Energy and low-carbon competitiveness: the case of low-income countries

Andrew Scott

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Abbreviations

AfDB	African Development Bank
AU	African Union
bpd	barrels per day
BTU	British thermal units
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DECC	Department of Energy and Climate Change
DRC	Democratic Republic of the Congo
EIA	Energy Information Administration
ETS	European Trading System
EU	European Union
EUA	European Unit of Account
GDP	Gross domestic product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GNI	Gross national income
Gt	Giga-tonne
GW	Giga-watt
IEA	International Energy Agency
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
Kg	Kilogramme
Kgoe	Kilogramme oil equivalent
kWh	Kilowatt hour
LIC	Low Income Country
LNG	Liquified natural gas
LPG	Liquefied petroleum gas
MVA	Megavolt ampere
MWh	Megawatt hour
NEPAD	New Partnership for African Development
OECD	Organization of Economic Cooperation and Development
ODI	Overseas Development Institute
PV	Photovoltaic
t	Tonne
Toe	Tonne oil equivalent
TPES	Total primary energy supply
TWh	Terawatt hour
UN	United Nations
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
USA	United States of America
WEF	World Economic Forum
WTI	West Texas Intermediate

Executive summary

The energy sector is important for a country's international competitiveness. The cost of energy affects costs in all sectors of the economy, and the security and reliability of energy supplies can affect production. In Low Income Countries, relatively high commercial energy costs and inadequate supply contribute to the low ranking of LICs in measures of competitiveness.

To meet their growth and human development objectives LICs must increase their consumption of energy. The costs of this increase will be a factor in the ability of each country to grow economically and compete internationally. These costs are influenced by local geography and energy resource endowments, by international markets, and by efficiencies within the energy sector.

There is significant variation between LICs in their patterns of energy production and consumption. Three-quarters of the total primary energy supply in LICs is renewable biomass, used for cooking, which does not influence the international competitiveness of LIC production. Commercial energy in LICs is dominated by electricity (46.6% renewable in 2009) and transport (predominantly fossil fuels). Electricity and the reliability of its supply are frequently cited as constraints on enterprise growth in LIC business surveys, and the quality of electricity is an indicator used in most competitiveness rankings.

LICs are all currently net importers of oil. Movements of oil prices in the world market and the degree of an LIC's dependence upon imported oil are therefore factors influencing competitiveness. Oil prices are expected to increase in real terms to 2035 by up to 2.4% annually, in response to increased costs of production and increased demand. The prices for coal and gas are expected to increase slightly and then remain fairly level to 2035. The small number of existing LIC coal and gas exporters, and future LIC oil exporters, will benefit from continuing high demand and increases in the prices of fossil fuels. However, increases in fossil fuel prices have a significant impact on costs of production and consumer prices in most LICs, and will especially affect the poor.

Carbon markets, intended to mitigate the effects of greenhouse gas emissions by increasing the cost of carbon-intensive energy and encouraging investment in renewable energy, had a total traded value in 2011 of US$176 billion. But Carbon prices have been in decline since mid-2011, and are becoming increasingly fragmented, due to the lack of international agreement to underpin a global market. To date, a small number of energy projects in LICs have received income through the Clean Development Mechanism, and the low carbon price will discourage further registrations.

Renewable energy for electricity is increasingly competitive with fossil fuel energy worldwide, as prices for the latter increase and the cost of renewables falls (especially solar and wind power) due to technological innovation and economies of scale in technology production. For off-grid schemes, which could serve small towns and remote settlements, renewable energy is often the most cost-effective option. LICs with large unexploited potential have ambitions to export hydro-electricity, though the availability of investment finance is limited for projects where political and market risks are high.

The production and consumption of biofuels in LICs has been quite limited to date. In some countries there is potential to produce and export biofuels, which will become more attractive as oil prices rise. Production for the export of biofuels would need to address sustainability concerns (covering emission reductions, carbon stocks, land use change and biodiversity).

LICs tend to have greater energy intensity (energy consumption to GDP ratio), because their industrial sector tends to be dominated by more energy-intensive industries, energy efficiency is poor, technology is not up-to-date, and low-quality fuels are used. There is thus potential to improve energy efficiency in most LICs. Improvements in manufacturing energy intensity in LICs are more likely to come through technical change, and improvements in energy efficiency in other sectors are likely to be achieved with investment in fixed capital.

1 Introduction

1.1 Background

Climate change and mitigation of the greenhouse gas emissions that cause it will lead to changes in patterns of production and consumption across the world. In this increasingly carbon-constrained world, growing demand for resources due to increases in population and income will also drive structural change in national economies and the global economy. The different ways that these changes will affect nations and the way that each adapts to the transition to a low-carbon global economy will be key factors determining their competitiveness and the future prosperity of their citizens. Changing patterns of trade, with competitiveness dependent on resource efficiency and low-carbon forms of production and marketing, present substantial risks but also generate opportunities for countries.

These risks and opportunities are especially important for today's low-income countries (LICs), whose integration into world markets is critical for their economic growth. Countries which have small domestic markets need export markets, and foreign investment can be an important source of capital and technological know-how. Environmental considerations may take second place to economic growth and poverty reduction in the national priorities of a low-income country, but the importance of being competitive in world markets is widely recognised. No less than wealthier nations, the competitiveness and growth prospects of LICs will be affected by their response to the evolution of a low-carbon global economy.

The energy sector is one of the key arenas where these changes will play out, in industrial and developing countries. Energy is a critical enabler of economic growth, but the production and consumption of energy generates more than two-thirds of global greenhouse gas emissions (IPCC, 2011). Any form of global low-carbon economy will require a reduction in these energy-related emissions, which are principally from burning fossil fuels. One of the ways to achieve this will be by reducing energy consumption but, in low-income countries, the production and consumption of more energy will be an inevitable consequence of economic growth and improved living standards.

Emission reductions can also be achieved by using energy from less carbon-intensive sources. According to some analysts, it would be technically possible to meet the world's current and future energy needs through 'zero carbon' energy (Jacobson and Delucchi, 2011). However, the most recent projection from the Internal Energy Agency suggests that the global economy has barely begun to reduce carbon, let alone set out on a pathway to zero-carbon (IEA, 2012). Transition to zero carbon or low-carbon energy systems will take time, and during the transition process differences between countries in their energy mix and in the rate of transition will affect their competitiveness.

Few countries yet take account of the effects of climate change and the imperative of reducing global greenhouse gas emissions when they assess their competitiveness. Where analysis has been undertaken it has been for high income and middle income countries[1], with uncertain or unknown influence upon policy. Competitiveness itself is interpreted differently, and when it comes to the role of energy in competitiveness the standard measures focus on the quality of the electricity supply[2]. The national situation of low-income countries is generally quite different from high- and middle-income countries (which tend to recognise they need to mitigate), and calls for an approach that specifically takes their circumstances into account.

For low-income countries there is a gap in the available analysis and in the tools of analysis that would enable them to assess their competitiveness in a way that takes account of the challenges

[1] The World Economic Forum's Sustainable Competitiveness Index (Schwab, 2012), UNEP's Climate Competitiveness Index (Accountability, 2010), and the G20 Low Carbon Competitiveness Index (Vivid Economics, 2012).

[2] For example WEF's Global Competitiveness Index, the World Bank's Ease of Doing Business, and Deloitte's Global Manufacturing Competitiveness Index.

and opportunities afforded by the transition to a low-carbon global economy. The energy sector will be a key element in such a competitiveness assessment, and requires special attention. This background paper, as part of a wider programme of work by ODI to develop a ‘Low-Carbon Competitiveness Diagnostic’, highlights the key energy issues that LICs will need to take into account for competitiveness in an increasingly low-carbon global economy.

The paper provides a brief review of trends in key energy markets and the impact these will have on LICs, as a contribution to the inception phase of ODI’s Low Carbon Competitiveness research programme. After outlining the links between energy and competitiveness assessment, the paper provides a short overview of energy production and consumption in LICs. Trends in global markets, and particularly prices, for fossil fuels and the economic impact these will have on LICs are then presented, followed by a similar analysis for the carbon market. Trends in renewable energy are considered next, followed by a discussion of energy efficiency in LICs. Finally, some conclusions are drawn with respect to implications for the low-carbon competitiveness of LICs.

1.2 Energy and competitiveness

In this paper the definition of competitiveness used is that adopted for the wider ODI programme of work[3]. Competitiveness is “a situation where a country produces goods and services cheaply enough to compete on world markets, and is thus able to export successfully, and/or to sell domestically without being out-competed by imports from other countries or requiring protection through costly trade barriers”. The focus is on international competitiveness, therefore, and differs from broader definitions of competitiveness[4] (Ellis, 2013).

Competitiveness analysis generally involves examining patterns of trade and production, the cost bases of key sectors and the identification of opportunities and barriers. The competitiveness of countries is often compared, or ranked, by an index or set of indicators. Such measures allow identification of the areas in which individual countries are perceived to be more and less competitive than others. The indicators included vary between the different competitiveness indices, but energy, or more specifically, electricity tends to be one of these (see Table 1).

Table 1: Energy components of general competitiveness indices

Index	Organisation responsible	Energy indicators included
Global Competitiveness Index	World Economic Forum	• Quality of electricity supply (lack of interruptions and lack of voltage fluctuations)
Ease of Doing Business	World Bank	• Getting electricity
Global Manufacturing Competitiveness Index	Deloitte	• Quality and efficiency of electricity grid, IT and telecoms • Cost competitiveness of energy

In contrast to general competitiveness measures, those that do take account of climate change include a substantial energy component. This reflects the importance of energy for the mitigation of greenhouse gases. However, as is clear from Table 2, there is no consistency in the indicators used by different low-carbon indices. The climate-sensitive competitiveness indices that have been compiled have been for high and middle-income countries. It is questionable whether all of the energy indicators used in these are relevant for comparing the competitiveness of LICs. For

[3] See Ellis (2013) Low-carbon Logic: Turning a Green Vision into a Smart Decision.

[4] For the G20 Low-Carbon Competitiveness Index, Vivid Economics define competitiveness as “the ability of a country to generate material prosperity (proxied by economic output) to its residents”.

example, the ‘efficiency of oil refining’ for countries without refineries, or ‘sustainable energy investment listed on the local stock exchange’ where stock exchanges are in their infancy.

Table 2: Energy components of low-carbon competitiveness indices

Index	Organisation responsible	Energy indicators included
Sustainable Competitiveness Index	World Economic Forum	• kg CO_2/kgoe energy use • population exposed to PM2.5 microgram/m^3 particulate matter
Climate Competitiveness Index – Performance Index	UNEP/ Accountability	• Gasoline price • Electricity price to industry • Access to electricity • Renewables % of electricity generation • Efficiency of electricity distribution • Quality of electricity supply • Emissions intensity trend • Emissions intensity trend in manufacturing sector • Emissions trend in the 5 largest companies
G20 Low Carbon Competitiveness Index	Vivid Economics	• Transport sector energy consumption per capita (‘000 tonnes oil equivalent per capita) • Clean energy production (percentage of total energy use) • Efficiency of oil refining (net energy input into oil refineries per unit of total output; ‘000 toe) • New sustainable energy investment (US$ equivalent listed on the local stock exchange) • Electricity distribution losses (% of total energy generated) • Annual growth in greenhouse gas emissions • Price of diesel fuel (US$/litre) • Carbon intensity of electricity (CO_2 per kWh)

Sources: Schwab, 2012; Accountability, 2010; and Vivid Economics, 2012.

