Not only land:
Drivers and the challenge of the energy-land-water nexus in Sub Saharan Africa

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Abstract

This paper explores recent patterns of domestic and foreign investments on renewable energies. It describes drivers and features of investment in renewable energies, with special attention to biofuels highlighting that they are likely to increase competition over land and water in a world where land and water are increasingly scarce. The analysis focuses on trends and developments in Sub Saharan Africa. Here capital is particularly needed not only because of low saving rates and domestic tax collection, but also to allow those higher rates of growth necessary to catch up and overcome developmental and energy gaps. Despite the large oil and gas reserves, Africa is still very far from meeting its energy needs. But the financing gap is not the only obstacle. The paper identifies and discusses a range of institutional, market and technological barriers that jeopardize the chances to meet energy goals. We maintain that the case of investing in renewable energies, and even more so in biofuels, is particularly interesting because it represents a valuable opportunity to break a so far unfair and unsustainable pattern due to incapacity of the current energy system to satisfy energy needs of the poor without compromising the ability of future generations to satisfy their own needs. But the role of domestic and foreign investors is different and to help local populations to fully benefit from investments, land and water rights have to be clearly defined and government commitments strong. The paper contributes also trying to put together scattered existing information on investment in land, renewable energies and biofuels, including recent public - private partnerships.

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, p. j). Indeed, during the last decade, several developing countries, also in Sub Saharan Africa, have attracted private capital. Due to limited domestic resources, private sector expansion, however, has been heavily dependent on external capital resources. This is particularly so in Sub- Saharan Africa (SSA), characterized by very low domestic private resources (low tax base on the one hand and low saving rates on the other, see OECD and AfDB 2010). Amongst foreign sources, official aid assistance has been increasingly put into discussion, while foreign direct investments and remittances are becoming more and more central. In particular, it has been maintained that foreign direct investment 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 special eye 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 last decade and until the 2008-2009 global economic crisis. Yet it is far from obvious that FDI have had the expected growth and developmental impact in many developing countries. A recent literature review (Reiter and Steensma, 2010), for instance, shows that empirical findings on the role of FDI in economic development are still 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 controversial results. The heterogeneity of evidence on the developmental impact of foreign direct investments is explained by resorting to 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 labor intensity in investment sectors. [2] On the one hand, FDI are still inadequate to match the rapid pace of development of many countries, particularly so in SSA, and are often inappropriate due to the nature of the projects they finance[3]. On the other hand, however, FDI impact on growth and employment crucially depends on the sector flows are channeled through. The type of FDI and its structural composition matter for developmental effects at least as much as the volume.

Bonassi et al. (2006), for instance, find that the developmental impact cannot be computed 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, more far 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 the growth effects differ (in terms of stimulus on domestic consumption, employment, etc.) but also the externalities are different. For instance, some

[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 therefore it could 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 in other developing countries, due to a higher poverty, distance from MDGs; furthermore, domestic funds are lower. However, 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).

investments in water intensive manufacturing industries can have positive growth effects in the short run but negative impacts in the long run because of depletion of resources or pollution. [5]

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

Against this background, this work and its companion paper deal with FDI and domestic investment trends and characteristics by analyzing specific sectors of destination. In this paper we focus on investment in renewable energy and in land, while, in the companion paper, Massa (2011) examines drivers and challenges of investment in water sector.

This paper, after a brief sketch of the general trends in domestic and foreign investment in Sub-Saharan Africa (section 2), discusses drivers and barriers of investments in renewable energy (section 3), trend in investments, with a focus on renewable energies and Sub Saharan Africa (section 4). It then discusses the energy-land-water nexus and the current wave of farmland investments in Sub-Saharan Africa (section 5), and concludes (section 6). An Appendix describes more in detail the recent land deals in Sub Saharan Africa and their intended use.

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

The last decades have witnessed significant increase both in domestic capital and in the inflows of foreign direct investment to developing countries. The existing gap between domestic savings[7] and desired level of investment in many developing countries has been filled by the transfer of resources from outside, FDI being one of the most important ones. Indeed in the 1990s, FDI were around 30% of total investments, in 2010 around 50% of total: 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, for the first time, flows to developing and emerging countries "absorbed more than half of FDI global flows" (OECD et al. 2011), showing a marked change from the past.

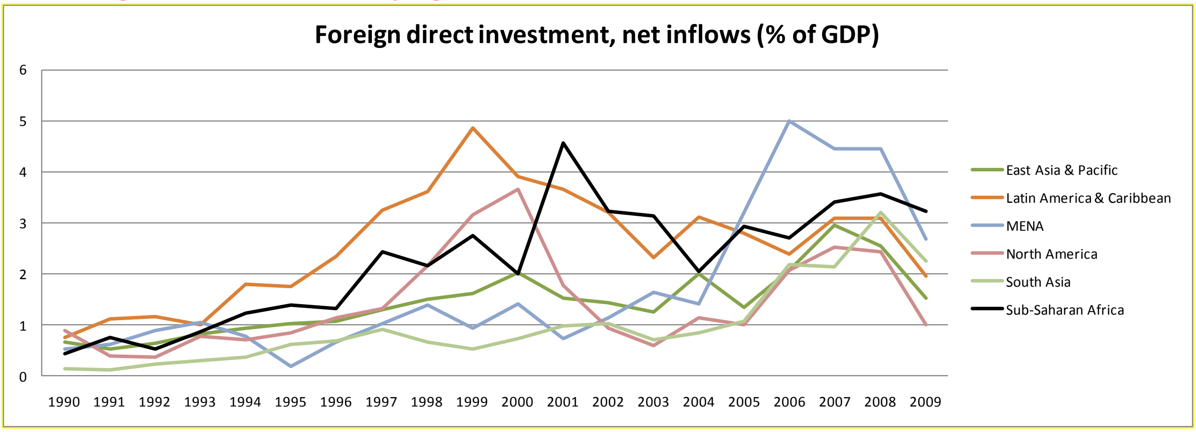
Figure 2.1 shows that the last two decades are still characterized by marked differences in levels and patterns of FDI as a percentage of GDP between different groups of developing countries.

[5] There has been in the literature a debate on the so called "dirty industries", which tend to be highly water intensive and water polluting and when environmental laws become more restrictive in developed countries are outsourced to developing countries (often in those with weak institutions). For instance, water is used intensively in textile production (for cleaning, bleaching, dyeing etc), where several high labor intensive phases of productions are offshored; 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 theretical and empirical literature on relationships between these different flows. He highlights the importance of sector: in manufacturing crowding in prevails, while in the primary it is crowding out to prevail.

[7] Low savings rate, in turn, can be explained by the low and volatile incomes and the demographic structure of African populations, which are dominated by young age-groups, high illiteracy rates, and low life expectancy. See Beck et al. (2011).

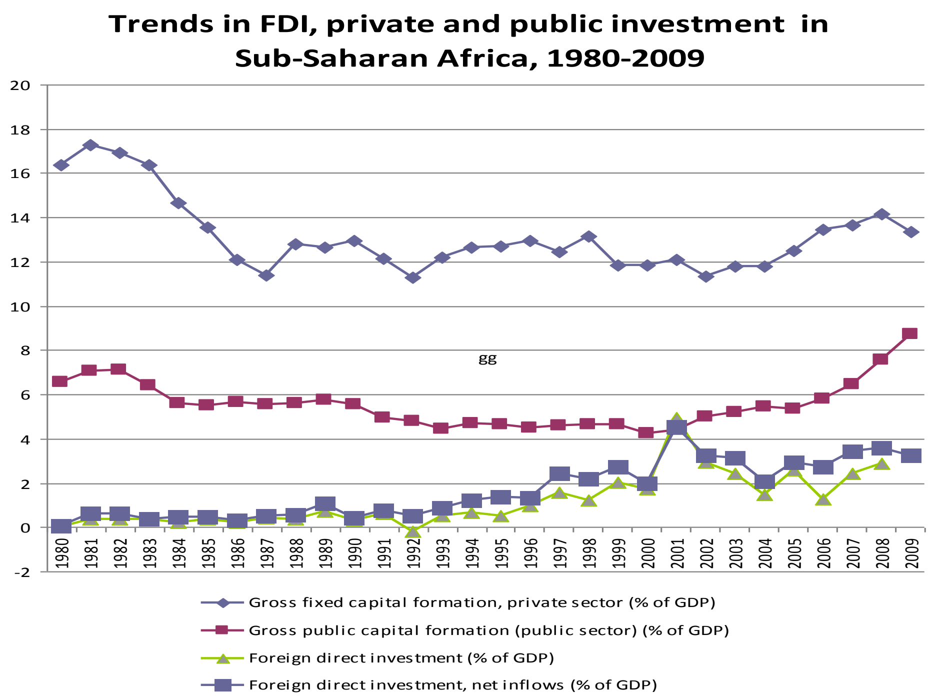
Figure 2.1: FDI to developing countries, % of GDP



Source: UNCTAD- WIR, accessed on September 2011

Up to the year 2000, middle income countries (especially in Latin America) have benefited more from foreign flows, while low income and Sub-Sahara countries have been left behind, also because of higher investment risk, low liberalization and weak infrastructures. Since 2000, however, there has been a rapid increase of capital flows. According to the African Economic Outlook (2011), total investment flows to Africa increased almost fivefold form 2000 to reach 126 billion dollar in 2010. And, even more importantly, their composition changed in favour of Foreign Direct Investment (contrasting a decrease of official aid). Fig 2.2 below displays the evolution of domestic and foreign investments in SSA countries as well as the private versus public investments (at home). The figure shows that, between 1980 and 1995 private and public domestic capital fell while FDI was low but fairly stable. After 1995 on average, FDI has been growing relatively more that domestic private flows. Public flows after a long period of stagnation (1980-2001) have recuperated only in the last few years (after 2005, see also Ernst & Young 2011).

Figure 2.2: Trends in FDI, private and public Investments, aggregate



Source: African Development Indicators, accessed on September 2011

Trends in domestic and foreign investment are closely connected. Ndikumana and Verick (2008), for example, find that in Sub-Saharan Africa 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 record is likely to act as a signal and attract also foreign capital. Given their close links, domestic and foreign investment are likely to be driven by similar factors. Indeed, a widespread negative perception of SSA has negatively affected both domestic and foreign investments up to the early 2000s (the lost decades). Things have recently changed (McKinsey 2010, Ernst & Young 2011, Radelet 2010), as shown also by the developments after 2005 (Graph 2).

FDI to (some countries in) Sub Saharan Africa had been increasing 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, Enst &Young, 2011). The increase has been higher in Africa than in non-African emerging economies (though the level is still lower, as pointed out in the recent Report by Ernst &Young, 2011), given SSA increasing attractiveness[8]. This growth pattern continued till the economic crisis of 2008-2009, which has reduced the total amount of funds and induced delays or cancellations of investment projects (Brambila-Macias and Massa, 2010, Allen and Giovannetti, 2011). In Sub-Saharan Africa, levels of risk can be high, but levels of profitability are high too, with competition in some sectors comparatively low[9]. According to Ernst and 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 twice the global average and 8% above that of other developing countries" (African economic Outlook, 2011, p. 44).

Despite the marked improvement of the last few years, there are still a number of elements acting as deterrent of investments in African countries with respect to other developing countries and therefore as potential explanation of the delay of Sub Saharan Africa: political risk and often inadequate human capital, macro-economic instability, low productivity, exchange rate volatility and lack of infrastructures[10] (see amongst others, 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 invest in a high risk continent 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 absence of capacity to manage public resources, which can lead to substantial problems of corruption[11]. The existence of good institutions in general helps attracting and most of all in keeping FDI (cf. Naudé and Krugell 2007). However, this view is sometimes challenged for Africa: not only in some sectors (e.g. manufacturing) foreign investments crowd in domestic investments and in other (primary sector) they crowd them out[12] , but also some specific investments, for instance those in land and "dirty industries", are often outliers, in that they tend to be channeled in countries with weak governance to avoid strict rules and laws. Furthermore,

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[8] Since 2005 Africa has been attracting more FDI than ODA.

[9] 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 to be able to exploit the potentialities is the often low level of human capital.

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

[11] One solution is the implementation of a mechanism that creates external controls on revenue generating entities.

[12] See for instance Erengha (2011) claiming that this is related to the different elasticity of the demand for export in different sectors. Further analysis, at more disaggregated level is needed to better investigate these issues.

according to Egger and Winner (2005) in the presence of excess regulation, weak enforcement rules and government bureaucracy, corruption serves as *helping hand* to foreign investors (instead of being a disruptive element).

Data on domestic and foreign capital flows at sectoral level are at best scattered. As for Sub-Saharan Africa, given abundant natural resources of the continent, there is little surprise that extractive industries are a major area for foreign investments. However, in the last few years, many investors started to diversify, investing in tourisms, consumer products, constructions, telecommunications,, financial sectors, land and renewable energies (see Ernst & Young, 2011 p.31, Mc Kinsey, 2010 and UNCTAD 2011).

