EUROPEAN REPORT ON DEVELOPMENT

SUB-SAHARAN AFRICA IN GLOBAL TRENDS OF INVESTMENT IN RENEWABLE ENERGY. DRIVERS AND THE CHALLENGE OF THE WATER-ENERGY-LAND NEXUS.

Prof Giorgia Giovannetti, University of Florence and European University Institute,
Dr Elisa Ticci, University of Siena

MOBILISING EUROPEAN RESEARCH FOR DEVELOPMENT POLICIES

SYNOPSIS

This paper explores recent patterns of domestic and foreign investments in renewable energies. It describes drivers and features of investment in renewable energies, with special attention to biofuels, highlighting that these forms of energy are likely to contribute to competition for land and water as the latter become increasingly scarce.

This paper served as a background paper to the European Report on Development 2011/2012: *Confronting scarcity: Managing water, energy and land for inclusive and sustainable growth*. The European Report on Development was prepared by the Overseas Development Institute (ODI) in partnership with the Deutsches Institut für Entwicklungspolitik (DIE) and the European Centre for Development Policy Management (ECDPM).

Contents

Contents 4
Tables, figures & boxes 5
Abbreviations 6
Executive Summary 7

1 Introduction 8

2 General trends and issues in (public, private and foreign) investment 10

3 Drivers of investment in renewable energy 13

3.1 Factors which boost investment in renewable energy 13
3.2 Barriers to investment in renewable energy 18

4 Global and regional trends in renewable energy investment 21

4.1 Total investments 21
4.2 FDI in renewable and alternative energy sector 24

5 Energy poverty and energy investment in sub-Saharan Africa 27

5.1 Trends in renewable energy investment in sub-Saharan Africa 28

6 Biofuel production in sub-Saharan Africa and the energy-land-water nexus 31

6.1 The current wave of land investments 32
6.2 The state of biofuel development 34
6.3 The way forward 38

7 Concluding remarks 40

Appendix 1 – Land deals in SSA: a look at the data 42
References 51

Tables, figures & boxes

Tables

Table 3.1 The role of investment in modern renewable energy for achieving the MDGs 17
Table A1 Land deals by country, a comparison of different sources of information (in ha) 44
Table A2 Unsigned, pending and cancelled land deals 45
Table A3 Purposes of land deals, by country 46
Table A4 Value of land in selected countries 47
Table A5 Evidence of impacts of biofuel and biogas projects in sub-Saharan Africa 48

Figures

Figure 2.1 FDI to developing countries as % of GDP 10
Figure 2.2 Trends in FDI, private and public investment in SSA, 1980-2009 11
Figure 3.1 Energy and oil price index (base year 2005) 13
Figure 3.2 World oil demand (1000 barrels/day) 14
Figure 3.3 Regional distribution of energy use and of population, 2008 14
Figure 3.4 Net energy imports (% of energy use) 15
Figure 4.1 Global trends in total financial investment in renewable energy (US$ billion) 21
Figure 4.2 a-b Financial new investment in renewable energy by technology (US$ billion) 22
Figure 4.3 Global financial new investment in 2004–2010 by technology (US$ billion and % shares) 23
Figure 4.4 a-b-c-d Investment in renewable energy by technology by top four countries and Rest of World (RoW) 23
Figure 4.5 Trends in total financial investment in renewable energy in selected areas (US$ billion) 24
Figure 4.6 Value of greenfield FDI projects in energy sector 2003–2010 (US$ million) 25
Figure 4.7 Number of greenfield FDI projects in energy sector, 2003–2010 25
Figure 5.1 Net energy imports in sub-Saharan African countries – 2008 (Mtoe) 28
Figure 5.2 Total value of greenfield FDI projects in renewable energy sector by region, 2003–2009* (US$ millions) 29
Figure 5.3 Trends in greenfield FDI projects in renewable energy sector by region, 2003–2008 (US$ millions) 30
Figure 5.4 Value of greenfield FDI projects in renewable energy sector in Sub-Saharan Africa's country, 2003-2009*(US$ millions) 30
Figure 6.1 World fuel ethanol production in 2006, million litres (ML) 35
Figure 6.2 Planned and executed biofuel investments in 22 SSA countries by ha of land accessed for estate cultivation and by origin of lead investor 36
Figure 6.3 Land deals in Ethiopia, Madagascar and Mozambique by nature of investment 37
Figure A1 Percentage of arable land by country and years 42

Boxes

Box 6.1 Types of biomass energy sources 32

Abbreviations

ASEAN	Association of South-East Asian Nations
BNEF	Bloomberg New Energy Finance
CEO	Chief executive officer
CGE	Computable general equilibrium
CIFOR	Center for International Forestry Research
CO_2	Carbon Dioxide
DRC	Democratic Republic of Congo
FDI	Foreign direct investments
GhG	Greenhouse gas
HICs	High Income Countries
Kwh	Kilowatt hour
LDCs	Least Developed Countries
LICs	Low-income countries
MDGs	Millenium Development Goals
MENA	Middle East and North Africa
MICs	Middle-income countries
ML	Million litres
MNC	Multinational corporation
Mtoe	Million Tons of Oil Equivalent
NGLs	Natural gas liquids
NGOs	Non-governmental organisations
ODA	Official development assistance
ODA	Official development assistance
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PPPs	Public–private partnerships
RoW	Rest of World
SOEs	State-owned enterprises
SSA	Sub-Saharan Africa
UNEP	United Nations Environment Programme

Executive Summary

This paper explores recent patterns of domestic and foreign investments in renewable energies. It describes drivers and features of investment in renewable energies, with special attention to biofuels, highlighting that these forms of energy are likely to contribute to competition for land and water as the latter become increasingly scarce. The analysis focuses on trends and developments in sub-Saharan Africa (SSA). Here capital is particularly needed not only because of low rates of savings and domestic tax collection, but also to permit the higher rates of growth necessary to overcome developmental and energy gaps. Despite large oil and gas reserves, Africa is still very far from meeting its energy needs. But the financial gap is not the only obstacle. The paper identifies and discusses a range of institutional, market and technological barriers thwarting the likelihood of meeting energy goals. Investment in renewable energies, especially biofuels, represents a valuable opportunity to break the unfair and unsustainable pattern caused by the inability of the current energy system to satisfy the energy needs of the poor without also compromising the ability of future generations to satisfy their needs. But domestic and foreign investors play distinct roles, and to help local populations to fully benefit from investments, land and water rights have to be clearly defined and governments must make strong commitments to doing so. The paper also seeks to bring together scattered information on investment in land, renewable energies and biofuels, including recent public–private partnerships (PPPs).

1 Introduction

'It's time for Africa … There is an increasing recognition that the continent is on an upward trajectory; economically, politically and socially' (Ernst & Young, 2011: j). Indeed, during the last decade, many developing countries, including in sub-Saharan Africa (SSA), have attracted private capital. Due to limited domestic resources, the expansion of the private sector has been heavily dependent on external capital resources. This is particularly so in SSA, which is characterised by very low domestic private resources because of the low tax base and saving rates (OECD and AfDB, 2010). Among foreign sources, official development assistance (ODA) is increasingly under discussion, while foreign direct investments (FDI) and remittances are becoming more central. Some have argued that FDI has 'the potential to contribute to accelerating growth and progress towards reaching development goals in Africa' (Ndikumana and Verick, 2008).

Against this background, this paper focuses on recent patterns of both domestic and foreign investment (FDI)[1], with a focus on the renewable energy sector and its links with investments in water and land, and on sub-Saharan Africa. Foreign private capital flows surged in the early noughties until the 2008–2009 global economic crisis. Yet it is far from obvious that FDI had the expected impact on growth and development in many developing countries. A recent literature review (Reiter and Steensma, 2010) shows that empirical findings on the role of FDI in economic development remain mixed, while Wooster and Diebel (2010) find that 'evidence of intrasectorial spillovers from FDI in developing countries is weak, at best'. UNCTAD (2011) observes that the literature on crowding in (out) of domestic investments has had controversial results. The heterogeneity of evidence on the developmental impact of FDI is explained by a wide range of arguments: institutional and legal contexts, corruption and social capability, the degree of the competition or complementarities with local activities, the technological gap, the level of human capital and development of host economies, the development of financial markets and receptiveness to trade, as well as investment regulation and labour intensity in investment sectors.[2] On the one hand, FDI cannot match the rapid pace of development in many countries, particularly in SSA, and is often inappropriate due to the nature of the projects financed.[3] On the other hand, the impact of FDI on growth and employment depends crucially on the sector through which it is channelled. In terms of its impact on development, the type of FDI and its structural composition matter at least as much as its volume.

Bonassi et al. (2006), for instance, find that the developmental impact cannot be calculated at the aggregate level since the effects in different sectors are very different. If the impact of FDI in the primary sector is considered to be limited or even negative, further-reaching positive connections and spillovers are expected in the case of capital flow into the manufacturing sector.[4] A closely linked issue is that not only do the effects on growth differ (in terms of stimulus on domestic consumption, employment, etc.) but so do the externalities. For instance, some investments in water-intensive manufacturing industries can have positive growth effects in the short run but negative long-term impacts because of depletion of resources or pollution.[5]

[1] We maintain that an investment-friendly environment attracts both domestic and foreign private capital and that there are several synergies between private and public investment, since the latter could improve the environment (for instance by financing infrastructures etc) and could therefore increase private investments, initiating a virtuous circle.

[2] See for instance, Alguacil et al., 2011; Alfaro et al., 2004; Blomstrom et al., 1994; Balasubramanyam and Sapsford, 1996; Borensztein et al., 1998; Kemeny, 2010; Lim, 2001; Reiter and Steensma, 2010.

[3] In SSA the needs are often higher than elsewhere, due to a higher poverty and the distance from attaining the MDGs. Furthermore, domestic funds are lower and foreign capital is lacking and at best concentrated in minerals/fuels, so that its development impact tends to be low.

[4] See also UNCTAD, 2001; Aykut and Sayek, 2007; Chakraborty and Nunnenkamp, 2008; and Doythc and Uctum, 2011.

[5] There has been a debate on the so-called 'dirty industries', which tend to be highly water-intensive and polluting. When environmental laws become more restrictive in developed countries these are outsourced to developing

In summary, both the source (domestic or foreign) and the sector of destination (services, manufacturing – whether 'dirty' or not – raw materials and further disaggregation) are crucial to assessing the development impact of investments: capital can be an important and powerful engine for growth, but its effects depend largely on its nature, the sectors in which it is focused, and to what extent – if any – there is a substitution effect between foreign and domestic investments.[6]

Against this background, this paper addresses FDI and domestic investment trends and characteristics by analysing specific sectors of destination. We focus on investment in renewable energy and in land. In the companion paper, Massa (2011) examines the drivers and challenges of investment in water sector.

The paper is structured as follows. After a brief sketch of the general trends in domestic and foreign investment in SSA (Section 2), it discusses drivers of and barriers to investments in renewable energy (Section 3), trends in investments, with a focus on renewable energies and SSA (Section 4). It then discusses the energy-land-water nexus and the current wave of land investments in SSA (Section 5), and draws conclusions (Section 6). An Appendix describes more in detail the recent land deals in SSA.

countries (often in those with weak institutions). For instance, water is used intensively in textile production (for cleaning, bleaching, dyeing etc), where several labour-intensive phases of productions are outsourced; also food manufacturing, thermal power, integrated circuits and electronic components, pulp and paper industries are water-intensive and highly polluting and often delocalised in developing countries. See for instance, Grether and de Melo (2003).

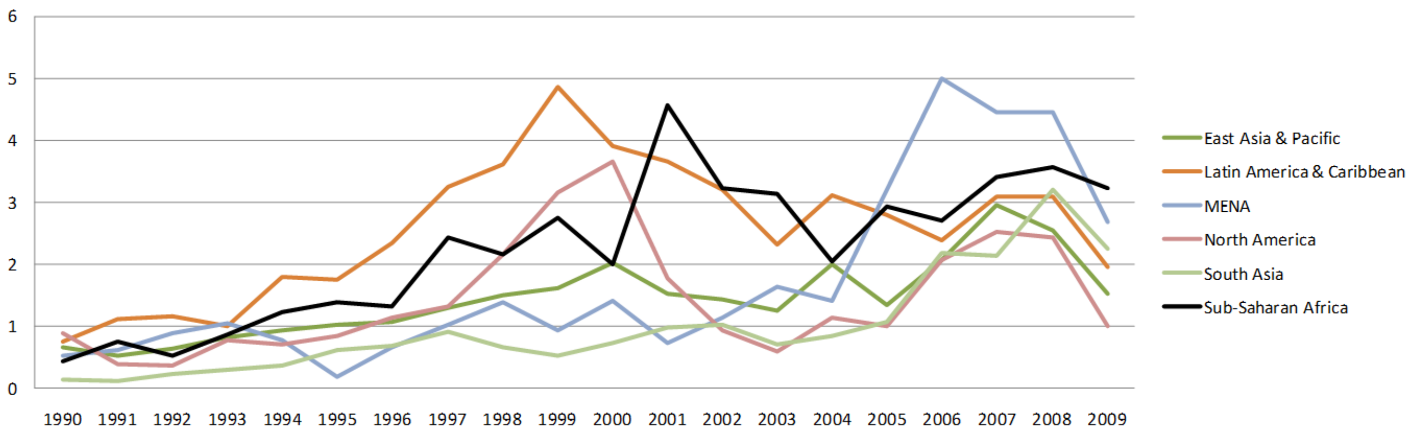
[6] Erengha (2011) estimates the dynamic links between FDI in ECOWAS and provides a detailed survey of both theoretical and empirical literature on relationships between these different flows. He highlights the importance of sector: in manufacturing crowding-in prevails, while in the primary sector it is crowding-out.

2 General trends and issues in (public, private and foreign) investment

The last decades have witnessed significant increase both in domestic capital and in the inflows of foreign direct investment to developing countries, where the gap between domestic savings and the desired level of investment has in many cases been filled by external resources, FDI being one of the most important. In the 1990s, FDI represented around 30% of total investments, rising to 50% by 2010: a substantial increase, despite a fall in 2009 in the aftermath of the economic and financial crisis and a limited recovery in 2010. Furthermore, in 2010, flows to developing and emerging countries for the first time 'absorbed more than half of FDI global flows' (OECD et al., 2011), a marked change from the past.

Figure 2.1 shows that the last 20 years are still characterised by differences in levels and patterns of FDI as a percentage of GDP across groups of developing countries.

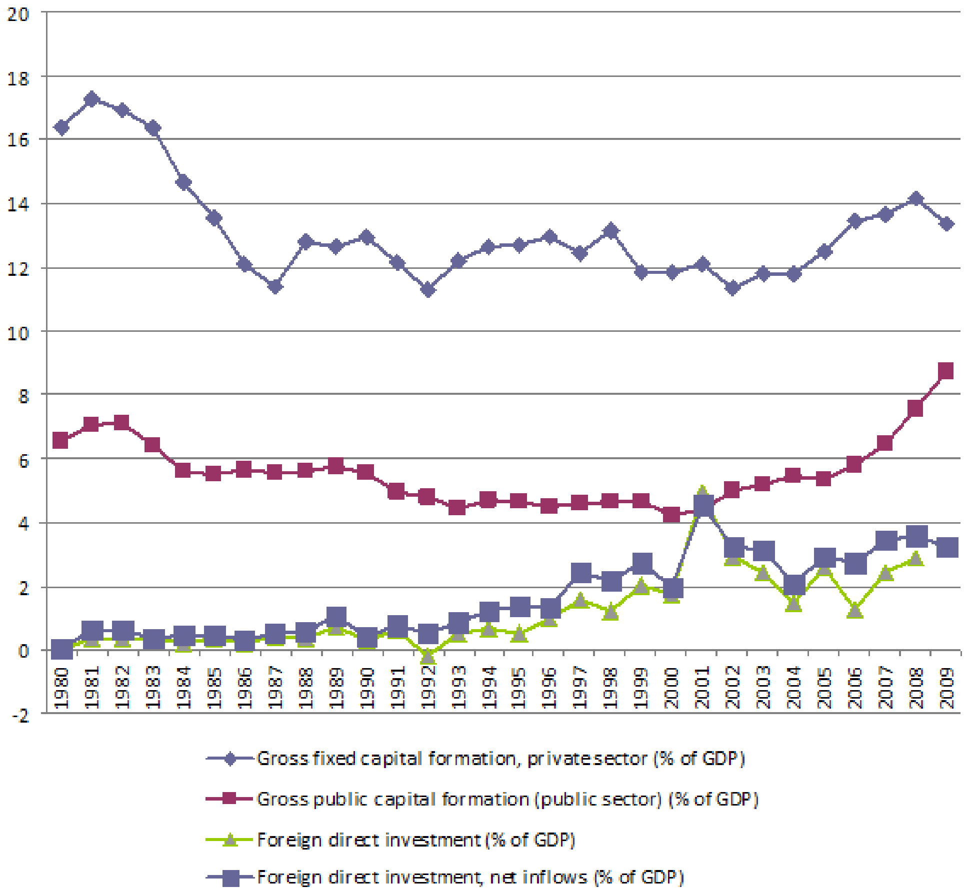
Figure 2.1 FDI to developing countries as % of GDP



Source: UNCTAD, 2011

Until 2000, middle-income countries (MICs) (especially in Latin America) benefited more from foreign flows, while low-income countries (LICs) in general and SSA countries in particular were left behind. This is explained by higher investment risk, low liberalisation and weak infrastructure. Since 2000, however, there has been a rapid increase of capital flows. According to the African Economic Outlook (2011), total investment to Africa increased almost fivefold from 2000 to reach US$126 billion in 2010. And, even more importantly, FDI increased while official development assistance (ODA) declined. Figure 2.2 below shows the evolution of domestic and foreign investments in SSA countries as well as the private versus public investments (at home). It shows that, between 1980 and 1995 private and public domestic capital fell while FDI was low but fairly stable. After 1995 average growth in FDI has been greater than domestic private flows. Public flows after a long period of stagnation (1980–2001) have recovered since 2005 (see also Ernst & Young, 2011).

Figure 2.2 Trends in FDI, private and public investment in SSA, 1980-2009



Source: African Development Indicators, accessed September 2011

Trends in domestic and foreign investment are closely connected. Ndikumana and Verick (2008), for example, find that in SSA the relationship runs both ways, but the impact of private domestic investment on FDI is stronger and more robust than the reverse relation. This suggests that strong private investment is likely to act as a signal and attract foreign capital. Given their close links, both domestic and foreign investment is likely to be driven by similar factors. Indeed, a widespread negative perception of SSA affected both domestic and foreign investments up to the early noughties (the lost decades). Things have recently changed (McKinsey, 2010; Ernst & Young, 2011; Radelet, 2010), as also shown by developments since 2005 (Figure 2.2).

FDI to some countries in SSA increased in absolute terms and as a share of GDP, fuelled by high commodity prices and improved macroeconomic stability and investment environment (World Bank Doing Business indicators, Ernst &Young, 2011). The increase was higher in Africa than in emerging economies in other continents (though the level is still lower, as pointed out by Ernst &Young, 2011).[7] This growth pattern continued until the start of the global economic crisis in 2008–2009, which reduced the total amount of funds and led to delays or cancellations of investment projects (Brambila-Macias and Massa, 2010; Allen and Giovannetti, 2011). In SSA the risks can be high, but so can profits, with competition in some sectors comparatively low.[8] According to Ernst & Young (2011) 'This investment window may not remain open for long, but it suggests that Africa actually appears to be relatively well positioned, with the only emerging region clearly ahead in terms of investor perceptions at this time being Asia' (p. 9). Over the last decade 'FDI's share of gross fixed capital formation in Africa has, at 20%, been

[7] Since 2005 Africa has attracted more FDI than ODA.

[8] Warnholz (2008) presents very interesting comparisons of profitability at macro and micro (firms) level, showing that investments in Africa (at least the countries of his sample) can be very profitable and that the main problem in exploiting the potential is the low level of human capital.

twice the global average and 8% above that of other developing countries' (African Economic Outlook, 2011: 44).

Despite the marked improvement of the last few years, there are still a number of elements deterring investments in African countries with respect to other developing countries: political risk and often inadequate human capital, macroeconomic instability, low productivity, exchange rate volatility and lack of infrastructure[9] (Asiedu, 2001; Razafimahefa and Hamori, 2005; Khadaroo and Seetanah, 2007; Ernst & Young, 2011). In highly unstable situations such as the current period of multiple crises, with uncertain environment and property rights, a significant obstacle to high-risk investment is that of contract enforceability and lack of commitment not to default. Recent research has also pointed to the importance of a sound legal framework and stable political environment to attract (foreign) capital, as well as to the influence of a country's history of default. A related issue concerns the lack of capacity to manage public resources, which can lead to substantial problems of corruption.[10] The existence of good institutions in general helps to attract – and keep – FDI (Naudé and Krugell, 2007). However, this view is sometimes challenged in relation to Africa: in some sectors (e.g. manufacturing) foreign investments 'crowd in' domestic investments and in others (e.g. primary sector) they 'crowd them out',[11] while some specific investments, for instance those in land and 'dirty industries', are often outliers as they tend to be focused on countries with weak governance in order to avoid strict rules and laws. Furthermore, according to Egger and Winner (2005) in the presence of excess regulation, weak enforcement rules and government bureaucracy, corruption provides a *helping hand* to foreign investors rather than being a disruptive element).