The use of these indices to assess the competitiveness of LICs is also challenged by the lack of relevant data for low-income countries. The most recently published index is the 2012 update of the G20 Low Carbon Competitiveness Index (Vivid Economics, 2012) but, as shown in Annex Table K, which attempts to compile the relevant energy indicators for LICs, there are significant gaps in the data. Indeed, there are gaps in the coverage of energy indicators for LICs in most sources. The World Development Indicators series does not contain continuous series for all LICs, the International Energy Agency’s database does not include all LICs, and while the US Energy Information Administration (EIA) has greater coverage of countries in its database, it is for a more restricted set of supply-oriented indicators.

Competitiveness rankings provide a snapshot at a particular point in time, allowing comparison between countries and identification of priorities for improving competitiveness at that time. Their ability to enable policy-makers to consider future competitiveness is limited, though the G20 Low-Carbon Competitiveness does include indicators identified as relevant to future performance (classified as Early Preparation and Future Prosperity) (Vivid Economics, 2012). When the effects upon competitiveness of climate change and mitigation actions are to be taken into account, likely future changes in global patterns of trade resulting from an increasingly carbon and resource constrained global economy, need to be considered. To determine appropriate policy responses, therefore, we need to look at market trends and forecasts.

In Sections 3 and 4 we review price and other trends in key energy markets, drawing from published and online sources. For price trend information, particularly short-term changes, this includes the websites of market analysts, including blogs and news sites, as well as published analysis from key energy institutions (e.g. the International Energy Agency, the US Energy Information Administration, World Energy Council, and International Renewable Energy Agency). For renewable energy, the focus is on trends in investment costs, which are more significant than operating costs when choosing between options.

2 Energy production and consumption in LICs

2.1 Overview

Low-income countries (LICs) are, almost by definition, low energy consumers. Their average per capita consumption of energy in 2010 was 363 kilogrammes of oil equivalent (kgoe), compared with a world average of 1,851 kgoe, and 7,164 kgoe per capita in the USA (World Development Indicators, 2012). The correlation between per capita gross national income (GNI) and per capita energy consumption is strong, but the relationship weakens once energy consumption reaches 1,000-3,000 kgoe per capita. To meet their growth and human development objectives energy consumption in LICs must increase. The costs of this increasing production and consumption of energy will be a factor in the ability of each country to grow economically and compete internationally. These costs are influenced by local geography and natural resource endowments, by international markets, and by efficiencies within the energy sector.

Across all LICs (excluding Afghanistan for which no data are available), 77% of total primary energy supply (TPES) in 2009 was from renewable energy sources (most of which is biomass, e.g. firewood or charcoal) and 23% from fossil fuels. This is almost the reverse of the energy supply mix in OECD countries, where 81% is from fossil fuels and 8% from renewables (excluding nuclear). The LIC average, however, conceals large differences between countries (see Annex Table A for details). At one extreme, North Korea's (reported) total primary energy supply is 89% fossil fuels (mainly coal), and at the other extreme 2% of Burundi's energy is from fossil fuels. Seven (out of 35) LICs have more than 40% of their energy supply from fossil fuels and another seven have between 20% and 40%.

The large proportion of renewables in the total primary energy supply of LICs is dominated by biomass (75% of TPES on average), which is used predominantly for domestic cooking. Apart from the energy derived from food for human labour and animal power, biomass energy for cooking is the principal source of energy consumed by low-income (and some middle-income) households. In 2005, across the 16 LICs for which we have data, household energy averaged 49% of total final energy consumption (see Annex Table B), against a world average of 16%. In Nepal and Ethiopia, around 90% of total final energy consumption was for domestic use. Most of this energy is from wood fuel, sourced locally and often supplied through household labour, rather than purchased. Much of the renewable energy consumed in LICs therefore is not reflected in GDP, and little of this biomass is traded internationally. From the point of view of a low-income country's international competitiveness it is useful to exclude this household energy consumption from the analysis, while recognising its importance to total energy demand in LICs.

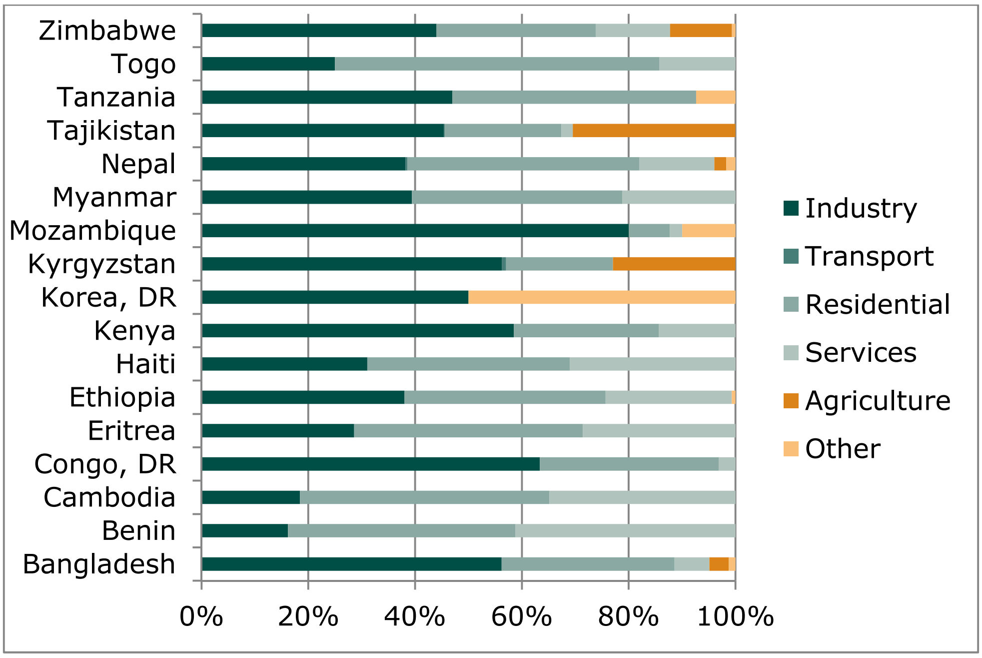
Commercial energy in LICs is dominated by the power (electricity) and transport sectors. Electricity can be generated from a variety of energy sources, while transport consumes oil and oil products almost exclusively. (Only in Kyrgyzstan, Nepal and Tajikistan does transport consume a marginally noticeable amount of electricity. See Annex Table C.)

On average in LICs, 46.6% of the electricity produced in 2009 was from renewable sources, predominantly hydro power. This is more than double the proportion in other country income groups. Globally, 19.1% of electricity production is from renewables (16.1% in high income countries). However, the variation among LICs in the proportion of electricity production from renewables is large, ranging from close to zero to almost 100%, reflecting the influence of geography, with some countries having a large hydro power resource and others almost none at all (see Annex Table D).

Electricity consumption varies between countries, ranging from 35 kilowatt hours (kWh) a year per capita in Haiti, to more than 1,900 kWh per capita in Tajikistan. Levels of access also vary, with almost universal access in the former Soviet countries of Kyrgyzstan and Tajikistan to less than 10% in a number of African LICs. (See Annex Table E.)

Sectorally, the main consumers of electricity are households (shown as residential in Figure 2 below) and industry, although there is also variation between countries in the share each of these sectors has in total electricity consumption. (We have the sectoral breakdown for only 16 LICs.) In most LICs the majority of households do not have access to electricity, but there is no obvious relationship between rates of access and the proportion of electricity consumed by the residential sector.

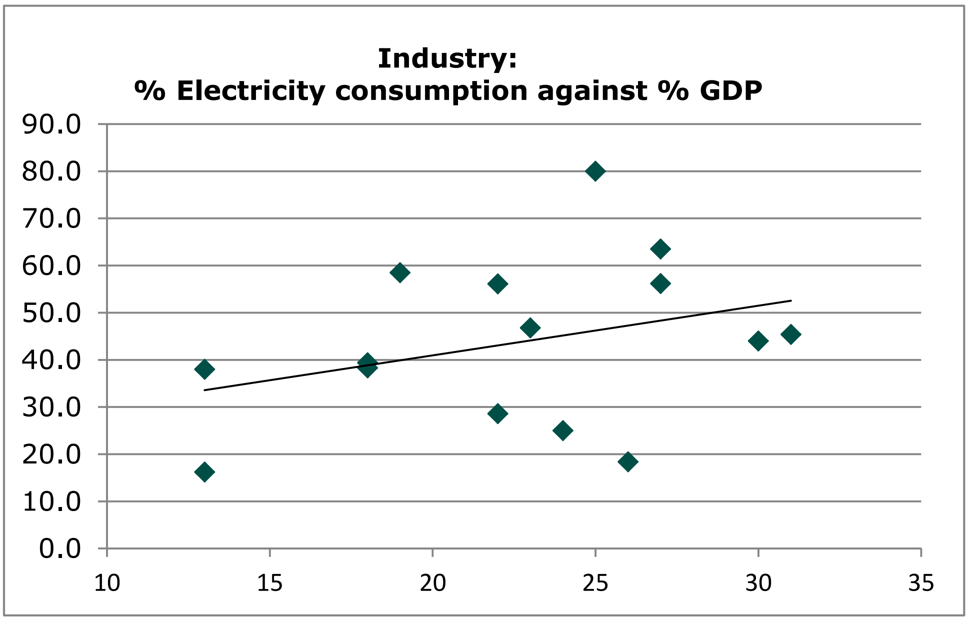
Figure 1: Electricity consumption by sector in selected LICs



Source: IEA

The proportion of electricity consumed by industry is not obviously related to the proportion of GDP accounted for by manufacturing value added, as revealed by Figure 2 (based on IEA and UNIDO data). The type of industry, the vintage of fixed capital and management practices will affect industrial energy consumption. According to UNIDO (2011), on average across industry types energy costs account for 4.3% of total industry input costs (excluding oil refining) in developing countries.

Figure 2: Proportion of electricity consumption by industry and proportion of GDP from manufacturing industry



Source: IEA and UNIDO

Energy intensity (units of energy per unit of GDP) is an indicator of how much energy is required to produce a unit of output, a factor that affects competitiveness. A country's energy intensity is determined by many factors, including efficiency in the use of energy, the size and climate of the country, and the structure of the economy (IEA, 2012). There are significant variations in energy intensity between LICs (as shown in Annex Table G), as well as differences in how energy intensity changes over time, both at an overall country level and in the manufacturing sector. In developing countries, industry tends to use around three times as much energy to produce one dollar of manufacturing value added as in industrialised countries (UNIDO, 2011).

The International Renewable Energy Agency (IRENA) has estimated the energy self-sufficiency of LICs in Africa. The self-sufficiency ratio ranges from about 50% of TPES (Guinea-Bissau) to more than 100%. Most are about 80-90% self-sufficient, due to the dominant place of biomass in TPES. However, all LICs are net importers of oil and oil products, and two, Mozambique and Myanmar, are net exporters of gas. Four (N Korea, Mozambique, Myanmar and Zimbabwe) are net exporters of coal. (Data are presented in Annex Table F.) Cross-border trade in electricity also takes place, and is likely to increase in future. Amongst LICs, Congo (DRC), Kyrgyzstan, Mozambique and Uganda are currently net exporters of electricity, mostly generated from hydropower.

For commercial energy consumers, reliability of supply is an important factor for competitiveness. Electricity and the reliability of its supply are frequently cited as constraints on enterprise growth in LIC business surveys, and the quality of electricity is commonly included as a competitiveness indicator in country rankings. Businesses in Africa lose 13% of their working time through power cuts, higher than other regions of the world. To compensate, many firms invest in their own generators which can collectively amount to significant capacity[5]. Of the companies which export, the proportion with generators is higher than average (Iarossi, 2009).