In what follows, we analyze trends and drivers of investment in different renewable energy applications in order to assess to what extent the global energy market is evolving towards a green and equitable energy system. We will therefore take a closer look at the trends in renewable energy investment in Sub-Saharan Africa, with particular reference to biofuel investment. Sub Sub-Saharan Africa is characterized by high energy poverty rates, a large energy financing gap, water scarcity and is attracting large-scale land investments for biofuel projects. This focus, therefore, allows us shedding some lights on the interrelationships between energy, land and water, a nexus which is receiving growing attention (see, for instance, Bazilian et al., in press) together with a greater awareness of increasing scarcity of natural resources.

3. Drivers of renewable energy investment

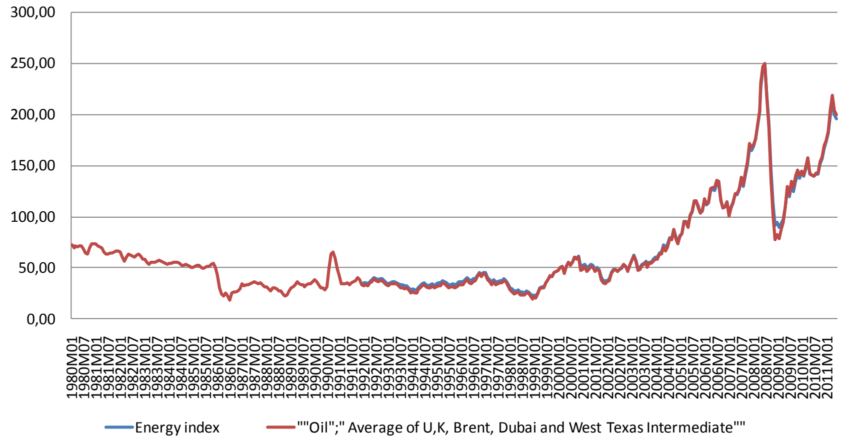
Over the last few years, oil price fluctuations around a general upward trend have revealed the growing vulnerability and limits of a global energy system which is underpinned by non-renewable resources. In particular, the current energy system has largely failed to meet energy needs of the poor while compromising the ability of future generations to satisfy their own needs. The large scale deployment of renewable energy can present a valuable opportunity to break this unfair and unsustainable pattern. Global investment in renewable energy, in the last decade, have grown about 7-fold, from $33 billion in 2004 to $211 billion in 2010 (UNEP and BNEF 2011). Still, after years of international policy commitments by many governments for deployment of low-carbon technologies, in 2009, renewable energy sources accounted for only 16 percent of global final energy consumption and, if we exclude traditional biomass and hydropower, the other renewables (solar, modern biomass, wind, geothermal, and biofuels) covered only 3 percent of world final energy consumption (REN21 2011). In 2010, total renewable investment, including hydro-electric power, reached $233 billion, of which $187 billion financed generation investments almost catching up investment in fossil-fuel power plant estimated at $219 billion. However, investment in all energy includes also coal, gas and other upstream investment costs and it is estimated at a much higher level of $1.2 trillion in 2010 (UNEP and BNEF 2011). Thus, at global level, renewable energy sector is growing fast but from a very small base. A series of factor have contributed to this pattern.

3.1. Factors which boost investment in renewable energy

***The role of fossil fuels "scarcity"*:** One of the factors fostering renewable technologies investment is represented by recent trends and future projections of high and growing fossil fuels prices. Until the 1990s - early 2000s, the global economy was characterized by a polarization between a narrow elite of "North" countries that increasingly import commodities and energy from the "South" that acted as the main supplier of these goods in a context of resource abundance and high price elasticity. Development path of North countries has been characterized by an unsustainable high energy intensity. The emergence of a group of new industrialized small countries did not alter this

equilibrium and supply continued to accommodate to demand increases with contained effects on energy prices, with the exception of the energy crises of the Seventies that were mainly caused by geo-political factors. In the last decade, instead, this situation has begun to change. The today New Industrialized Countries (mainly China and India) are real giants whose population represent a large portion of world population. Moreover, starting from lower level of environmental regulations and technological development, their productions tend to be highly energy intensive.
As a result, the economic boom of these countries has brought a rapid increase in demand for energy and primary commodities that has translated in growing oil prices (Figure 3.1).

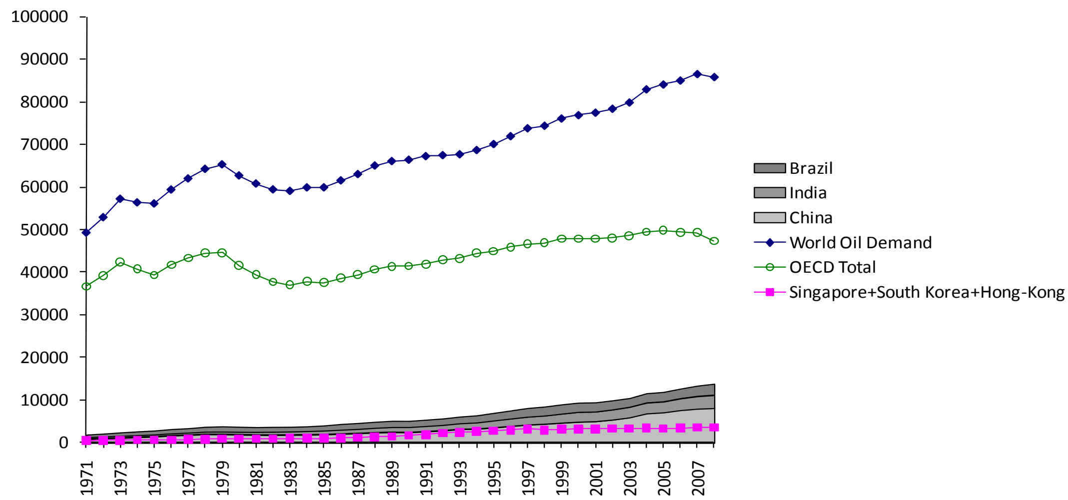
Figure 3.1: Energy and oil price index, base year=2005



Source: IMF

This pattern is reflected in global trends of energy use and demand. Between 1993 and 2008, world oil demand grew by 27 percent compared to a rise of 5 percent in the previous 15 years; Asian Tigers's 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 oil demand (Figure 3.2).

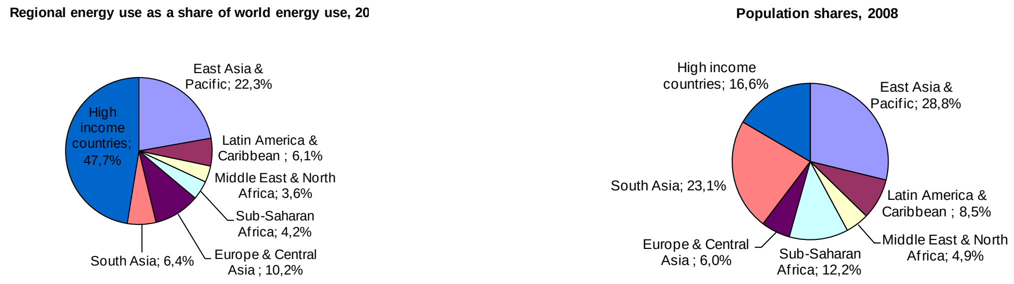
Figure 3.2: World Oil Demand (thousand barrels/day)



Source: International Energy Agency

Per capita energy use[13] in high income countries have been always 4-10 times higher than in the rest of the world (WDI data), they host less than 17 percent of population but they account for almost 48 percent of global energy use (Figure 3.3).

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

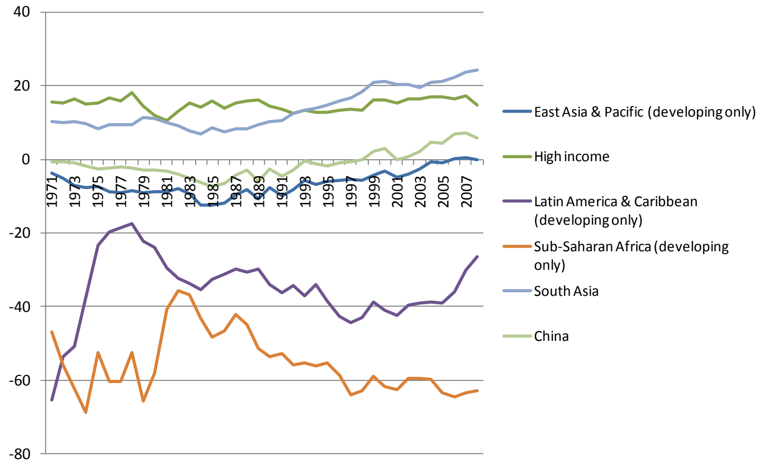


Source: WDI

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

The growth in world energy demand is expected to continue and, by 2030, is estimated to be more than 40% higher than it is today (OPEC 2010). Even under the hypothesis of a cautious implementation of current governments' policy commitments, oil demand will constantly increase: in this scenario, the energy demand is estimated to grow by 36 percent between 2008 and 2035 and fossil fuels will continue to dominate the rise in global primary energy demand with a share of more than 50 percent (OECD/IEA, 2010).

Figure 3.4: Net Energy Imports (% of energy use)



Source:WDI

On the supply side, other factors can push oil prices up. The public opinion and international NGOs exert a growing pressure to consider environmental and social damages often associated with resources extraction. This greater awareness of externalities caused by fossil fuels production can make them more costly or can create supply constraints. With the only exception of Latin America,

[13] Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.

in non-OPEC countries, for instance, oil crude and natural gas liquids (NLGs) supply is forecasted flat or in decline and, in particular, in OECD countries, increasing costs and stricter regulations are regarded as possible factors which will contribute to a decline in crude oil production (OPEC 2010). In sum, though reserves of fossil fuels so far have not been scarce, their availability at low costs is less abundant than in the past. According to the International Energy Agency (OECD/IEA 2010), in fact, the supply and demand oil curves are becoming less sensitive to oil prices and this will lead to growing oil prices. 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 spurt of demand rather than to political factors or other exogenous factors.

In the sake of energy security: governments' willingness to reduce dependence on Middle Eastern and on political turmoil in oil-producer countries has also contributed to the development of renewable energy. Renewable energy source are more naturally distributed across regions than fossil fuels which, in contrast, tend to be highly concentrated. Moreover, renewable energy production has been spreading all over the world, especially from Europe to Asia, and, this geographical expansion increases the trust that renewable energy markets are less vulnerable to political instability and choices of specific countries (REN21 2011).

Declining costs and competitiveness gains of several renewable energy technologies: in several cases, production and distribution costs are a strong constraint for the competitiveness and economic viability of renewable energies. Indeed, IPCC estimates (2011) that, on average, the costs of many renewable energy generating systems over their lifetime are higher than current energy prices, though large variations across regions and sources of energy exist. However, cost reductions in solar PV, in wind turbines and biofuel processing over the last years have contributed to the growth of renewable sector (REN21 2011). Indeed, some renewable energy applications are becoming economic. BNEF's analyses show that prices of solar modules, for instance, have more than halved since 2008 and also small solar projects are more competitive, especially in sunny places (such as Italy and Turkey) where prices have gone down to $22 cents/kwh (BNEF 2011). A World Bank study (Kulichenko and Wirth 2011) estimates that costs of several components for concentrating solar thermal power applications will decrease between 15 and 30 percent by 2020. Learning-by-doing and economy of scales are expected to further decrease costs as renewable energy applications will spread. Some promising signals on renewable energy competitiveness also come from developing countries. In a study on Ethiopia, Kenya and Ghana, Deichmann et al. (2011), find that in several rural areas, though decentralized renewable power has higher unit production cost than fossil electricity, it is competitive compared to centralized power provision, usually fossil-fuel-based, once that the cost of extending transmission and distribution are computed. Similar results are obtained by Nouni et al. (2008) in niche 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 option to mitigate GHG emissions. Existing evidence shows that, in general, renewable energy technologies produce lifecycle GHG emissions that are significantly lower than those generated by non-renewable resources, though for 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 UN climate meeting in Copenhagen in 2009 of limiting the global temperature increase to 2°C, over 60 percent of the global GW additions needed between 2010 and 2035 should come from renewable plants improvements (3869 GW out of 6385 additions), even when energy efficiency improvements are computed. The

international agenda against climate change, therefore, is pushing for a large-scale deployment of renewable energy technologies.