Data on domestic and foreign capital flows at sectoral level are at best scattered. Given abundant natural resources in SSA it is not surprising that extractive industries are a major area for foreign investment. Recently, however, many investors have started to diversify, investing in tourism, consumer products, construction, telecommunications, financial sectors, land and renewable energies (Ernst & Young, 2011:31; McKinsey, 2010; UNCTAD, 2011).

In the following section, we analyse trends in and drivers of investment in different areas of renewable energy in order to assess how far the global energy market is evolving towards a green and equitable energy system. We focus on trends in renewable energy investment in SSA, with particular reference to biofuel investment. Sub-Saharan Africa is characterised by high rates of energy poverty, a large gap in energy financing, and water scarcity, and is attracting large-scale land investments for biofuel projects. This review will shed some light on the interrelationships between energy, land and water, a nexus that is receiving growing attention (e.g. Bazilian et al., in press) together with a greater awareness of increasing scarcity of natural resources.

[9] Adequate public infrastructure (for instance through public investment) reduces the costs of doing business and increases the marginal return to investment.

[10] One solution is a mechanism that creates external controls on revenue-generating entities.

[11] Erengha (2011) claims that this is related to the different elasticity of the demand for export in different sectors. There is a need for further analysis at more disaggregated level to examine these issues.

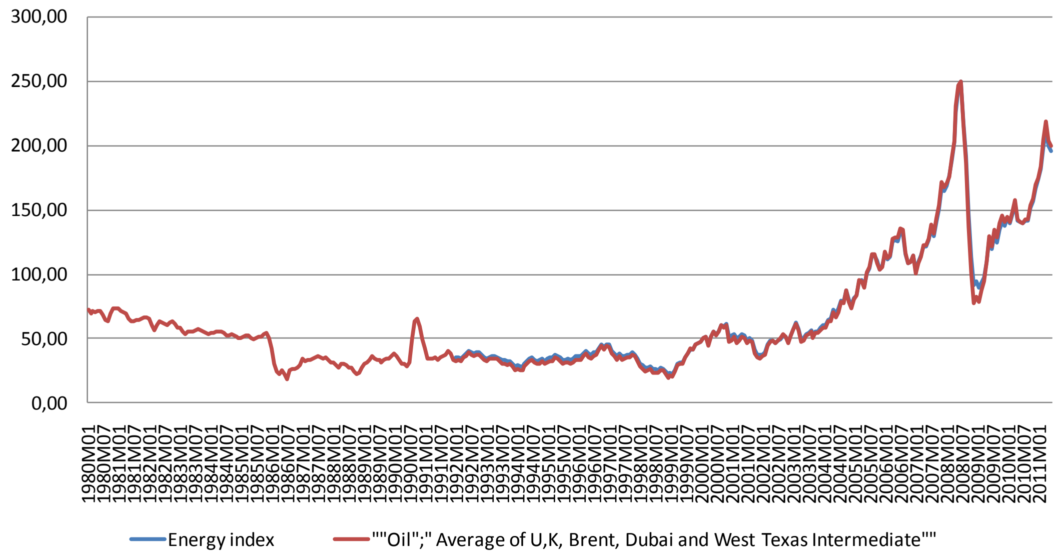
3 Drivers of investment in renewable energy

Recent oil-price fluctuations around a general upward trend have revealed the growing vulnerability and limits of a global energy system that relies on non-renewable resources. In particular, the current energy system has largely failed to meet energy needs of the poor while also compromising the ability of future generations to satisfy their needs. The large-scale deployment of renewable energy could be a valuable opportunity to break out of this unfair and unsustainable pattern. Global investment in renewable energy grew from US$33 billion in 2004 to US$211 billion in 2010 (UNEP and BNEF, 2011). Yet, after years of international policy commitments to deploy low-carbon technologies, renewable energy sources accounted for only 16% of global final energy consumption in 2009. If we exclude traditional biomass and hydropower, the other renewables (solar, modern biomass, wind, geothermal, and biofuels) accounted for only 3% of world final energy consumption (REN21, 2011). In 2010, total investment in renewable energies, including hydroelectric power, reached US$233 billion, of which US$187 billion financed generation, approaching investment in fossil-fuel power plant, which was estimated at US$219 billion. However, if investment in energy also includes coal, gas and other upstream investment costs the estimate rises to US$1.2 trillion in 2010 (UNEP and BNEF, 2011). Thus, at global level, the renewable energy sector is growing fast but from a very small base. A series of factors have contributed to this pattern.

3.1 Factors which boost investment in renewable energy

The role of fossil fuels 'scarcity': One factor that is fostering renewable technologies investment is the recent trends and future projections of the high and growing price of fossil fuels. Until the 1990s and early 2000s, the global economy was characterised by a polarisation between a narrow elite of countries in the 'North' that import commodities and energy from the 'South', which supplied these goods in a context of resource abundance and high price elasticity. Development in the North has been characterised by unsustainably high energy intensity. The emergence of a group of new industrialised small countries did not alter this equilibrium and supply continued to accommodate increased demand, which contained the effect on prices – with the exception of the 1970s energy crises, which were caused mainly by geo-political factors. This situation is changing. The New Industrialised Countries (mainly China and India) are real giants with huge populations. Moreover, starting from weaker environmental regulations and technological development, their production tends to be highly energy-intensive. As a result, their economic boom has brought a rapid increase in demand for energy and primary commodities, leading to rising oil prices (Figure 3.1).

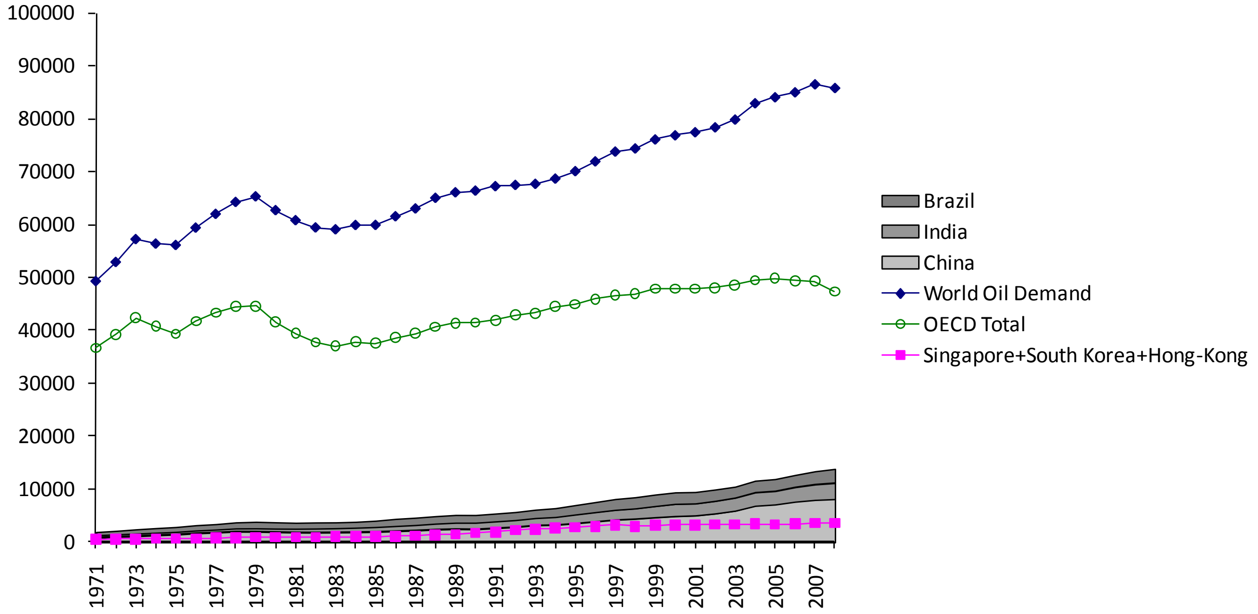
Figure 3.1 Energy and oil price index (base year 2005)



Source: IMF

This pattern is reflected in global trends of energy use and demand. Between 1993 and 2008, world demand for oil grew by 27% compared to a rise of 5% in the previous 15 years; the Asian Tigers' contribution to the global oil demand is quite modest in the entire period, while Brazil, India and China account for a significant and increasing share of the increased demand (Figure 3.2).

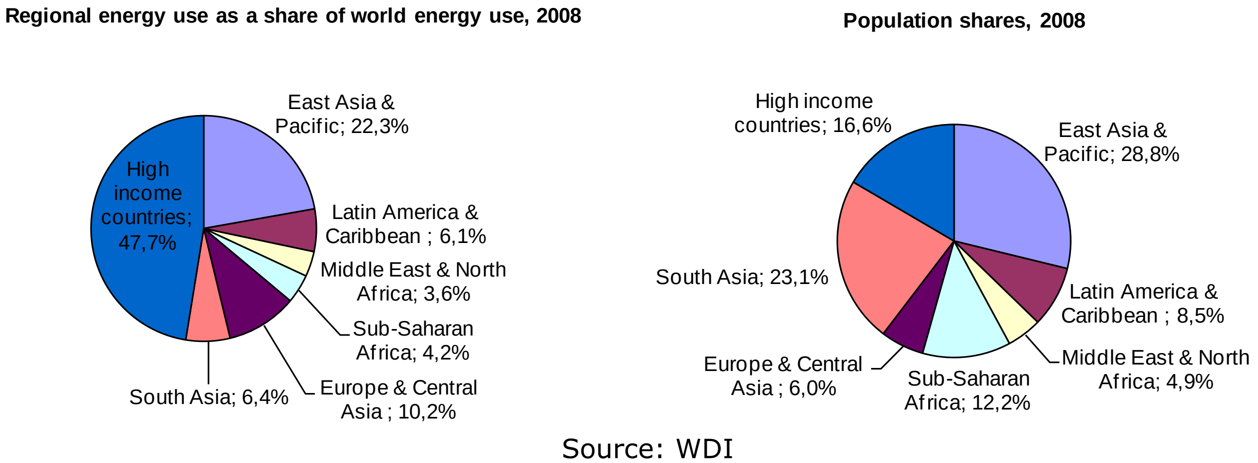
Figure 3.2 World oil demand (1000 barrels/day)



Source: International Energy Agency

Per-capita energy use in HICs has been always between four and ten times higher than in the rest of the world (WDI data): they represent less than 17% of the global population but account for almost 48% of global energy use (Figure 3.3).

Figure 3.3 Regional distribution of energy use and of population, 2008

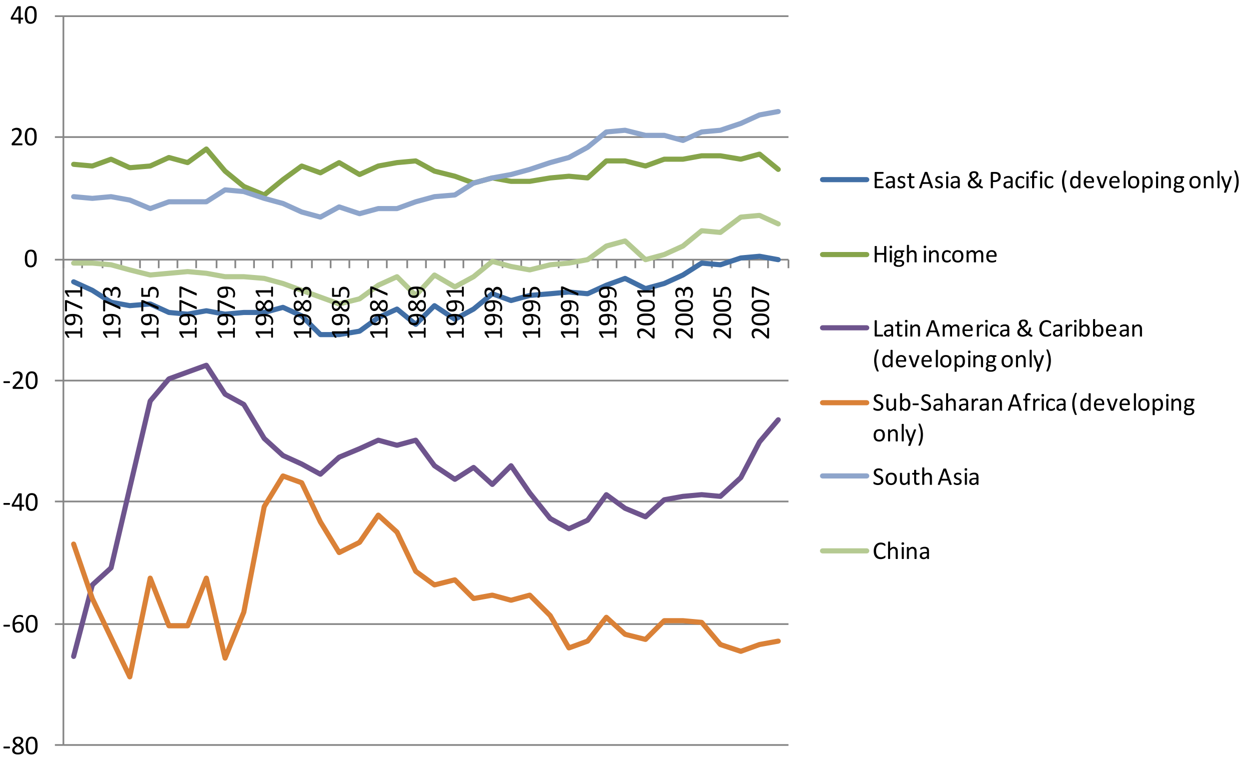


Source: WDI

Moreover, at regional level, HICs and South Asia (mainly driven by India) were until the mid-2000s the only net energy importers (Figure 3.4). With China's booming energy demand, whose share of global energy use rose from 11% in 2000 to almost 18% in 2008, the East Asia and Pacific region has been a net energy importer since 2006.

The growth in world energy demand is projected to reach more than 40% more than current levels by 2030 (OPEC, 2010). Even assuming cautious implementation of current government policy commitments, oil demand will rise constantly: in this scenario, energy demand is estimated to grow by 36% between 2008 and 2035 and fossil fuels will continue to represent over 50% (OECD/IEA, 2010).

Figure 3.4 Net energy imports (% of energy use)



Source: WDI

Other supply-side factors can push oil prices up. Public opinion and international NGOs exert growing pressure to consider environmental and social damage often associated with resources extraction. This greater awareness of externalities in the production of fossil fuels can make them more costly or create supply constraints. With the exception of Latin America, in non-OPEC countries, for instance, the supply of oil crude and natural gas liquids (NGLs) is forecasted to flatten or decline and in OECD countries especially, increasing costs and stricter regulations are regarded as possible factors that will contribute to a decline in crude oil production (OPEC, 2010). In sum, although reserves of fossil fuels are not yet scarce they are no longer available at such low cost. According to the International Energy Agency (OECD/IEA, 2010), because supply and demand are becoming less sensitive to oil prices this will lead to price rises. Indeed, in the last few years, the correlation between price commodities and world economic growth rate has increased and, as noted by Lopez (2011), for the first time in history, the recent oil-price shock was linked to a spike in demand rather than to political factors or other exogenous factors.

Energy security: governments' reluctance to depend on the Middle East and on oil-producing countries facing political turmoil has contributed to the development of renewable energy. Renewable energy sources are better distributed across regions than fossil fuels, which tend to be highly concentrated. Moreover, the production of renewable energy has spread worldwide, especially in Europe and Asia. This geographical expansion increases the trust that renewable energy markets are less vulnerable to political instability and the policy options of specific countries (REN21, 2011).

Declining costs and competitiveness gains of several renewable energy technologies: production and distribution costs may constrain the competitiveness and economic viability of renewable energies. Indeed, the IPCC (2011) estimates that the average lifetime costs of many renewable energy-generating systems are higher than current energy prices, although there are large variations across regions and sources of energy. However, the reduced cost of solar PV, wind turbines and biofuel processing has contributed to the growth of the renewable sector (REN21, 2011) to the extent that some applications are becoming economically viable. BNEF analyses show that prices of solar modules, for instance, have more than halved since 2008 and that small solar projects are more competitive, especially in sunny places (such as

Italy and Turkey) where prices have gone down to US$22 cents/kwh (BNEF, 2011). A World Bank study (Kulichenko and Wirth, 2011) estimates that the costs of several components for concentrating solar thermal power will decrease by between 15% and 30% by 2020. Learning by doing and economies of scale are expected to further reduce costs as the technology spreads. Some promising signals on competitiveness also come from developing countries. In a study on Ethiopia, Ghana and Kenya, Deichmann et al. (2011) find that in several rural areas, although decentralised renewable power has a higher unit production cost than fossil electricity, it is competitive compared to centralised power provision, usually based on fossil fuels, once the cost of extending transmission and distribution are taken into account. Nouni et al. (2008) found similar results in areas of rural India.

International efforts to combat climate change: the IPCC estimates that fossil fuels contribute to more than half of anthropogenic greenhouse gas (GhG) concentrations that are the main cause of the global warming. The extensive deployment of renewable energies is one of the main options to mitigate GhG emissions. Existing evidence shows that, in general, renewable energy technologies produce significantly lower lifecycle GhG emissions than those generated by non-renewable resources, although the GhG balance for bioenergy generation critically depends on land-use management and indirect effects in terrestrial carbon stocks (IPCC, 2011).

It is estimated (OECD/IEA 2010) that, in order to meet the goal agreed at the 2009 UN Climate Change Conference in Copenhagen to limit the global temperature increase to 2°C, over 60% of the contribution to reducing global warming between 2010 and 2035 should come from renewable plants improvements, even when greater energy efficiency is included. The international agenda against climate change, therefore, is pushing for a large-scale deployment of renewable energy technologies.

MDG agenda*:* increasing awareness that the attainment of the MDGs depends on the development of renewable energy is another factor behind investment in this sector, since it can contribute to enhancing access to reliable and affordable energy in poor countries and for poor populations. Reducing energy poverty is critical to the MDGs since energy is behind all human activities. Several studies and institutions have underlined the link between each MDG and access to modern energy sources, renewable or non-renewable (Modi et al., 2005; GNESD 2007; Bazilian et al., 2010; OECD/IEA, 2010). Renewable energy, however, presents several advantages. Many applications are devised to produce decentralised electricity and energy and several renewable energy sources, such as wind, solar irradiance, crop residues and animal wastes are often widespread in rural areas. This means that they could be harnessed to provide energy to rural areas, which are usually the poorest and the most excluded from energy access since the cost of grid connection and fuel transport seriously impede access and investment. Some renewable energy applications (such as solar energy for water heating, bioenergy for transport, heating, cooking and lighting) can also serve informal settlements in peri-urban areas where many households are not served by the electricity grid. Finally, in non-oil-producing countries the development of renewable energy can reduce dependence on imports of oil, coal and natural gas (see Table 3.1).

Table 3.1 The role of investment in modern renewable energy for achieving the MDGs

MDGs	*Investment in modern renewable energy*
MDG 1: Eradicate extreme poverty	• Access to modern, affordable and sustainable energy and electricity sources can enhance household incomes by increasing production and work hours, labour productivity, educational attainment and health conditions and by reducing the burden of time-consuming domestic labour. • Energy access enhances returns to labour and productive assets as well as labour and business opportunities since energy services such as lighting, heating, cooking, locomotion, mechanical power, transport and telecommunications are essential for economic activities and socioeconomic development. • Providing more energy for agriculture, irrigation and transport will increase food production and food security, thus helping alleviate world hunger.
MDG 2 and 3: Achieve universal primary education and promote gender equality and empower women	• Access to energy can reduce child labour by increasing adults' productivity. • Access to energy reduces time-consuming domestic work needed to collect traditional fuels, fetch water, prepare food or perform other labour-intensive chores. This may enable children to attend school and to study at home. Women can be more productive and also have more opportunities to participate in social and community life, which may contribute to their economic and social empowerment. • Street lighting improves safety, facilitating children's school attendance and women's participation in community activities. • Electricity facilitates access to telecommunication services.
MDG 4, 5 and 6: Reduce child mortality; improve maternal health; combat HIV/AIDS, malaria and other diseases	• Substitution of cooking, heating and lighting systems based on traditional biomass with modern appliances reduces indoor air pollution, which causes respiratory diseases, and facilitates the use of boiled water, which reduces the risk of waterborne diseases, a major cause of child mortality. • Pumping and treating water, which requires energy, contributes to a clean water supply. • Having electricity enables health facilities to stay open longer, maintain a cold chain, and improve their general functioning. Transport and communication facilitate access to healthcare and emergency medical services and information campaigns to combat preventable diseases.
MDG 7: Ensure environmental sustainability	• Most modern renewable energy sources produce fewer GhG emissions and are less polluting, and make less intensive use of water and natural resources than non-renewable and traditional biomass energy. Thus, their large-scale development can contribute to global and local environmental sustainability.

