prospect for environmental fiscal reforms and the search for optimal energy mix under is subject of a later chapter.

2.7 Chapter summary

The chapter discussed the Malawian economy in terms of (i) economic structure and performance, (ii) aggregate energy use and supply the, (iii) energy demand by production activities and households, (iv) implications of energy use profile on forest resources and forest cover, and (v) national environmental and energy policies. The chapter has revealed that the energy profile of the economy mainly consists of biomass sources, and that, although Malawi has a large installed hydroelectric capacity, its supply strategy which is biased towards industrial users has failed to tap into the large demand for energy from households. To remedy the situation, the IEP proposed the expansion of infrastructure to rural areas in a bid to shift demand from biomass sources to more efficient hydro-energy.

The chapter also revealed that Malawi remains an agricultural driven economy in terms of employment, contribution to GDP and exports. Further, the manufacturing industry has been shown to rely heavily on agriculture, a situation that increases the country's macroeconomic vulnerability to the same risks that agriculture as a sector faces. There are however prospects that Malawi might diversify into non-agricultural sectors such as mining, services and construction.

The IEP, together with the NEP have been heralded as the twin agents of change in the energy sector. In particular, through the IEP, and the subsequent passing of the Electricity Act (GoM, 1998b), rural electrification has started to be implemented in phases. However, rationalization of prices through fiscal measures and regulation as envisaged by both the IEP and NEP are yet to be experimented with. The delay may reflect the fact that policy makers are yet to be convinced that the new price and fiscal reforms aimed at incorporating environmental concerns in the energy sector would result in the intended efficiency and distribution effects purported by IEP and NEP.