MDGs agenda: The increasing awareness that the way to achieving MDGs passes through development of renewable energy is another factor which pushes investment in this sector. Development of modern renewable energy can contribute to enhance access to reliable and affordable energy sources in poor countries and for poor populations. Reduction in energy poverty has a key role in pursuing MDGs since energy is behind all human activities. Indeed, the link between each MDGs and access to modern energy sources, either renewable or non-renewable, has been acknowledged by several studies and international institutions (Modi et al. 2005, GNESD 2007); Bazilian et al. 2010, OECD/IEA 2010). Renewable energy, however, presents several advantages. Many renewable energy applications are devised to produce decentralized electricity and energy and several renewable energy sources, such as wind, solar irradiance, crop residues and animal wastes are often widely widespread in rural areas. Therefore, they are suited to provide energy to rural areas, which are usually the poorest and the most excluded from energy access since costs for grid connection and fuel transport obstacle energy access and investment. However, some of renewable energy applications (such as solar energy for water heating, bioenergy for transportation, heating, cooking and lighting) can also serve slums in peri-urban areas where many households lack access to nearby electricity grids. Finally, in non-oil-producer countries, renewable energy development can reduce dependence on oil, coal and natural gas imports (see Table 3.1 on the role of energy investment for MDGs).

Table 3.1. The role of investment in modern renewable energy in 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, labor productivity, educational attainments and health conditions and by reducing the burden of time-consuming domestic labor. • Energy access enhances returns to labor and productive assets as well as labor and business opportunities since energy services such as lighting, heating, cooking, motive power, mechanical power, transport and telecommunications are essential for economic activities and socio-economic development. • Providing more energy for agriculture, irrigation and transportation will increase food production and food security helping alleviate the world's hunger.
MDG 2 and 3: Achieve universal primary education and promote gender equality and empower women	• Access to energy can reduce child labor by increasing adults' labor productivity. • Access to energy reduces time-consuming domestic labor needed to collect traditional fuels, fetch water, process food or to carry out other physical works. As a result, children have more time to attend to schools and to study at home. Women can develop productive activities and can have more opportunities to participate to social and community life with positive effects on their economic and social empowerment. • Street-lighting improves children's and women's safety facilitating their attendance to schools and their participation to community activities. • Electricity provision facilitates the 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 cause respiratory diseases facilitates the use of boil water decreasing the risk of waterborne diseases, one of the main causes of child mortality. • Pumping and treating water, which require energy, contribute to a clean water

	supply. • Electricity provision to health care facilities helps improve population health by allowing longer hours for services, refrigeration of vaccines and by helping the general functioning of health care facilities and services. Transport and communication services improve access to health care services, emergency medical services and information campaigns to combat preventable diseases.
MDG 7: Ensure environmental sustainability	• Most modern renewably energy sources produce less GHGs emissions and are less polluting, less water and natural resource intensive than non renewable and traditional biomass energy. Thus, their large scale development can help global and local environmental sustainability.

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

All these factors create market incentives for investment in renewable energy sector and push governments to introduce renewable energy policies such as incentives, subsidies and targets. From 2005 to 2011, the number of countries with targets or policy measures in favor to renewable energies, in fact, passed from 55 to 119 with developing countries representing more than half of them (REN21 2011). Policy support seems one of the main drivers of renewable energy investments, since this sector faces also a large range of market policy, institutional and informative barriers. It is commonly acknowledged that without government's support renewable energy industry cannot take off and that governments have played a crucial role in fostering 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 able to provide worldwide energy for all purpose from wind, water, and sunlight. They find that energy cost might be similar than today, and that the development of such as power system is not likely to be constrained by the availability of material resources (such as steel, platinum, lithium etc). 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 of the United States by 2050. Despite these encouraging findings, several barriers still hinder the large-scale development of renewable energy, especially in poorest countries.

Unfavorable 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, are still in place in many countries, especially, but not limited, in oil-rich nations. In non-OECD countries, governments utilize consumption and production fuel subsidies to enhance energy access, to reduce dependence on traditional biomass energy and to sustain economic growth and employment. In OECD countries consumption subsidies are rare, but production subsidies are quite widespread though, in 2009, G-20 leaders committed to phase out and rationalize fossil-fuel subsidies. These financing mechanisms work against renewable energy investment, since they undermine their competitiveness and discourage the transition to clean energy production. To have an idea of their importance, the IEA estimates that in 2009 subsidies to fossil-fuel final consumption and to electric power generation amounted to $312 billion[14] compared to only $57 billion of worldwide government support to electricity from renewables and to biofuels. Interestingly, annual average investment required to

[14] To be note that 37 countries account to 95 percent of global subsidized fossil-fuel consumption.

achieve universal access to modern by 2030, estimated at $36 billion, would be less than one twelfth of 2009 global consumption fossil-fuel subsidies (OECD/IEA 2010).

Among other competitors of renewable energy sources, natural gas represents an important challenge. According to UNEP and BNEF (2011), low prices of natural gas have undermined renewable energy projects especially in the wind and solar sector. Moreover, in the future, competition might grow, given that prospects of natural gas markets are very promising with increasing demand, abundant recoverable resources, and increasing international trade in natural gas (OECD/IEA 2011).

Prices of different energy sources do not include externalities of energy production and uses nor their potential contribution in reductions of GHGs or other adverse social and environmental impacts. A study conducted in Senegal, for instance, shows, that in three remote rural regions the levelized electricity costs from PV technologies are lower than the cost of energy from grid extension once that environmental externalities are include (Thiam, 2010).

Costs and financing barriers*:* as mentioned above, several renewables are not cost-competitive at the present market conditions. The levelized cost of electricity for renewable energy sources, in many cases, has a higher range than those of traditional power sources (IPCC 2011).[15] Moreover, high up-front capital costs, immaturity of technologies, uncertainties 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 increasing investors' risk perceptions and hampering their access to financing.
Costs are decreasing, but, overall, 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 and 2011, UNEP and MISI 2009, Hamilton 2010). Based on evidence from MENA countries, South Africa and India, Kulichenko and Wirth (2011), for instance, underscores that there exist several regulatory frameworks that help in improving economic and financial affordability of concentrating solar thermal power such as properly designed feed-in tariff schemes, also combined with auctioning mechanisms, Renewable Portfolio Standard schemes, concessional financing, sovereign guarantees for power purchase agreements for concentrating solar thermal power projects. Looking at a different aspect of renewable energy competiveness and diffusion, namely at innovation capacity, Johnstone et al. (2010) show that public policies, from public expenditures on R&D to feed-in-tariffs, and renewable energy certificates, have had a positive influence on patent activity in OECD countries over the period 1978–2003.

Integration of renewable energy with the current energy system requires institutional and market changes as well as adaption and expansion of the current infrastructures. The needed efforts to create hybrid, flexible and integrated energy systems are substantial since distribution, variability, production scale and techniques of renewable energy greatly differ from those of dominant fossil fuel energy systems. Integration into the current energy system, therefore, can represent a narrow bottleneck for large scale development of renewable energy. Available evidence based on stakeholder surveys in ASEAN countries show that grid-connection and infrastructure barriers are a major concerns for investors in the renewable energy sector (Ölz and Beerepoot, 2010). Where conventional power grids are underdeveloped, as in most Sub-Saharan African countries, the

[15] A recent study by the World Bank (Kulichenko and Wirth, 2011), for instance, finds that in several emerging countries (such as in India, Morocco, and South Africa) the levelized cost of electricity for concentrating solar thermal power are still too high and projects at current investment costs have a rate of return that not allow to meet commercial infrastructure investment requirements.

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 characterized by a monopolistic or oligopolistic structure. Foster and Briceño-Garmendia (2008) find that in Sub-Saharan Africa state-owned enterprises manage the largest share of public infrastructure expenditures, in power sector included, and also Nkwetta et al. (2010) observe that in many cases national energy supply responds to a monopolistic conception. Ölz and Beerepoot (2010) underscore that in the ASEAN region the power sector is characterized by the dominance of a state-owned or controlled utility. In these contexts, independent power producers might face serious entry-market obstacles due to low competition, centralized infrastructure, institutional arrangements and prevailing standards which are conceived for a concentrated market structures.

Low awareness of benefits, information barriers, lack of human capital. In addition to capacity to pay, also consumers' and policy makers' awareness of potential benefits, applications, technically and economically feasibility of renewable energy technologies are a key determinant of political commitment in favor of their development as well as of renewable energy demand[16]. These factors, in turn, can negatively influence investors' decisions. At the same time, shortage of trained technical personnel to operate and maintain the energy systems and inadequate expertise of energy regulators can discourage demand and investments in renewable energy sector especially in developing countries (Ölz and Beerepoot 2010).

Social barriers: opposition of population groups against the use or the production of renewable energy sources can be another barrier to renewable energy investments. Cooking habits, for instance, can help to explain in some developing countries part of the installed improved fuelwood stoves are not used (Bailis et al. 2009, Neudoerffer et al. 2001, Zuk et al. 2007). Concerns for implications on biodiversity and landscape can also jeopardize social acceptance of renewable energy plants, but the strongest resistance is likely to be put up by population groups that claim competing land and water rights. As discussed in the section on farmland and biofuel investment, expansion of biofuel cultivations can reduce or hamper land and water uses of local populations. Even if they are not the focus of this paper, also large hydropower plants and dams can be mentioned for their devastating effects on displaced and downstream populations that has been found in several countries[17].

4. Global and regional trends in renewable energy investment

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

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

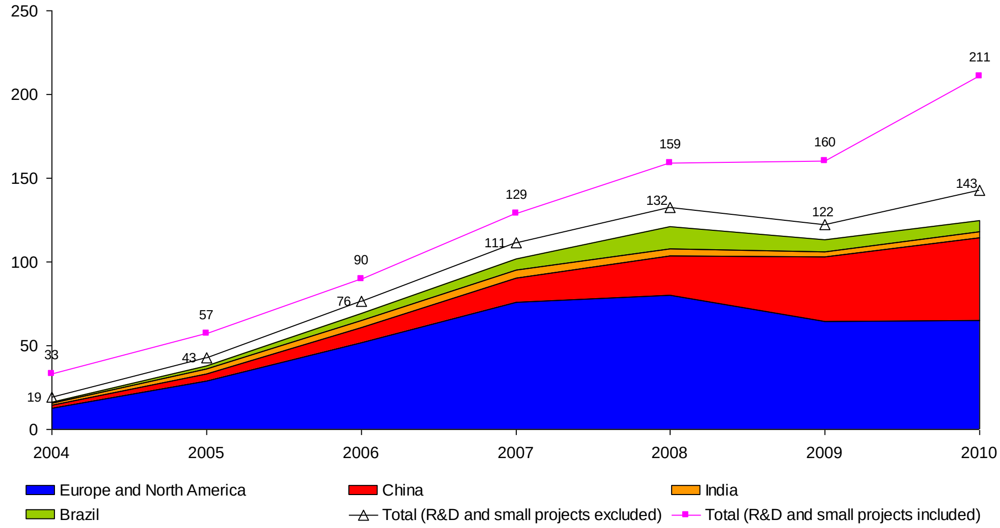
[17]The Report of World Commission on Dams (2000) is clear in this sense. One of its main findings is that, despite the significant contribution of dams to human development, "(i)n too many cases an unacceptable and often unnecessary price has been paid to secure those benefits, especially in social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

4.1. Total investments[18]

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

Total money invested in renewable energy companies and utility-scale (medium and large) generation and biofuel projects (Figure 3.5) rebounded in 2010 after a downturn in 2009, which was mainly due to a 18 percent decline in investment in Europe and United States under the effect 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, to a rapid expansion of small projects in some high income countries[19] and, above all, to China's performance, which more than doubled renewable energy financial investment between 2008 and 2010 passing from $23.9 to $48.9 billion.

Figure 3.5: Global trends in total financial investment in renewable energy ($BN)



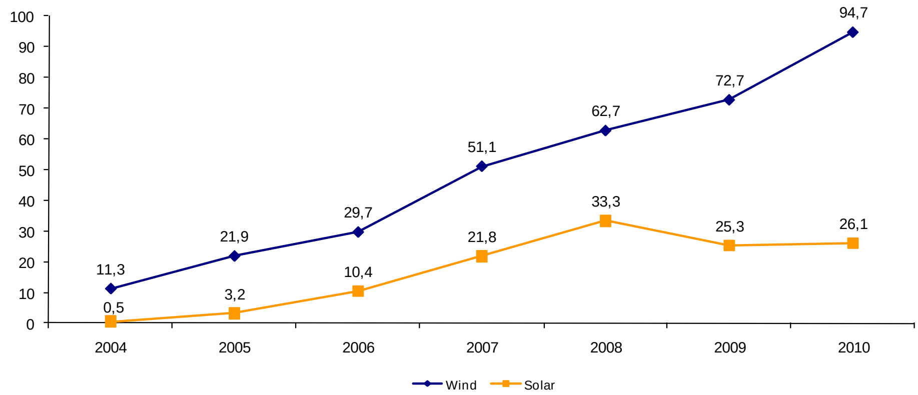
Trends in renewable sector investment also vary across technologies (Figure 3.6.a-b). Biofuel investment jumped to $20 billion in 2006-2008, in conjunction with the oil price shock, but it came back to the 2005 level (around $6 billion) in the following years with the persistence of the global economic crisis. Investment in biomass and waste-to-energy sectors was less affected by the economic crisis as it constantly increased over the 2004-2010 period. Investment in small-hydro, geothermal and marine energy presents a stable trend fluctuating around much lower levels (4, 1.4 and 0.2 billion of US dollar, respectively). But the dominant sectors in investment trends are wind followed by solar energy. In particular, the world economic downturn did not touch total investment in wind energy, which was benefited from mega-projects in China. Investment in wind energy has risen almost 9-fold from 12 to 94 billion of dollar between 2004 and 2011 accounting for 53 percent of all investment in renewables in the entire period (Figure 3.7). Starting from a very low base ($0.4

[18] 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 liters or more per year. BNEF defines utility-scale solar parks as greater than 500 kW in capacity.