Source: Adapted from UN Energy (2005) and OECD/IEA (2010)

All these factors create market incentives for investment in the renewable energy sector and encourage governments to introduce enabling policies such as incentives, subsidies and targets. Between 2005 and 2011, the number of countries adopting targets or policy measures to favour renewable energies rose from 55 to 119, over half of which are developing countries (REN21, 2011). Policy support seems to be one of the main drivers of investments in renewable energy in view of the large range of market policy, institutional and information barriers the sector faces. It is widely recognised that without government support the renewable energy industry cannot take off and that governments have played a crucial role in fostering the development and deployment of renewable energy technologies.

3.2 Barriers to investment in renewable energy

Recent studies suggest that a complete transition to a renewable energy system is economically and technically feasible. Jacobson and Delucchi (2011) simulated an energy system that could meet the world's energy needs from wind, water, and sunlight. They find that energy costs might be similar as today's, and that the development of such a system is unlikely to be constrained by the availability of raw materials such as steel, platinum or lithium. Fthenakis et al. (2009) find that solar energy alone has the technical, geographical, and economic potential to provide more than one third of US energy needs by 2050. Despite these encouraging findings, several barriers still hinder the large-scale development of renewable energy, especially in the poorest countries.

Unfavourable relative prices: subsidies to conventional energy, cheap gas and exclusion of externalities*:* Fiscal support for fossil fuels, such as fuel subsidies, exploration concession waivers, investment tax holidays, export guarantees and soft loans, still obtain in many countries, especially but not exclusively in oil-rich nations. In non-OECD countries, governments use subsidies on the consumption and production of fuel to enhance access to energy, reduce dependence on traditional biomass energy and sustain economic growth and employment. Consumption subsidies are rare in OECD countries, but production subsidies are quite widespread – although in 2009, G-20 leaders committed themselves to phasing out and rationalising fossil-fuel subsidies. These financing mechanisms work against investment in renewable energy since they undermine their competitiveness and discourage the transition to clean energy production. To illustrate their importance, the IEA estimates that in 2009 government subsidies for fossil-fuel final consumption and electric power generation amounted to US$312 billion globally[12] compared to only US$57 billion in total government support for electricity from renewables and for biofuels. Interestingly, the average annual investment required to achieve universal access to modern forms of energy by 2030, estimated at US$36 billion, would be less than 8% of 2009 global consumption subsidies for fossil fuels (OECD/IEA 2010).

Natural gas represents an important challenge to renewable energy. According to UNEP and BNEF (2011), low prices of natural gas have undermined renewable energy projects especially in the wind and solar sectors. If such competition grows, given that increased demand, abundant recoverable resources, and increasing international trade in natural gas make its prospects very promising (OECD/IEA 2011).

The pricing of different energy sources exludes both externalities of energy production and uses and their potential contribution to reducing GhG emissions or other adverse social and environmental impacts. A study conducted in Senegal, for instance, shows, that in three remote rural regions, once environmental externalities are taken into account, the electricity from PV technologies costs less than energy from grid extension (Thiam, 2010).

Costs and financing barriers*:* as mentioned above, several renewables are not cost-competitive in current market conditions. The levelised cost of electricity for renewable energy sources, in many cases, has a higher range than that of traditional power sources (IPCC 2011).[13] Moreover, high up-front capital costs, immaturity of technologies, uncertainties

[12] Note that 37 countries account for 95% of global subsidies for consumption of fossil fuels.

[13] A recent World Bank study (Kulichenko and Wirth, 2011) finds that in several emerging economies (such as in India, Morocco, and South Africa) the levelised cost of electricity for concentrating solar thermal power are still too

regarding prices and regulatory frameworks, inadequate data and mapping of the technical potential of renewables, can increase the financial and premium risks of the projects, which heightens investors' perception of risk and hampers their access to financing.

Costs are decreasing, but most analysts and researchers agree that policy support is needed in order to make renewable energy more competitive and promote its large-scale development (IPCC, 2011; OECD/IEA, 2010, 2011; UNEP and MISI, 2009; Hamilton, 2010). Based on evidence from MENA countries, India and South Africa, Kulichenko and Wirth (2011), for instance, underscore several regulatory frameworks that could help in improving the economic and financial affordability of concentrating solar thermal power, such as properly designed feed-in tariff schemes, combined with auctioning mechanisms, Renewable Portfolio Standard schemes, concessional financing, sovereign guarantees for power purchase agreements for solar thermal power projects. Looking at a different aspect of renewable energy competitiveness and diffusion, namely innovation capacity, Johnstone et al. (2010) show that public policies, from public expenditures on R&D to feed-in-tariffs, and renewable energy certificates, had a positive influence on patent activity in OECD countries over the period 1978–2003.

Integration of renewable energy with the current energy system*:* This requires institutional and market changes as well as the adaptation and expansion of current infrastructure. Substantial efforts are required in order to create hybrid, flexible and integrated energy systems since distribution, variability, production scale and techniques greatly differ from those of dominant fossil-fuel energy systems. Integration into the current energy system, therefore, can represent a narrow bottleneck for the large-scale development of renewable energy. Available evidence based on stakeholder surveys in ASEAN countries show that grid-connection and infrastructure barriers are major concerns for investors in the renewable energy sector (Ölz and Beerepoot, 2010). Where conventional power grids are underdeveloped, as in most SSA countries, the challenges to create efficient and reliable energy networks with a high renewable energy penetration are even greater.

Low competition, monopoly or oligopoly market structure*:* In several countries, energy and power sectors are characterised by a monopolistic or oligopolistic structure. Foster and Briceño-Garmendia (2008) find that state-owned enterprises (SOEs) in SSA manage the largest share of public expenditure on infrastructure, the power sector included, and Nkwetta et al. (2010) observe that in many cases national energy supply is based on a monopoly. Ölz and Beerepoot (2010) underscore that in the ASEAN region the power sector is characterised by the dominance of state-owned or controlled utilities. In these contexts, independent power producers might face serious entry-market obstacles due to low competition, centralised infrastructure, institutional arrangements and prevailing standards, which are conceived for concentrated market structures.

Low awareness of benefits, information barriers, lack of human capital*:* In addition to the capacity to pay, consumers' and policy-makers' awareness of potential benefits, applications, technically and economically feasibility of renewable energy technologies are a key determinant of political commitment to their development as well as of demand for renewable energy.[14] These factors, in turn, can exert a negative influence on investors' decisions. At the same time, the shortage of trained technical personnel to operate and maintain the energy systems and inadequate expertise on the part of energy regulators can discourage demand and investments in the sector (Ölz and Beerepoot, 2010).

Social barriers*:* Popular opposition to the use or production of renewable energy can be another barrier to investment. Cooking habits, for instance, help to explain why in some cases the installed improved fuelwood stoves are not used (Bailis et al., 2009; Neudoerffer et al., 2001; Zuk et al., 2007). Concerns about the implications for biodiversity and the landscape can also undermine social acceptance of renewable energy plants, but the strongest resistance is likely to come from population groups claiming land and water rights. As discussed in the

---

high and projects at current investment costs have a rate of return that make it impossible to meet commercial infrastructure investment requirements.

[14] One of the key messages of 2011 Bloomberg New Energy Finance Summit, for instance, points out that decision-makers are insufficiently informed about the options, progress and benefits of renewable energy (BNEF, 2011).

section on land and biofuel investment, the expansion of the area under biofuel cultivation can reduce or hamper local uses of land and water. While they are not the focus of this paper, large hydropower plants and dams can also have devastating effects on downstream communities and in causing population displacement.[15]

[15] The Report of World Commission on Dams (2000) is clear in this sense. One of its main findings is that, despite the significant contribution of dams to human development, '[i]n too many cases an unacceptable and often unnecessary price has been paid to secure those benefits, especially in social and environmental terms, by people displaced, by communities downstream, by taxpayers and by the natural environment' (p. xxviii).

4 Global and regional trends in renewable energy investment

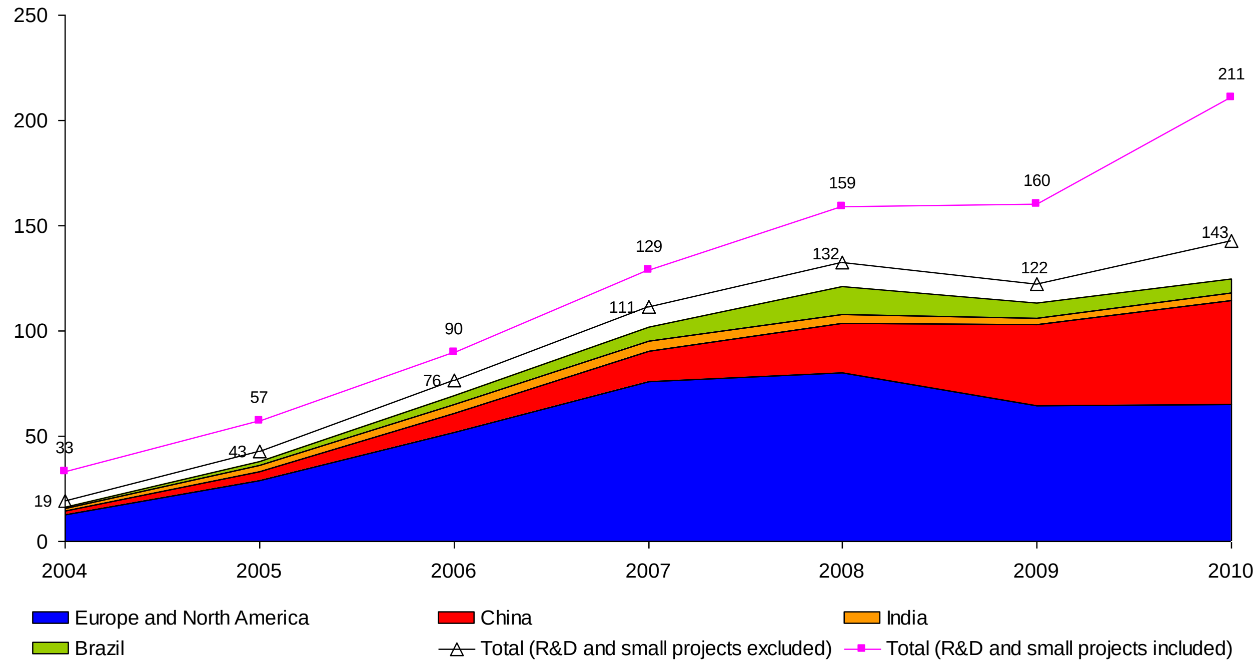
The key role of policy measures, specific institutional arrangements, coordination and integration between different energy sources and existing energy networks, and access to capital and information is mirrored by the trends and spatial distribution of renewable energy investment. High-income countries and some emerging economies, which enjoy greater policy support, purchasing power and investment capacity, lead the sector, while poorer areas are still at the margins of this growing market.

4.1 Total investments[16]

As mentioned above, the renewable energy sector is experiencing rapid growth: between 2004 and 2010, global investment rose at a compound annual growth rate of 36% (UNEP and BNEF, 2011). Overall, the impact of financial crisis was relatively contained, albeit with some variations across regions, technologies and types of investment.

The total investment in renewable energy companies and utility-scale (medium and large) generation and biofuel projects (Figure 4.1) rebounded in 2010 after a downturn in 2009, which was mainly due to a 18% decline in investment in Europe and USA as a result of the financial and economic crisis. However, the global trend in total renewable energy investment was constantly positive thanks to an increase in government expenditure in R&D, rapid expansion of small projects in some HICs[17] and, above all, China's performance, which more than doubled financial investment in renewable energy between 2008 and 2010, from US$23.9 billion to US$48.9 billion.

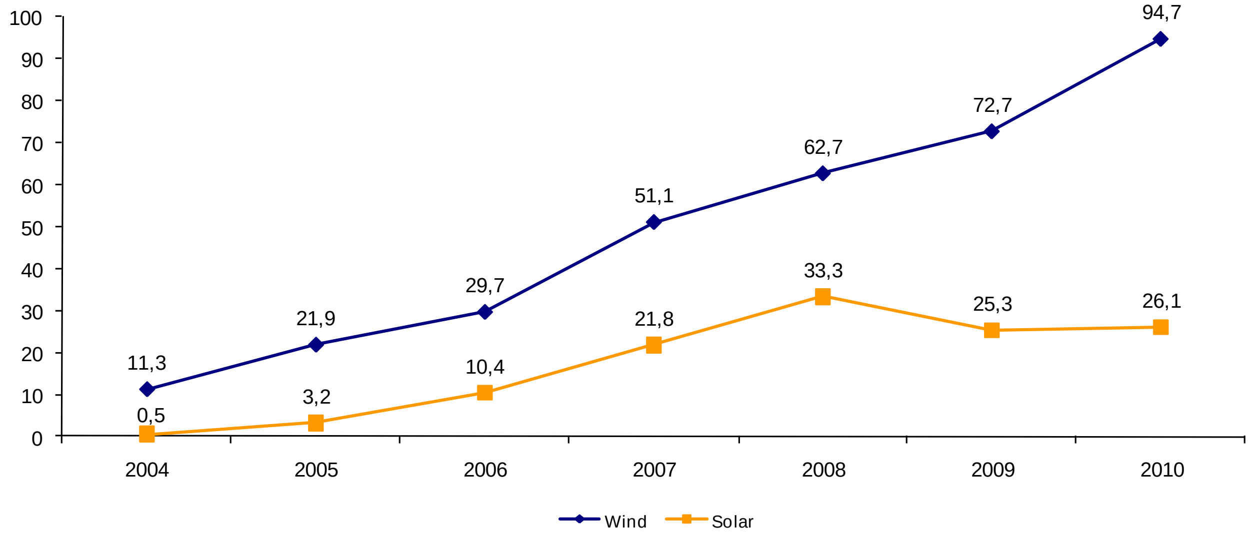
Figure 4.1 Global trends in total financial investment in renewable energy (US$ billion)



[16] Figures in this section are drawn from the Bloomberg New Energy Finance's (BNEF) data reported in Global Trends in Renewable Energy Investment 2011 (UNEP and BNEF, 2011) unless otherwise specified. Renewable energy projects include all biomass, geothermal, and wind-generation projects of more than 1 MW, all hydro projects of between 0.5 and 50 MW, all solar power projects of more than 0.3 MW, all ocean energy projects, and all biofuel projects with a capacity of 1 million litres or more per year. BNEF defines utility-scale solar parks as greater than 500 kW in capacity.
[17] Notably Germany, Italy and the USA.

Investment trends in the renewable energy sector investment also vary across technologies (Figure 4.2.a-b). Biofuel investment rose to US$20 billion in 2006–2008, in conjunction with the oil price shock, but has since reverted to the 2005 level (around US$6 billion) with the persistence of the global economic crisis. Investment in biomass and waste-to-energy sectors was less affected by the economic crisis as it steadily increased over the 2004–2010 period. Investment in small-hydro, geothermal and marine energy presents a stable trend fluctuating around much lower levels (US$4 billion, US$1.4 billion and US$0.2 billion, respectively). The dominant sectors in investment trends are wind and solar energy. The global economic downturn did not affect total investment in wind energy, which benefited from mega-projects in China and rose from US$12 billion to US$94 billion between 2004 and 2011, accounting for 53% of all investment in renewables over the period (Figure 4.3). Starting from a very low base (US$0.4 billion in 2004), solar energy saw investment peaking at US$33 billion in 2008. Despite a 24% slowdown in 2009, it still attracted about 20% of all investment in renewable energy over the period, the second highest by sector.

Figure 4.2 a-b Financial new investment in renewable energy by technology (US$ billion)



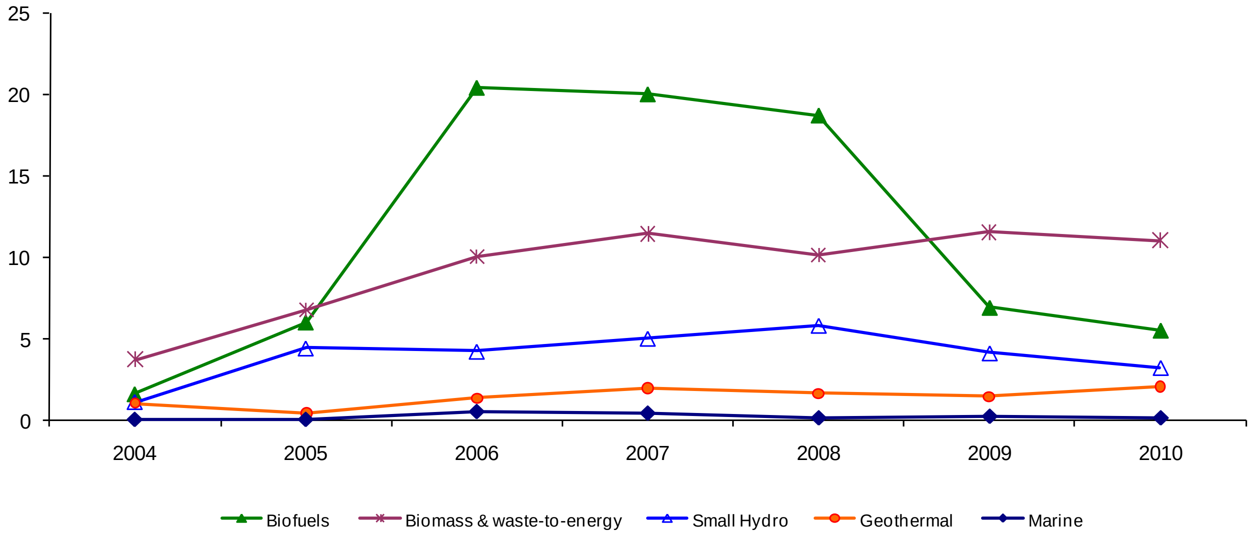
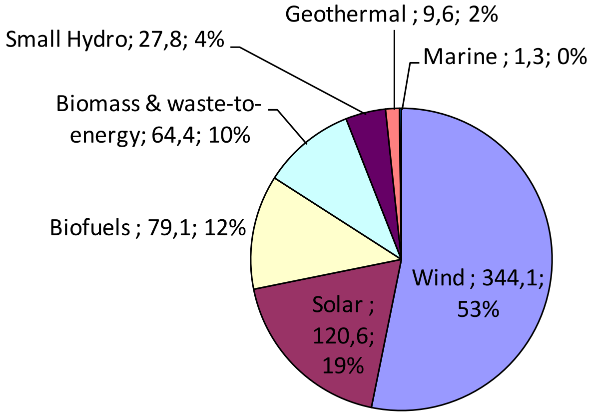
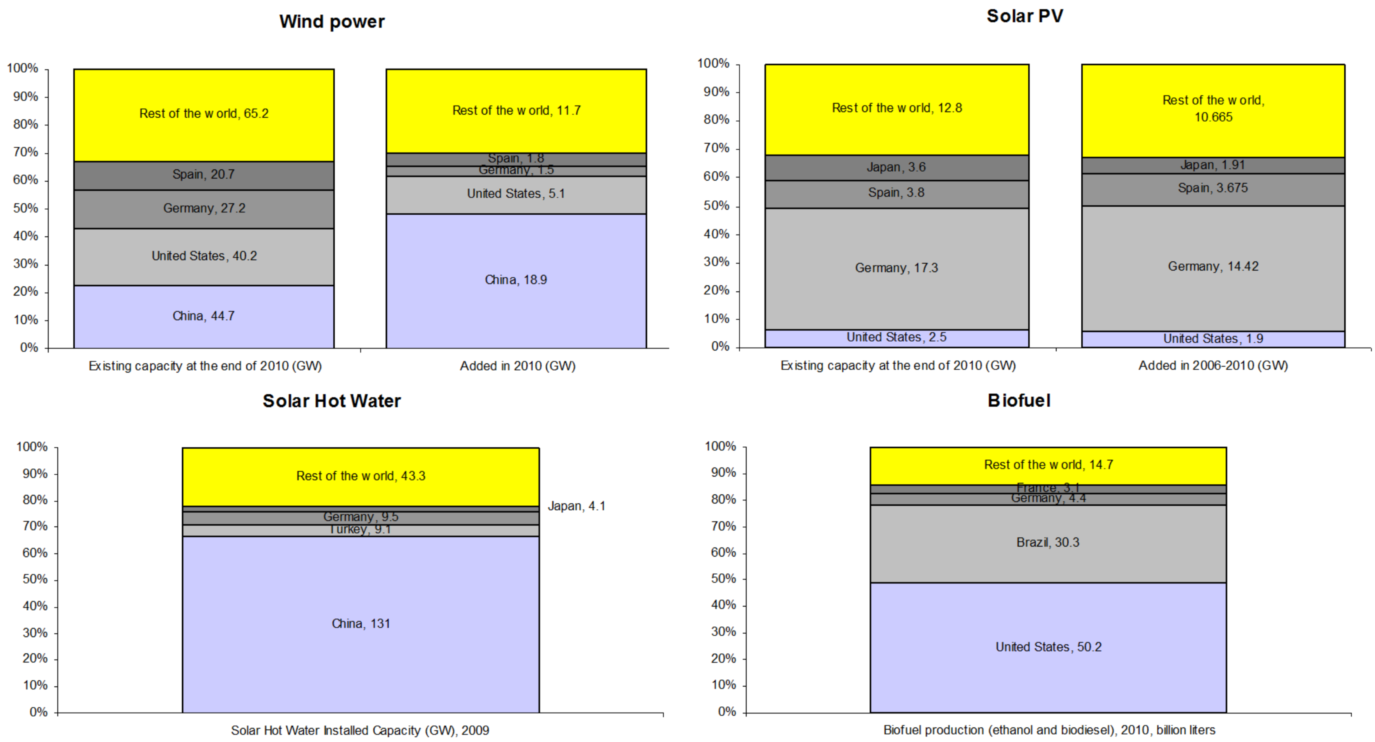


Figure 4.3 Global financial new investment in 2004-2010 by technology (US$ billion and % shares)



The renewable energy sector is also characterised by a pronounced geographical concentration. In 2010, four countries accounted for about 70% of existing and added capacity in wind power and PV solar markets, while four countries covered more than 75% of global biofuel production and solar water heating installed capacity (Figure 4.4). China leads the wind and solar hot-water sectors, the USA accounts for 20% of total wind capacity and it is the top producer of biofuels, followed by Brazil. Germany is one of the top markets in solar PV and wind power capacity and investment. Given that the technical potential and supply of renewable energies tend to be more evenly distributed than fossil fuels, such a spatial concentration of renewable energy production and investment indicate that institutional, policy and economic factors hinder the expansion of this sector.