3 Fossil fuel markets

3.1 Oil

Oil accounted for 32.4% the world's total primary energy supply in 2010, and an average of 15% amongst LICs. The International Energy Agency (IEA, 2012b) expects the share of oil in global energy supply to reduce slightly over the next two decades (to 27.4%), but oil will continue to be a substantial component of the global energy mix (unless policy change occurs). The total global consumption of oil is forecast to increase by 12.8% by 2035, with all of this increase taking place in non-OECD countries and the largest increase in China (Holden, 2012).

LICs are all currently net importers of oil, but recent reserve discoveries in Ghana, Uganda and Kenya may enable them to become net exporters. Oil production in LICs, however, is unlikely to make a significant difference to the global market (Holden, 2012). For LICs, therefore, movements of oil prices in the world market and their degree of dependence upon (imported) oil will continue to be factors influencing competitiveness.

Major oil price changes have historically been related to political phenomena, and in the past supply to the world market was managed by the producer countries in OPEC (King et al., 2012). OPEC countries now supply a smaller share of the total, and their influence on prices has reduced, but oil production continues to be concentrated in a small number of countries, in and out of OPEC. Oil prices will continue to be subject to fluctuation arising from perceptions of future supply and demand in the short-term. We, therefore, need to distinguish between short-term price changes or shocks, and long-term structural changes due to depletion of low-cost resources and increased levels of demand.

There are two main world prices, West Texas Intermediate (WTI) crude oil and Brent crude oil, currently (6 February 2013) $96.63 per barrel and $116.52 per barrel respectively. At the end of 2012, the US Energy Information Administration (EIA) forecast the price of WTI crude oil to average about $90.00 per barrel in 2013, rising to $91.00 per barrel by 2014.

Oil price forecasts vary in accordance with the models and assumptions used by forecasting agencies. The US Energy Information Administration, among others, produces forecasts for different scenarios (cases). Their 2012 compilation of forecasts (see Table 1) shows a range between $82.24/barrel and $116.91/barrel for prices in 2015, and range between $94.78/barrel and $138.49/barrel in 2030 (all in constant prices). Provisional 2013 figures for their Reference case forecast an increase to $148.03/barrel in 2035 and up to $160.68/barrel in 2040 in 2011 real prices (EIA, 2013). The range of prices generated by different forecasts is well-illustrated in Figure %, which shows the UK Department of Energy and Climate Change comparison between its own oil price forecasts and those of other agencies. In its central forecast, DECC expects the real price of oil to increase by 16% to $135.00 per barrel by 2030 (DECC, 2012a).

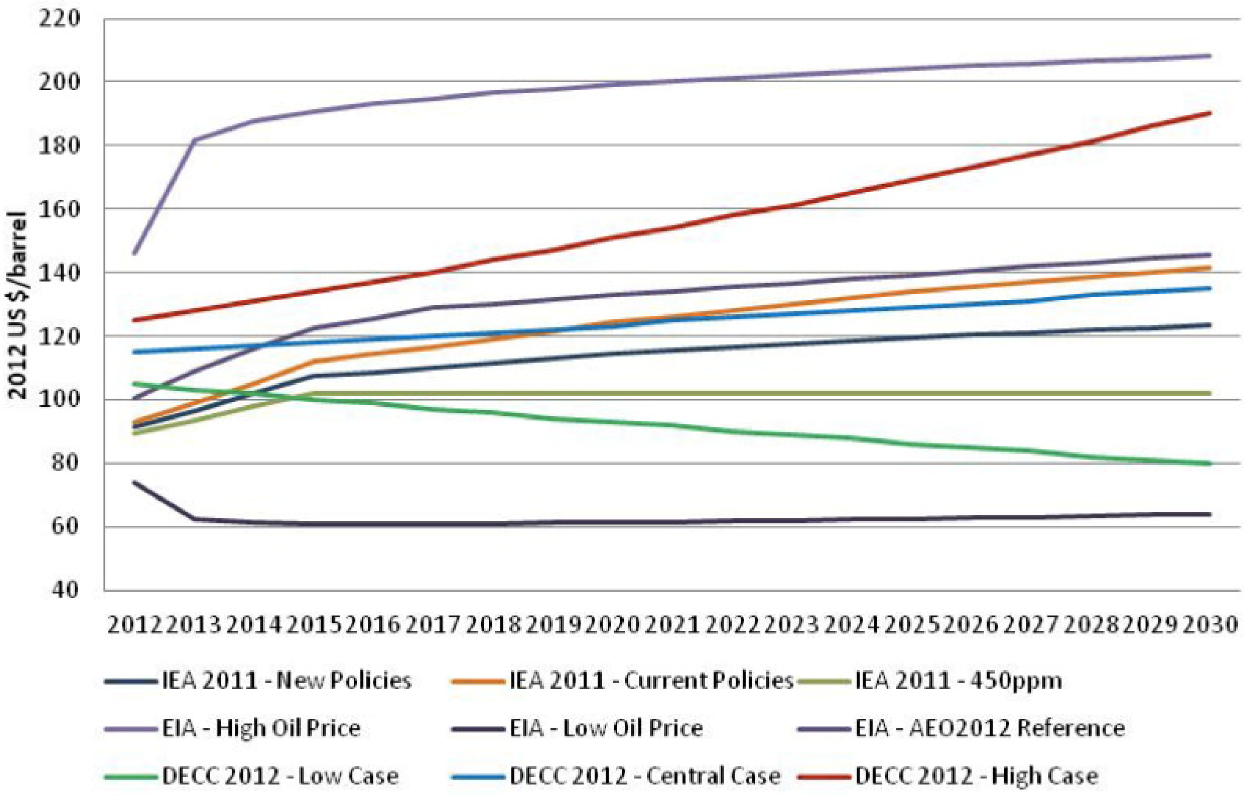
[5] During research in Nepal for ODI's Low-Carbon Competitiveness project, estimates of 700-800 MW capacity in stand-by generators were quoted, roughly equal to total conventional installed capacity.

Table 3: Projections of world oil prices 2015-2035 (2010 US$/barrel)

Projection	2015	2020	2025	2030	2035
AEO2012 (Reference case)	116.91	126.68	132.56	138.49	144.98
AEO2011 (Reference case)	95.41	109.05	118.57	124.17	126.03
EVA	82.24	84.75	89.07	94.78	102.11
IEA (Current Policies Scenario)	106.30	118.10	127.30	134.50	140.00
INFORUM	91.78	105.84	113.35	117.83	116.76
IHSGI	99.16	72.89	87.19	95.65	98.08
Purvin & Gertz	98.75	103.77	106.47	107.37	107.37
SEER	94.20	101.58	107.13	111.26	121.94

Source: EIA, 2012

Figure 3: Comparison of oil price forecasts until 2030 (2012 prices)



Source: DECC, 2012a

The International Energy Agency expects real oil prices to rise steadily over the next 25 years under its New Policies Scenario, largely as a consequence of rising average production costs. However, uncertainty about the implementation of policy changes introduces a degree of uncertainty into medium- and long-term forecasts of oil prices. Though production from low-cost oil fields is declining, new reserves are being identified, mitigating the effect on prices of concerns about oil scarcity. At the same time, higher costs of production from unconventional sources, and mitigation policies in industrialised countries, will influence demand. Oil-importing LICs, who take their price from the world market, are therefore faced with short-term oil price variability and longer-term oil price uncertainty.

The impact of an oil price increase on an oil-importing economy (i.e. most LICs) is felt initially through a worsening of the balance of payments resulting from the higher cost of imports, reinforced by exchange rate changes. For LICs embarking on oil production, such as Ghana and Uganda, revenues may increase as a result of market price rises, but the costs of exporting oil when the relevant infrastructure is under-developed will mitigate the extent a world market price change is felt.

The demand for oil is inelastic in the short-term, so costs of production and the cost of living for consumers will increase when oil prices rise. Overall demand will be reduced, leading to economic contraction – a fall in growth (Bacon, 2005; te Velde, 2007). According to Bacon (2005) the impact of a sudden oil price increase is directly proportional to the percentage rise multiplied by the ratio of net imports of oil and oil products to GDP. Although actual impact may not be exactly to this formula, the degree of self-sufficiency in oil and the degree to which energy supply is oil-dependent, along with energy intensity, determine a country's vulnerability to oil price increases. Bacon and Kojima (2008) add inflation and exchange rate factors into their vulnerability analysis. Annex Table H presents the most recent available data for these factors.

Low-income countries tend to have higher energy intensity (i.e. more energy is required to produce a unit of GDP) and are therefore more adversely affected by oil price rises than higher income countries. Previous analysis by ODI found that a one-third increase in oil prices over a two-year period would lead to a 1% reduction in GDP in sub-Saharan Africa, and as much as a 4% reduction in the poorest countries (te Velde, 2011).

In analysis for the IMF, Rasmussen and Roitman (2011) found that the global impact of oil price shocks is partly offset, in the short-term, by increases in exports generally and other income flows. However, there is a delayed effect on oil-importers that depends on the size of oil imports relative to GDP. Typically, for oil importing countries, a 25% increase in oil prices causes a loss of GDP of less than 0.5% over a 2-3 year period. For those with oil imports greater than 5% of GDP, which includes three out of four of the 16 LICs for which there are data, the output loss increases to about 1%. Their economies will be negatively affected by the expected 2% annual increase in real oil prices to 2030, and will also be affected by price spikes resulting from price volatility.

Oil price rises affect individual households directly, through increased costs of consumption of kerosene or LPG, and indirectly through the inflationary effect of higher energy prices in other sectors, especially transport. The lowest income groups experience the greatest proportional increase in their cost of living. A study for the African Development Bank and African Union concluded "higher oil prices exacerbate the incidence and depth of poverty and highly distort income distribution structures" (AfDB/AU 2009).

The impact of higher oil prices does depend on the extent to which governments pass on the increase to consumers. In a study of 49 developing countries, including 11 LICs, Kojima (2009) found that nearly all developing countries intervened with price-based policies when the world price rose during 2007-2008. Some governments also used targeted subsidies and tax reductions to manage the effects of higher oil prices. Factors that influence the impact of oil price changes, and the degree to which prices are managed, include the size of the economy, the mode of transport for imported fuel (especially for land-locked countries), and the legal and regulatory environment for doing business (Kojima et al., 2010).

Among LICs, only Bangladesh subsidises diesel to the extent that the retail price is lower than the world market price (GIZ, 2011). Myanmar, Ethiopia and Kyrgyzstan subsidise to the extent that the retail price is lower than in the USA. These countries would experience pressures on their national budgets from a world oil price change, as well as effects on the balance of payments. As Arndt et al. (2008) stress, this forces governments, such as in Mozambique, towards a trade-off between short-term mitigation and long-term growth.

In some LICs, the retail price of diesel is higher than in the rest of the world. In Malawi, Burundi, Rwanda and Central African Republic, for example, the price of diesel is higher than the lowest retail price in Europe. However, transport costs for oil imports are the key factor, rather than fiscal policy.

Although consumption of oil products does not change substantially in the short-term in response to price increases, the longer-term trend to higher oil prices could stimulate investment in substitutes, such as renewable energy. How and when this occurs will vary between countries. The existing pattern of oil consumption, the local availability and cost of alternative energy sources and national policies will determine how substitution for oil takes place.