[19] Notably, in Germany, Italy and United States.

billion in 2004), solar energy saw a sharp investment growth with a peak of $33 billion in 2008. Despite a 24 percent slowdown in 2009, solar has attracted about one fifth of all renewable energy investment in the reference period reaching the second position as sector of investment destination.

Figure 3.6.a-b: Financial new investment in renewable energy by technology ($BN)



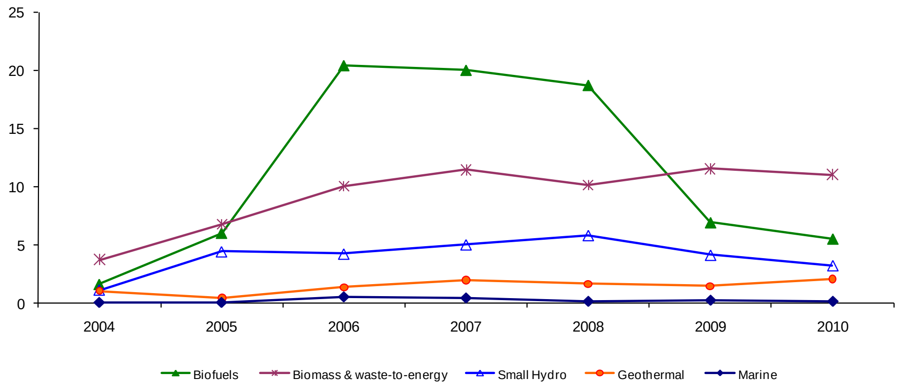
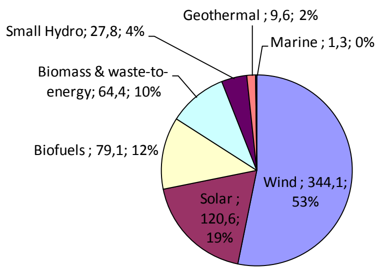
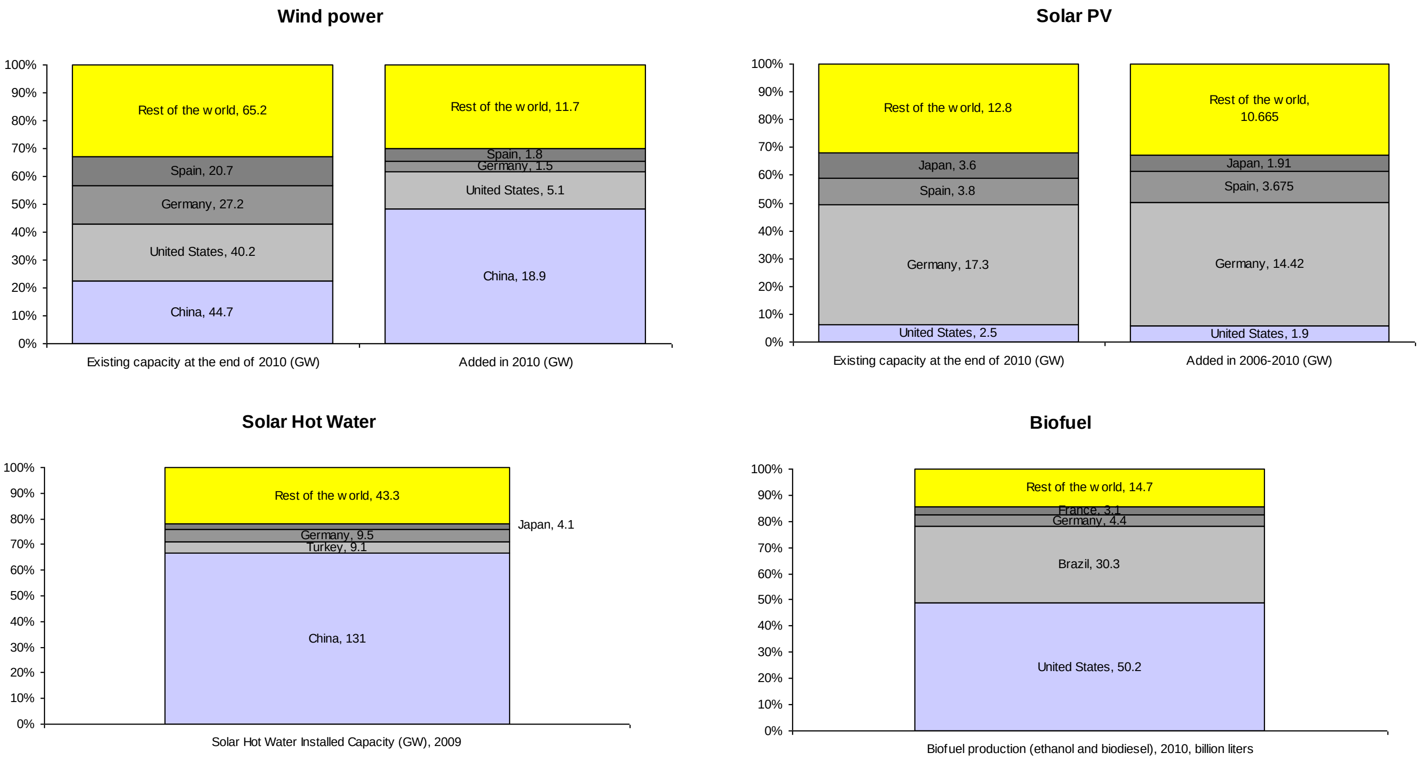


Figure 3.7: Global financial new investment in 2004-2010 by technology ($BN and % shares)



The renewable energy sector is also characterized by a pronounced geographical concentration. Only four countries account for about 70 percent of existing and added capacity in 2010 in wind power and PV solar markets, while four countries cover more than three fourths of global biofuel production and solar hot water installed capacity (Figures 3.8). China leads the wind and solar hot water sectors, USA accounts for 20 percent of total wind capacity and it is the first producer of biofuels, followed by Brazil, while 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 point out that relevant institutional, policy and economic factors hinder the expansion of this sector.

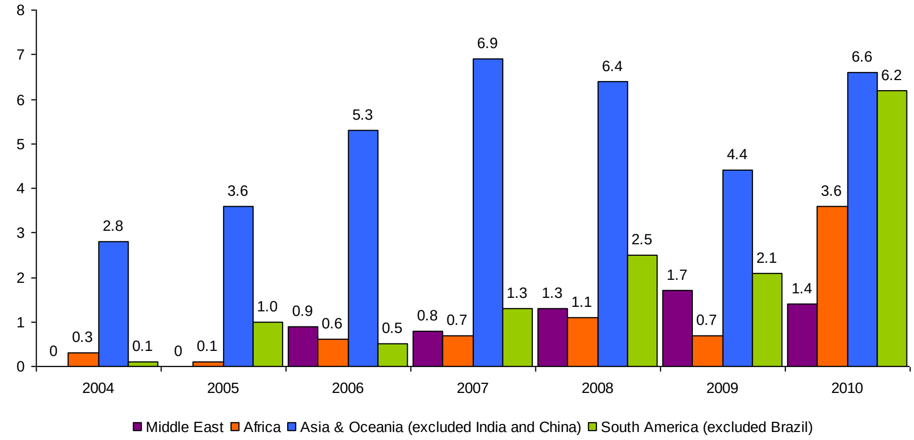
Figure 3.8.a-b-c-d: Investment in renewable energy by technology- Top 4-countries and Rest of the World



Source: REN21, 2011. Notes: 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 1m litres or more per year.

Trends in renewable energy investment exhibit the same spatial concentration. As shown in Figure 3.5, Europe, North America and the largest emerging countries (China, Brazil and India) attract the bulk of global investment in renewables. In 2010, all the other countries accounted for about 12 percent of total new investment though they saw a growing interest in renewable energy sector. In South America (Brazil excluded), investment sharply increased from $0.1 BN in 2004 to $2.1BN in 2009 before jumping to $6.2 BN in 2010. Also Africa and Middle East experienced a strong acceleration of renewable energy investment in the last years, but from a far lower base.

Figure 3.9: Trends in total financial investment in renewable energy in selected areas ($BN)

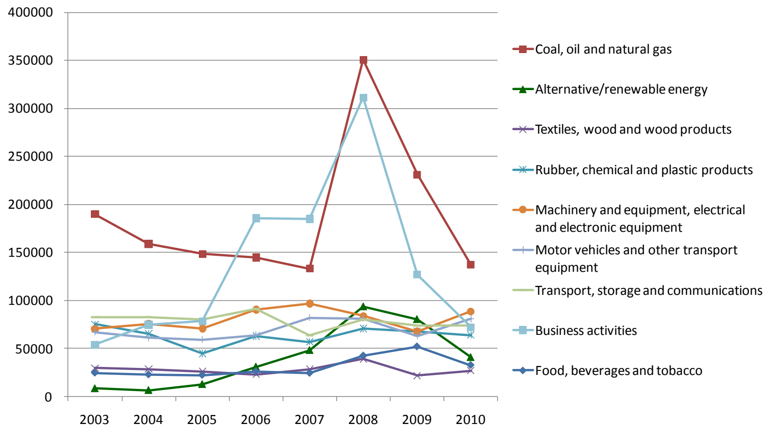


4.2. FDI in renewable and alternative energy sector

It is not easy to analyze the role of FDI in renewable energy sector since data disaggregated at country and sector level are not always collected systematically or they 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 used databases on greenfield investment projects. Figure 3.10 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 3.11 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 $312 billion, while Bloomberg New Energy Finance's (BNEF) data recorded $430 billion of asset financing[20] of utility-scale renewable energy projects in the same period. Thus, FDI seem to play an important role in financing new projects, but these evidences do not allow drawing further conclusions about the contribution of foreign capitals to renewable energy investment because the two data sources have a different coverage[21].

Figure 3.10: Value of greenfield FDI projects in energy sector, 2003-2010 (Millions of dollars)



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

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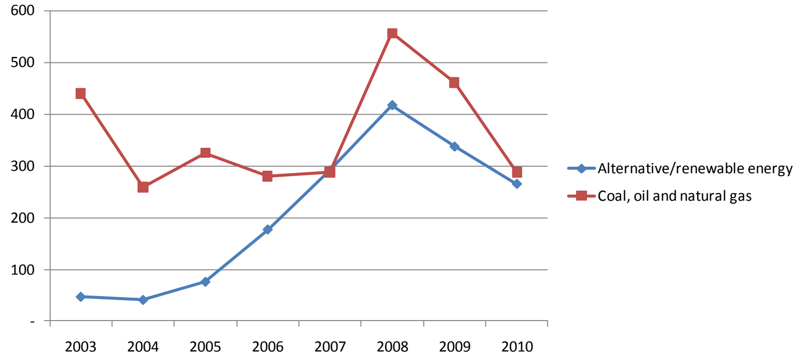
[20] Asset financing is defined as all money invested in renewable energy generation projects, whether from internal company balance sheets, from debt finance, or from equity finance.

[21] 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 3.11: 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 amounts of capital investment.

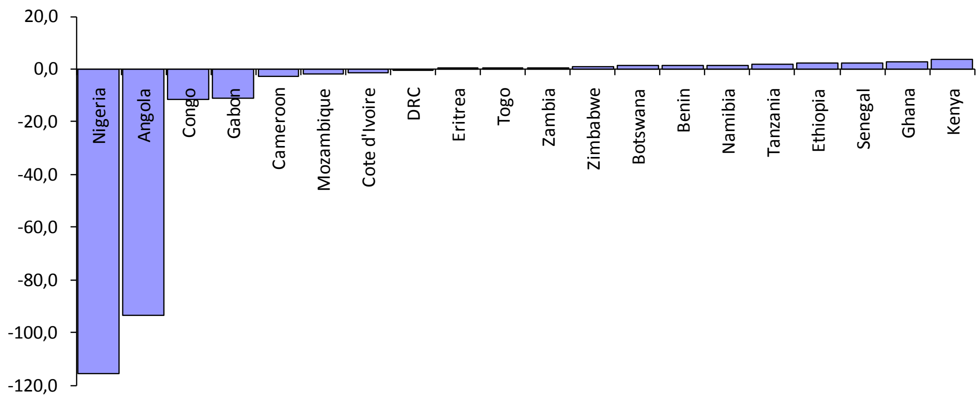
The estimated value of greenfield FDI projects in renewable energy surged from $8.2 in 2003 to more than $93 billion in 2008. In this period, renewable energy was one of the fastest-growing sector in terms of greenfield FDI projects, together with business activities, non-renewable energy and, to a lesser extent, food, beverage 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, instead, renewables still lag behind, though 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 showed a good resilience to the recent economic crisis, greenfield FDI projects were heavily hit and they experienced a drop both in 2009 (-14 percent) and, above all, in 2010 (-49 percent) when their estimated value declined to $40.7 billion. The number of projects has followed the same trend: it almost doubled in 2008 and then it has come back to pre-boom levels.