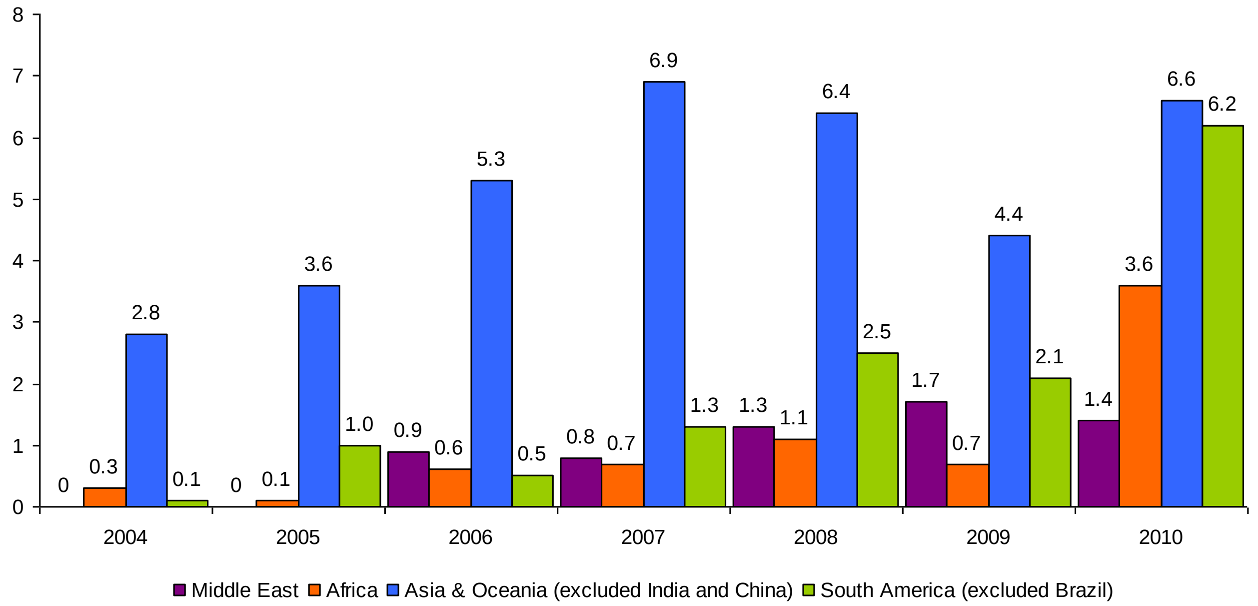
Figure 4.4 a-b-c-d Investment in renewable energy by technology by top four countries and Rest of World (RoW)



Source: REN21, 2011. Data cover all biomass and wind-generation projects of more than 1MW, all solar projects of more than 0.3MW, and all biofuel projects with a capacity of 1 million litres or more per year.

Trends in renewable energy investment exhibit the same spatial concentration. As shown in Figure 4.5, Europe, North America and the largest emerging economies (Brazil, China and India) attract the bulk of global investment in renewables. In 2010, all other countries combined accounted for about 12% of total new investment, although they saw a growing interest in the renewable energy sector. In South America (Brazil excluded), investment increased from US$0.1 billion in 2004 to US$2.1 billion in 2009 before jumping to US$6.2 billion in 2010. Africa and the Middle East also experienced a strong acceleration of renewable energy investment in the last years, but from a far lower base.

Figure 4.5 Trends in total financial investment in renewable energy in selected areas (US$ billion)



4.2 FDI in renewable and alternative energy sector

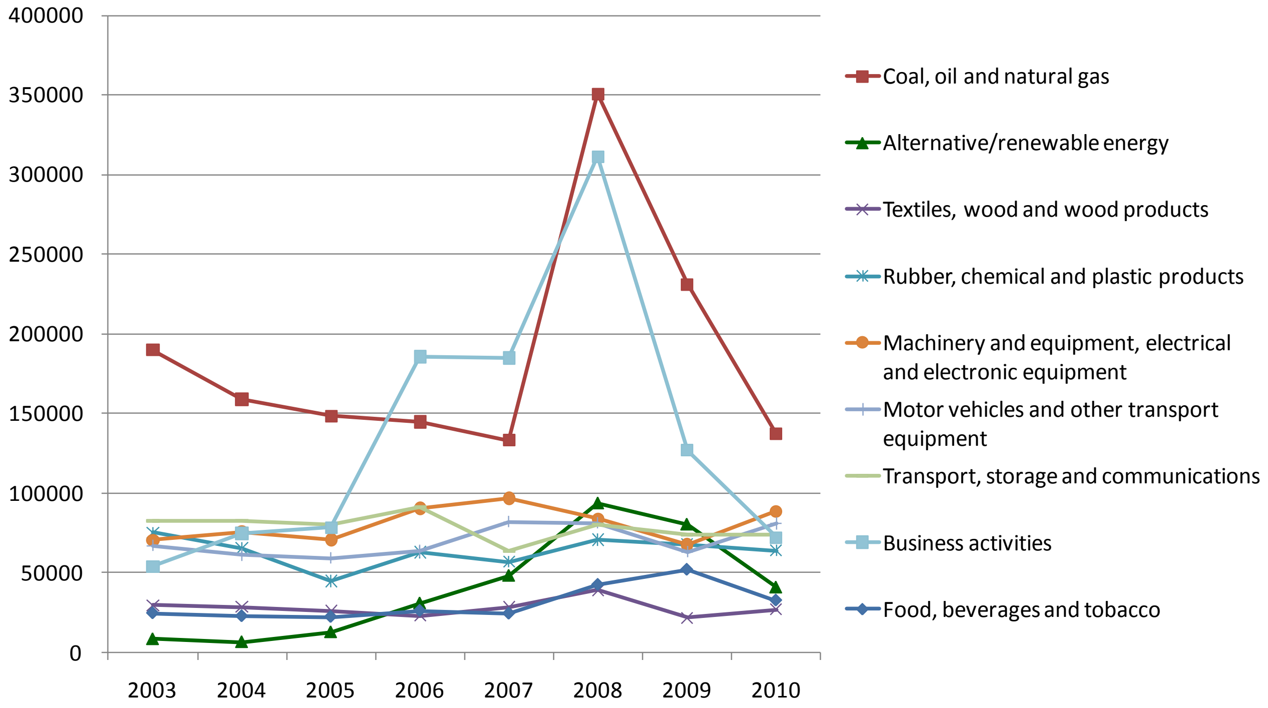
It is not easy to analyse the role of FDI in the renewable energy sector since data disaggregated by country and sector are not always collected systematically or are not fully comparable with information on total energy investment flows. We try to delineate trends in FDI in renewable energy using the fDi Markets database of the Financial Times Ltd, one of the most widely used databases on greenfield investment projects. Figure 4.6 reports the estimated global value of greenfield FDI projects in alternative and renewable energy compared to other sectors, by sector from 2003 to 2010, while Figure 4.7 shows the number of FDI projects in renewable and non-renewable energy sector over the same period.

According to fDi Markets data, the total value of greenfield FDI projects in alternative and renewable energy over the 2004–2010 period is estimated at US$312 billion, while Bloomberg New Energy Finance's (BNEF) data recorded US$430 billion of asset financing[18] of utility-scale renewable energy projects in the same period. Thus, FDI seems to play an important role in financing new projects, but the evidence does not permit any further conclusions to be drawn about the contribution of foreign capital to renewable energy investment because of the difference in coverage between the two data sources.[19]

[18] Asset financing is defined as all money invested in renewable energy generation projects, whether from internal company balance sheets, from debt finance, or from equity finance.

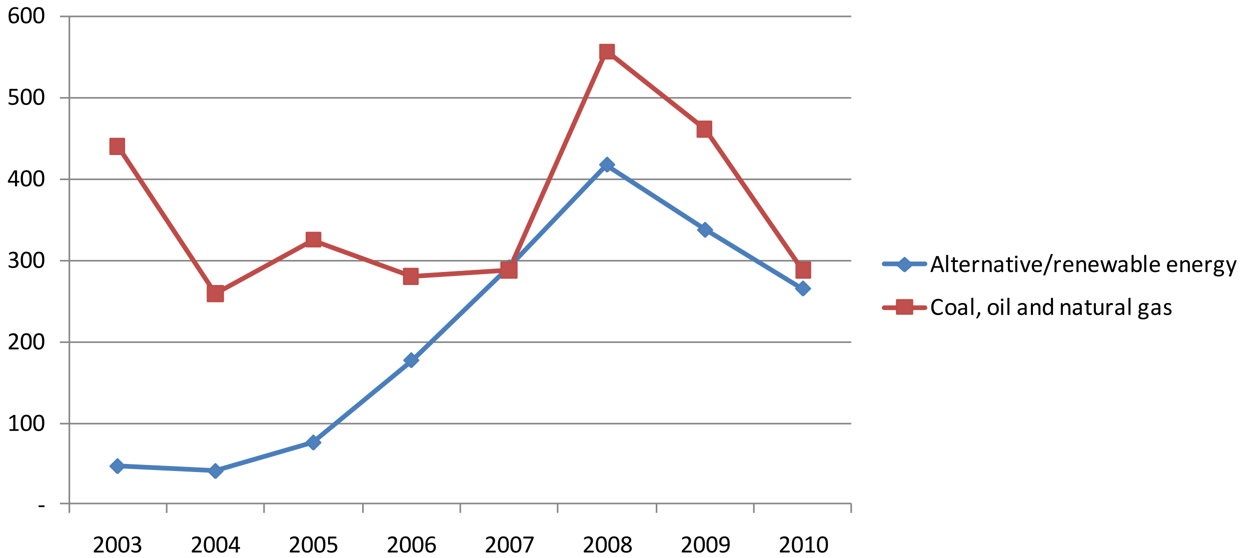
[19] For instance, the fDi Markets database, unlike the Bloomberg New Energy Finance's (BNEF) database, includes only greenfield projects and does not specify upper limit of project scale, covering also large hydropower plants.

Figure 4.6 Value of greenfield FDI projects in energy sector 2003-2010 (US$ million)



Source: UNCTAD (2011) based on Financial Times Ltd, fDi Markets. Data refer to estimated capital investment.

Figure 4.7 Number of greenfield FDI projects in energy sector, 2003-2010



Source: UNCTAD (2011) based on information from the Financial Times Ltd, fDi Markets. Note: Data refer to estimated capital investment.

The estimated value of greenfield FDI projects in renewable energy surged from US$8.2 in 2003 to more than US$93 billion in 2008. In this period, renewable energy was one of the fastest-growing sectors in terms of greenfield FDI projects, together with business activities, non-renewable energy and, to a lesser extent, food, beverages and tobacco. Starting from very low levels, in 2008–2009 renewable energy greenfield FDI reached values that were similar to those of other important sectors, such as machinery and electronic equipment, but also transport equipment and transport, storage and communications.

Compared to FDI in non-renewable energy, renewables still lag behind, but the gap is narrowing: while FDI in coal, oil and natural gas were about 23 times higher than FDI in renewable energy in 2003, the gap has now decreased to about 3 times and the recovery is even more marked in terms of number of projects.

Unlike total renewable energy investments, which have been fairly resilient during the current economic crisis, greenfield FDI projects were heavily hit and saw a drop both in 2009 (-14%) and 2010 (-49%) when their estimated value declined to US$40.7 billion. The number of projects followed the same trend: almost doubling in 2008 and then returning to pre-boom levels.

5 Energy poverty and energy investment in sub-Saharan Africa

Sub-Saharan Africa is one of the world's most energy-poor regions, despite its technical potential. The continent has almost 10% of the world's oil reserves (UNECA, 2011). Some countries have been important oil producers (notably Angola and Nigeria) for many years and, recently, the petroleum industry is showing increased interest in oil reserves in West Africa. Côte d'Ivoire, Liberia and Sierra Leone, for instance, are already hosting intense oil exploration. In Ghana, there was an important discovery in 2007. Analysts believe that this region might represent a new frontier for non-OPEC oil production, although political and economic risks and the unfavourable investment climate make difficult to predict when investment and production will really take off (EIA, 2010). But Africa's real energy wealth is its solar, wind, water and bioenergy resources. According to REN21 data, Africa and the Middle East have about 57% and 8% of the world's potential solar and wind power respectively (Ecofys NL – REN21, 2008). Africa has also a large hydropower capability that is less exploited than in other regions: the continent accounts for 11% of exploitable capability but it hosts 3% of world current installed hydropower capacity (World Energy Council, 2010a).

Despite this potential energy wealth, the quality and quantity of energy supply in most of SSA is very poor. About 80% of the population relies on traditional biomass fuel for cooking, the largest share in the world (OECD/IEA 2010). Moreover, 585 million people (69% of the population) lack access to electricity, representing more than 40% of the 1.4 billion people worldwide who live without electricity. Energy access is particularly problematic in rural areas where 80% of those lacking any electricity supply live. Finally, all SSA countries, with the exception of South Africa, are in the bottom half of the Energy Development Index ranking, an aggregate indicator which takes into account per-capita electricity and energy consumption, modern fuels use and access to electricity (OECD/IEA 2010).

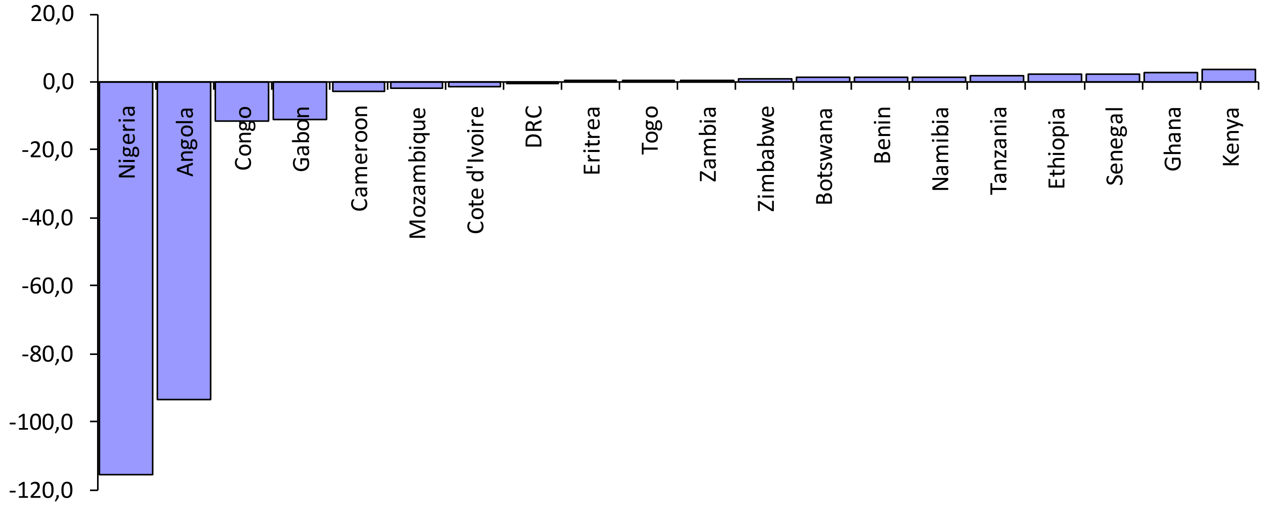
Sub-Saharan Africa's energy sector faces multiple challenges: low generation capacity, high costs, unreliable and underdeveloped energy infrastructure and a large financing gap (AfDB, 2010). Electricity networks are often weak and unstable, affected by high power losses and failures, and are usually made up of non-interconnected systems (Nkwetta et al., 2010). The resulting frequent power cuts affect agricultural and manufacturing productivity. Hidden costs due to under-pricing, under-collection and unaccounted losses in the power sector are also widespread. Briceño-Garmendia et al. (2008) observe that inefficiency improvements could considerably enhance government revenues, as they estimate that average annual hidden costs amount to 0.8% of Africa's GDP.

Finally, low energy consumption is combined with particularly constrained systems of energy production and distribution. This weakness further hampers energy security and aggravates exposure to international market fluctuations. Indeed, most SSA countries are net energy importers[20] (Figure 5.1), although the region as a whole is a net energy exporter.

While SSA countries need to invest in energy generation, this is not enough in the absence of other measures. Such investment does not necessarily reduce energy poverty. In the poorest countries, where grid-based access to energy is particularly low, improvements in power-generating capacity face greater obstacles to translating this into greater access, and are more likely to increase supply to those who already have access (Bazilian et al., 2011). There is also a need for investment in maintenance, expansion and development of power grids, in energy efficiency, in capacity-building and in setting alternative financing and incentives mechanisms which are appropriate to different technologies and to different types of user (large and small firms, poor households, rural and urban population).

[20] Forty-three African countries are energy net importers (Amigun et al., 2011).

Figure 5.1 Net energy imports in sub-Saharan African countries - 2008 (Mtoe)



Source: IEA (2010), 'World energy balances', IEA World Energy Statistics and Balances.

Recent estimates (Briceño-Garmendia et al., 2008) find that SSA's aggregate power infrastructure needs between 2006 and 2015 – both for new investment and operations and maintenance – amount to about US$43 billion a year (7% of GDP), significantly higher than the annual average spending of US$11 billion in the 2001–2006 period. Capital expenditure in energy infrastructure accounted for US$4.6 billion a year (about 40% of total spending). New investments in energy infrastructure were, therefore, similar to those in the water and sanitation sector (US$4.6 billion a year) but about half of the capital expenditure in the transport sector (US$8.4 billion a year). With an average annual expenditure of US$2.4 billion, domestic public finance was the largest source of funds for the energy sector, followed by non-OECD financiers (mainly the Export-Import Bank of China) and by ODA which, on average, provided US$1.1 billion (24%) and US$0.7 billion (15%) a year respectively. The contribution of the private sector was quite low: US$0.5 billion (11%).

Renewable energy has many advantages for improving access to affordable and clean energy. It reduces the dependence on imported fuels, enhancing national trade balance and energy security. It has been calculated that decentralised renewable technologies are cost-competitive in remote and large rural areas of SSA (Deichmann et al., 2011) and they could therefore play a key role in enhancing rural energy access. Finally, large-scale deployment of wind, solar and hydropower energy could also reduce dependence on traditional biomass, which is harmful for health, the environment and workloads, especially for women. A decline in the use of biomass energy could also alleviate pressure on water resources: according to some estimates, Africa produces only 9% of world's total primary energy, but its energy production consumes more than one-third of water used in the energy sector worldwide (data referred to 2005), mainly due to the extensive use of biomass energy (World Energy Council, 2010b).

Renewable energy markets in SSA are still largely underdeveloped. In 2009, for instance, SSA (South Africa excluded) produced only 74 GWh of electricity from solar, wind, tide and wave compared to 51480 GWh in all non-OECD countries (IEA, 2011).