In the transport sector, which accounts for over half of oil consumption globally, and 40% of the forecast increase in oil demand derives from road freight (IEA, 2012b), there are few renewable alternatives to petrol and diesel. Biofuels are produced in only seven LICs, at levels of one hundred or two hundred barrels per day or less (equivalent to less than 0.1% of their annual oil consumption) (Annex Table I). Electrifying the transport systems would require substantial investment in supply infrastructure and generation capacity. Alternatives to oil for electricity generation include coal and gas, as well as renewables. The initial capital investment for fossil fuel electricity generation is lower than for renewables, so expectations about long-term prices will be critical.

3.2 Gas

Natural gas accounted for 21.4% of global total primary energy supply in 2010 (IEA, 2012b). The production and consumption of gas is expected to increase and the share in global TPES is expected to increase slightly over the next two decades, to between 21.6% and 23.2% by 2035. Natural gas currently plays a significant part in the energy mix of only a few LICs[6], and on average accounts for 11% of their TPES. New reserves in Mozambique particularly, but also elsewhere in Eastern Africa, are expected to be brought into production in the near future (Holden, 2012).

As with oil, the future projections of the price, production and consumption of natural gas differ according to the assumptions underlying the models. Unlike oil, there are price differences between regional markets for gas, due to the costs of transporting gas over long distances. International trade in liquefied natural gas (LNG) is increasing but requires substantial investment in infrastructure. Mozambique and Myanmar are already net exporters of gas and would benefit from increasing global demand, provided the costs of transporting gas to major markets (e.g. China) do not disadvantage them.

The real price of natural gas is expected to rise in the short term but then remain fairly steady for a number of years. DECC's central scenario, for example, predicts gas prices as rising until the end of this decade and then to remain constant over the period to 2030 at £0.72 per therm. Known reserves of conventional and unconventional (i.e. shale) gas are increasing faster than production, and are likely to mitigate any pressure on prices from growing global demand (Holden, 2012).

For LICs that do not have gas reserves, these changes in the gas market are unlikely to have a significant impact, unless their energy mix changes. The combustion of gas generates lower greenhouse gas emissions than other fossil fuels which, in combination with a steady price, for example, may encourage more investment in gas-fired electricity generation[7]. Investment in gas-fired power generation by LICs will be influenced by the costs in comparison to alternatives (including costs of additional supply infrastructure) and anticipated lead times to commissioning.

[6] Bangladesh, Kyrgyz Republic, Myanmar, and Tajikistan (see Annex Table A).

[7] Globally the share of electricity generation from gas increased from 12.1% in 1973 to 22.2% in 2010 (IEA, 2012b).

3.3 Coal

Coal accounted for 27.3% of global total primary energy supply in 2010 (IEA, 2012b), three times the average share in LICs. In the IEA's central forecast (their New Policies Scenario) demand for coal worldwide increases through the 2020s and then levels off – resulting in an annual growth rate of 0.4% until 2035, the main driver being demand for electricity generation, and half of this in China. Coal has been the primary energy source behind the rapid economic growth of China, which now accounts for 44% of the world's coal production (Holden, 2012). Though the rate of increase in coal consumption in China is slowing it continues to increase in India.

Projections of coal prices depend to some extent on assumptions made about actions to address greenhouse gas emissions and in particular, whether significant steps will be taken to mitigate emissions from coal-fired electricity. On current projections, demand will continue to increase, production will expand to meet it, and coal reserves are large and widespread enough that scarcity will unlikely be a factor influencing prices. DECC's central scenario for coal prices is close to the IEA's New Policies Scenario, and shows coal prices increasing steadily back up to around $120.00/tonne by 2020, and then staying at this level.

Coal is currently consumed in 14 LICs, as shown in Annex Table A. In five of these countries, coal accounts for less than 1% of total primary energy supply, and in another five countries it accounts for less than 5% of the energy supply. Coal is, however, a significant source of energy in Cambodia, North Korea, Kyrgyzstan and Zimbabwe. Countries which are net coal exporters would gain from the expected short-term rise in coal prices and continuing demand for power generation in emerging economies.

4 Carbon markets

4.1 Carbon markets

Carbon markets are one of the key measures adopted to date to mitigate the effects of greenhouse gas emissions. Trade in carbon allowances or permits is intended to increase the cost of carbon-intensive energy and encourage investment in renewable energy. Inter-country offsetting of allowances provides finance for low-carbon investment in developing countries.

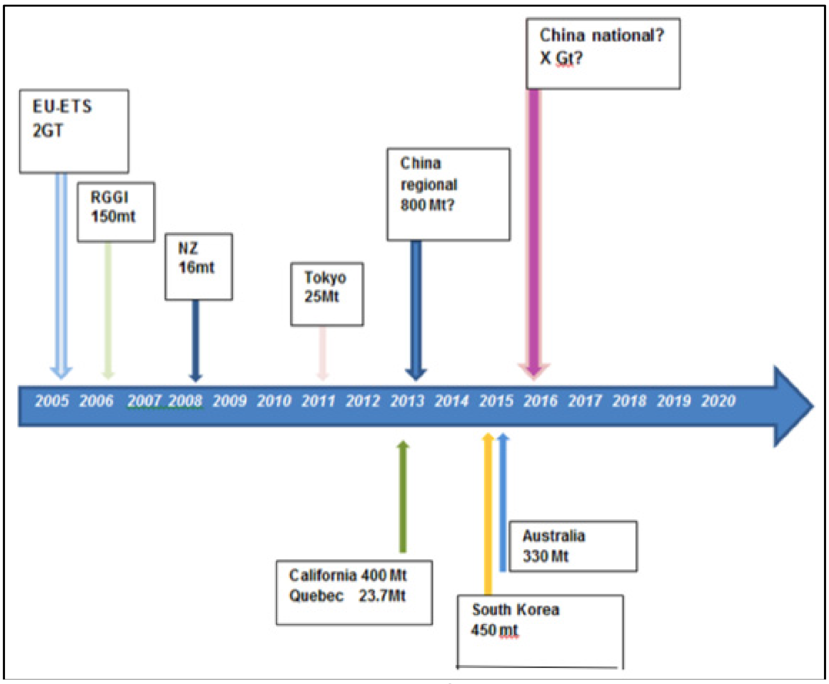
Carbon markets are created by regulations designed to bring about a reduction in greenhouse gas emissions. The efficiency of the market and the price of carbon depend on the policy and regulatory framework established by government. Two kinds of regulation are used: A 'cap-and-trade' system sets a limit on allowable emissions, with the exchange of allowances or permits between companies taking place at variable prices. Under a carbon tax system the price of carbon is regulated, but with uncertain outcomes in terms of emission reductions (Ackerman, 2008).

There are several carbon markets, defined by the jurisdictions of different regulations. The European Trading System (ETS) accounted for 84% of the value of traded carbon in 2010, while the Clean Development Mechanism (CDM) accounted for 14%. Because Certified Emission Reductions (CERs) of the CDM can be used by companies to meet their emission reduction obligations under the ETS (i.e. by offsetting) these two dominant markets do interact. The total value of carbon traded in these markets in 2011 was $176 billion (World Bank, 2012).

The voluntary market, the aggregation of voluntary offsetting schemes, is quite small relative to the trade in ETS and CDM. In 2011, a total of 95 million tonnes CO_2e was traded with a total value of $576 million, at an average price of $6.1 per tonne (Peters-Stanley et al., 2012). Most of this related to emission savings from changes in land use.

Domestic cap-and-trade systems are now being implemented or discussed in the USA, Japan, Australia, South Korea, New Zealand, and Switzerland, among others. Within Europe, the UK, Poland and Germany have decided to auction future allowances separately, rather than under the common platform of the ETS. Emerging economies such as China have begun to designate cities and provinces in which to launch carbon-trading systems. China is also preparing to establish a country-wide carbon trading scheme. Over the next few years new and surviving emission trading schemes (Figure 9) are likely to evolve and develop across the world, with market integration coming at a later stage.

Figure 4: Emerging emission trading schemes



Source: Tuerk et al. (2013)

The increasing fragmentation of carbon markets, which is due to the lack of international agreement to underpin a global market, gives rise to concerns that carbon markets will become more complex, costly and insecure. An international framework could benefit from the strengths of different systems, but the broad range and features of the various schemes could also constrain market convergence (Tuerk et al., 2013). Though the EU has clearly stated its objective is to link up the ETS with compatible systems around the world to form the backbone of a global carbon market, a primary condition for linking carbon markets will be guaranteeing demand for carbon credits through effective emission caps (Seppänen et al., 2013).

4.2 Trends in carbon prices

The price of carbon is difficult to forecast, due to uncertainties about the future of the ETS and the Kyoto Protocol. The time period for forecasts is also an important factor. Long-term price forecasts are based on modelling, with emission reduction in mind, each model making critical assumptions about economic growth, technical change and discount rates. The Intergovernmental Panel on Climate Change (IPCC) identified two models in which carbon prices treble during the period 2030-2050. In other models, the rate at which carbon prices increase declines over time (IPCC Fourth Assessment Report). The model used by DECC has rising prices over time under low, medium and high price scenarios, ranging from £6.45-13.36/t in 2015, £8.55-17.33/t in 2020 and £37.83-113.48/t by 2030 (DECC, 2012b).

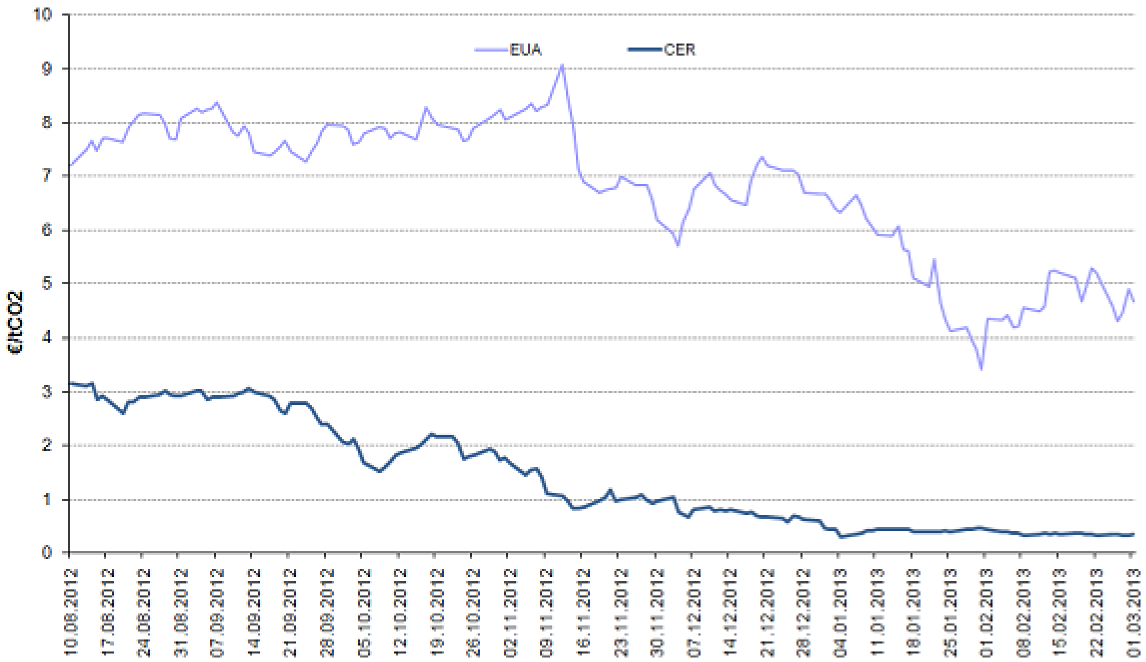
A carbon price that increases over time would be the result of substantial and effective emission reduction measures. The Durban Platform agreed under the United Nations Framework Convention on Climate Change in December 2011 does not envisage significant global emission reductions much before 2020.