4. Energy poverty and energy investment in Sub-Saharan Africa

Sub-Saharan Africa is one of the most energy poor region, despite its technical potential. Africa has almost 10 percent of the world's oil reserves (UNECA 2011). Some countries have been important oil producer (notably Angola, Nigeria) for many years and, recently, the petroleum industry is showing an increasing attention to oil reserves of West African countries. Côte d'Ivoire, Liberia, and Sierra Leone, for instance, are already hosting an intense activity of oil exploration. In Ghana, there was a recent (2007) and important discovery. Analysts reckon that this region might represent a new frontier for non-OPEC oil production, though political and economic risks and the unfavorable climate investment make difficult to predict when investment and production will really take off (EIA 2010). But the real energy wealth of Africa is constituted by its solar irradiance, winds, water and bioenergy resources. According to REN21 data, it is estimated that Africa and Middle East have about 57 and 8 percent of world technical potential solar and wind electric 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 percent of technically exploitable capability but it host 3 percent of world current installed hydropower capacity (World Energy Council 2010a).

Despite this potential energy wealth, the quality and quantity of energy supply in most Sub-Saharan Africa's country is very poor. In Sub-Saharan Africa, about 80 percent of the population relies on traditional use of biomass for cooking (this is also the largest share in the world (OECD/IEA 2010)). Moreover, 585 million people (69 percent of the population) lack access to electricity representing more than 40 percent of the 1.4 billion people which, worldwide, live without access to electricity. Energy access is particularly problematic in rural areas where are concentrated about 80 percent of those without electricity. Finally, all Sub-Saharan Africa's countries, with the exception of South Africa, are in the bottom half of the ranking in the Energy Development Index, 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 infrastructures and a large financing gap (AfDB 2010). Electric 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 also productivity in agriculture and especially in manufacturing industry. Hidden costs due to underpricing, undercollection and unaccounted losses in the power sector are also widespread. Briceño-Garmendia et al. (2008) observe that inefficiency improvements could considerably enhanced governments' availability of funds as they estimate that, in Africa, average annual hidden costs reach 0.8 percent of GDP.
Finally, low energy consumption is combined with particularly constrained energy production and distribution systems. This weakness further hampers energy security and aggravates exposure to international market fluctuations. Indeed, most Sub-Saharan Africa's countries are net energy importers[22] (Figure 4.1), though the region, as a whole, is a net energy exporter.
Sub-Saharan Africa's countries, therefore, need to invest in energy generation, but it is not enough. Energy generation investment, in fact, does not always go hand in hand with reduction in energy poverty. In poorest countries where grid-based access to energy is particularly low, improvements in power generating capacity face greater obstacles in traducing in larger access to energy and are more likely to increase supply to those who already have access (Bazilian et al. 2011). A crucial role is also played by 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 appropriated to different technologies and to different types of users (large and small firms, poor households, rural and urban population).

Figure 4.1: Net energy imports in Sub-Saharan African countries – 2008 (Mtoe)



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

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

Recent estimates (Briceño-Garmendia et al. 2008) find that Sub-Saharan Africa's aggregate power infrastructure needs between 2006 and 2015 — both for new investment and operations and maintenance — amount at about $43 billion a year (7 percent of GDP), a figure which is significantly higher than the annual average spending of $11 billion in 2001-2006 period[23]. Capital expenditure in energy infrastructures accounted for US$4.6 billion a year (about 40 percent of the total spending). New investments in energy infrastructures were, therefore, similar to those in water and sanitation sector (US$4.6 billion a year) but about half of 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 percent) and US$0.7 (15 percent) billion a year, respectively. The contribution of the private sector was quite low: US$0.5 equivalent to 11 percent.

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. At the same time, it has been calculated that decentralized renewable technologies are cost-competitive in remote and large rural areas of Sub-Saharan Africa (Deichmann et al. 2011) and, therefore, they could 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 cause adverse effects on health conditions, environment and workload, especially for women. Moreover, a decline in the use of biomass energy could also alleviate pressure on water resources: according to some estimates, Africa produces only 9 percent 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) and this is mainly due to the extensive use of biomass energy (World Energy Council 2010b).
Renewable energy markets in Sub-Saharan Africa, instead, 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).

4.1. Trends in renewable energy investment in Sub-Saharan Africa

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

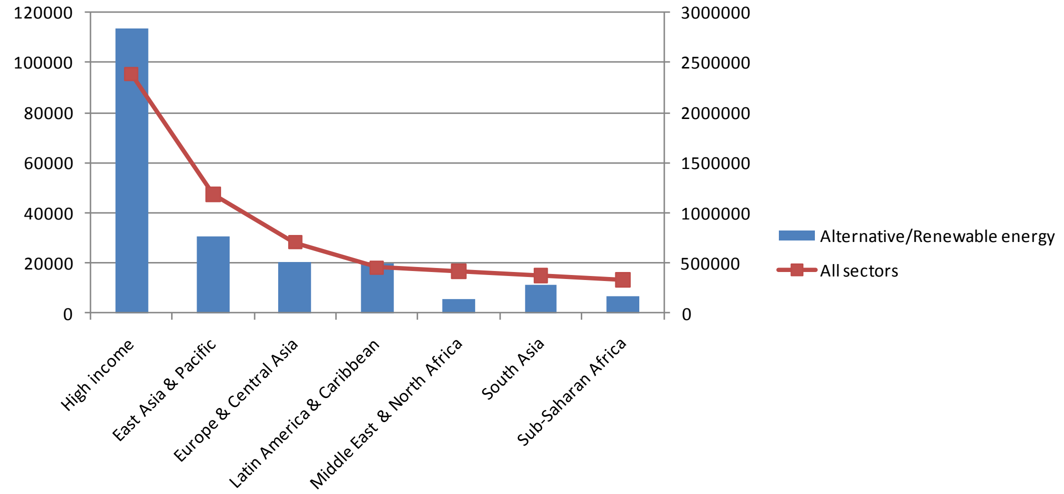
Information on medium and large projects highlights that renewable energy investment (large hydropower excluded) are still very low but it is growing at high rates with a strong acceleration in 2010 (Figure 3.9) when it jumped to $3.6 billion from $0.7 billion in the previous year. These data, however, include also North African countries and show that the boom was spatially concentrated. Both in 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, Zambia, Morocco and Cape Verde) have seen some advances in renewable energy, but Egypt and Kenya accounted for more than 70 percent of all money invested in African renewable energy market in 2010.

UNEP and BNEF's data on small-scale generation projects do not include solar water heaters, biomass and other heat systems which might be more accessible in developing countries. However, available evidence suggests that also the recent surge in small-scale generation projects, which

[23] Based on annualized averages for 2001–06. Figures are extrapolations based on a 24-country sample.

might be well-suited to enhancing energy access in rural areas through decentralized and distributed energy generation in rural areas, has been dominated by high and middle income countries. Investment in small distributed capacity rose from $13 billion in 2007 to $60 billion in 2010, but the top-ten countries (Germany, Italy, United States, Japan, France, Czech Republic, Australia, China, Belgium, Israel, in this order), accounting for almost $53 billion of investment in 2010, have driven this boom. Data on greenfield investment confirm the minor role of Sub-Saharan Africa in the clean energy market. Mirroring the general regional trends in FDI flows, as shown in Figure 4.2, between 2003 and 2009, Sub-Saharan Africa has attracted less FDI in renewable energy than all the other regions, with the only exception of Middle East and North Africa.

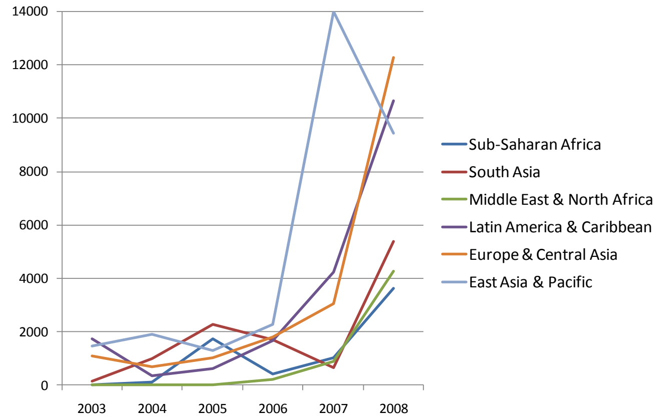
Figure 4.2: Total value of greenfield FDI projects in renewable energy sector by region, 2003-2009* (Millions of dollars)



Source: Authors' computations based on information from the 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.

The last years have seen an acceleration of FDI in renewable energy to Sub-Saharan Africa (see Figure 4.3), though the boom has been more pronounced in East Asia and Pacific, in Europe and Central Asia and in Latin American and Caribbean regions.

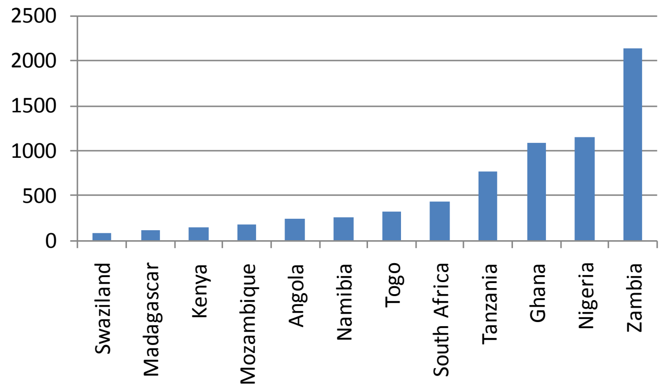
Figure 4.3: Trends in greenfield FDI projects in renewable energy sector by region, 2003-2008 (Millions of dollars)



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

Moreover, within SSA, greenfield FDI concentrated in a small group of countries, while in the remaining countries new renewable energy projects financed by foreign capitals have been very limited or negligible (Figure 4.4).

Figure 4.4: Value of greenfield FDI projects in renewable energy sector in Sub-Saharan Africa's country, 2003-2009*(Millions of dollars)



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

5. Biofuel production in Sub Saharan Africa and the energy-land-water nexus

Benefits and potentials largely vary across type of renewable energy sources and not all of them are uncontested. Biofuels, in particular, are at the center of a heated debate. This section discusses the development of biofuels in Sub-Saharan Africa. 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 tackle the persistent energy crisis (on the classification of bioenergy sources see box 5.1). Liquid biofuels have also the advantage that can be used in the transport sector without significant modification in the existing infrastructure. At the same time, they can be harnessed for non-transport applications (cooking, lighting, and electricity-generation). Africa's biofuels potential production has been receiving growing attention by foreign investors as revealed by the recent wave of large landfarm investments for biofuel production. The 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's Renewable Energy Directive according to which by 2020 at least 10 percent of each Member State's transport fuel must come from renewable sources. 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 a preferential access, but also for positive projections in the domestic markets: the prices of fuel in sub-Saharan African countries are about double those in the most competitive markets, demand for transport fuels is in expansion and cooking applications and off-grid electricity generation in rural areas could receive higher attention in future (Mitchell, 2011). Expected positive impacts 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 currencies earnings from biofuel exports, reduction in GHGs emissions. Despite these potential opportunities, the scope for biofuels development in Sub-Saharan Africa and elsewhere, is very controversial and even its proponents warns about its economic, social and environmental risks. Biofuel expansion might (i) create up-pressure on food prices[24] and compete with food production undermining food security; (ii) give a low contribution to energy security as the sector is mainly export-oriented; (iii) produce frictions with alternative land and water uses and produce pressure on water resources; (iv) create incentives for deforestation, and produce severe environmental impacts such as water pollution and soil degradation while having negative carbon balance[25]. Risks for water stress are particularly alarming as the continent suffers for high levels of water scarcity. Water footprint of biofuels, especially first-generation ones, indeed, is much larger than water footprint of fossil fuels (Gerbens-Leenes et al. 2009, King and Webber, 2008)[26]. Finally, as large corporations which operates simultaneously in the sectors of energy, animal feed and OGM seeds are increasingly interested in biofuel production and commercialization (Borras et al. 2010, Neville and Dauvergne 2010), concerns for equity and sustainability of this energy transition have arisen.