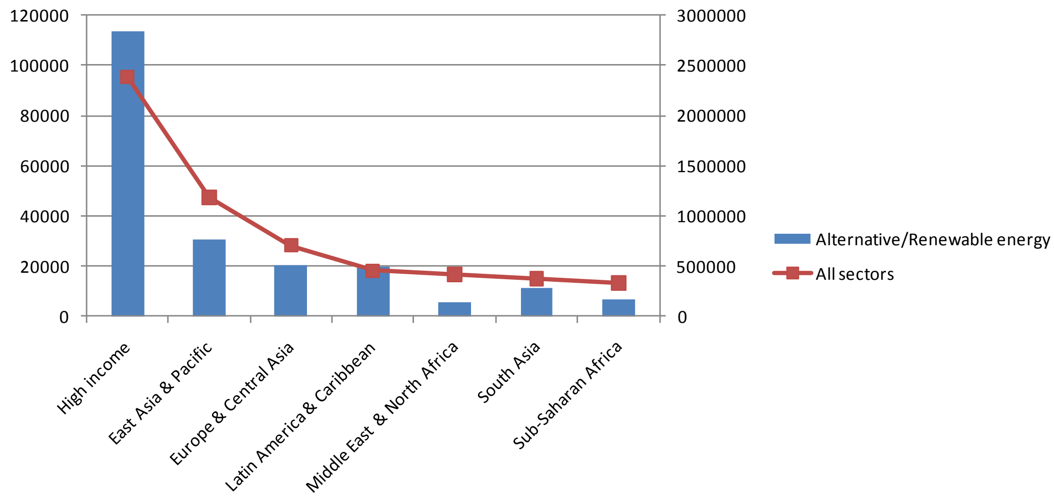
5.1 Trends in renewable energy investment in sub-Saharan Africa

Data on renewable energy investment in Africa are sparse, largely incomplete and seldom comparable. This section will use different data sources in order to provide a snapshot of the trends in and characteristics of Africa's renewable energy market.

Information on medium and large projects highlights that investment in renewable energy (large hydropower excluded) is still very low but is growing fast: in 2010 (Figure 4.5) it jumped to US$3.6 billion from US$0.7 billion in the previous year. The data include North African countries and show that the boom was geographically concentrated. In both Egypt and Kenya investment rose to $1.3 billion (UNEP and BNEF, 2011). UNEP and BNEF (2011) report that, in the same year, other countries (notably Cape Verde, Morocco and Zambia) have seen some advances in renewable energy, but in 2010 Egypt and Kenya accounted for more than 70% of all money invested in Africa's renewable energy market.

UNEP and BNEF data on small-scale generation projects do not include solar water heaters, biomass and other heating systems that might be more appropriate in developing countries. The available evidence suggests, however, that the recent surge in small-scale generation projects, which might enhance energy access in rural areas through decentralised and distributed energy generation, has been dominated by HICs and MICs. Investment in small distributed capacity rose from US$13 billion in 2007 to US$60 billion in 2010, but the boom was driven by ten countries (Germany, Italy, the USA, Japan, France, Czech Republic, Australia, China, Belgium, Israel, in order of magnitude) accounting for almost US$53 billion. Data on greenfield investment confirm the minor role of SSA in the clean energy market. Mirroring the regional trends in FDI flows, as shown in Figure 5.2, between 2003 and 2009, SSA attracted less FDI in renewable energy than all the other regions, with the sole exception of Middle East and North Africa (MENA).

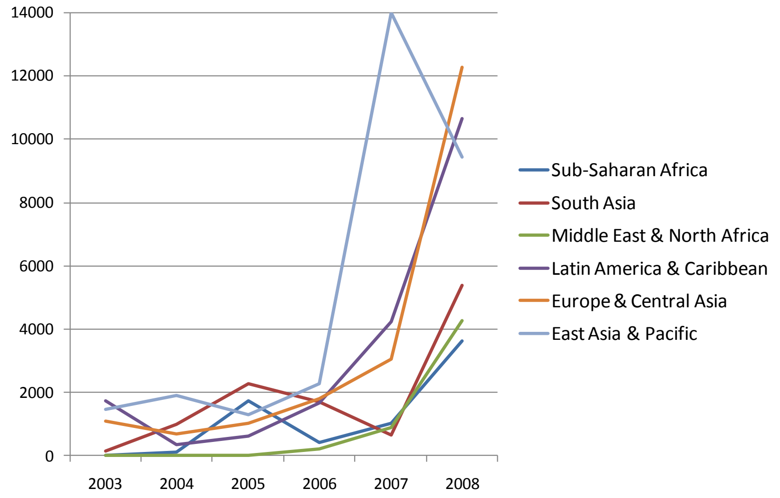
Figure 5.2 Total value of greenfield FDI projects in renewable energy sector by region, 2003-2009* (US$ millions)



Source: Authors' calculations based on information from Financial Times Ltd, fDi Markets (www.fDimarkets.com). Note: the secondary axis refers to the category 'All sectors'. *2009 data include only first months of the year.

Recent years have seen an acceleration of FDI in renewable energy in SSA (see Figure 5.3), though the boom has been more pronounced in East Asia and the Pacific, Europe and Central Asia and in Latin America and the Caribbean.

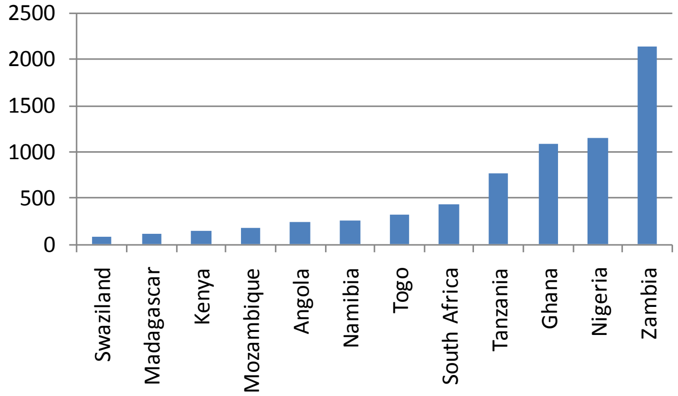
Figure 5.3 Trends in greenfield FDI projects in renewable energy sector by region, 2003-2008 (US$ millions)



Source: Authors' computations based on information from the Financial Times Ltd, fDi Markets (www.fDimarkets.com).

Moreover, within SSA, greenfield FDI was concentrated in a small group of countries, while in the remaining countries there have been limited or negligible new renewable energy projects financed by foreign capital (Figure 5.4).

Figure 5.4 Value of greenfield FDI projects in renewable energy sector in Sub-Saharan Africa's country, 2003-2009*(US$ millions)



Source: Authors' calculations based on information from the Financial Times Ltd, fDi Markets (www.fDimarkets.com). *2009 data include only first months of the year.

6 Biofuel production in sub-Saharan Africa and the energy-land-water nexus

Benefits and potentials vary across types of renewable energy sources and some are contested. Biofuels, in particular, are at the centre of a heated debate. This section discusses the development of biofuels in SSA. While traditional biomass is the main source of energy in the continent, processed bioenergy, such as biofuel and biogas, are regarded as new and more efficient form of carbon-based renewable energy that can contribute to tackling the persistent energy crisis (on the classification of bioenergy sources see Box 5.1). Liquid biofuels have also the advantage that they can be used in the transport sector without significantly modifying the existing infrastructure. At the same time, they can be used for non-transport applications (cooking, lighting, and electricity-generation). Foreign investors have been showing increasing interest in Africa's potential biofuels production, as the recent wave of large-scale land investments for biofuel production. The European Union (EU), in particular, has played an important role in this trend as European countries will need to imports biofuels in order to meet the binding targets set by the EU Renewable Energy Directive according to which by 2020 at least 10% of each Member State's transport fuel must come from renewable sources. The biofuel sector is expected to be attractive in several African countries because of promising export opportunities, especially in the EU market where several African countries enjoy preferential access, but also for positive projections in the domestic markets: the prices of fuel in SSA are about double those in the most competitive markets, demand for transport fuels is rising, and cooking applications and off-grid electricity generation in rural areas could receive higher attention in future (Mitchell, 2011).

The anticipated benefits of biofuels production include diversification and improvement of income sources in rural areas, direct and indirect employment creation, improvement in energy security and reduced dependence on oil imports, foreign currency earnings from biofuel exports and reduction in GhG emissions. Despite these potential opportunities, biofuels development in SSA and elsewhere is very controversial and even its proponents warns of the economic, social and environmental risks. Biofuel expansion might (a) push up food prices[21] and compete with food production, undermining food security; (b) contribute little to energy security as the sector is mainly export-oriented; (c) create frictions among competing uses for land and water uses and place pressure on water resources; (d) create incentives for deforestation, and have severe environmental impacts such as water pollution and soil degradation and a negative carbon balance.[22] The risk of water stress is particularly alarming as the continent already suffers high levels of water scarcity. The water footprint of biofuels, especially the first-generation ones, is much larger than that of fossil fuels (Gerbens-Leenes et al., 2009; King and Webber, 2008).[23] Finally, the fact that large corporations operating simultaneously in the energy, animal feed and OGM seeds sectors are increasingly interested in biofuel production and commercialisation (Borras et al., 2010; Neville and Dauvergne, 2010) has given rise to concerns about the equity and sustainability of this transition.

[21] Timilsina and Shrestha (2010), following an extensive review of recent studies on the impact of biofuel growth on food prices and on the 2008 food price shock, observe that there is a general consensus on the fact that biofuel expansion exerts upwards pressure on food prices, but there is a considerable variation in the estimates of the magnitude of this impact.

[22] As noted by Delucchi (2010), estimates of net GHG emissions of biofuels depend on assumptions on fossil fuels used in cultivation of biomass feedstocks and in the production of the biofuel; the amount of nitrogen fertiliser applied, the treatment of carbon emissions from land use change. There is a consensus that net mitigation of GHG emissions is positive when land conversions for biofuel production are not considered, but the contribution of biofuels in mitigating climate change pressure is largely contested when land use changes are computed. See Timilsina and Shrestha (2010), for a detailed literature review.

[23] The water footprint of biomass energy varies across climate conditions, agricultural production systems and the crops used, but Gerbens-Leenes et al. (2009) calculate that, on average, it is 70 to 400 times larger than that of the other energy sources (nuclear, crude oil, solar thermal, wind, natural gas energy). Several estimates suggest that expansion of biofuel production, with its large water requirements, will increase demand and competition for water (Berndes, 2002; De Fraiture et al., 2008; Yang et al., 2009; Galan-del-Castillo and Velazquez, 2010).

Box 6.1 Types of biomass energy sources

The term 'biomass energy' refers to fuelwood, crop residues, dung, and the solid, liquid and gaseous products derived from them. Biomass energy includes:

Unprocessed sources: Fuelwood, agricultural and forestry residues, dung.

Processed sources: Charcoal, biofuels (methanol/ethanol, biodiesel, etc), biogas (methane from manure), and gases (CO, H2, CH4) made from the destructive distillation of biomass.

Biofuels fall into two categories:

First-generation biofuels are biofuels made from sugar, starch, vegetable oil, or animal fats using conventional technology. Several by-products of commercial value are derived from the production of first-generation biofuels: animal feeds and products used in the food industry are obtained by grain-based ethanol and as by-products of biodiesel. Residuals from sugar cane ethanols are used in electricity production.

Second-generation biofuels are produced in processes that can use a variety of non-food crops and cellulosic sources such as grasses and trees. They include waste biomass, the stalks of wheat, maize, wood, and special energy or biomass crops. More research is needed to understand their potential risks, but they usually perform better than first-generation biofuels in terms of socio-environmental impacts: better carbon and energy balance, reduced competition for land-use changes and for food production. However, available technologies usually have higher costs of production and are less economically viable. Further technical and organisational advances are needed to make them competitive.

Third-generation biofuels are at the research stage. They are derived from algae and they are expected to produce at higher yields and less water intensity than the previous generations of biofuels.

Sources: Openshaw (2010); World Energy Council (2010a); Fonseca et al. (2010); Mitchell (2011)

The debate revolves around projections and expected impacts and opportunities as the sector in the region is at its first stages of development, but some evidence is now available. Table 5.1 in Annexe 1 presents a short overview of the recent literature findings on the effects of biofuels production in SSA. No definitive conclusions can be drawn from this snapshot of case studies. Moreover, generalisations and stylised facts do not always match the facts on the ground. Bearing in mind these limitations, we can delineate some preliminary evidence on the local effects of the existing biofuel projects in SSA. For example, large-scale plantations, especially if they are based on large-scale land acquisitions, are usually problematic: in several cases there have been local objections, few or less than expected benefits and concerns about negative externalities and impacts. Projects based on small producers through cooperatives, groups of farms, outgrower farming schemes or other network system between smallholder farmers and biofuel processing or commercialising firms appear to offer more promising solutions, although they still have problems of economic competitiveness and viability.

6.1 The current wave of land investments

The debate on biofuel opportunities and risks is linked with the discussion on the current wave of large-scale land investments in several regions of the world. The expansion of agrifuel cultivation is seen as a driver of the so-called 'land grabbing' phenomenon. Before analysing the state of development of biofuel sector in SSA, we discuss the link between biofuel and land investments in the continent, the subject of heated debate.

Land acquisition is not a new phenomenon: it dates back at least to colonial times. Over the last 50 years, however, land deals have risen substantially. This is particularly true in the last decade, when domestic and foreign investors have bought or leased land in developing countries. The debates on the number, characteristics and impacts of this trend have been particularly lively since 2009 (GRAIN, 2010; Cotula et al., 2009; Friis and Reenberg, 2011; Görgen et al., 2009; Smaller and Mann, 2009; von Braun and Meinzen-Dick, 2009). Concrete information on the magnitude of the challenge, in terms of the amount and location of land concerned, on the state of the deals (concluded or planned), on the use of the land (agriculture, industry, tourism, mining etc) and on the players involved, is still very limited, often approximate and not always calculated with scientific rigour. (See Appendix 1 for details on land deals in SSA.) Data based on media reports reveal that an estimated 56 million ha might have been subject to recent deals in developing countries; in SSA the interest in land is estimated at 29 million ha (Deininger et al., 2011).

While domestic investors tend to be elites, local entrepreneurs or the local government, foreign investors usually belong to two groups: (s) governments or state enterprises or state funds from oil-rich countries with little arable land, water scarcity and harsh climate conditions or (b) private companies from industrialised and emerging countries with large populations and rapid economic growth, investing mainly in agrifuel projects (von Braun and Meisen-Dick, 2009; Deininger et al., 2011). China and India are good examples of 'new' investors. The former mainly aim to improve food security and reduce the dependence on high and volatile food prices. The latter face an increasing demand for feed and renewable resources, which they try to address via FDI in land. This strategy helps them to reduce their dependence on world markets.[24]

Drivers, not mutually exclusive and often interconnected, include:

1. Increasing population and corresponding decline in the average amount of land per capita, combined with a very uneven distribution of population growth, of soil degradation, climate change impacts and land resources.[25] Due to relative scarcity, the value of agricultural land is increasing. According to von Braun (2008) and Castel and Kamara (2009), in 2007 the price for agricultural land increased by about 16% in Brazil (where it is around US$5000–US$6000), 31% in Poland and 15% in the US Mid-West (where it is around US$7000). Sub-Saharan Africa has vast unexploited agricultural land and agricultural land prices in Africa are low and have not yet begun to increase (the estimated average price per hectare in Africa is between US$800–US$1000, according to Development Afrique (2009).[26] Hence, buying land in SSA has become a very attractive investment.
2. Increasing and shifting demand for food, feeds, and bio-fuel (fostered by fuel prices above historical levels and growing interest in green energy). Projections of the future demand for food suggest an increase of around 70% by 2050 (HLPE, 2011). Improved standards of living suggest an increase in the consumption of meat and dairy produce, for which more land will be required. According to Cotula et al. (2008), biofuel expansion is expected to increase demand to over 3% of arable land by 2030.
3. Investments in governments' quest to secure food in countries lacking enough land and water to feed their population. For instance, it has been argued that water is the hidden agenda behind many land acquisitions (Woodhouse and Ganho, 2011). The purchase (or lease) of land is de facto an investment in water since land comes with associated water rights and access. In other words, it seems to come 'for free' in the land-deal valuations. Furthermore, while there is scarce information on land deals, there is even less information on investments in water. The existing literature seldom estimates the water resources involved in land deals, their relative importance, or how they fit into water history or use. Yet the availability of water determines land productivity, especially for smallholder farming.
4. Speculative investments and commodification of land. Since the 2008–2009 financial crisis, land has become an alternative way to invest capital in a moment of low and risky returns on financial assets. Higher prices for agricultural produce, such as those prevailing in 2008, may have pushed this trend. Moreover, the commercial value of land in SSA is still relatively low and has increased less than in other region, which fuels expectations of large increases in the future. The UK's Agricultural Africa Land Fund, for instance, pays US$350–US$500 per ha in Zambia (about 10% of the cost of land in

[24] A detailed description of the different players involved in large land deals is in CFS, HLPE, 2011: 16–17.

[25] According to data reported in Friis and Reenberg (2011) the average amount of land per person has declined from around 7.9 ha in 1990 to around 2 ha in 2005 and the prediction for 2050 is approximately 1.6 ha.

[26] See the table in the Appendix for a comparison of land prices.

Argentina or the USA). Many countries in SSA have large tracts of unexploited land, although in many cases land that is perceived as 'empty' and 'idle' is being used on the basis of informal rights.

In summary, there are many reasons to invest in land and many land investments are targeting SSA on the grounds that the region has large unexploited agricultural potential (Deininger, 2011; Cotula et al., 2009). The process is leading to land concentration, the development of agricultural production and distribution systems, and labour relations oriented to the agri-business model, greater integration with urban and international markets, and restrictions on resource uses that are not formally recognised. The host governments are attempting to seize the opportunity represented by the rising value of land and water. They hope to promote economic development and reduce poverty by exchanging abundant resources (land) for scarce ones (capital, infrastructure, skills, technology). But things do not always work out like this and, if this wave of land acquisitions continues, the consequences could be profoundly negative, persistent and not easily reversible. The conditions within which the poverty-reducing effects of domestic and foreign investment in land can work are in fact very strict. Among others, the basic requirements include a clear definition and recognition of existing resource-use rights; the balanced, informed, competent and transparent engagement of all stakeholders; the implementation, monitoring and enforcement of participatory decision-making processes; and of fair land deals and contract arrangements (ERD, 2009). These conditions seldom hold in developing countries, especially in SSA. This explains why a recent report of the High Level Panel of Experts on Food Security and Nutrition commissioned by the UN Committee on World Food Security leaves no room for doubt about the negative impacts of ongoing large-scale land investments, concluding that 'large scale investment is damaging the food security, incomes, livelihoods and environment for local people' (HLPE, 2011: 8). Indeed, Deininger et al. (2011) find a positive correlation between large-scale land acquisitions and low recognition of land tenure. This implies that some developing countries, for instance those with weak institutions, tend to attract massive foreign capital in mining, land or in the so-called 'dirty' manufacturing industries – which tend to be water-intensive and highly polluting – because of the lack of control and higher potential for corruption. Coming back to the potential role of the biofuel market in promoting economic and social development in SSA, we can conclude that biofuel investments are propelled by and have implications for the global, regional and local trends of land and water scarcity, entitlements and distribution. The promotion of this sector, therefore, should be evaluated in a more holistic perspective which takes into account the water-energy-land nexus and its meaning for water, food and energy security.

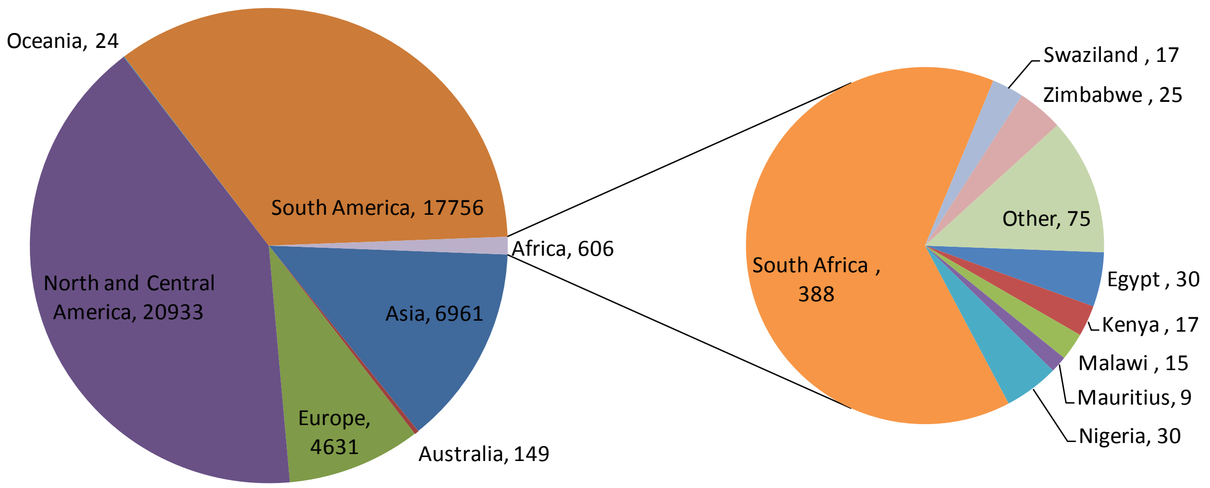
6.2 The state of biofuel development

Beyond its effects, what is the current state of biofuel development in Sub-Saharan Africa? Some main features can be identified:

- *Second-generation biofuels are marginal.* The feedstocks most used in first-generation biofuels are sugar cane and molasses to produce ethanol and jatropha to produce biodiesel or an oil than can fuel stationary power plants (Mitchell, 2011). But cassava, sweet sorghum and oil palm are also used. Mozambique, for instance, approved sugar cane, sweet sorghum, coconut and jatropha for biofuels production. In contrast, South Africa has classified jatropha as invasive species.
- Available data (see Figure 6.1) suggest that so far Africa has lagged behind in the global biofuel market. In 2006, its ethanol production was estimated at 606 ML, or about 1% of global production. Excluding South Africa, SSA's ethanol production, estimated at 189 ML, was lower than Colombia's production alone (280 ML). Within the continent, South Africa accounted for the largest share of Africa's ethanol market, producing 388 ML, but it appears that Kenya, Malawi, Nigeria and Zimbabwe are becoming relatively important ethanol producers.
- In the biodiesel sector, SSA plays an even less significant role. Even if jatropha is widely cultivated, most countries have only just begun to promote this form of renewable energy. In southern Africa, where there are several small and medium-scale producers, the biodiesel market is more developed. However, Africa's first large-scale plant was inaugurated in 2007 in Zimbabwe but in 2009 was still

operating at less than 5% of capacity because of problems in the supply of raw materials. The first commercial biodiesel plant opened in Mozambique in 2007 and also encountered problems of feedstock supply (Amigun et al., 2011).