For short-term forecasts of carbon prices we need to look to market analysts. Carbon prices have been in decline since mid-2011, but market forecasts were significantly revised when European

Units of Account (EUA) fell below €5.00/t in January 2013 (Figure 6). On 25 January 2013 the price in the ETS fell to €4.16 per tonne (Reuters, 2013), but recovered to €7.84/t by mid-February 2013 (Carbonex, 2013). In December 2012, Point Carbon reported that the average of forecasts for 2013 EUAs was €8.48/t, 7% lower than the estimate the previous month. According to these estimates, the price could increase to €11.54/t in the period 2014-2015 (Point Carbon, 2012). The price in 2013 was variously forecast to average €9.00/t by Point Carbon, €10.2/t by Deutsche Bank and €5.00/t by UBS. In January 2013, Société Générale forecast an average price for EUAs of €6.50 per tonne in 2013, and predicted the price would not rise above €8.50/t before 2015. This was itself a steep correction from their December 2012 projection, which had EUA prices averaging €9.60/t in 2013. Barclays Capital forecast a price of €8.50/t in 2013 (Point Carbon, 2012). The reasons for these depressed prices lie partly in the expected increase in supply of EUAs, following over-supply in its early stages, when carbon allocations were generous and costless. The general economic outlook in Europe is also limiting demand, as businesses have less need for carbon allowances because production levels are depressed.

For CERs there is a similar if not worse picture of low prices in the short term. In 2012, the average price of CERs was €2.09/t and it is expected to increase only marginally to €2.17/t in 2013 (Point Carbon, 2012). This equals a 29.24% decrease in forecasted price from the previous predictions. The January 2013 price for CERs was €0.38/t (ICIS, 2013a). In December 2012, analysts cut their forecasts for 2014 CERs, by 26% to €2.81/t, and for 2015 CERs by 24% to €3.80/t. These forecasts may yet be corrected further downwards (Climate Connect, 2013), and a number of credit organizations are refraining from projecting CER prices over the next few years.

Figure 5: Trends in carbon prices August 2012 to March 2013



Source: Bloomberg New Energy Finance

4.3 Implications for LICs

The performance of the ETS, and therefore of most of the global carbon market, has little direct bearing on the economies of LICs because it trades in European allowances. Only when CERs (offsetting) are purchased by market actors in the ETS is there potential for an impact on LICs. The majority of traded CERs are purchased by actors within the ETS, with the value of the secondary CER market at US$ 23.1 billion in 2011[8] (World Bank, 2012). From 2013, the market for CERs in the ETS will be limited to new projects in LDCs. The CER market - the CDM - will remain the most significant carbon market for developing countries for several years to come.

How important is the CDM for LICs today? By the end of January 2013, a total of 6,603 projects had been registered or were close to registration under the CDM. In January 2012, just 1% of active projects were located in LICs, with average emission savings of 85,593 tonnes per year per project. One quarter of these LIC CDM projects were in Uganda, seven in Kenya, six in Nepal and five in Rwanda. The other 13 projects were in eight different countries. In 23 LICs, there are no registered CDM projects.

The size of the CDM projects in LICs, in terms of emission savings, is smaller than the overall average for CDM projects. The transaction costs for CDM project registration and emission reduction verification are a fixed cost, and are significant for smaller projects. Banks, brokers, offset buyers and other institutions in the CER market, therefore prefer industrial projects which generate large volumes of emission savings (Milder et al., 2010). Reddy (2011) estimates that less than 30% of CER revenues actually reach developing countries, the majority being taken up by the costs of brokers, bankers and verification costs.

In LICs, the limited number of projects to have achieved CDM registration can be attributed in part to the limited capacity to prepare project proposals for CDM. Where the National Designated Authority has been established in good time and project developers have the capacity to consider and plan for CDM finance, projects have been entered into the system. A loan scheme, making available interest-free loans to cover the cost of project development, has been introduced to help increase the number of CDM projects in Least Developed Countries and countries with fewer than 10 CDM projects.

In some LICs hydropower potential is substantial and remains largely unexploited (e.g. Nepal, Mozambique, Ethiopia and Congo). In such countries, where a large proportion (more than 80%) of electricity is already sourced from hydro-power, the scope for emission savings in the generation of electricity is small. In Nepal, Mozambique and Congo, for example, emissions per kWh electricity (and heat) are 4 grammes/kWh, 1 g/kWh and 3 g/kWh respectively (IEA, 2011). There is, therefore, limited potential in these countries for the sale of carbon credits (CERs) in the CDM market, from generation of electricity for the domestic market. However, there may be CDM potential for hydropower generation to export electricity to markets where electricity emissions are higher. Congo, Kyrgyzstan, Mozambique and Uganda are currently net exporters of electricity, while Ethiopia and Nepal have plans to do so.

Taking the February 2013 CER price of around €2.50/t, the average annual market value of emission savings from CDM projects in LICs would be approximately €214,000 for each project. For LICs, therefore, CDM has potential to be a source of several millions of Euros per year; but not tens of millions. Because the CER price has dropped to unexpected levels, and is unlikely to increase significantly in the short-term, the carbon revenue from CDM projects in LICs will be lower than was expected when the projects were initiated[9]. According to GIZ, the price of CERs has fallen below levels that provide an economic incentive for clean development projects and prices are too low to justify the transaction costs of project registration and issuance of CERs (ICIS,

[8] This compares with the US$ 2 billion total value in received by the originators of CERs (World Bank, 2012).

[9] Point Carbon report the CER market price in February 2013 (€0.30/t) is considerably below the minimum expected by the Chinese authorities and buyers are seeking contract renegotiations. (http://www.pointcarbon.com/aboutus/pressroom/pressreleases/1.2199929)

2013b). The low CER price will discourage further registrations, though it is less certain that this will prevent many planned investments from going ahead. CDM finance has not always been decisive in investment decisions.

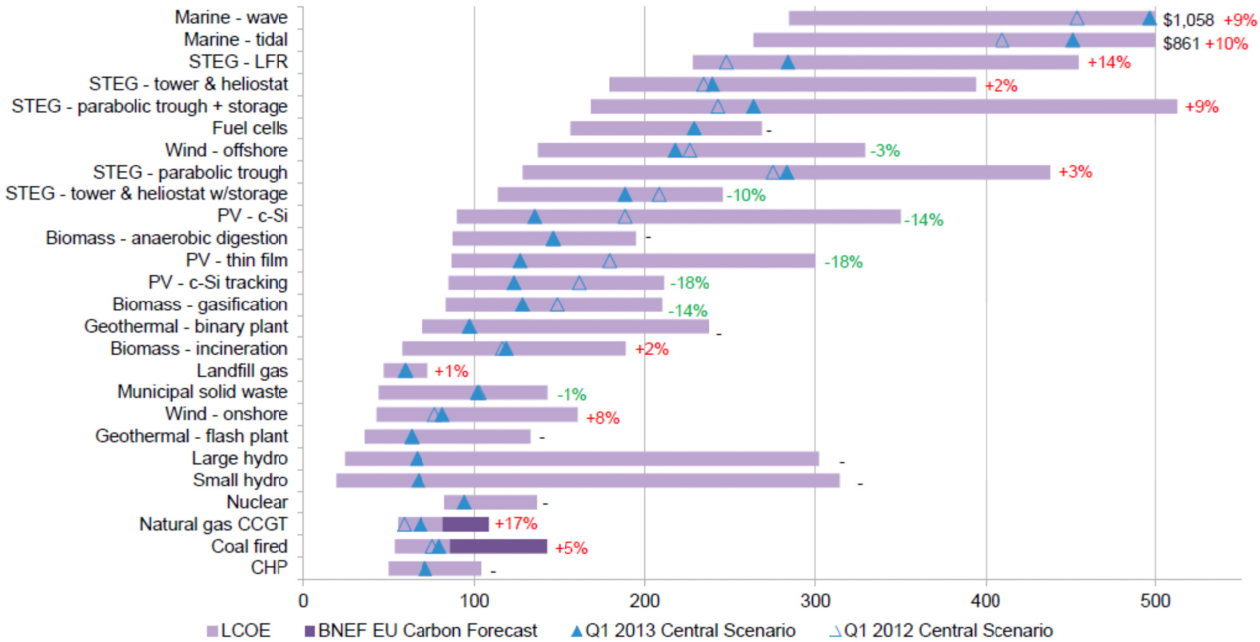
5 Renewables

5.1 Renewables and low-carbon competitiveness

Renewable energy sources (hydropower, wind, solar, geothermal and bioenergy), provide a low-carbon alternative to fossil fuels. The use of renewable energy has been expanding rapidly globally, with renewable electricity growing by 17.8% between 2005 and 2009, and renewable heat by 5.9% in the same period (IEA, 2012b). In 2011, global investment in renewable energy reached a record $260 billion, some five times higher than in 2004 (Bloomberg New Energy Finance, 2012).

Costs vary according to scale, source of energy, technology and location of investment (See Figure 7). For electricity generation, comparisons tend to be in terms of cost per MW installed capacity, cost per kWh energy output, or total annualised (levelised) costs (when fuel as well as investment costs need to be taken into account).

Figure 6: Levelised costs of energy in 2013



Source: Bloomberg New Energy Finance, 2012

Renewable energy is increasingly competitive with fossil fuel energy worldwide, as prices for the latter increase and the cost of renewables falls due to technological innovation and economies of scale in technology production (Brown et al., 2011). For off-grid schemes, which could serve small towns and remote settlements, renewable energy is often the most cost-effective option. However, the potential for renewables varies between countries, depending on geography and policy frameworks.

The renewable energy potential of developing countries has been assessed by IRENA, with most having high hydro and solar power potential (See summary in Annex Table J). Lower renewable energy costs will make investment more attractive, despite the high initial capital costs.

The long lead time for large-scale infrastructure projects, and fixed investment in currently installed capacity, would make a rapid transition to renewable commercial energy in LICs difficult. Costs and capacity to implement energy projects take higher priority in decision-making than the nature of the source energy. Inclusion of the costs of carbon in international fossil fuel prices, through carbon taxes or emission caps, would make investment in renewable electricity generation more attractive (Seth, 2012). The European Report on Development (2012) highlights that if appropriate policies are put into place to overcome the great investment costs for renewable electricity, and to ameliorate the business environment, renewable energy in least developing countries may boost business and growth and reduce poverty. Under current market conditions, however, it is uncertain whether it would make economic sense to embark on a transition to a completely low-carbon energy system immediately.

The high proportion of renewable energy in the total primary energy supply of LICs, as noted above in Section 2, is due mainly to traditional biomass for domestic cooking. For the purpose of assessing international competitiveness it is the proportion of renewables in commercial energy that must be considered, i.e. renewables in electricity generation and in transport fuels.

5.2 Renewable electricity

On average in LICs, 46.6% of electricity was produced from renewable energy sources in 2009. However, there is a wide range between countries, with some generating almost all of their electricity from renewable sources (e.g. Nepal and Mozambique) and others (e.g. Benin and Eritrea) almost exclusively using fossil fuels for electricity. The renewable electricity that is found is predominantly hydropower. Only Kenya, which has geothermal energy in its mix, has more than 20% of its electricity from non-hydro renewable sources.

Thus hydropower is the dominant source of renewable commercial energy, producing 3,431 TWh (16%) of global electricity production in 2010 and 84% of renewable electricity. Global installed hydropower capacity has grown 50% since 1990, and is expected to continue to expand in emerging and developing economies. Most African LICs have good potential for hydropower (see Annex Table J), only a small part of which has been exploited. Countries with large unexploited potential (e.g. Ethiopia and DRC) have ambitions to export hydro-electricity. The NEPAD/AU Programme for Infrastructure Development in Africa lists several large hydropower schemes as priority investments (NEPAD/AU, 2012), but they face a challenge in the limited availability of investment finance for projects where political and market risks are perceived to be high (IEA, 2012b).