Box 5.1: 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), producer gas (CO, H2, CH4), made from the destructive distillation of biomass.

In turn biofuels are distinguished in two groups:

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 which can use a variety of non-food crops and cellulosic sources such as grasses and trees. They include waste biomass, the stalks of wheat, corn, wood, and special-energy-or biomass crops. More research is needed to understand their potential risks, but they usually perform 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 lower economic viability. Further technical and organizational 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 first and second-generations biofuels

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

The bulk of the debate is based on projections and expected impacts and opportunities as the sector in the region is at its first stages of development, but some evidence are already available. Table 5.1 in the Annex presents a short overview of the recent literature findings on the effects of biofuels production in Sub-Saharan Africa. No definitive conclusions can be drawn from this snapshot of

[24] Timilsina and Shrestha (2010), after an extensive review of the 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 exert up-pressure on food prices, but there is a considerable variation in the estimates of the magnitude of this impact.

[25] 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 fertilizer 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.

[26] 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 suggested that expansion of biofuel production, with their 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)

cases studies. Moreover, generalizations and stylized facts do not always perfectly match the facts on the ground. However, keeping in mind these limitations, we can delineate some preliminary evidence on the local effects of the existing biofuel projects in Sub-Saharan Africa. We can observe that large scale plantations, especially if they require large land acquisitions, are usually problematic: in several cases are associated with local contestations, few or less than unexpected benefits or concerns for negative externalities and impacts. Projects based on small producers through cooperatives, groups of farms, outgrowing farming scheme or other network system between small holder farmers and biofuel processing or commercializing firms appear more promising solutions even if they still have problems of economic competitiveness and viability.

5.1. The current wave of farmland investments

The debate on biofuel opportunity and risks is strictly linked with the discussion on the current wave of large farmland investments in several regions of the world. Expansion of agrifuel cultivations are, indeed, seen as a driver of the so-called "land grabbing" phenomenon. Before analyzing the state of development of biofuel sector in Sub-Saharan Africa, this paragraph discusses the link between biofuel and land investments in the continent, a topic which is at the centre of a hot and lively debate.

Land acquisition is not a new phenomenon: it dates back to colonial times. Over the last fifty years, however, land deals have substantially risen. This is particularly true in the last decade, when domestic and foreign investors have bought or leased land in developing countries. The debates on number, characteristics and impacts of this trend, has been particularly lively in the last couple of years (GRAIN 2010, Cotula et al. 2009, Friis and Reenberg 2011, Görgen et al. 2009; Smaller and Mann 2009, von Braun and Meinzen-Dick 2009). Nevertheless, 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, not always carried out with scientific rigour (See the Appendix for details on land deals in SSA). Data collected from media reports reveal that an estimated 56 million hectares might have been recently subject to bargaining in developing countries; in Sub-Saharan Africa land interested is estimated at 29 million hectares (Deininger et al., 2011).

While domestic investors tend to be elites, local entrepreneurs or the local government, foreign investors usually belong to two groups: (i) governments or state enterprises or state funds from oil rich countries with poor resources of arable land, water scarcity and harsh climate conditions or (ii) private companies from industrialized and emerging countries with large populations and rapid economic growth, investing mainly in agro-fuel projects (see Von Braun J. and R. Meizen-Dick 2009, Deininger et al. 2011; China and India are good examples of "new" investors). The former mainly aim at improving food security and reducing the dependence on high and volatile food prices. The latter faces an increasing demand for feed and renewable resources and try to countervail it by FDI in land. This strategy helps them to grow less dependent on the world markets[27].

Drivers, not mutually exclusive and often interconnected, include:

1. Increasing population and corresponding decline in the average amount of land per person, combined with a very uneven distribution of population growth, of soil degradation, climate change impacts and land resources[28]. Due to relative scarcity, in fact, the value of agricultural land is increasing. According to von Braun (2008) and Castel and Kamara (2009),

[27] A detailed description of the different players involved in large land deals is in CFS, HLPE 2011, p. 16-17.

[28] 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.

the price for agricultural land has increased by about 16% in Brazil (where it is around US$5-6000), 31% in Poland and 15% in the US Mid-West in 2007(where it is around US$ 7000). Sub-Saharan Africa has vast unexploited agricultural land and agricultural land prices in Africa are low and have not yet increased that much (the estimated average price per hectare in Africa is between US$800-1 000, according to Development Afrique, 2009)[29]. 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, growing interest in green energy). Projections for future demand for food suggest an increase of around 70% by 2050 (HLPE 2011). Improvement in the standard of life suggests an increase in the consumption of meat and dairy, with a consequent higher use of land. According to Cotula et al. (2008), bio-fuel expansion is expected to rise land demand to over 3 percent of arable land by 2030.
3. Investments in quest to secure food supply by governments in countries that do not have enough land and water to feed their populations. 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 results in investment in water in foreign countries. Indeed, any land has associated water rights and access. In other worlds, the water investment through land seems to come "for free" in the valuation given to land in the deals. Furthermore, despite the risible amount of information on land deals, information on investments in water is even lower. Existing literature usually does not estimate the amount of water resources involved, nor the relative importance of the water resources, nor how the water resources fit into water history or use. However the availability of water also affects the productive condition of land, in particular of smallholder farming. Speculative investments and commodization of land. Since the 2008-2009 financial crisis, land has been considered as an alternative way to invest capital in a moment of low and risky returns on financial assets. Higher agricultural prices, such as those prevailing in 2008, may have pushed the trend. Moreover, the commercial value of land in Sub-Saharan Africa is still relatively low and has increased less than other countries so that many have expectations of large increase in the future. The UK's Agricultural Africa Land Fund for instance pays 350 – 500 USD per hectare in Zambia (about a tenth the price of land in Argentina or the USA). Sub-Saharan Africa has a lot of land when compared in pure acreage and large parts are not yet exploited, though in many cases lands which are perceived as "empty" and "idle" are used on the basis of informal rights.

In summary, there are many reasons to invest in land and many land investments are targeted in Sub Saharan Africa on the ground that the sub-continent has large unexploited agricultural potential (Deininger 2011; Cotula et al. 2009). The direction of this process is heading towards 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 of no formally recognised-resource uses. The countries towards which land investments are directed are attempting to take the opportunity represented by the rising trend of land and water value. The underlying idea is to promote economic development and reduce poverty by exchanging abundant resources (land) with scarce ones (capital, infrastructures, skills, technology). But not always things work this way and, if this wave of land acquisitions continues to expand according to the current pattern, the consequences at stake could be profoundly negative, persistent and not easily reversible. The conditions that should be met for the poverty-reducing effects of domestic and foreign investment farmland to work, indeed, are very strict. Among others, the basic requirements include a clear definition and recognition of pre-

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

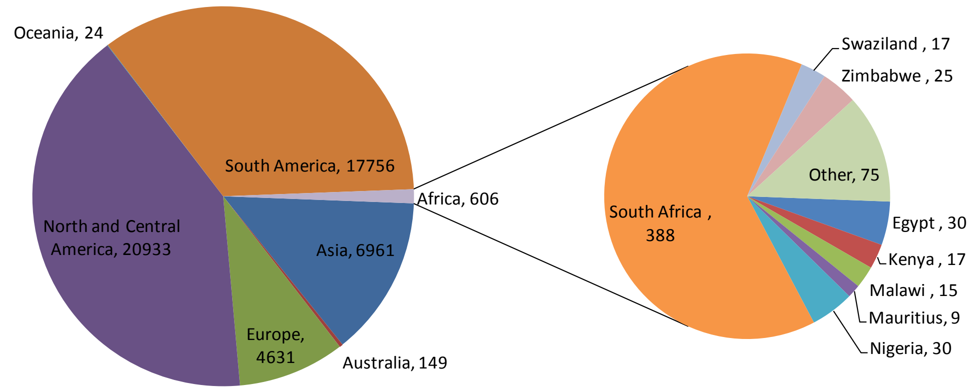
existing resource-use rights; a balanced, informed, capacitated and transparent engagement of all stakeholders; the implementation, monitoring and enforcement of participatory decision making processes and of fair land deals and contract arrangements (ERD 2009). Most of these conditions do not hold in developing countries, especially, in Sub-Saharan Africa. This can explain 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 doubt about the negative impacts of the on-going large scale land investments. Drawing on available evidence, it concludes that "large scale investment is damaging the food security, incomes, livelihoods and environment for local people (p. 8)" (HLPE, 2011). Indeed, Deininger et al. (2011) find that the probability of attracting large scale farmland acquisitions is higher for lower levels of rural land tenure recognition. These mechanisms can imply that some developing countries, for instance those with loose institutions, tend to attract massive foreign capital in mining, land or in the so-called "dirty" manufacturing industries, which tend to be highly water intensive and highly polluting, because of lack of control and higher potentials for corruption. Coming back to the potential role of biofuel market for economic and social development in Sub-Saharan Africa, we can conclude that biofuel investments are fuelled 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.

5.2. 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 that are receiving more attention for first-generation biofuels are sugarcane and molasses to produce ethanol and jatropha to produce biodiesel or a oil than can fuel stationary power plants (Mitchell 2011). But also cassava, sweet sorghum and oil palm are used. Mozambique, for instance, approved sugarcane, sweet sorghum, coconut and jatropha for biofuels production. In contrast, South Africa has classified Jatropha as invasive species.
- Available data (see Figure 5.1) suggest that so far Africa has lagged behind in the global biofuel market. In 2006, Africa's ethanol production was estimated at 606 ML, namely about 1 percent of the world production. Excluding South Africa, Sub-Saharan Africa'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 the Africa's ethanol market with a production of 388 million of liters, but data suggest that also Nigeria, Zimbabwe, Kenya and Malawi are emerging as relatively important ethanol producers.
- In biodiesel sector, Africa plays even a lower role. Even if Jatropha is cultivated in many countries, most countries have just began to promote this form of renewable energy. In South African region, where there are several small and medium-scale producers, the biodiesel market is more developed. However, the first Africa's large scale plant was inaugurated in Zimbabwe quite recently (in 2007) and in 2009 was still operating at less than 5 percent of its capacity because of problem in raw materials availability and also the first commercial biodiesel plant opened in Mozambique in 2007 encountered same problems of feedstock supply (Amigun et al. 2011).

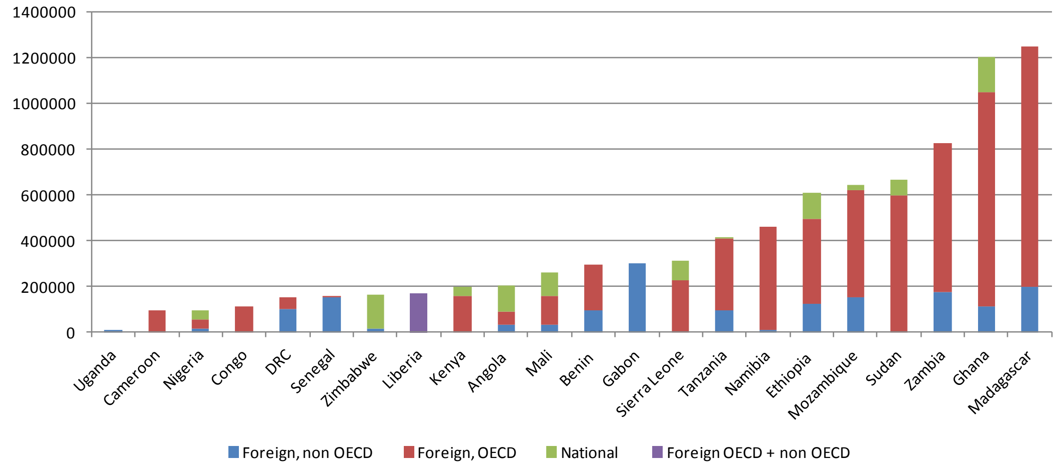
Figure 5.1: World fuel ethanol production in 2006, million liters



Source: Authors' elaboration from F.O. Licht estimates reported in Renewable Fuels Association (2007)

- In the future, the Africa's position in the biofuel market is expected to increase. South Africa, Mozambique and Malawi are among the pioneers of biofuel production, but cultivations of biofuel crops are expanding in other countries (see figure 5.2) and national plans for supporting this sector have been promoted, for instance, in Ghana, Angola, Mozambique, Nigeria, South Africa, Tanzania, Zambia, Zimbabwe, Uganda, Benin, Mali, Malawi, Senegal, Mauritius, Swaziland (Amigun et al. 2011). General policy statements do not always translate in concrete legislative strategies (Richardson 2010), but it is a signal of the incipient governments' commitment to promote biofuel markets. Moreover, the region is receiving a growing attention from investors and, in some cases, also from external donors, governmental 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.