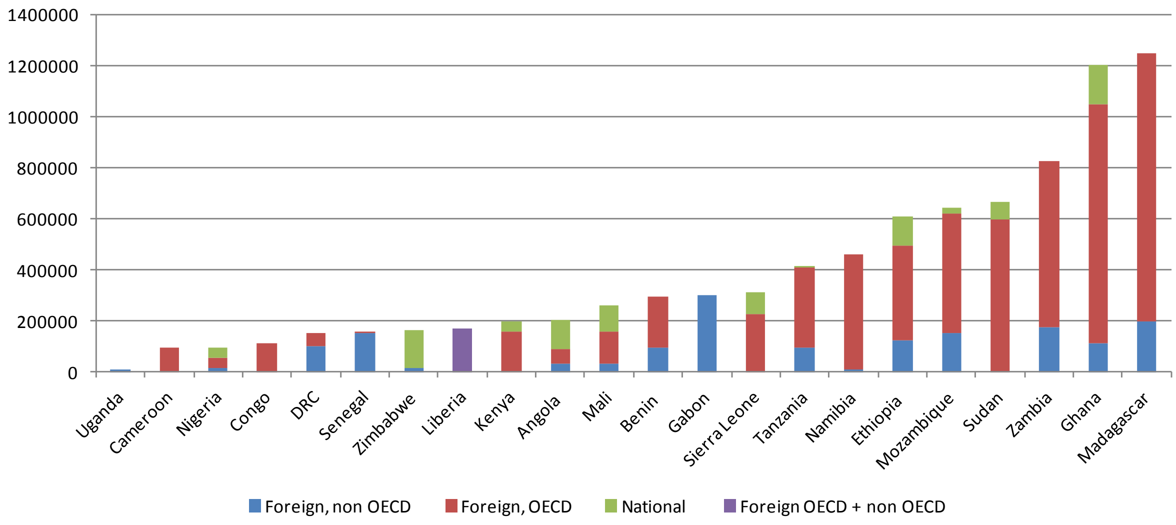
Figure 6.1 World fuel ethanol production in 2006, million litres (ML)



Source: Authors' calculations based on Licht estimates reported in Renewable Fuels Association (2007)

- Africa's position in the biofuel market is expected to expand. Malawi, Mozambique and South Africa are among the pioneers of biofuel production, but cultivation of biofuel crops is expanding elsewhere (see Figure 6.2) and national plans have been promoted in Angola, Benin, Ghana, Malawi, Mali, Mauritius, Mozambique, Nigeria, Senegal, South Africa, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe (Amigun et al., 2011). General policy statements do not always translate into concrete legislative strategies (Richardson, 2010), but they nevertheless signal government commitment to promoting biofuel markets. Moreover, a growing number of investors are interested in the region. So, in some cases, are donors, government agencies or NGOs, which encourage integration of biofuel crops and food production to promote income diversification and to meet energy needs at household and community level.

Figure 6.2 Planned and executed biofuel investments in 22 SSA countries by ha of land accessed for estate cultivation and by origin of lead investor

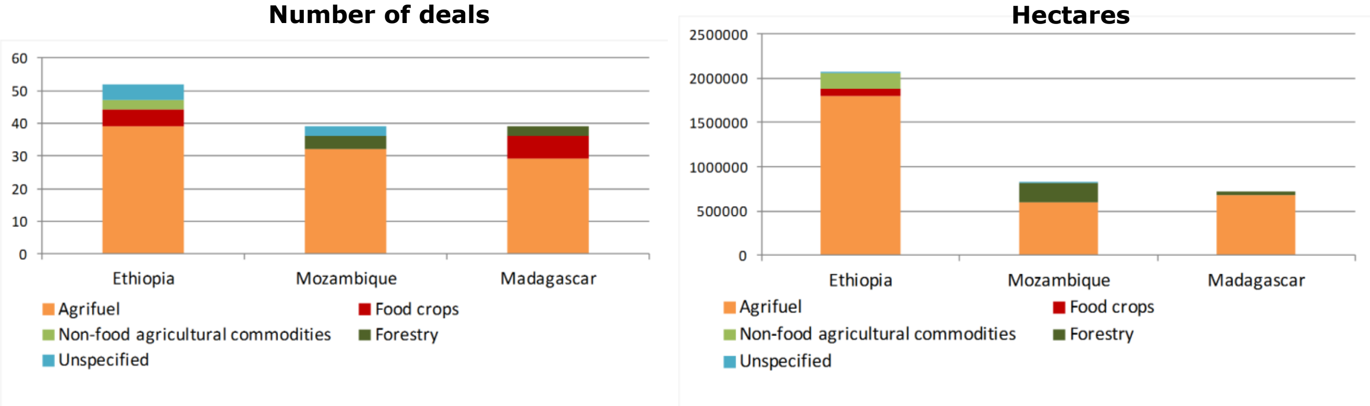


Source: Developed by the authors using CIFOR Global Biofuel Information Tool, using various reliable media, corporate and government sources and external publications. Accessed October 2011.

- Biofuel projects in Africa are very heterogeneous. Small farms of biofuel crops for local use have been promoted in Ethiopia, Ghana, Mali, Mozambique, Senegal, Tanzania and Zambia (von Maltitz et al., 2009 and 2011; Diaz-Chavez et al., 2010). However, small-scale farmers are most commonly involved as outgrowers to supply large national and international producers of liquid biofuel blends. Often biofuel projects are large-scale commercial plantations financed by big corporations. Southern African countries, in particular, have attracted large-scale and mainly foreign investments in this sector, because of their comparative advantage, especially in sugar cane production, and their perceived land and fresh-water abundance (Richardson, 2011). Watson (2011), for instance, estimates that, in Angola, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe, 6 million ha are potentially suitable and available for sugar cane production, even excluding protected areas, closed canopy forests and wetlands, areas under food and/or cash crops, and areas with biophysical constraints. In Benin, Cameroon, Congo, Ghana, Kenya, Nigeria and Sierra Leone large agrifuel plantations are planned or planted (von Maltitz et al. 2009; FoEE, 2010).
- Trends in commercial farmland investment reveal the interest in Africa's potential for biofuel production. Evidence based on information posted between October 2008 and August 2009 on the blog of the NGO GRAIN (Deininger et al., 2011) indicates that about 25% of large-scale land investments in SSA, the region targeted for large-scale land acquisitions, are related to biofuel production. The same source shows that the continent attracted 48% of worldwide projects covering about two-thirds of the global targeted area (i.e. 39.7 million ha of a total of 56.6 million ha). Information from the land transactions database on agrifuel projects suggest that the involvement of SSA in biofuel-related acquisitions of land might even greater.[27] Data recorded in this inventory point out that biofuel production lies behind most of the land deals in Ethiopia, Madagascar and Mozambique (see Figure 6.3), three of the top destinations for commercial land investment in SSA.

[27] This inventory includes land deals which have been negotiated from 2000 in rural areas and that imply a transformation of land-use rights from communities and smallholders to commercial use (see http://www.commercialpressuresonland.org/monitoring-land-transactions).

Figure 6.3 Land deals in Ethiopia, Madagascar and Mozambique by nature of investment



Source: Land transactions database, portal 'Commercial Pressure on Land', International Land Coalition, accessed 3 October 2011.

- Foreign investments are a very important component of biofuel projects in SSA. Van Gelder and German (2011) find that foreign producers, companies and financiers control the sugar industry in Malawi, Tanzania and Zambia and are dominant also in the oil-palm sector in Cameroon, the Congo and DRC. They conclude that: 'Much of the feedstock and biofuel development in Africa depends on grants, (soft) loans and investments by foreign governments, foreign development banks and foreign state-owned companies' (p.6). In Ghana, Schonevald et al. (2010) identify 17 biofuel companies of which 15 are foreign-owned and/or financed by the Ghanaian diaspora, and all but one have large-scale plantations. The OECD (notably European) countries are the main foreign investors in SSA (see Figure 6.2) but investors from non-OECD countries are increasing in importance, and South–South collaborations and joint ventures are expanding. According to data based on the CIFOR Global Biofuel Information Tool, foreign companies dominate land transactions for agrifuel projects in most countries, with the exception of Angola, Nigeria and Zimbabwe and, to a lower extent, Kenya and Mali (see Figure 6.2). OECD countries usually lead the trend, but non-OCED investors already control the largest share of the land for planned and executed biofuel investments in DRC, Gabon, Senegal and Uganda and also invest in many other countries. Investors from Brazil, China, India, Lebanon and Saudi Arabia account for a large share of agrifuel-related land deals in Ethiopia, while South African investors have negotiated significant land transactions in Mozambique (based on ILC Land Transaction Database). Dauvergne and Neville (2010) list a number of examples of South–South partnerships in other African countries: a Nigerian biofuel refinery developed a consortium with African, Philippine, Italian and Canadian partners. Malaysian and Chinese companies also have commercial interests in oil-palm plantations in Liberia and in DRC, respectively. Richardson (2010) reports that Brazil, Angola and Mozambique signed cooperation agreements while a Brazilian and two Angolan companies have agreed on a US$210 million joint investment in Angola.
- Despite these signs of acceleration in biofuel projects, the scaling up of biofuel production and its future trends are very uncertain, since investors' expressions of interest do not always lead to the start-up of production, while the initial evidence of returns on biofuel investment in the continent is not very encouraging. Investment decisions in the SSA biofuel sector are still risky. In several cases, local resistance, financial problems, unexpected technical difficulties, uncertain market and regulatory conditions have represented barriers to the implementation of the projects. Based on case studies in DRC, Mozambique, Tanzania and Zambia, Deininger et al. (2011) find that many large-scale land investments in this sector

experienced financial problems and were cancelled after the 2008 oil boom. For instance, they report implementation difficulties in DRC and observe that in Mozambique, all the large biofuel projects they surveyed were delayed and none operated at full capacity. In Madagascar, riots and contestations against a 99-year lease of about 1.3 million ha to Daewoo brought down the government and led to the cancellation of the deal. Also van Gelder and German (2011) observe that in some countries, areas cultivated with biofuel feedstocks are much smaller than the areas acquired by investors. Another study finds that it is not economically viable for Kenyan small farmers to sell jatropha seeds to commercial processors (GTZ 2009a, cited in Hunsberger, 2010). Some case studies of companies with operations in Africa suggest that building capacity in proper planting, caring and processing takes time and is essential to the performance of jatropha. Moreover, the long delay between project proposal, investment, and production as well as the decline in energy prices, created financial difficulties (Mitchell, 2011). Friends of the Earth Europe (FoEE, 2010) reports that in Mozambique and Swaziland small farmers who started to cultivate crops for agrifuel feedstock, in many cases under outgrowing schemes with large (mainly European) companies, claim low yields, processing difficulties, problems with pests and in accessing inputs (water, seeds, pesticides). These barriers to the expansion of biofuel production are reflected in the lack of data on investment trends in the sector. Van Gelder and German (2011) estimate that the ten largest companies invested about US$5.7–US$6.7 billion to produce biofuels between 2000 and 2009 in a group of 20 countries, but sugar-based ethanol production in Brazil, capturing investments worth some US$3.8–US$4.2 billion, accounted for most of the volume together with Colombia, Indonesia and Malaysia. In contrast, investments in nine forest-rich African countries with significant biofuel activities were small or negligible.

- In line with the dominance of foreign investors and barriers to biofuel productions, current evidence suggests that in several African countries most biofuel crops are exported (Franco, 2010; van Gelder and German, 2011), which implies that the main value-added will be captured externally.

6.3 The way forward

Our analysis shows that the SSA biofuel sector is growing but is at a very preliminary stage of development and several barriers hinder its expansion and its pro-poor potential. Now is the time to introduce corrective measures to ensure that Africa will benefit from the growth in biofuel production. If existing incentives to biofuel development continue to drive large-scale land acquisitions and land-use conversion from food to biofuel crops, the risks pose serious concerns – and are also irreversible. Governments that have chosen to promote the agrifuel sector, making land available to big investors and focusing exclusively on large-scale deals, have so far reaped little success. Expected and documented impacts of large land acquisitions in SSA cast doubts on the pro-development role of biofuel investments under such conditions. In theory, investment in land could be positive for host countries as long as rules are followed and employment created, but with the current governance structure it is likely that the risks outweigh the benefits. Host countries often lack adequate regulation to protect their populations. Land tenure is complicated, land rights are not recognised, local farmers can be displaced and not even compensated for their loss. Incentives for the elites and government to protect public goods rather than private interests are low and often lack credibility. In these circumstances, investments in land are likely to worsen local food security, increasing the risks of conflicts and social tensions as well as undermining access to water.

Moreover, biofuel development is controversial even when it is not accompanied by large-scale land acquisitions. The 'biofuel is good' and 'biofuel is bad' hypotheses usually mask widely diverging views, and behind this debate lies the dilemma on the role of agribusiness: does it exacerbate exclusion and poverty of small farmers or does it help to connect them with global markets or offer new labour opportunities? These issues are beyond the scope of this paper, other than to note that simplistic narratives can be misleading and that the role of pro-developmental state institutions appears to be essential in fostering virtuous collaborations and synergies between agribusiness and smallholders. Moreover, the evidence presented in this paper suggests that a strategy for biofuel development which pivots on small farmers and on small-scale contractors might have greater chances of success than large-plantation farming systems.

In addition, the issue of the possible pressure on other human and productive uses of water and soil resources remains open, while the role of biofuels in mitigating GhG emissions is questionable. These indirect effects on biofuel development are also shaped by the choice of feedstock and the type of land use. Second-generation biofuels, for instance, generally require less fertiliser and produce less CO_2 emissions (Delucchi, 2010) than first-generation crops. They may also have less impact on food production since they can be produced from crops that grow on poor land and from waste products (Fonseca et al., 2010). Second- and third-generation biofuels seem, therefore, to offer more promising perspectives in terms of social and environmental sustainability, but so far they are not economically competitive (Mitchell, 2011; Fairley, 2011).

Promoting energy from residues and waste rather than energy crops, and financing more research and investment in advanced biofuels, are therefore a priority for ensuring the economic, environmental and social sustainability of the large-scale deployment of biofuels.

7 Concluding remarks

This paper has tried to delineate the current global trends, drivers and features of investment in renewable energy with a focus on sub-Saharan Africa. It has also delved into the state of development of biofuels, a sector which exemplifies the close links between food, energy and water security, with specific attention to some of the challenges posed by water and land scarcities and their complex interconnections[28] and on differences between domestic and foreign investments.

First, our analysis argues that the current structure of global energy market, demand and use is largely unfair, unsustainable and, as shown by the recent peaks in energy, commodity and food prices, increasingly fragile. Reduced energy demand, especially in the richest and emerging countries, is the essential condition for equitable and sustainable economic development at the global level. The focus on energy policy mandates, which are formulated in relative terms, risks diverting international attention from absolute targets and from the priority to reduce energy demand and to promote dematerialisation of both production and consumption – especially in advanced countries, which account for a disproportionate share of global energy and material uses.

We have shown that large-scale deployment of renewable energy can make an important contribution to the struggle against energy, financial and non-financial poverty as well as against environmental degradation and climate change.

Available evidence suggests that, at the global level, renewable energy is gaining ground on fossil fuels and investment in this sector is growing at spectacular rates, but renewables remain marginal to world energy consumption. Moreover, the renewable energy market and the growth in investment tend to be concentrated in a small group of countries. Despite its great technical potential, Africa lags behind in terms of access to energy and deployment of modern renewable energy technologies. Renewable energy could be important in reducing energy poverty and in helping Africa to meet its future energy needs, but there is a need to mobilise financial resources, policy support, research efforts, and to improve governance.

Bridging the financing gap is a first step. Bazilian et al. (2011), for example, estimate that, even if all energy-related investment were used to increase access to energy, most LDCs[29] would not achieve universal household electrification by 2030: on average, the yearly investment needed to attain this goal is five times greater than current energy-related financial flows. Bridging the financing gap also means mobilising private resources and reducing premium risks of investment in renewable energy, which requires, among other conditions, a stable and favourable regulatory and policy framework.

The financing gap is only one of the obstacles to investment in renewable energy. We have identified and discussed a range of institutional, market and technological barriers that set back the large-scale development of and investment in renewable energy both in high- and low-income countries. More and better government policies, international initiatives, multilateral agreements and development assistance are needed to remove or reduce these obstacles. Policy options include (a) initial subsidies (feed-in tariffs, output and investment subsidies) which can be removed after the consolidation of the renewable energy sector; (b) phasing out of fossil-fuel subsidies and promotion of a pricing system which reflects externalities of energy production and use; (3) public investments and institutional arrangements for creating hybrid and flexible energy networks in order to facilitate integration of renewable energy in the current energy system and the entry of new and independent

28 While there are some scattered data on the size of land acquisitions, and preliminary surveys on the use of the acquired land (see also Table A3), to our knowledge there is no study on the amount of water resources involved nor their relative importance with respect to other economic activities. According to World Bank (2007), for instance, agriculture is responsible for 70% (85% for developing countries) of global freshwater withdrawals, much of it for irrigation (although in Africa irrigation covers only 4% of agricultural land). When investing in land, water comes 'for free'. But water is (and has historically been) a source of conflict, which is likely to be exacerbated by the current trend of land acquisitions and biofuels production.

29 Note that 33 of the 48 LDCs are in Africa.

energy producers; (d) financing and supporting research initiatives for development of appropriate technologies to local contexts and for reducing production, social and environmental costs of renewable energy. In addition, information campaigns and other systems of sharing information can help to heighten the awareness of consumers, policy-makers and investors of the potential benefits, applications, and technical and economic feasibility of renewable energy technologies. Finally, in LICs and MICs there is a need for specific political commitment to combat energy poverty as a basis for ensuring that higher energy production translates into better access to clean and affordable energy for the poor.

The choice of energy carriers is also crucial. Biofuels, in particular, represent (together with hydropower) one of the most debated forms of renewable energy. Even if we anticipate important developments, for the foreseeable future the transport sector will continue to rely on liquid fuels. Sub-Saharan Africa is still a marginal player in the biofuels market, but its role is growing. Southern Africa has been described as a potential 'Middle East of biofuels'[30] and FDI in land acquisitions for biofuel projects is concentrated in certain African countries. We have seen that the risks and opportunities of biofuel production and use are particularly relevant for SSA as the continent simultaneously faces energy poverty, high vulnerability to climate change, widespread poverty, low rates of growth in agricultural productivity, food insecurity and water stress and scarcity. Biofuels can help African populations to meet their current and increasing energy needs, and to develop alternative, sustainable and profitable income sources in the agricultural sector, but this will be possible only if the conditions to reap the benefits are met in advance or in conjunction with investment projects. These conditions include (a) clear definition and recognition of existing resource-use rights; (b) balanced, informed, comptent and transparent engagement of all stakeholders; (c) knowledge and technology transfer to local communities; (d) careful assessment of indirect land-use change and water intensity and requirements; (e) implementation of rules and actions to facilitate the use of biofuel production to provide local energy. The prevailing government approach, both in the main consumer and producer countries, which is centred on policy mandates, targets and subsidies, should be reconsidered as it either produces or does not prevent unwanted side-effects.

Finally, we have highlighted the main differences between domestic and foreign direct investments. These are particularly important for land (and therefore also for renewable energies, which need land). Domestic investors tend to acquire smaller areas of land than foreign investors, which are likely to have more capital.[31] Furthermore, domestic investors tend to consult more with the local communities before deciding whether and how to use the land while foreign investors tend to exploit possible economies of scale.