Solar is the fastest growing renewable energy technology worldwide. Cumulative installed capacity of solar PV was 40 GW at the end of 2010, which represents an increase of 75% in a decade. Most of this expansion took place in Europe. The cost of solar PV fell by 44% between 2010 and 2012, as a result of technical innovation and expanded manufacture, and in many off-grid locations it is now a very competitive option (IEA, 2012b). As oil prices rise and solar PV costs fall, the latter is becoming competitive in more favourable markets. According to IRENA, solar has high potential in the majority of African LICs (see Annex Table J).

Wind power is currently the second main source of renewable electricity, with total installed capacity worldwide of 238 GW in 2011. The costs of on-shore wind power make it competitive in many places, but off-shore wind power remains relatively costly and depends on government support. As with solar, technical innovations and manufacture in emerging economies are expected to result in lower costs. However, potential for wind power is more unevenly distributed between countries than for hydro and solar.

The costs of electricity generated from renewable sources need to take account of scheme designs that accommodate variability in the primary energy supply (e.g. wind, solar). At a small-scale this might be through storage and hybrid designs (combinations of renewables), and at a large-scale through inter-connected grids, including inter-connections with other countries. The management challenge, increasingly assisted by technical innovations, is akin to the challenge faced by fossil-fuel systems to ensure fuel supplies and sufficient capacity to manage fluctuations in demand.

5.3 Biofuels

Biofuels are a renewable liquid fuel alternative to petrol and diesel for the transport sector, and in 2009 provided the equivalent of 3% of total road transport fuels worldwide. Biofuels (and solid biomass energy) can also be used for the generation of heat and electricity. The USA, European Union and Brazil together account for about 90% of global biofuel consumption today. Under the IEA's New Policies Scenario, global biofuels consumption will more than double before 2035, led by the transport and aviation sectors (IEA, 2012b).

Feedstock accounts for the largest part of the cost of biofuels, varying between countries according to agroecological conditions. Other factors determining the competitiveness of biofuels include the processing technology, subsidies and opportunities for co-production revenues (IEA, 2007). Ethanol continues to be the main biofuel, accounting for about three-quarters of biofuels supply. The USA is a major importer of ethanol, from Brazil and other countries in Latin America. A growing supply gap for ethanol in Asia, suggests opportunities in the short-term for exporters (Licht, 2012). The market is policy driven, through blending mandates, fuel duty rebates, renewable energy standards and subsidies.

International trade in biofuels and bioenergy (in pellet form) is expected by the IEA to increase in the period to 2035. The European Union and India are likely to be the largest importers, and Brazil the largest exporter. Indonesia and developing countries in Asia are also likely to become significant exporters (IEA, 2012b).

The production and consumption of biofuels in LICs has been quite limited to date. The US EIA data lists eight LICs producing biofuels in 2011, at a level of one hundred or two hundred barrels per day, or less. The policy of the main emerging economy producers of biofuels (Brazil, Indonesia and India) is to focus on domestic consumption, for energy security reasons. Although LIC governments may follow suit (in four of the seven LIC producers, domestic consumption accounts for half or more of production), export earnings will also be a driver for increased production, provided oil prices are high and stable.

In some countries there is potential to produce and export biofuels, which will become more attractive as oil prices rise. Large-scale commercial production for export would require significant land area for feedstock cultivation, as well as water and other inputs, in competition with other uses for these resources. Concerns about the environmental, economic and social impact of biofuel production, and higher oil prices, have stimulated development of second and third generation biofuel technologies, which are not yet in commercial production. Exports of biofuels would need to meet sustainability criteria (covering emission reductions, carbon stocks, land use change and biodiversity) to enter European and North American markets.

6 Energy efficiency

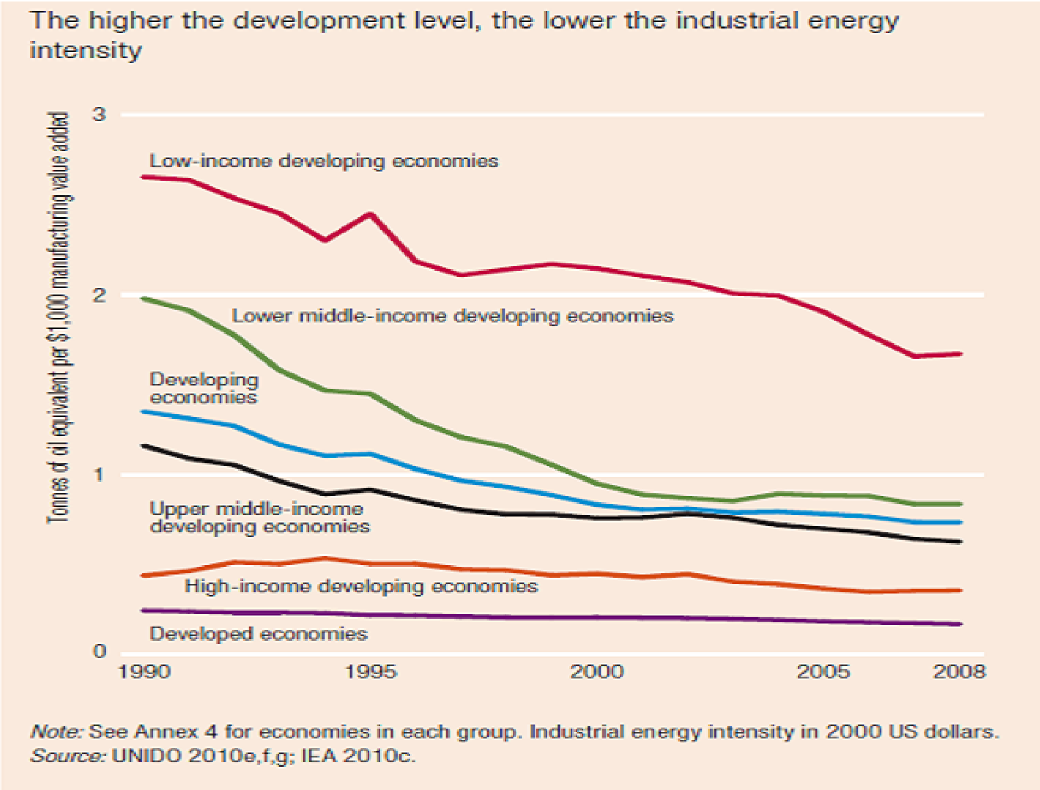
Increasing energy efficiency is the quickest and least costly way to address the challenges of improving energy security and reducing greenhouse gas emissions, according to the International Energy Agency (IEA, 2011). Energy efficiency is perceived to have multiple benefits in reducing resource use, pollution (emissions) and costs, thereby contributing to economic growth, and to competitiveness (Rath, 2011; Cantore, 2009).

The key global drivers for energy efficiency policies are increasing oil prices and the imperative to reduce greenhouse gas emissions, while energy security and energy costs drive efficiency at national and company levels. A report published by the UN Foundation in 2007 concluded that doubling the rate of improvement in energy efficiency would allow atmospheric CO_2 concentrations to be held below 550ppm and return the world to 2004 energy consumption levels. A package of 25 recommendations from the IEA would, they estimate, reduce world energy consumption in 2030 by 17% of current levels (IEA, 2011).

Poverty forces the poor to use energy with poor efficiency (Rath, 2011). This is most noticeable in cooking, with inefficient stoves causing indoor air pollution which prematurely kills around 2 million women and children each year. Poorer countries tend to have greater energy intensity (energy consumption to GDP ratio), because their industrial sector tends to be dominated by more energy-intensive industries (e.g. materials processing rather than manufacturing), energy efficiency is poor, technology is not up-to-date, and low-quality fuels are used.

Improvements to energy efficiency can be achieved through fuel switching (i.e. greater efficiency in the transformation of primary energy into useful energy) or through efficiency in use. The IEA advocate 6 policy actions to improve energy efficiency: increasing visibility/raising awareness; prioritising energy efficiency in decision-making; improving its affordability (e.g. financing instruments); incentives for technology change; reporting; governance and administrative capacity. However, there are large differences between countries in energy supply and demand, energy production and consumption patterns, and thus in energy and carbon intensity. The potential for efficiency measures to achieve emission reductions therefore differs greatly between countries. Improvements in manufacturing energy intensity in LICs are more likely to come through technical change, than changes in the structural composition of industry, and improvements in energy efficiency in other sectors are likely to be achieved with investment in fixed capital.

Figure 7: Industrial energy intensity by income group 1990–2008



Source: United Nations Industrial Development Organization (UNIDO), 2011

It is clear that in emerging economies where energy consumption is greater and energy efficiency (intensity) has been analysed there is considerable potential both to reduce emissions and improve productivity through energy efficiency measures. As shown in Figure 8, energy intensity in LICs tends to be high and there is significant potential to improve energy efficiency. When countries start to increase income levels they are able to reduce energy intensity by the adoption of more energy-efficient technologies. In high income countries the potential for energy efficiency improvements in manufacturing is lower, and reductions in energy intensity are determined by the shift to less energy-intensive, lower-carbon service sectors (UNIDO, 2011).

According to the UNIDO Industrial Development Report on Energy Efficiency (2011) many energy efficiency projects perform significantly better than most financial investments but their profitability varies widely and is sensitive to the time horizon of the investments. Of 119 industrial energy efficiency projects in developing countries, assessed by UNIDO, the average internal rate of return was slightly more than 40% for projects with an expected lifetime of five years. This was because highly profitable projects often involve smaller investments, process reorganization and housekeeping measures, and minor changes to infrastructure. McKinseys calculates that there is abatement potential from energy efficiency of some 11 Gt CO_2e per year globally, by 2030, in which energy savings actually outweigh upfront investments (McKinsey 2009). At a microeconomic level Cantore and te Velde (2011) and Cantore and Cali (2011) show, through econometric analyses, that energy efficiency improves productivity, innovation and profitability of firms in developing countries. However, the Industrial Development Report (IDR) explains that many barriers prevent firms from implementing energy efficiency options. These include market failures (e.g. insufficient information, limited access to capital), bounded rationality (e.g. imprecise evaluation methods) and transaction costs.

Thus in sum, energy efficiency can provide a triple dividend in terms of economic improvements (profits increase), environment (reduction of emissions, efficiency in the use of other inputs such as water) and social sustainability (increased employment). The drawback is that there are barriers to the adoption of energy efficiency and benefits in many cases may only materialize in the medium to long term.

7 Conclusions

The energy sector is important for a country's international competitiveness. The cost of energy affects costs in all sectors of the economy, and the security and reliability of energy supplies can affect production. In Low Income Countries, relatively high commercial energy costs and inadequate supply contribute to the low ranking of LICs in measures of competitiveness.

For most LICs, the priority for development of the energy sector is the expansion and security of energy supply to meet growing domestic demand. They need to supply electricity and modern fuels to significant proportions of their populations who lack access, and they need to provide reliable and increasing amounts of affordable energy to businesses, and middle and higher income consumers. The development of low-carbon, renewable energy, as a strategy to diversify energy supplies, would help to reduce vulnerability to fossil fuel price volatility and improve predictability and energy security for productive sectors.

For competitiveness in a global low-carbon economy, perhaps the most important energy question is whether energy costs in LICs will be lower and offer a cost advantage for the production of other goods and services. Electricity costs in sub-Saharan Africa tend to be higher than in Asia and Latin America, and the supply more unreliable.