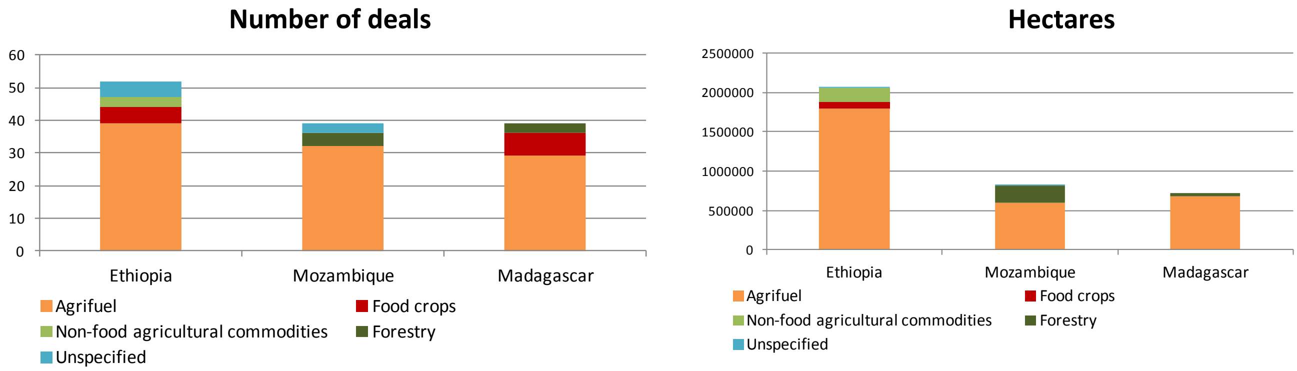
Figure 5.2: Planned and executed biofuel investments in 22 Sub-Saharan Africa's. Area of land accessed for estate cultivation (in ha), by origin of lead investor.



Source: Authors' elaboration from CIFOR Global Biofuel Information Tool based on various reliable media, corporate and government sources and external publications. Accessed on October 2011.

- Biofuel projects indeed in Africa are very heterogeneous. Small farms of biofuel crops which produce for local uses have been promoted in several countries including Mali, Ethiopia, Ghana, Mozambique, Senega, 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 that supply national and international large producers of liquid biofuel blends. But in many cases biofuel projects are large-scale commercial plantations financed by big corporations. Southern African countries, in particular, have attracted large-scale investments in this sector, mainly from foreign sources, 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 of hectares are potentially suitable and available for sugar cane production even when protected areas, closed canopy forests and wetlands, areas under food and/or cash crops, and areas with biophysical constraints are excluded. But also in Sierra Leone, Ghana, Benin, Nigeria, Ghana, Cameroon, Congo, and Kenya large agrifuel plantations are planned or planted (von Maltitz et al. 2009, FoE 2010).
- Trends in commercial farmland investment reveals the great interests on Africa's potential of 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 a fourth of large scale land investments in Sub-Saharan Africa were negotiated to produce biofuels. It is worth reminding that the region is also the main target area of the current rush of large-scale land acquisitions. According to the same data source, in fact, the continent attracted 48 percent of worldwide projects covering about two-thirds of the global targeted area (i.e. 39.7 million out of 56.6 million hectares). Information from the land transactions database on agrifuel projects suggest that the involvement of Sub-Saharan Africa in biofuel-related acquisitions of lands might even greater[30]. Data recorded in this inventory point out that the production of biofuels has been the purpose of the majority of land deals in Ethiopia, Madagascar and Mozambique (see Figure 5.3) which, as maintained above, are three of the top-destination countries of commercial land investment in Sub-Saharan Africa.

Figure 5.3: Land deals in Ethiopia, Madagascar and Mozambique by nature of investment



[30] 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)

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

- Foreign based investments are a very important component of biofuel projects in Sub-Saharan African. 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 summarize 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. In the continent, OECD (notably European) countries are the main foreign investors, (see Figure 5.2) but investors from non OECD countries are becoming important players in the sector and South-South collaborations and joint ventures are expanding. According to the data which draw from CIFOR Global Biofuel Information Tool, foreign companies dominate the land transactions for agrifuel projects in most countries, with the exception of Zimbabwe, Angola, Nigeria and, to a lower extent, Mali and Kenya (see Figure 5.2). OECD countries usually lead the trend, but non OCED investors already control the largest share of the land accessed for planned and executed biofuel investments in Democratic Republic of Congo, Uganda, Gabon, Senegal and invest in many other countries. Investors from Saudi Arabia, China, Lebanon, India, Brazil 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; some Malaysian and Chinese companies have commercial interests in oil palm plantations in Liberia and in the Democratic Republic of the Congo, respectively. Richardson (2010) report that Brazil, Angola and Mozambique signed co-operation agreements while a Brazilian and two Angolan companies have agreed on $210m 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 interests do not always match with the start-up of the production, while the initial evidence of return to biofuel investment in the continent are not very encouraging. Investment decisions in biofuel sector in Sub-Saharan Africa are still risky. In several cases, local resistance, financial problems and unexpected technical difficulties, uncertain market and regulatory conditions have represented barriers to the implementation of the projects. Based on cases studies in DRC, Zambia, Mozambique and Tanzania, Deininger et al. (2011) find that many land large-scale investment in this sector experienced financial problems and were cancelled after the 2008 oil-boom. For instance, they report implementation difficulties in Democratic Republic of Congo and observe that in Mozambique, all large biofuel projects that they surveyed were delayed and none of them operate at full capacity. In Madagascar, riots and contestations against a 99-year lease of about 1.3 million ha of land to Daewoo end up with government's fall and 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 land areas acquired by investors. A study, instead, 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 cases studies of companies with operations in Africa suggest that building capacity in properly planting, caring and processing takes time and it is essential to the performance of the jatropha plant. Moreover, the long lag between project proposal,

investment, and production as well as the decline in energy prices, created difficulties of financing (Mitchell 2011). Analogously, Friend of the Earth (2010) reports that in Mozambique and Swaziland small farmers that started to cultivate crops for agrofuel feedstock, in many cases under outgrowing schemes with large companies (especially from Europe), claim low yields, processing difficulties, problems with pests and in accessing inputs (water, seeds, pesticides). These barriers to biofuel production expansion are reflected by the few available data on investment trends in the sector. Van Gelder and German (2011) estimate that the ten largest companies invested about US$ 5.7–6.7 billion to produce biofuels between 2000 and 2009 in a group of 20 feedstock-country cases, but sugar-based ethanol production in Brazil, capturing some US$ 3.8–4.2 billion investments, accounted for the majority of the volumes together with Colombia, Malaysia, Indonesia. In contrast, investments in nine forest-rich African countries with significant biofuel activities were small or negligible.

- In line with the dominant presence of foreign investors and barriers to biofuel productions, available evidence, finally, suggest that in several Africa countries most biofuel crops are exported (Franco, 2010; van Gelder and German 2011,). This implies that the largest part of the value added is likely to be captured externally.

5.3. The way forward

Our analysis shows that the biofuel sector in Sub-Saharan Africa is growing but it is at its very preliminary stage of development and several barriers hinder its expansion and its pro-poor potential. Now is, therefore, the time to introduce corrective measures which ensure that biofuel production in Africa could grow for Africa's benefit. If existing incentives to biofuel development continue acting as drivers of large-scale land acquisitions and land conversion from food to biofuel crops, risks at stake are very worrisome and irreversible. Governments' choice to promote agrifuel sector making land available to big investors and focusing exclusively on large-scale deals so far has been unsuccessful. Expected and documented impacts of large land acquisitions in Sub-Saharan Africa, indeed, cast doubts on pro-development role of biofuel investments under these conditions. In theory, investment in land could be positive for receiving countries, if rules were followed and employment created, but given the current governance structure, it is likely that the risks overrun the benefits. Host countries have often insufficient regulation to protect their populations. Land tenure is complicatde, land rights non vested, local farmers can be displaced and not even compensated for it. Incentives for the elites and government to act sustaining public goods instead of private interest are low and often not credible. In these circumstances, investments in land are likely to worsen local food security, increasing the risks of conflicts and social tensions as well as access to water.

Moreover, biofuel development show controversial implications even when it is not accompanied to large farmland acquisitions. The "biofuel is good" and "biofuel is bad" hypotheses usually mask large differentiated experiences and behind this debate there is also the dilemma on the role of agribusiness: does it exacerbate exclusion and poverty of small farmers or does it help to connect them with globalised markets or to offer new labor opportunities? This issue is beyond the scope of this paper, but we can note that simplistic narratives can be misleading. We can, however, observe that for triggering virtuous collaborations and synergies between agribusiness and smallholders the active role of pro-developmental state institutions appear essential. Moreover, evidence we have collected suggest 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 is still open and also the role of biofuels for mitigating GHGs emissions is quite 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 fertilizer and produce less CO2 emissions (Delucchi 2010) than first-generation crops. Their impact on land use for food production might also lower since they can be produced from crops which grow on poor land and from waste products (Fonseca et al. 2010). Second and third biofuel generations, therefore, seem offering 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 for advanced biofuels are therefore another priority for ensuring the economic, environmental and social sustainability of large scale deployment of biofuels.

6. Conclusive 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. In addition, we have delved into the state of development of biofuels, a sector which exemplifies the strict link between food, energy and water security, with a specific eye on some of the challenges posed by water and land scarcities and their complex interconnections[31] and on differences between domestic and foreign investments.

First of all, our analysis point out that the current structure of global energy market, demand and use is largely unfair, unsustainable and, as unveiled by the recent peaks in energy, commodity and food prices, increasingly fragile. Reduction of energy demand, especially in the richest and emerging countries, should be acknowledged as a *sine qua no* for equitable and sustainable economic development at global level. The ongoing focus on energy policy mandates which are formulated in relative terms, instead, risks diverting the international attention from absolute targets and from the priority to reduce energy demand and to promote dematerialization of both production and consumption especially in advanced countries which account for a disproportional share of global energy and material uses.

Having said that, we have shown that large scale deployment of renewable energy can bring an important contribution to the struggle against energy, monetary and non monetary poverty as well as against environmental degradation and climate change.

Available evidence suggests that, at global level, renewable energy is gaining ground on fossil fuels and investment in this sector are growing at spectacular growth rates, but the contribution of renewables to world energy consumption is still marginal. Moreover, renewable energy market and investment expansion tend to be concentrated in a small group of leading countries. In fact, despite its great technical potential, Africa lags behind in terms of energy access and deployment of modern renewable energy technologies. Renewable energy sources can have an important role in reducing

[31] While we start having data (even though still scattered) on the size of land acquisitions, and preliminary surveys on the use of the acquired land (see also the table below), to our knowledge there is no study on the amount of water resources involved not the relative importance of these water resources 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 with the larger part of the demand coming from irrigation (in Africa, however, 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 conflicts. Under the current trend of land acquisitions and biofuels production, these conflicts are likely to be exacerbated.

energy poverty and in helping Africa to meet its future energy needs, but much more advances are necessary in terms of mobilization of financial resources, policy support, research efforts, and governance improvements.

Bridging the financing gap is a first step. Bazilian et al. (2011), for instance, estimate that, even if all energy-related investment were used to increase energy access, most LDCs[32] would not achieve universal household electrification by 2030: on average, the yearly investment needed to this goal is five-fold greater than the current energy-related financial flows. Bridging the financing gap also means mobilizing private resources and reducing premium risks of investment in renewable energy which requires, among other conditions, a stable and favorable regulatory and policy framework.

But the financing gap is not the only obstacle to renewable energy investment. We identified and discussed a range of institutional, market and technological barriers which set back large-scale development of renewable energy and renewable energy investments both in high and low income countries. More and better governments' policies, international initiatives, multilateral agreements and development assistance are needed to remove or reduce these obstacles. Policy options include (i) ad-hoc initial subsidies (feed-in tariffs, output and investment subsidies) which can be removed after the consolidation of the renewable energy sector; (ii) phasing out of fossil-fuel subsidies and promotion of a pricing system which reflects externalities of energy production and use; (iii) 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 energy producers; (iv) 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 information-sharing can help to improve consumers', policy makers' and investors' awareness of potential benefits, applications, technically and economically feasibility of renewable energy technologies. Finally, in low-medium income countries, a specific political commitment to combat energy poverty is necessary to ensure that higher energy production translates in better access to clean and affordable energy for the poor.

The choice of energy carriers that should be prioritized is also crucial. Biofuels, in particular, represent (together with hydropower) one of the most debated form of renewable energy even if we could expect that it will see important developments since for the foreseeable future transport sector will continue to rely on liquid fuels. Sub-Saharan Africa is still a marginal player in the biofuel market, but its role is emerging. Southern Africa has been described as a potential 'Middle East of biofuels'[33] and some African countries are the most targeted areas of FDI in lands for biofuel projects. We have seen that the risks and opportunities of biofuel production and use are particularly relevant for Sub-Saharan Africa as the continent faces simultaneously energy emergency, high vulnerability to climate change, widespread poverty, low rates of agricultural productivity growth, food insecurity and water stress and scarcity. Biofuels can help local African populations to meet their current and increasing energy needs, to develop alternative, sustainable and profitable income sources in the agricultural sector, but it will be possible only if the conditions to reap the benefits are met in advance or in conjunction with investment projects. These conditions include (i) a clear definition and recognition of pre-existing resource-use rights; (ii) a balanced, informed, capacitated and transparent engagement of all stakeholders; (iii) knowledge and technology transfer to local communities; (iv) a careful assessment of indirect land use change and water intensity and requirements; (v) the implementation of rules and actions which facilitate the

[32] Note that 33 out of 48 Least Developed Countries are in Africa region.