Last but not least we broach the issue of links between investment and the quality of institutions. Further work is needed in this area. However, we suggest that while in general good institutions are conducive to investments, a large literature highlights that some specific types of investment seem to obey different rules. Investment in land is one such example, as also emphasised by Deininger (2011). Investments in so-called 'dirty industries', i.e. manufacturing industries which are water-intensive and polluting, are another example. It seems that such investments tend to be made in countries where rules are less stringent and easier to break, a tendency that becomes more marked as regulations in developed countries become tighter. This has obvious implications for the impact of investments on development and for the possibility of local populations to reap the benefits of investments in land, water and renewable energies.

[30] Andrew Owens, CEO of Greenergy at Biofuels Markets Africa Conference, Cape Town, 30 November–1 December 2006.

[31] According to the Norwegian's People Aid (2011) study on Sudan, for instance, domestic investors' average size of land is around 9000 ha, while foreign investors is around 175,000 ha. Other studies confirm the differences for other countries.

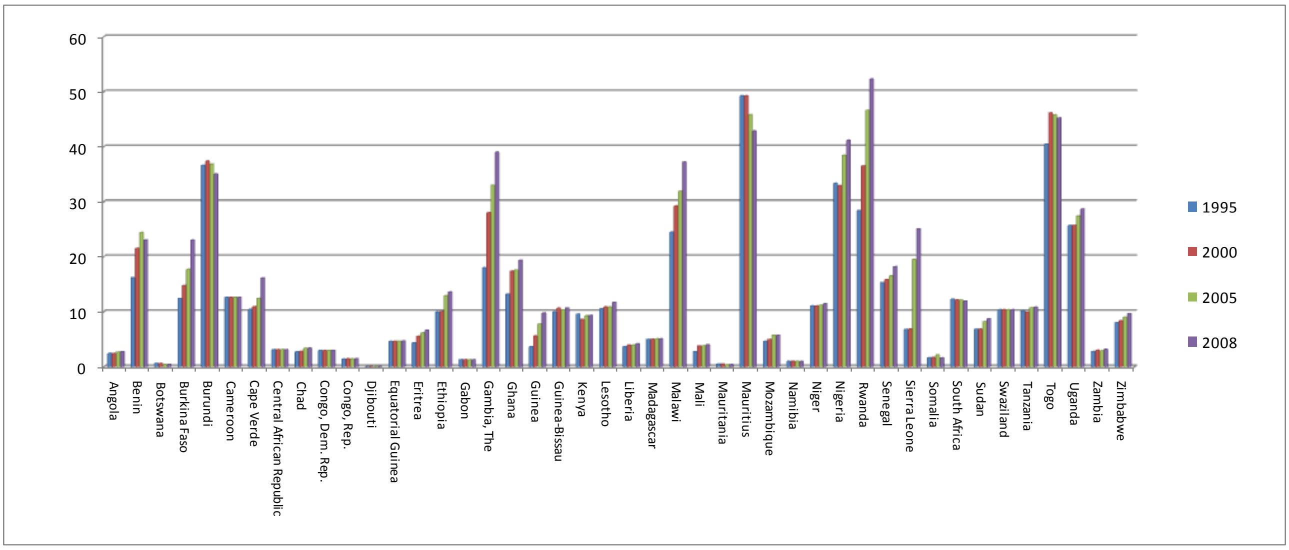
Appendix 1 – Land deals in SSA: a look at the data

Land deals occur within and between regions, and South–South deals are increasingly common: China is one of the main investors in land in SSA.[32] In general, domestic investors are elites, local entrepreneurs or the local government, while foreign investors are either (a) governments or state enterprises or state funds from oil-rich countries or (b) private companies from industrialised and emerging countries, investing mainly in agrifuel projects (see von Braun and Meisen-Dick, 2009; Deininger et al., 2011).[33] If the large number of domestic investors raises some concerns, since large domestic acquisitions are likely to exert a negative effect on land distribution, foreign acquisitions pose far greater concerns, especially the possible loss of countries' or communities' control over land. Furthermore, foreign land deals are often not followed up with productive investments: according to Deininger et al. (2011) only 20% of announced investments have led to agricultural production.

Information on existing deals is at best scattered, approximate and incomplete. Most information is derived from (sometimes unreliable) media reports, or case studies that may not have been carried out in a rigorous manner.[34] Furthermore, existing reports have very different coverage: some exclude allocations below 10 ha, some include deals still under negotiation, and often there is no clear-cut distinction between land that is leased or bought, nor whether the investor is domestic or foreign.

A starting point for understanding the size of the phenomenon is that only 3 billion ha out of the world total land surface of 13 billion ha is suitable for agriculture and only 50% of this arable land is currently cultivated (Deininger, 2011). Sub-Saharan Africa is characterised by heterogeneity in terms of land availability as well as land rights and the quality of institutions. For instance Rwanda and Malawi are land-scarce (Deininger, 2011) while DRC, Tanzania and Zambia among others are land-abundant.

Figure A1 Percentage of arable land by country and years



Source: FAO stat accessed August 30 2011

[32] Land acquisition typically involves leases of periods up to 99 years and often in excess of 10,000 ha. The main actor is the private sector, both domestic and foreign: agribusiness, banks, commodity traders, hedge funds (see for instance Friis and Reenberg, 2011). However, in the past few years, states and sovereign funds have begun to play an increasingly important role. Depending on who is on the 'other side of the deal', this can create important asymmetries with policy implications. A detailed analysis of these issues is beyond the scope of this paper. Discussions can be found in Friis and Reenberg (2011) as well as in the GRAIN and ILC blogs.

[33] For a detailed description of the different players involved in large land deals see CFS, HLPE 2011, pp. 16–17.

[34] A recent project 'monitoring land transactions' jointly carried out by GIZ, Oxfam International and various research institutes is trying to create a database.

Tanzania has well defined land rights while DRC does not. A first look at the data seems to suggest that the negative correlation between the quality of institutions and the number of deals. Tanzania, for instance, transferred only 50 000 ha to foreign investors between 2004 and 2009, while more fragile countries with weak institutions gave away much more. Existing estimates indicate transfer of 2.7 million ha in Mozambique, 5 million ha in Sudan, 1.6 million ha in Liberia and 1.2 million ha in Ethiopia. Ethiopia, Madagascar and Sudan have the largest number of individual land deals (see Table A1).

Table A1 Land deals by country, a comparison of different sources of information (in ha)

Country	*Deininger et al. (2011)*	*GTZ*	*Cotula et al. (2009)*	*Office of Niger (2009)*	*Gorgen et al.*	*Oakland Inst. (2011)*	*Schoneverd (2010)*	*Commercial Land Pressure webL*	*Global Land Project web (and Friis and Reenberg, 2010)*	*Land deal Brief, June (2011)*
Period covered		Up to 2009	2004–2009		Up to 2009			Up to 2010	(2008 onwards)	
Angola								25000	140,000	
Kenya								40000		
Ethiopia	1,190,000		602,760					13,000-18,000	2,892,000-354,000	
Madagascar		1,720,300	803,414		1,720,300			502,000	2,745,000	
Sudan	3,965,000		471,660					1,297,000	3,171000-4,899,000	
South Sudan										600,000 (plus 400,000)
Cameroon								10,000	1,0000	
Tanzania								45,000	1,717,000-11,000,000	
Mali		159,505	162,850	242,577	159,505			100,000	2,417,000-2,419,000	
Mozambique	2,670,000								10,305,000	
Uganda									1,874,000-1,904,000	
DRC								2,800,000	1,1048,000	
Nigeria								10,000	821,000	
Zambia									2,245,000	
Ghana			452,000				107,500	452,000	89,000	
Malawi									307,000	
Sierra Leone						500,000				
Senegal									510,000	
Zimbabwe								101,000		
Liberia	1,602,000							17,000		
TOTAL		2.5 millions								

Sources: Deininger et al. (2011); GTZ (2009b); Cotula et al. (2009); The Oakland Institute (2011); Gorgen et al. (2009); Schoneverd (2010); Commercial Land Pressure web site, Land deal Brief, June 2011; von Braun and Meisen-Dick (2009); Friis and Reenberg (2010).

Some additional useful information can be extracted by noting that there are a number of cancelled deals and the status of many is unknown (Table A2).

Table A2 Unsigned, pending and cancelled land deals

Country	Planned/under discussion/status unknown	Disrupted
Congo Rep	8,000,000	
Ethiopia	602,760	
Madascar	1,500,000	1,300,000
Mali	62,850	
Mozambique	10,000	Value US$800 million
Sudan	378,000	
Tanzania	505,500	
Zambia	2,200,000	

Source: Odhiambo (2011, table 1)

As mentioned earlier, land deals, especially foreign investments, are often not followed up with productive investments. When they are, they tend to be used: (a) to produce biofuels such as jatropha and sugar for ethanol (the 'new Middle East of biofuels'); (b) for mining platinum or uranium; (c) for timber (indigenous forest clearance, some plantations); (d) for tourism: enclosures for safaris or sea resorts, exclusion of fishing communities.

Table A3 summarises, for countries for which information is available, our best estimate of where investments in land have been targeted. The sources are different. In some cases, information is confined to the fact that some investment was in mining or tourism but without any reference to the number of projects. The only study providing such numbers is Odhiambo (2011) (but only some countries are scrutinised and the study is not exhaustive).

Table A3 Purposes of land deals, by country

Country	Food production	Biofuels	Industrial production	Mining	Tourism	Hydroelectric	Forestry	Water stress
Angola	*	*		*		*		
Benin		*						
Botswana	*							
Cameroon	*							9.5
Congo Republic	*	*						16.0
Cote d'Ivoire	*	*						
Djibouti	*							
DRC	*	*						10.0
Eritrea	*							
Ethiopia	x	xxx	*					3.5
Ghana	*	*						
Kenya	xx							2.0
Liberia	*							13.0
Madascar	x	xxx	*					10.0
Malawi	*	*		*				
Mali		*						7.5
Mauritius		*						
Mozambique		*		*	*	*	*	8.0
Namibia								
Niger	*							
Nigeria	*	*						
Senegal	*	*						
Sierra Leone	*	*						
Somalia	*							
South Africa	*			*				
South Sudan								n/a
Sudan	xxx	x			x			3.5
Swaziland	*	*						
Tanzania	*	*		*				5.0
Uganda		*						5.0
Zambia	*	*						7.5
Zimbabwe	*	*		*				
Estimated Percentage	50% (Cotula, 2011) 37% (GRAIN web)	40%(Cotula, 2011) 35% (GRAIN, web)						

Sources: Authors' calculations based on: Friis and Reenberg (2011); Land deal Brief, June (2011); The Oakland Institute (2011); Odhiambo (2011); GTZb, 2009; Von Braun and Meisen-Dick (2009); Cotula et al. (2009).

Notes: 'x' if the number is known and is between 1 and 5 projects, 'xx' if the number is between 5 and 10, 'xxx' if it is above 10 and '*'if the number is not known but there is information on the existence of at least one project. Water Stress is from ODDO (2010).

Current estimates suggest that, on average (with large heterogeneity), between 35% and 50% of the land is used for food production and around 35%–40% is used for biofuels (see Table A3), but they also suggest that the biofuel share is increasing. Much less land is being used for other purposes. Information on land deals used for tourism is incomplete, but in some cases, such as Sudan, the area involved is very large, which makes the sector seem more active than it really is.

The impact on development of each use is likely to be different as is the impact of investments in different sectors. There is need for further analysis and more detailed data in order to assess such impacts. Given the importance of institutions, the impact is also likely to be very country-specific. A reasonable guess is that, in line with the literature reported above, investments in land aimed at a supply chain in food production (manufacturing) are likely to have a higher positive impact and create more spillover with domestic investments than biofuels. However, most projects seem to be (see Table A3) focused on intensive farming and do not take into account the environmental considerations nor seek to create a balance between organic and intensive agriculture. Hence, they could have perverse effects.

Table A4 Value of land in selected countries

Value of land per ha	Countries
Less than US$100	Bhutan, Chad, Egypt, Ethiopia, Guyana, Mali, Mauritania, Mozambique, Nepal, Niger, Sierra Leone, Sudan, Tanzania, Uganda, Vietnam
US$ 100–200	Burundi, Burkina Faso, Cambodia, Equatorial Guinea, Kenya, Madagascar, Malawi Nigeria, Somalia, Zambia
US$ 201–300	Bangladesh, Benin, Central African Republic, Gambia, Ghana, Haiti, Jordan, Liberia, Nicaragua, Rwanda
US$ 301–500	Algeria, Cape Verde, Côte d'Ivoire, DRC, Guinea, Lesotho, Togo, Zimbabwe
US$ 501–1,000	Angola, Bolivia, Cameroon, Congo, Djibouti, Oman, Senegal, Swaziland
US$ 1,001–2,000	Albania, Chile, Cuba, Dominican Republic, Iran, Latvia, Lebanon, Moldova, South Africa, Syrian Arab Republic, Romania, Tunisia
US$ 2,001–3,000	Botswana, Costa Rica, Namibia, Venezuela
US$ 3,001–5,000	Mauritius, Reunion, Uruguay
US$ 5,001–10,000	Argentina, Cyprus, Gabon, Greece, Israel, Korea, Malta, Portugal, UAE
US$ 10,001–15,000	Australia, Canada
US$ 15,001–20,000	Belgium, Norway, Spain, UK
US$ 20,001–30,000	Austria, Finland, France, Germany, Italy, Netherlands, Sweden, USA
Greater than US$ 30,000	Denmark, Luxemburg, Japan

Source: authors elaboration on http://www.fao.org/docrep/003/x8423e/x8423e10.htm#P1851 and http://news.mongabay.com/bioenergy/2006/09/land-prices-in-africa.html. Note that some data refer to the late1990s.

Table A5 Evidence of impacts of biofuel and biogas projects in sub-Saharan Africa

Issues	Source	Area/Scale	Countries	Evidence
Competing land and water uses; employment opportunities	Franco (2010)	Large-scale project involving 30,000 ha	Mozambique	Diversion of arable land, water resources and other public resources from food production. In 2007, conflicts about the resettlement of local communities to set up a sugarcane ethanol plantation on 30,000 ha in Gaza province. Few jobs created or sustained.
Land deals	Vermeulen and Cotula (2010)	Large land deals	Ethiopia, Ghana, Mali, Madagascar, Mozambique and Tanzania	Local people's capacity to bargain or give free consent to investments is limited by their lack of access to economic and institutional alternatives. In negotiations, government agencies tend to align with the interests of large-scale investors.
Competing land and water uses; environmental pressure; economic and political viability of the projects	Deininger et al. (2011) Nhantumbo and Salomão (2010)	Large-scale project: concession of use rights on 30,000 ha to an MNC to produce sugar cane for ethanol (project cancelled)	Mozambique	Local people lost access to forest for fuelwood, game meat, fish and reduced access to water. Biofuels projects exacerbate competition for land, water and other resources. Low enforcement of legislation and agreements between investors and communities, no genuine community consultation.
Competing land and water uses; environmental pressure; land deals	Sulle and Nelson (2009)	Large-scale biofuel investments (22,000 in process of being acquired and 8,211 already acquired)	Tanzania	Negative impacts on access to forest and community-based natural resources or livestock grazing. Inadequate compensation to local communities.
Generation of income sources and employment opportunities, land access	Sulle and Nelson (2009)	Hybrid model (FELISA) which combines large plantations and contract farming. It involves about 5,000 ha.	Tanzania	Low impact on land access. Potential positive impacts on employment and agricultural production opportunities.
Competing land and water uses; employment opportunities	Deininger et al. (2011)	Large-scale project on 20,000 ha	Mozambique	Negative effects on grazing and fertile land and forest community rights. Few jobs created or sustained
Food security, economic viability of the projects	Diaz-Chavez et al. (2010)	Five small jatropha producer projects and venture (Mali Folkecentre's Garalo project, Mali Biocarburant SA, the Jatropha Mali Initiative, and GERES)	Mali	In one project, water access was identified as one of the main barriers for planting jatropha. Also access to inputs is an obstacle. The demand for jatropha grains greatly surpasses the supply. Ethanol produced is consumed in Mali and Burkina Faso. Jatropha programmes have not compromised food production at local level

Environmental risks and opportunities	Romijn (2011)	Unspecified	Angola, Tanzania, Zambia, Mozambique and Zimbabwe	Jatropha can help sequester atmospheric carbon when grown on complete wastelands and in severely degraded conditions. Conversely, when introduced in tropical woodlands with substantial biomass and medium/ high organic soil carbon content, jatropha creates significant emissions that offset any GhG savings from the rest of the biofuel production chain.
Energy security, macroeconomic impacts	Franco (2010)	Uspecified	Mozambique	Biofuels are largely for export to EU countries and South Africa.
Economic viability of the projects	GTZ (2009) cited in Hunsberger (2010)	Small-scale farming	Kenya	It is not economically viable for Kenyan small farmers to sell jatropha seeds to commercial processors.
Macroeconomic impacts on poverty and economic growth	Arndt et al. (2009)	Large-scale projects	Mozambique	This study estimates the impact of large-scale biofuel investments in Mozambique on economic growth and income distribution using a dynamic computable general equilibrium (CGE) model. It found that biofuels investment can promote economic growth and reduce poverty with potential for strong gains.
Generation of income, environmental impacts, food security	Mitchell (2011)	5,000 small outgrowers who work for Diligent company and have planted 3,500 ha	Tanzania	Case study on a outgrowing farming scheme which involves 5,000 smallholders who produce jatropha seeds for sale to a Dutch company (Diligent). The model ensures a high degree of social and ecological sustainability. Farmers share significantly in the value chain and their jatropha hedges do not limit other farming activities. The sale of jatropha seeds provides extra income. There is no impact on deforestation.
Generation of income, competition for land	Sulle and Nelson (2009)	5,000 small outgrowers who work for Diligent company and have planted 3,500 ha (see above)	Tanzania	No direct negative impacts on local land access, agricultural diversification through jatropha cultivation
Generation of income, environmental impacts, food security, access to energy	Practical Action Consulting (2009)	Cooperative of c300 jatropha producers. 600 ha are under cultivation on land previously used to grow cotton.	Mali	Within the Garalo Project, small-scale farmers supply jatropha oil to a private power company that provide electricity to local consumers. The project provides a stable income to farmers and access to electricity for the community, both having stimulated the local economy.
Generation of income, access to energy, environmental risks	Practical Action Consulting (2009)	4,500 ha under cultivation; smallholder and out-grower farming	Tanzania	A sisal growing and processing company (Katani Ltd) uses sisal waste to produce biogas and to convert it into electricity (currently 150 kwh).This has increased farmers' income and community access to electricity with positive effects on local economy, public services, access to education, communication and healthcare services. Access to electricity for cooking reduces the pressure on forest

				resources.
Environmental pressure, land competition and compensation	Schoneveld et al. (2010)	Large-scale plantations	Ghana	*Opaque and non-participatory negotiations. Inadequate compensations. Community land losses and evictions. Diversion of lands from food production. People who lost their lands have shortened fallow period on the remaining plots and have lost income, suffer increased food insecurity, and lost access to vital forest products*

References

African Development Bank (2010) *Financing of Sustainable Energy Solutions*, African Development Bank.

Alfaro, L., Chanda, A., Kalemli-Ozcan, S. and Sayek, S. (2004) 'FDI and economic growth: the role of local financial markets', *Journal of International Economics* 64(1): 89–112.

Alguacil, M., Cuadros, A. and Orts, V. (2011) 'Inward FDI and growth: the role of macroeconomic and institutional environment', *Journal of Policy Modeling* 33(3): 481–496.

Allen, F. and Giovannetti, G. (2011) 'The effects of the financial crisis on sub-Saharan Africa', *Journal of Development Finance* 1:1–28.

Amigun, B., Musangob, J.K. and Stafford, W. (2011) 'Biofuels and sustainability in Africa', *Renewable and Sustainable Energy Reviews* 15:1360–1372.

Anyanwu J. (2011) 'Determinants of Foreign Direct Investment Inflows to Africa, 1980–2007', Working Paper No. 136, Tunis: African Development Bank.

Asiedu, E. (2001) 'On the determinants of foreign direct investment to developing countries: is Africa different?', *World Development* 30(1): 107–119.

Aykut, D., and Sayek, S. (2007) 'The role of the sectoral composition of foreign direct investment on growth', in L. Piscitello and G. Santangelo (eds) *Do multinationals feed local development and growth?*, Amsterdam: Elsevier.

Bailis, R., Cowan, A., Berrueta, V., and Masera, O. (2009) 'Arresting the killer in the kitchen: the promises and pitfalls of commercializing improved cookstoves', *World Development* 37(10): 1694-1705.

Balasubramanyam, V. N., Salisu, M. and Sapsford, D. (1996) 'Foreign direct investment and growth in EP and IS Countries', *Economic Journal* 106: 92–105.