Investment in a reliable, adequate and lower cost energy supply will be necessary in all LICs for economic growth and international competitiveness. In some cases this would be investment in fossil fuel energy and in others, investment in renewables, depending on the national situation and endowment of energy resources. Since renewable prices are increasingly competitive under current market structures, with rising fossil fuel prices and falling solar PV and wind energy costs, investment in renewable commercial energy is likely to increase in LICs.

A small number of LICs currently export energy. Existing LIC coal and gas exporters, and future LIC oil exporters, will benefit from continuing high demand and increases in the prices of fossil fuels forecast by the IEA and others. Higher oil prices and price volatility, however, will have a significant impact on costs of production in most LICs, where industries are relatively energy-intensive.

A few LICs export renewable electricity or have the potential to do so. The cross-border infrastructure for this is already present in some parts of Africa and South Asia, and there are plans to develop regional power pools further. Large-scale hydro or solar schemes are also required to generate sufficient power for export. Though LICs with unexploited hydropower resources (e.g. Ethiopia, Congo and Nepal) may have potential to expand electricity exports, for competitiveness it will also be essential to meet domestic demand.

The only other tradable renewable energy prospect is biofuels. Production in LICs is currently at a very low level, although this may increase as oil prices rise. This production may, however, be directed towards the domestic market as a way of reducing dependency on oil imports, leaving little space for exports. Any exports would have to meet the sustainability criteria now being adopted by importing industrialised countries.

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Appendix

Annex Table A: Total Primary Energy Supply by Energy Source in LICs (%)

Country	Fossil Fuels				Renewables					
	Total Fossil Fuels	Oil	Coal	Natural Gas	Total Renewable	Biomass	Hydro	Geo-thermal	Solar	Wind
Afghanistan	70				30					
Bangladesh	69	16		53	30	30	0			
Benin	45	45	0		55	55	0	0		0
Burkina Faso	19	19	0		80	80	0.4	0		0
Burundi	2	2	0.1		98	97	0.9	0		0
Cambodia	28		28		71	71				
Central African Rep	8	8			92	91	1			
Chad	6	6			94	94				
Comoros	41	41			58	58	0.4			
Congo, Dem. Rep	3	2	1	0.03	96	93	3			
Eritrea	23	23			77	77			0.02	
Ethiopia	7	7			93	92	1	0.04		
Gambia, The	31	30		0.5	70	70				
Guinea	10	10		0.002	90	89	1			
Guinea-Bissau	51	51			49	49				
Haiti	28	28			72	71	1			
Kenya	17	17	0.3		83	76	1	6		0.01
Korea, Dem Rep.	89	3	86		11	5	6			
Kyrgyz Republic	72	40	14	18	28	0	28			
Liberia	8	8			92	92				
Madagascar	9	9	0.1		91	90	1			
Malawi	2	1	1		88	84	4			
Mali	21	21			79	78	1			
Mozambique	8	7	0.1	1	92	78	14			
Myanmar	27	9		18	72	70	2			
Nepal	12	10	2		89	86	3			
Niger	7	4	3		93	93				
Rwanda	9	9		0.02	91	91	0.2		0.001	
Sierra Leone	16	16			84	84	0.06			
Somalia	4	4			96	96	0.02			
Tajikistan	42	22	4	16	59		59			
Tanzania	11	8	0.3	3	89	88	1			
Togo	15	15			85	85	0.3			
Uganda	6	6	0		94	93	1	0		0
Zimbabwe	27	7	20		73	69	4			
All LICs	23	15	9	11	77	75	5	1	0	0

a. Excludes nuclear. *Sources: IEA online statistics http://www.iea.org/stats/index.asp and IRENA Country Profiles* http://www.irena.org/

Annex Table B: Energy consumption by sector in 2009 (% of total final consumption)

	Industry	Transport	Agriculture, Forestry & Fishing	Services	Residential	Non-energy Uses
Afghanistan						
Bangladesh	21.06	11.36	5.08	1.63	51.76	8.94
Benin	1.93	30.91	0.00	9.69	57.47	0.00
Burkina Faso						
Burundi						
Cambodia	1.74	7.95	2.51	1.14	86.67	0.00
Central African Rep						
Chad						
Comoros						
Congo, DR	22.26	1.01	0.00	0.08	76.28	0.14
Eritrea	2.61	7.43	0.00	9.64	79.72	0.40
Ethiopia	2.16	4.46	0.00	0.90	92.36	0.12
Gambia, The						
Guinea						
Guinea-Bissau						
Haiti	16.65	18.65	0.00	1.84	62.61	0.26
Kenya	5.60	10.80	0.92	0.59	80.63	1.05
Korea, North	68.17	1.85	0.00	0.00	0.15	0.00
Kyrgyzstan	29.42	30.76	5.11	0.00	4.46	2.55
Liberia						
Madagascar						
Malawi						
Mali						
Mozambique	18.60	6.44	0.09	0.50	73.05	0.00
Myanmar	9.69	6.74	0.01	0.62	72.83	1.53
Nepal	3.57	5.78	1.14	1.57	87.89	0.00
Niger						
Rwanda						
Sierra Leone						
Somalia						
Tajikistan	26.60	4.83	17.85	1.26	12.77	0.05
Tanzania	13.31	6.75	4.22	0.00	72.48	0.09
Togo	2.09	18.33	0.00	9.72	69.50	0.37
Uganda						
Zimbabwe	10.92	4.29	7.66	2.57	73.51	0.16

Source: IEA http://www.iea.org/stats/index.asp

Annex Table C: Electricity consumption by sector (%)

	Industry	Transport	Residential	Services	Agriculture	Other
Afghanistan						
Bangladesh	56.2	0.0	32.4	6.6	3.6	1.3
Benin	16.2	0.0	42.6	41.2	0.0	0.0
Burkina Faso						
Burundi						
Cambodia	18.4	0.0	46.7	34.9	0.%	0.0
Central African Republic						
Chad						
Comoros						
Congo, Dem. Rep	63.5	0.0	33.6	3.1	0.0	0.0
Eritrea	28.6	0.0	42.9	28.6	0.0	0.0
Ethiopia	38.0	0.0	37.7	23.6	0.0	0.7
Gambia, The						
Guinea						
Guinea-Bissau						
Haiti	31.0	0.0	37.9	31.0	0.0	0.0
Kenya	58.5	0.0	27.2	14.3	0.0	0.0
Korea, Dem Rep.	50.0	0.0	0.0	0.0	0.0	50.0
Kyrgyz Republic	56.1	0.8	20.0	0.0	22.9	0.0
Liberia						
Madagascar						
Malawi						
Mali						
Mozambique	80.0	0.0	7.7	2.3	0.0	10.0
Myanmar	39.4	0.0	39.4	21.2	0.0	0.0
Nepal	38.3	0.4	43.6	14.1	2.2	1.8
Niger						
Rwanda						
Sierra Leone						
Somalia						
Tajikistan	45.4	0.2	21.8	2.1	30.5	0.0
Tanzania	46.8	0.0	45.5	0.0	0.0	7.4
Togo	25.0	0.0	60.7	14.3	0.0	0.0
Uganda						
Zimbabwe	44.0	0.0	29.8	13.9	11.6	0.7
LIC average	43.3	0.1	33.5%	14.8	4.2	4.2

Source: IEA http://www.iea.org/stats/index.asp

Annex Table D: Proportion of electricity production from renewable sources (2009)

	Electricity production from renewable sources, excluding hydroelectric (% of total)	Electricity production from hydroelectric sources (% of total)	Electricity production from all renewable sources (% of total)
Afghanistan			82.6
Bangladesh	0.0	4.1	4.1
Benin	0.0	0.0	0.0
Burkina Faso			21.9[a]
Burundi			98.2
Cambodia	0.5	3.9	4.4
Central African Republic			81.5[a]
Chad			0.0[a]
Comoros			9.3[a]
Congo, Dem. Rep.	0.0	99.6	99.6
Eritrea	0.7	0.0	0.7
Ethiopia	0.4	87.3	87.6
Gambia, The			0.0[a]
Guinea			52.9[a]
Guinea-Bissau			0.0[a]
Haiti	0.0	28.7	28.7
Kenya	24.4	31.6	55.9
Korea, Dem. Rep.	0.0	59.1	59.1
Kyrgyz Republic	0.0	89.3	89.3
Liberia			0.0[a]
Madagascar			63.4[a]
Malawi			85.7[a]
Mali			28.6[a]
Mozambique	0.0	99.9	99.9
Myanmar	0.0	71.5	71.5
Nepal	0.0	99.6	99.6
Niger			0.0
Rwanda			36.3[a]
Sierra Leone			31.7[a]
Somalia			4.6[a]
Tajikistan	0.0	98.0	98.0
Tanzania	0.0	60.2	60.2
Togo	1.6	73.8	75.4
Uganda			71.3[a]
Zimbabwe	0.0	53.3	53.3
All low income countries	0.9	45.7	46.6

a. 2008 *Sources: World Development Indicators, http://data.worldbank.org/indicator/all; IRENA Country Profiles*

Annex Table E: Electricity consumption per capita and access to electricity

	Electricity consumption per capita 2009 (kWh)	Households with access to electricity %	Residential as % of total electricity consumption
Afghanistan	49	14.4	
Bangladesh	228	41.0	32.4
Benin	88	24.8	42.6
Burkina Faso	43[a]	10.0	
Burundi	23	2.8	
Cambodia	123	24.0	46.7
Central African Republic	37[a]	5.1	
Chad	9[a]	3.5	
Comoros	84[a]	40.1	
Congo, Dem. Rep.	101	11.1	33.6
Eritrea	51	32.0	42.9
Ethiopia	45	15.3	37.7
Gambia, The	136[a]	8.3	
Guinea	102[a]	20.2	
Guinea-Bissau	10[a]	11.5	
Haiti	35	38.5	37.9
Kenya	146	15.0	27.2
Korea, Dem. Rep.	743	26.0	0.00
Kyrgyz Republic	1402	99.9	20.0
Liberia	87[a]	3.3	
Madagascar	45[a]	19.0	
Malawi	85[a]	9.0	
Mali	111[a]	17.4	
Mozambique	453	11.7	7.7
Myanmar	99	13.0	39.4
Nepal	91	43.6	43.6
Niger	40	9.3	
Rwanda	22[a]	4.8	
Sierra Leone	11[a]	5.1	
Somalia	33[a]		
Tajikistan	1937	99.9	21.8
Tanzania	85	11.5	45.5
Togo	99	20.0	60.7
Uganda	40[a]	9.0	
Zimbabwe	1022	41.5	29.8
OECD average	8012		
World average	2729		

a. 2008.

Sources: Electricity consumption from IEA http://www.iea.org/stats/index.asp and IRENA http://www.irena.org/REmaps/africamap.aspx; access rate from UNDP/WHO, 2009; residential proportion from IEA.