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

use of biofuel productions for local energy provision. In contrast, the prevailing governments' approach, both in the main consumer and producer countries, which is centered on policy mandates, targets and subsidies, should be reconsidered as it produces or does not allows preventing 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 get smaller land areas than foreign investors, which are likely to have more capital to invest[34]. Furthermore, they tend to consult more with the local communities before deciding whether and how to use the land while foreign investors tend to better exploit possible economies of scale.

Last but not least we have started to tackle the issue of links between investment and quality of institutions. Further work is needed in this area. However, we can suggest that while in general good institutions are conducive of investments, as a large literature highlights, there are some specific type of investments that seem to obey different rule. Investments in lands are an example, as also emphasized by Deininger (2011). Investments in so called "dirty industries", I.e. those manufacturing industries which are water consuming and polluting, are another example. It seems that these specific investments are directed to countries where rules are easier to break and less stringent and this is more so, the more stringent become the rules in developed countries. These developments have obvious implications for the discussion of the developmental impact of investments and for the possibility of local populations to reap the benefits of investments in land, water and renewable energies.

[34] According to the Norwegian's People Aid (2011) study on Sudan for instance, domestic investors average size of land in around 9000 ha, while foreign investors around 175000. Other studies confirm the differences for other countries.

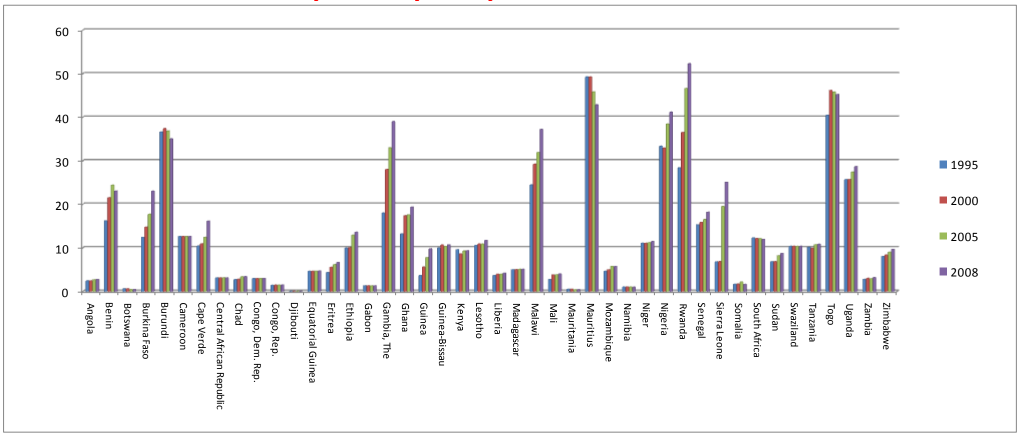
Appendix 1. Land deals in SSA: a look at the data

Land deals occur within and between regions, South –South deals are becoming increasingly common: China is indeed one of the main investors in land in SSA[35]. Domestic investors are in general elites, local entrepreneurs or the local government, while foreign investors are either (i) governments or state enterprises or state funds from oil rich countries or (ii) private companies from industrialized and emerging countries, investing mainly in agro-fuel projects (see Von Braun J. and R. Meizen-Dick 2009, Deininger et al. 2011).[36] If the large number of domestic investors raises some concerns, since large domestic acquisitions are likely to negatively affect land distribution, concerns related to foreign acquisitions are indeed many more, the main being a possible loss of control over land for countries or local communities. Furthermore, land deals carried out by foreigners often are not followed up by productive investments: according to Deininger et al. (2011) only 20% of announced investments have been followed through with agricultural production.

Information on existing deals is at best scattered, approximate and not exhaustive. Most information is derived from media reports, often not credible, or case studies, not always carried out with the appropriate level of scientific rigor[37]. Furthermore, existing reports have a very different coverage: some exclude the so-called small deals, i.e. allocations below 10 ha, some includes deals still under negotiation, and often there is no clear-cut distinction between land that is leased or bought, nor weather the investor is domestic or foreign.

A starting point to understand the size of the phenomenon is that only three billion ha out of the world total of 13 billion ha of land surface is suitable for agriculture and only 50% of this arable land is currently cultivated (Deininger 2011). Sub Saharan Africa is characterized by very heterogeneous countries in terms of land availability as well as land right, quality of institutions. For instance Rwanda and Malawi are very land scarce (Deininger, 2011) while Tanzania, Zambia and the DRC amongst others are land abundant.

Figure A1: % of arable land by country and years



Source: FAO stat accessed August 30 2011

[35] Land acquisition typically involves leases of periods up to 99 years and often in excess of 10000 ha. The main actor is the private sector, both at domestic and foreign level: agribusiness, banks, commodity traders, hedge funds (see for instance Friis and Reenberg, 2011). However, in the past few years, states and sovereign funds have began 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 outside the scope this paper. Discussion can be found in Friis and Reenberg (2011) as well as in the GRAIN and ILC blogs.

[36] A detailed description of the different players involved in large land deals is in CFS, HLPE 2011, p. 16-17.

[37] A recent project "monitoring land transactions" jointly carried out by GIZ, Oxfam etc is trying to provide a database.

But Tanzania has well assessed land rights, while DRC does not. A first look at the data seems to suggest that quality of institutions is negatively correlated to number of deals. Tanzania for instance, only transferred to foreign investors 50000 ha between 2004 and 2009, while countries with weak institutions or in situation of fragility 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, furthermore, are the three countries with the larger number of individual land deals (see table A1 below).

Table A1: Land deals by country, a comparison of different sources of information (all the numbers are in ha)

Country	*Deininger et al (2011)*	*GTZ*	*Cotula et al (2009).*	*Office of Niger (2009)*	*Gorgen et al*	*Oakland Inst. (2011)*	*Schonev erd (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	140000	
Kenya								40000		
Ethiopia	1190000		602760					13000- 18000	2892000-354000	
Madagascar		1720300	803414		1720300			502000	2745000	
Sudan	3965000		471660					1297000	3171000-4899000	
South Sudan										600000 (plus 400000)
Cameroon								10000	10000	
Tanzania								45000	1717000-11000000	
Mali		159505	162850	242577	159505			100000	2417000-2419000	
Mozambique	2670000								10305000	
Uganda									1874000-1904000	
DRC								2800000	11048000	
Nigeria								10000	821000	
Zambia									2245000	
Ghana			452000				107500	452000	89000	
Malawi									307000	
Sierra Leone						500000				
Senegal									510000	
Zimbabwe								101000		
Liberia	1602000							17000		
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 J. and R. Meizen-Dick 2009, , Friis and Reenberg (2010).

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

Table A2: Unsigned, pending and cancelled land deals

Country	Planned/under discussion/status unknown	disrupted
Congo Rep	8000000	
Ethiopia	602760	
Madascar	1500000	1300000
Mali	62850	
Mozambique	10000	Value 800 mill $
Sudan	378000	
Tanzania	505500	
Zambia	2200000	

Source: Odhiambo (2011), table 1.

We mentioned that often land deals, especially carried out by foreigners, are not followed up by productive investments. When they are, often they are aimed at different tasks: (i) to produce biofuels: jatropha and sugar for ethanol (the "new Middle East of biofuels"); (ii) for mining: platinum, uranium; (iii) for timber (indigenous forest clearance, some plantations); (iv) for tourism: enclosures for safaris / coastal resorts, exclusion of fishing communities.

Table A3 summarizes, for countries for which information is available, to the best of our knowledge, in which sectors investments in land have been targeted. The sources are different. In some cases, information is confined to the fact that some investment were in mining or tourism but without reference to the number of project in the sectors. The only study providing numbers is Odhiambo (2011) (but only some countries are scrutinized 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								na
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 elaboration on: Friis and Reenberg, 2011, Land deal Brief, June 2011; The Oakland Institute 2011; Odhiambo (2011), GTZb, 2009; Von Braun J. and R. Meizen-Dick, 2009, Cotula et al, 2009; "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), Appendix 1.*

The existing estimates suggest that, on average (with large heterogeneity), between 35-50% 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 share of biofuel is increasing over time. Much less land is at the moment 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, so that in terms of ha the sector seems more active than what it is.

The impact on development of the different uses is likely to be different as it is the impact of investments in different sectors. There is need for further analysis and more detailed data in order to assess the exact developmental impact. It is also likely to be very country specific, in that institutions matter for it. 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 (Cfr Table A3) on intensive farming and do not take into account environmental considerations nor a balance between organic and intensive agriculture. Hence, they could have perverse effects, too.

Table A4: Value of land in selected countries

Value of land per ha	countries
Less than US$ 100	Ethiopia, Nepal, Uganda, Vietnam, Sierra Leon, Niger, Mali, Chad, Sudan, Bhutan, Mauritania, Guyana, Egypt, Tanzania, Mozambique
US$ 100-200	Burundi, Malawi, Guinea Bissau, Cambodia, Burkina Fasu, Kenya, Nigeria, Madagascar, Somalia, Zambia, Equatorial guinea, Zambia
US$ 201-300	Haiti, Rwanda, Bangladesh, Gambia, Benin, Ghana, Nicaragua, Central African Republic, Jordan, Liberia
US$ 301-500	Cote d'Ivoire, Togo, Lesotho, DRC, Zimbabwe, Algeria, Guinea, Cape Verde
US$ 501-1000	Angola, Senegal, Congo, Cameroon, Swaziland, Djibouti, Bolivia, Oman
US$ 1001-2000	Chile, Cuba, South Africa, Albania, Latvia, Tunisia, Romania, Lebanon, Dominican republic, Syrian Arab republic, Moldova, iran
US$ 2001-3000	Namibia, Botswana, Costa Rica, Venezuela
US$ 3001-5000	Mauritius, Reunion, Uruguay
US$ 5001-10000	Portugal, Israel, Korea, Greece, Argentina, Malta, Cyprus, Gabon, UAE
US$ 10001-15000	Canada, Australia
US$ 15001-20000	Belgium, UK, Spain Norway
US$ 20001- 30000	Germany, Sweden, France, Italy, Austria, USA, Finland, Netherlands
Greater than US$ 30000	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 refers to the end of 1990s.

Appendix 2. Table A.5: 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, J. (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 have been 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 the real 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 a multi-national company to produce sugarcane for ethanol (the project was cancelled)	Mozambique	Local people lost access to forest for fuel wood, game meat, fish and they suffer worsening in water uses. Biofuels projects exacerbate competition for land, water and other resources. Low enforcement of legislation and agreements between investors and communities, no genuine community consultations.
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 compensations 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 operative on 20,000 ha	Mozambique	Negative effects on grazing and fertile land and forest community rights. Few jobs have been created or sustained
Food security, economic viability of the projects	Diaz-Chavez et al. (2010)	5 small Jatropha producers projects and venture (Mali Folkecentre's Garalo project, Mali Biocarburant SA, the Jatropha Mali Initiative, and GERES)	Mali	In one of these projects, water access was identified as one of the main barriers for Jatropha adoption. Also access to inputs is an obstacle. The demand for Jatropha grains greatly surpasses the supply. The actual ethanol production is consumed in Mali and Burkina Faso. Jatropha programs have not compromised food production at local level
Environmental risks and opportunities	Romijn (2011)	Non specified	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 on tropical woodlands with substantial biomass and medium/ high organic soil carbon content, Jatropha will induce significant emissions that offset any GHG savings from the rest of the biofuel production chain.

Energy security, macroeconomic impacts	Franco, J. (2010)	Non specified	Mozambique	Biofuels are aimed largely at 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. The results find that biofuels investment can promote economic growth and reduce poverty showing potential for strong gains
Generation of income sources, 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 involve 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 provide them with additional incomes. There is no impact on deforestation.
Generation of income sources, 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 sources, environmental impacts, food security, access to energy	Practical Action Consulting (2009)	Cooperative of Jatropha producers which involve about 300 small farmers. 600 ha are under cultivation on land previously used for cotton cultivation	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 sources, access to energy, environmental risks	Practical Action Consulting (2009)	4500 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 in electricity (currently 150 kwh).This has increased farmers' income and community access to electricity at local level 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. Communities' land losses and expulsions. Diversion of lands from food production. People who lost their lands have shortened fallow period on the remaining plots and have experienced reduced incomes, increased food insecurity, and loss of access to vital forest products

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