Bazilian, M., Nussbaumer, P., Haites, E., Levi, M., Howells, M. and Yumkella, K. (2010) 'Understanding the scale of investments for universal energy access', *Geopolitics of Energy* 32(10-11): 21–42.

Bazilian, M, Rogner, H., Howells, M., Hermann, S., Arent, D., Gielen, D., Steduto, P., Mueller, A., Komor, P., Tol, R.S.J., and Yumkella, K.K. (2011) 'Considering the energy, water and food nexus: towards an integrated modelling approach', *Energy Policy*, in press.

Bazilian, M., Gualberti, G., Haites, E., Levi, M., Siegel, J., Kammenf, D.M., and Joergen, F. (2011) 'Informing the Financing of Universal Energy Access: An Assessment of Current Flows', FEEM Working Paper No. 56.2011, Milan: FEEM.

Beck, T., Maimbo, S., Faye, I. and Triki T. (2011) *Financing Africa through the crisis and beyond*, Washington, DC: World Bank.

Berndes, G. (2002) 'Bio-energy and water-the implications of large-scale bio-energy production for water use and supply', *Global Environmental Change* 12: 253–271.

Blomstrom, M., Lipsey, R. E. and Zejan, M. (1994) 'What explains developing country growth', NBER Working Paper No. 4132, Cambridge, MA: NBER.

BNEF (2011) *Bloomberg New Energy Finance Summit: Results Book 2011*, 4–7 April, New York: BNEF.

Bonassi, C., Giovannetti, G. and Ricchiuti, G. (2006) 'The Effects of FDI on Growth and Inequality', in G. A.Cornia (ed.) *Pro Poor Macroeconomics – Potential and Limitations*, Basingstoke: Palgrave Macmillan.

Borensztein, E., De Gregorio, J. and Lee, J. W. (1998) 'How does foreign direct investment affect economic growth?', *Journal of International Economics* 45: 115–135.

Brambila-Macias, J. and Massa, I. (2010) 'The global financial crisis and sub-Saharan Africa: the effects of slowing private capital inflows on growth', *African Development Review* 22: 366–377.

Briceño-Garmendia, C., Smits, K., and Foster, V. (2008) 'Financing Public Infrastructure in Sub-Saharan Africa: Patterns, Issues, and Options', AICD Background Paper 15, Africa Infrastructure Sector Diagnostic, Washington, DC: World Bank.

CAPRi-UNDP (2011) 'Land Rights for African Development From Knowledge to Action', CAPRi Policy Brief, Washington, DC: IFPRI.

Castel V. and Kamara, A. (2009) 'Foreign Investments in Africa's Agricultural Land: Implications for Rural Sector Development and Poverty Reduction', African Development Bank Development Research Brief, no. 2, Office of the Chief Economist, Tunis: AfDB.

Chakraborty, C., and Nunnenkamp, P. (2008) 'Economic reforms, FDI, and economic growth in India: a sector level analysis', *World Development* 36(7):1192–1212.

Cotula, L., Dyer, N., and Vermeulen, S. (2008) *Fuelling Exclusion? The Biofuels Boom and Poor People's Access To Land*, London: IIED.

Cotula, L., Vermeulen, S., Leonard, R. and Keeley, J. (2009) *Land grab or development opportunity? Agricultural investment and international land deals in Africa*, London & Rome: IIED, FAO & IFAD.

Daniel, S. and Mittal, A. (2009) *The great land grab. Rush for world's farmland threatens food security for the poor*, Oakland, CA: The Oakland Institute.

Daniel, S. and Mittal, A. (2010) *(Mis)Investment in agriculture. The role of the international finance corporation in global land grabs*, Oakland, CA: The Oakland Institute.

Dauvergne, P. and Neville, K.J. (2010) 'Forests, food, and fuel in the tropics: the uneven social and ecological consequences of the emerging political economy of biofuels', *Journal of Peasant Studies* 37(4): 631–60.

De Fraiture, C., Giordano, M. and Liao, Y.S. (2008) 'Biofuels and implications for agricultural water use: blue impacts of green energy', *Water Policy* 10: 67–81.

Delucchi, A.M. (2010) 'Impacts of biofuels on climate change, water use, and land use', *Annals of the New York Academy of Science* 1195: 28–45.

Deichmann, U., Meisner, C., Murray, S. and Wheeler, D. (2011) 'The economics of renewable energy expansion in rural Sub-Saharan Africa', *Energy Policy* 39: 215–227.

Deininger, K. (2011) 'Challenges posed by the new wave of farmland investments', *Journal of Peasant Studies* 38: 217–247.

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H. and M, Stickler (2011) *Rising Global Interest in Farmland: Can it Yield Sustainable and Equitable Benefits?,* World Bank, Washington, DC.

Development Afrique (2009) 'Foreign Investment in African Agriculture: New Land Grab or Opportunity?' October, available at: http://developmentafrique.com/?p=75.

Diaz-Chavez, R., Mutimba, S., Watson, H., Rodriguez-Sanchez, S. and M. Nguer (2010) 'Mapping Food and Bioenergy in Africa: A Report Prepared for FARA. Accra, Ghana.

Doythc, N., and Uctum, M. (2011) 'Does the worldwide shift of FDI from manufacturing to services accelerate economic growth? A GMM estimation study', *Journal of International Money and Finance* 30: 410–427.

Ecofys NL – REN21 (2008) 'Global Potential of Renewable Energy Sources: A Literature Assessment', available at: http://www.ren21.net/.

Egger, P. and Winner, H. (2005) 'Evidence on corruption as an incentive for foreign direct investment', *European Journal of Political Economy* 21(1): 932–952.

EIA – US Energy Information Administration (2010) *International Energy Outlook 2010*, Washington, DC: US Department of Energy.

Eregha, P.B. (2011) 'The Dynamic Linkages Between Foreign Direct Investment and Domestic Investment in ECOWAS Countries: A Panel Cointegration Analysis', paper presented at the CSAE Conference, University of Oxford, 20–22 March.

Ernst & Young (2011) *It's Time for Africa: Ernst & Young's 2011 Africa Attractiveness Survey*, Cape Town: Ernst & Young.

Farley, P. (2011) 'Introduction: next generation biofuels', *Nature* 474, S2–S5, 23 June.

Franco, J. (2010) 'Assumptions in the European Union biofuels policy: frictions with experiences in Germany, Brazil and Mozambique', *The Journal of Peasant Studies* 37(4): 661–698.

FIAN (2010) 'Land grabbing in Kenya and Mozambique: A report on two research missions –and a human rights analysis of land grabbing', Heldelberg: FIAN.

Fonseca, M. B., Burrell, A., Gay, H., Henseler, M., Kavallari, A., M'Barek, R., Pérez Domínguez, I., and Tonini, A. (2010) *Impacts of the EU Biofuel Target on Agricultural Markets and Land Use: A Comparative Modelling Assessment*, Seville: European Commission Joint Research Centre, Institute for Prospective Technological Studies.

FoEE (Friends of the Earth Europe) (2010) *Africa: up for grabs. The scale and impact of land grabbing for agrofuels*, Brussels: FoEE.

Fthenakis, V., Mason, J.E. and Zweibel, K. (2009) 'The technical, geographical, and economic feasibility of solar energy to supply the energy needs of the US', *Energy Policy* 37: 387–399.

Friis, C. and Reenberg, A. (2010) 'Land grab in Africa: Emerging land system drivers in a teleconnected world', GLP Report No. 1, Copenhagen: GLP-IPO.

Galan-del-Castillo, E. and Velasquez, E. (2010) 'From water to energy: the virtual water content and water footprint of biofuel consumption in Spain', *Energy Policy* 38: 1345–1352.

GNESD (2007) *Reaching the Millennium Development Goals and Beyond: Access to Modern Forms of Energy as a Prerequisite*, Roslkilde: Global Network on Energy for Sustainable Development (GNESD).

Gerbens-Leenes, P.W., Hoekstra, A.Y., and van der Meer, T.H. (2009) 'The water footprint of energy from biomass: A quantitative assessment and consequences of an increasing share of bio-energy in energy supply', *Ecological Economics* 68:1052–1060.

Grether J. M., and de Melo, J. (2003) 'Globalisation and Dirty Industries: Do Pollution Havens Matter?,' NBER Working Papers 9776, Boston, MA: NBER.

Görgen, M., Rudloff, B. Simons, J. Üllenberg, A., Väth, S. and Wimmer, L. (2009) *Foreign direct investment (FDI) in land in developing countries*, Tyskland: GTZ, Federal Ministry For Economic Cooperation and Development, Division 45.

GRAIN (2010) 'Turning African Farmland Over to Big Business: The US's Millennium Challenge Corporation', *Seedling*, 3–5 April.

GTZ (2009a) 'Jatropha Reality Check: A field assessment of the agronomic and economic viability of Jatropha and other oilseed crops in Kenya', report prepared by Endelevu Energy, World Agroforestry Centre and Kenya Forestry Research Institute, Nairobi: GTZ.

GTZ (2009b) 'Foreign Direct Investment (FDI) in land in developing countries', Eschborn: GTZ.

Hamilton, K. (2010) 'Scaling up Renewable Energy in Developing Countries: finance and investment perspectives', Energy, Environment & Resource Governance Programme Paper 02/10, London: Chatham House.

Hammouda, H.B. and Osakwe, P. (2006) Financing development in Africa: trends, issues and challenges, ATPC Work in Progress No. 48, UNECA, December.

HLPE (2011) *Land tenure and international investments in agriculture: A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security*, Rome: HLPE.

Hunsberger, C. (2010) 'The politics of *Jatropha*-based biofuels in Kenya: convergence and divergence among NGOs, donors, government officials and farmers', *Journal of Peasant Studies* 37(4): 939–962.

IEA (2011) *Energy Statistics for non-OECD Countries*, Paris: International Energy Agency.

IPCC (Intergovernmental Panel on Climate Change) (2011) *Special Report on Renewable Energy Sources and Climate Change Mitigation*, available at http://srren.ipcc-wg3.de/.

Jacobson, M.Z. and Delucchi, A. (2011) 'Providing all global energy with wind, water, andsolar power, Part I: Technologies, energy resources, quantities and areas of infrastructure, and materials', *Energy Policy* 39: 1154–1169.

Johnstone, N., Haščič, I. and D. Popp (2010) 'Renewable energy policies and technological innovation: evidence based on patent counts', *Environmental and Resource Economics* 45(1):133-155.

Kemeny, T. (2010) 'Does foreign direct investment drive technological upgrading?', *World Development* 38(11):1543–1554.

Khadaroo, B. and Seetanah, A. J. (2007) 'Foreign Direct Investment And Growth: New Evidences from Sub-Saharan African Countries', paper presented at the CSAE Conference on 'Economic Development in Africa', University of Oxford, 20–22 March.

King, C.W. and Webber, M.E. (2008) 'Water intensity of transportation', *Environmental Science and Technology* 42(21): 7866–7872.

Kulichenko, N. and Wirth, J. (2011) 'Regulatory and Financial Incentives for Scaling Up Concentrating Solar Power in Developing Countries', Energy and Mining Sector Board Discussion Paper No. 24, Washington, DC: World Bank.

Land Deal Brief (2011) *Understanding Land Investment Deals in Africa*, Oakland, CA: The Oakland Institute.

Lim, E.G. (2001) 'Determinants of, and the relation between, foreign direct investment and growth: a summary of the recent literature', IMF Working Paper No. 175, Washington, DC.

López, R. (2011) 'World Economic Crises: Commodity Prices and Environmental Scarcity As Missing Links', in *Proceedings of the 2010 ABCDE Conference, Stockholm, Sweden, June 1-3, 2010*, Washington, DC: World Bank.

Massa, I. (2011) 'Sub-Saharan Africa in global trends of water investment drivers and the challenge of the private sector', paper prepared for the 2011–2012 European Report on Development (draft).

McKinsey Global Institute (2010) *Lions on the move: The progress and potentials of African Economies*, June.

Mitchell, D. (2011) *Biofuels in Africa: Opportunities, Prospects, and Challenges*, Washington, DC: World Bank.

Modi, V., McDade, S., Lallement, D. and Saghir, J. (2005) *Energy Services for the Millennium Development Goals*, Energy Sector Management Assistance Programme, United Nations Development Programme, UN Millennium Project and World Bank, New York: World Bank & UNDP.

Naudé, W. A. and Krugell, W.F. (2007) 'Investigating geography and institutions as determinants of foreign direct investment in Africa using panel data', *Applied Economics* 39 (10–12):1223–34.

Ndikumana L. and Verick, S. (2008) 'The Linkages between FDI and Domestic Investment: Unravelling the Developmental Impact of Foreign Direct Investment in Sub-Saharan Africa', IZA Discussion paper 3296, Bonn: IZA.

Neudoerffer, R.C., Malhotra, P. and Ramana, P.V. (2001) 'Participatory rural energy planning in India – a policy context', *Energy Policy* 29(5): 371–381.

Nhantumbo, I., and Salomão, A. (2010) *Biofuels, Land Access and Rural Livelihoods in Mozambique*, London: IIED.

Nkwetta, D.N., Smyth, M., Van Thong, V., Driesen, J., and Belmans, R. (2010), 'Electricity supply, irregularities, and the prospect for solar energy and energy sustainability in Sub-Saharan Africa', Journal of Renewable and Sustainable Energy 2(2): 023102.

Nouni, M.R., Mullick, S.C. and Kandpai, T.C. (2008) 'Providing electricity access to remote areas in India: niche areas for decentralised electricity supply', *Renewable Energy* 34(2): 430–434.

Norwegian People's Aid (2011) 'The New Frontier. A baseline survey of large-scale land-based investment in Southern Sudan', Oslo: NPA.

ODDO (2010) 'Land grabbing, myth or reality?' Paris: ODDO Securities.

OECD/AfDB (2010) *African Economic Outlook 2010*, Paris: OECD & AfDB.

OECD, AfDB, UNECA, UNDP (2011) *African Economic Outlook 2011: Africa and its Emerging Partners*, Paris: OECD & AfDB.

OECD/IEA (2010) *World Energy Outlook*, Paris: International Energy Agency.

OECD/IEA (2011) *Clean Energy Progress Report*, Paris: International Energy Agency.

Odhiambo, M. O. (2011) *Commercial pressures on land in Africa: A regional overview of opportunities, challenges, and impacts,* International Land Coalition, Commercial Pressure on Land, Rome: ILC.

Ölz, S. and Beerepoot, M. (2010) *Deploying Renewables in Southeast Asia: Trends and potentials*, Paris: OECD & IEA.

OPEC (2010) *World Oil Outlook 2010*, Vienna: OPEC.

Openshaw, K. (2010) 'Can Biomass Power Development?', *IIED Gatekeeper* 144, London: IIED.

Practical Action Consulting (2009) 'Small-Scale Bioenergy Initiatives: Brief description and preliminary lessons on livelihood impacts from case studies in Asia, Latin America and Africa', prepared for PISCES and FAO by Practical Action Consulting.

Razafimahefa, I. and Hamori, S. (2005) 'An empirical analysis of FDI competitiveness in sub-Saharan Africa and developing countries,' *Economics Bulletin* 6: 1–8.

Radelet, S. (2010) 'Emerging Africa: how 17 countries are leading the way', Washington, DC: Center for Global Development.

Richardson, B (2010) 'Big sugar in southern Africa: rural development and the perverted potential of sugar/ethanol exports', *Journal of Peasant Studies* 37(4): 917–38.

Reiter, S.L. and Steensma, H. K. (2010) 'Human development and foreign direct investment in developing countries: the influence of FDI policy and corruption', *World Development* 38(12): 1678–1691.

REN21 – Renewable Energy Policy Network for the 21st Century (2011) *Renewables 2011 Global Status Report*, Paris: REN21 Secretariat.

Romijn, H.A. (2011) 'Land clearing and greenhouse gas emissions from Jatropha biofuels on African Miombo Woodlands', *Energy Policy* 39(10): 5751–5762.

Schoneveld, G.C., German, L.A. and Nukator, E. (2010) 'Towards Sustainable Biofuel Development: Assessing the Local Impacts of Large-Scale Foreign Land Acquisitions in Ghana', paper prepared for World Bank Annual Conference on Land Policy and Administration, Washington, DC, 26–27 April.

Smaller, C. and Mann, H. (2009) *A thirst for distant land: Foreign investment in agricultural land and water*, Winnipeg: International Institute for Sustainable Development (IISD).

Sulle, E. and Nelson F. (2009) *Biofuels, land access and rural livelihoods in Tanzania*, London: IIED.

The Oakland Institute (2011) *Understanding land investments in Africa*, *Sierra Leone,* Oakland, CA: The Oakland Institute.

Thiam, D.R. (2010) 'Renewable decentralised in developing countries: appraisal from microgrids project in Senegal', *Renewable Energy* 35(8): 1615–1623.

Timilsina, G. R. and Shrestha, A. (2010) 'Biofuels: Markets, Targets and Impacts', World Bank Policy Research Working Papers 5364, Washington, DC: World Bank.

UNCTAD (2001) *World Investment Report*, New York & Geneva: United Nations.

UNCTAD (2005) *Economic Development in Africa – Rethinking the Role of Foreign Direct Investments*, New York & Geneva: United Nations.

UNCTAD (2009) *World Investment Report – Transnational Corporations, Agricultural Production and Development*, New York & Geneva: United Nations.

UNCTAD (2011) *World Investment Report 2011: Non-Equity Modes of International Production and Development*, New York & Geneva: United Nations. Also available at: http://www.unctad.org/

UNECA (2011) *Economic Report on Africa 2011. Governing development in Africa – the role of the state in economic transformation*, Addis Ababa: UNECA.

UN Energy (2005) 'The Energy Challenge for Achieving the Millennium Development Goals', UN Energy Paper, New York: United Nations.

UNEP and BNEF (2011) *Global Trends in Renewable Energy Investment 2011. Analysis of Trends and Issues in the Financing of Renewable Energy*, available at http://www.fs-unep-centre.org/.

UNEP and MISI (2009) *Why Clean Energy Public Investment Makes Economic Sense - The Evidence Base,* available at http://www.unep.org.

van Gelder, J.W. and German, L. (2011) 'Biofuel finance: Global trends in biofuel finance in forest-rich countries of Asia, Africa and Latin America and implications for governance', CIFOR infobriefs, No. 36, January, Bogor: CIFOR.

Vermeulen, S. and Cotula, L. (2010) 'Over the heads of local people: consultation, consent, and recompense in large-scale land deals for biofuels projects in Africa', *Journal of Peasant Studies* 37(4): 899–916.

von Braun J. (2008) 'Food and Financial Crises: Implications for Agriculture and the Poor', Brief prepared for the CGIAR annual general meeting, Maputo, December

von Braun, J. and Meinzen-Dick, R. (2009) *'Land grabbing' by foreign investors in developing countries: Risks and opportunities*, IFPRI Policy Brief 13, Washington, DC: International Food Policy Research Institute.

von Maltitz, G., Haywood, L., Mapako, M., and Brent, A. (2009) 'Analysis of opportunities for biofuel production in sub-Saharan Africa', CIFOR Environmental Services Briefs, Bogor: CIFOR.

von Maltitz, G. and Stafford, W. (2011) Assessing opportunities and constraints for biofuel development in sub-Saharan Africa, CIFOR Working Paper 58, Bogor: CIFOR.

Warnholz, J.-L. (2008) 'Is investment in Africa low despite high profits?' CSAE WPS/2008-3, available at: http://ora.ox.ac.uk/objects/uuid%3A4554a673-c330-4336-9edd-6ad44a6a41fd.

Watson, H.K. (2011) 'Potential to expand sustainable bioenergy from sugarcane in southern Africa', *Energy Policy* 39: 5746–5750.

Wooster, R.B. and Diebel, D.S. (2010) 'Productivity spillovers from foreign direct investment in developing countries: a meta-regression analysis', *Review of Development Economics* 14(s1): 640–655.

Woodhouse, P. and Ganho, S. (2011) 'Is water the hidden agenda of agricultural land acquisition in SSA', Paper presented at the International Conference on Global Land Grabbing, University of Sussex, 6–8 April.

World Bank (2007) *'Agriculture for Development', World Development Report 2008*, Washington, DC: World Bank.

World Commission on Dams (2000) *Dams and Development – A New Framework for Decision-Making,* London & Sterling, VA: Earthscan.

World Energy Council (2010a) *2010 Survey of Energy Resources*, London: WEC.

World Energy Council (2010b) *Water for Energy*, London: WEC.

Yang, H., Zhou, Y. and Liu, J. (2009) 'Land and water requirements of biofuels and implications for food supply and the environment in China', *Energy Policy* 37(5): 1876–1885.

Zuk, M., Rojas, L., Blanco, S., Serrano, P., Cruz, J., Angeles, F. , Tzintzun, G., Armendariz, C., Edwards, R.D., Johnson, V., Riojas-Rodriguez, H. and Masera, O. (2007) 'The impact of improved wood-burning stoves on fine particulate matter concentrations in rural Mexican homes', *Journal of Exposure Science and Environmental Epidemiology* 17(3): 224–232.