Annex Table F: LIC net imports/exports of energy

	Electricity net imports (MWh) 2009	Oil net imports '000 barrels/day 2008	Net imports natural gas (Bn Cu Feet) 2009	Net imports of coal ('000 short tonnes) 2009
Afghanistan	1377	5.193	0	0.00
Bangladesh	0	67.040	0	881.85
Benin	866	23.733	0	0.00
Burkina Faso	144.6	12.543	0	0.00
Burundi	80	1.334	0	0.00
Cambodia	842	34.338	0	0.00
Central African Republic	0	2.481	0	0.00
Chad	0	1.753	0	0.00
Comoros			0	0.00
Congo DR	-782	11.502	0	230.38
Eritrea	0	2.670	0	0.00
Ethiopia	0	42.483	0	0.00
Gambia, The	0	2.870	0	0.00
Guinea	0	8.969	0	0.00
Guinea-Bissau	0	2.577	0	0.00
Haiti	0	16.588	0	0.00
Kenya	11	33.921	0	104.72
Korea, North	0	7.966	0	-2884.75
Kyrgyzstan	-320	23.042	22.6016	434.31
Liberia	0	4.040	0	0.00
Madagascar	0	14.250	0	11.02
Malawi	0	7.209	0	16.53
Mali	0	4.567	0	0.00
Mozambique	-5070	13.202	-89.347	-5.51
Myanmar	0	12.730	-292.761	-1176.17
Nepal	539	17.247	0	339.51
Niger	500	3.329	0	0.00
Rwanda	78	5.125	0	0.00
Sierra Leone	0	5.594	0	0.00
Somalia	0	1.796	0	0.00
Tajikistan	57	10.546	6.67454	15.43
Tanzania	0	32.678	0	0.00
Togo	683	6.829	0	0.00
Uganda	-57.04	23.950	0	0.00
Zimbabwe	5444	12.650	0	-174.17

Source: World Development Indicators, http://data.worldbank.org/indicator/all

Annex Table G: Energy intensity – overall and manufacturing sector

	Overall energy intensity (Btu per (2000) US $)			Manufacturing energy intensity (toe per US$1000 of MVA)		
	1990	2000	2006	1990	2000	2008
Afghanistan	11,719	1,922	802			
Bangladesh	846	1,053	1,118	0.287	0.281	0.350
Benin	1,652	2,897	3,669	2.143	1.675	1.776
Burkina Faso	912	1,358	1,059			
Burundi	1,140	1,620	1,385			
Cambodia	706	399	284	0.515	0.266	0.156
Central African Rep.	1,236	1,422	1,433			
Chad	893	383	208			
Comoros	3,228	3,317	3,342			
Congo, DR	4,819	7,404	6,124	4.758	19.049	17.736
Eritrea	- -	2,965	3,152	6.441	1.852	3.898
Ethiopia	1,451	1,395	1,517	1.989	2.238	3.275
Gambia, The	2,223	2,112	1,971			
Guinea	1,428	953	835			
Guinea-Bissau	5,000	5,498	6,123			
Haiti	626	1,124	1,298	0.614	1.620	1.947
Kenya	3,124	3,010	3,393	2.932	3.172	2.932
Korea, DPR	31,753	22,715	22,375	5.930	6.131	4.419
Kyrgyzstan	- -	48,968	32,444	4.921	1.872	2.324
Liberia	14,011	8,486	12,299			
Madagascar	1,468	2,252	2,632			
Malawi	2,327	1,881	1,834			
Mali	1,009	820	755			
Mozambique	3,988	11,898	15,728	8.191	4.822	3.177
Myanmar	2,024	1,980	1,515	4.589	2.182	1.245
Nepal	810	1,608	1,606	0.560	0.799	0.898
Niger	1,952	1,658	1,457			
Rwanda	1,563	1,520	1,231			
Sierra Leone	1,742	2,477	1,603			
Somalia	3,987	3,651	3,225			
Tajikistan	- -	61,694	42,825	1.597	1.523	1.041
Tanzania	4,378	3,502	3,300	3.541	4.074	3.801
Togo	2,510	4,928	7,230	4.691	7.976	6.302
Uganda	1,626	1,426	1,130			
Zimbabwe	6,941	6,021	7,295	1.491	1.222	2.121

Sources: Overall energy intensity from EIA; manufacturing energy intensity from UNIDO, 2011.

Annex Table H: Factors determining vulnerability to oil prices

Country	Fuel Imports as % GDP (2009)	% TPES from Oil (2009)	Energy Intensity (2006) Btu per (2000) U.S. Dollars
Afghanistan	14.16	-	802
Bangladesh	-	16	1,118
Benin	-	45	3,669
Burkina Faso	-	19	1,059
Burundi	-	2	1,385
Cambodia	5.55	-	284
Central African Republic	0.14	8	1,433
Chad	-	6	208
Comoros	-	41	3,342
Congo, Dem. Republic	-	2	6,124
Eritrea	-	23	3,152
Ethiopia	4.58	7	1,517
Gambia	7.83	30	1,971
Guinea	12.74[a]	10	835
Guinea-Bissau	-	51	6,123
Haiti	-	28	1,298
Kenya	8.22	17	3,393
Korea (North)	-	3	22,375
Kyrgyzstan	3.03	40	32,444
Liberia	-	8	12,299
Madagascar	5.48	9	2,632
Malawi	3.93	1	1,834
Mali	-	21	755
Mozambique	6.60	7	15,728
Myanmar	-	9	1,515
Nepal	5.95	10	1,606
Niger	-	4	1,457
Rwanda	2.34	9	1,231
Sierra Leone	-	16	1,603
Somalia	-	4	3,225
Tajikistan	-	22	42,825
Tanzania	7.96	8	3,300
Togo	-	15	7,230
Uganda	6.15	6	1,130
Zimbabwe	8.11	7	7,295

a. 2008. *Sources: Fuel imports from World Development Indicators 2011. (Calculated from 'Imports of goods and services (% GDP)' and 'Fuel imports (% merchandise imports)' where data available.) TPES from IRENA. Energy Intensity from EIA.*

Annex Table I: Production and Consumption of Biofuels in LICs, 2010

Country	Production (bpd)	Consumption (bpd)
Cambodia	80.5	0.5
Ethiopia	100	50
Malawi	200	100
Mozambique	20	0
Rwanda	10	10
Tanzania	10	10
Zimbabwe	120	0

Source: EIA database

Annex Table J: Renewable potential in African LICs

H = High potential M = Medium potential L = Low potential U = Unknown potential	Wind	Solar	Hydro	Biomass	Geothermal	Ocean
Afghanistan	M	H	H	M	H	n/a
Bangladesh	M	H	M	H	U	U
Benin	M	M	H	H	U	L
Burkina Faso	M	M	H	M	U	n/a
Burundi	M	H	H	M	U	n/a
Cambodia	M	H	H	M	U	U
Central African Rep.	M	H	H	L	U	n/a
Chad	H	H	L	M	U	n/a
Comoros	M	H	H	U	H	U
Congo, DR	H	H	H	H	H	M
Eritrea	H	H	U	L	M	L
Ethiopia	H	H	H	H	H	n/a
Gambia, The	L	M	U	U	U	M
Guinea	H	M	H	M	U	M
Guinea-Bissau	L	H	M	H	U	M
Haiti	H	H	H	L	U	U
Kenya	H	H	H	M	H	M
Korea, DPR	M	H	U	H	U	U
Kyrgyz Republic	H	H	H	M	U	n/a
Liberia	L	M	H	H	U	M
Madagascar	H	H	H	M	L	H
Malawi	M	H	H	M	H	n/a
Mali	H	H	H	M	U	n/a
Mozambique	M	H	H	M	U	L
Myanmar	H	H	H	H	H	U
Nepal	M	H	H	H	U	n/a
Niger	H	H	M	M	U	n/a
Rwanda	H	H	M	L	H	n/a
Sierra Leone	M	M	H	M	U	M
Somalia	H	H	H	U	U	H
Tajikistan	M	H	H	L	U	n/a
Tanzania	H	H	H	H	H	M
Togo	M	M	H	M	U	L
Uganda	M	H	H	M	H	n/a
Zimbabwe	M	H	H	M	H	n/a

Source: IRENA Country Profiles (www.irena.org)

Annex Table K: LIC Energy Indicators for G20 Low-Carbon Competitiveness Index

	Transport (road) sector energy consumption per capita (kgoe)	Clean energy production (% total use)	Efficiency of oil refining	New sustainable energy investment	Electricity distribution losses	Annual growth of greenhouse gas emissions (2008-09)	Price of diesel US$/litre (2010)	Carbon intensity of electricity (g CO_2/kWh) (2010)
Afghanistan	n/a	n/a	n/a	n/a	7.0%	675.70%	1	n/a
Bangladesh	13.30	46.0%	n/a	n/a	2.2%	9.69%	0.63	593
Benin	113.67	0.0%	n/a	n/a	145.7%	19.39%	1.21	706
Burkina Faso	n/a	n/a	n/a	n/a	7.0%	-10.08%	n/a	n/a
Burundi	n/a	n/a	n/a	n/a	17.1%	6.12%	1.28	n/a
Cambodia	43.00	5.0%	n/a	n/a	7.0%	0.24%	0.98	813
Central African Rep	n/a	n/a	n/a	n/a	30.5%	-9.86%	1.69	n/a
Chad	n/a	n/a	n/a	n/a	7.0%	-16.30%	1.31	n/a
Comoros	n/a	n/a	n/a	n/a	7.0%	0.00%	n/a	n/a
Congo, DR	3.67	284.1%	n/a	n/a	7.0%	-4.30%	1.27	3
Eritrea	8.38	2.3%	n/a	n/a	10.9%	21.74%	1.07	662
Ethiopia	10.20	132.4%	n/a	n/a	13.3%	3.91%	0.78	82
Gambia, The	n/a	n/a	n/a	n/a	9.7%	6.25%	n/a	n/a
Guinea	n/a	n/a	n/a	n/a	7.0%	-11.84%	0.95	n/a
Guinea-Bissau	n/a	n/a	n/a	n/a	7.0%	3.90%	n/a	n/a
Haiti	34.02	66.5%	n/a	n/a	7.0%	-6.78%	n/a	522
Kenya	36.90	790.0%	n/a	n/a	61.2%	18.84%	1.27	331
Korea, DPR	11.58	622.2%	n/a	n/a	16.1%	n/a	n/a	482
Kyrgyz Republic	154.19	3044.3%	n/a	n/a	16.3%	n/a	0.79	94
Liberia	n/a	n/a	n/a	n/a	28.4%	-13.73%	0.96	n/a
Madagascar	n/a	n/a	n/a	n/a	7.0%	-4.61%	1.26	n/a
Malawi	n/a	n/a	n/a	n/a	7.0%	-13.73%	1.54	n/a
Mali	n/a	n/a	n/a	n/a	7.0%	3.09%	1.25	n/a
Mozambique	22.74	1403.9%	n/a	n/a	7.0%	12.36%	0.86	1
Myanmar	10.88	313.7%	n/a	n/a	9.1%	-13.17%	0.8	256
Nepal	18.66	269.7%	n/a	n/a	34.5%	-0.72%	0.91	3
Niger	n/a	n/a	n/a	n/a	7.0%	30.04%	1.16	n/a
Rwanda	n/a	n/a	n/a	n/a	7.0%	3.13%	1.62	n/a
Sierra Leone	n/a	n/a	n/a	n/a	7.0%	6.04%	0.94	n/a
Somalia	n/a	n/a	n/a	n/a	7.0%	-8.47%	n/a	n/a
Tajikistan	12.50	5904.3%	n/a	n/a	17.1%	n/a	0.91	26
Tanzania	21.45	110.3%	n/a	n/a	22.1%	7.66%	1.19	293
Togo	48.94	31.0%	n/a	n/a	126.6%	4.65%	1.17	n/a
Uganda	n/a	n/a	n/a	n/a	7.0%	-7.14%	1.11	n/a
Zimbabwe	29.35	363.9%	n/a	n/a	6.7%	n/a	1.15	660
Source	World Bank	IEA/ World Bank			EIA	US Carbon Dioxide Information Analysis Center	World Bank	IEA

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