Rabobank

Financing and the emerging bio-energy markets

The Rabobank view

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Preface

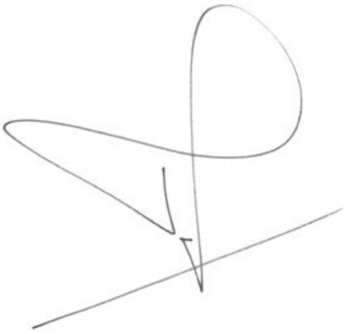
Human beings have been on this planet for a very short time (around 200,000 years); and yet we use more natural resources and produce more waste than any other species.

According to the World Watch Institute's 2006 State of the World report, the projected growth of India and China alone will, by 2030, double the current annual use of natural resources. This means that we will soon be using the resources of two planets. At the same time, we're undercutting the capacity of the earth to generate these resources, as a result of the damage inflicted by human production and consumption processes. In addition, the distribution of resources and the wealth derived from using them is far from equal.

Clearly this isn't sustainable. We only have one world; its natural resources are finite, and its complex life-supporting ecosystems may be more vulnerable than we would like to admit. The transition to a more resource-efficient and equitable low-impact economy with a sustainable energy basis is therefore of the highest priority.

There is no doubt in my mind that we can achieve this transition. We are fast learners and adept at overcoming challenges. The planet's resources may be finite but human ingenuity is infinite. I believe that we are witnessing an exceptionally innovative period in human history. We can and will break away from conventional, unsustainable practices. We are making great strides in harnessing renewable energy resources and thereby greatly reducing our impact on the environment. The technology is available and affordable. Moreover, there are strong economic drivers to employ it: resource scarcity, the internalisation of external costs by governments and, perhaps most importantly, changing customer preferences. Small wonder then that the transition to a more resource-efficient economy is increasingly driven by profit. Of course, this transition will require huge investments. It is therefore encouraging to see that the 'clean tech' sector is rapidly attracting venture capital, becoming more mature and thus bankable.

As a co-operative bank driven by a triple bottom line, Rabobank is committed to enabling a more sustainable and equitable energy future. After all, our core clients are in the business of natural resource development. Hence, sustainable development is key to both their and our long-term success. In my view, the transition towards a resource-efficient, sustainable economy offers exceptional opportunities for the food and agri sector, as bio-energy and biodegradable materials take over from fossil fuel resources. This transition will not only secure a more equitable global energy supply, but also provide the financial means to transform the food and agri sector in areas with low productivity and unsustainable practices. Indeed, it is a challenge and a responsibility to use the financial resources earned by energy farming to develop increasingly sustainable and productive forms of agriculture for food and energy.



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Introduction

Global energy demands are rising while fossil fuel reserves are diminishing. At the same time, evidence of global warming – and the need to do something about it – is overwhelming. This has created significant opportunities for sustainable energy sources – and a 'hot' new investment sector.

It is estimated that global energy requirements will surge more than 50% by 2030. In order to meet this demand, in the face of energy security issues and the greenhouse gas reduction targets outlined by the Kyoto Protocol, alternative energy sources will have to be developed.

Although potential sources of alternative energy are not exclusively agricultural, agriculture is seen as an important contributor to tomorrow's supply of clean, sustainable and renewable energy. This is because bio-energy is generated from plant and animal sources such as wood, food crops and livestock waste. These sources are not finite or limited to certain geographic locations in the same way that oil reserves are, and can significantly reduce the greenhouse gas emissions linked to global warming. The global production and consumption of liquid biofuels is developing favourably. Biofuels are, in the short term, the only renewable resource suited to replace fossil fuels for the transport sector, currently one of the main contributors to global carbon emissions.

This study will first discuss the need to put more effort into the transition to a sustainable and efficient energy basis for the economy. This is because fossil fuels are finite and the combustion of these fuels is, to a large extent, responsible for the emission of greenhouse gases and hence a degradation of our environment. In chapter two, we focus on bio-energy and the wave of investment in bio-energy projects in recent years. Chapter three focuses on risk analysis and financing options specifically aimed at biofuel projects. As such, the chapter looks at how a broader range of bio-energy projects might be approached from a banking perspective. In addition, attention will be paid to renewable energy sources (including bio-energy) and developing countries, as renewable energy technologies can provide energy services for sustainable development based on indigenous sources, with almost no net emissions of greenhouse gases. Chapter five will conclude the study by outlining the ways in which Rabobank steers the activities of clients in the direction of sustainable development by offering taylor-made financial products and services.

This report's focus on bio-energy is not meant to imply that other renewable energy resources, such as solar and wind energy, are less worthy of attention[1]. We promote a suite of complementary renewable energy and energy-efficient technologies, all of which contribute to a more sustainable and more equitable energy future.

1 For instance, see the Rabobank publication (in Dutch, 2004): Energy: the need for alternative energy sources, Economic Research Department.

Towards a renewable energy economy

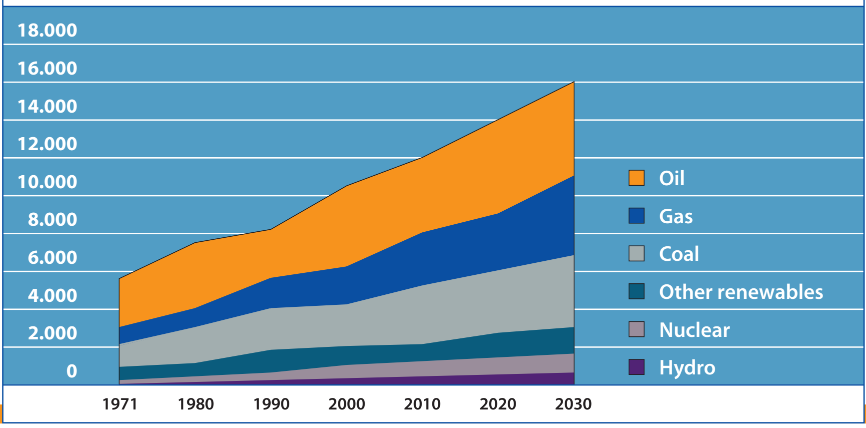
Global energy demand is increasing, as are concerns about energy security. At the same time, evidence of global warming – and the need to do something about it – is overwhelming. As a result, there is growing interest in 'sustainable', 'renewable' and 'clean' energy generation. Furthermore, the current run-up in energy prices has improved the relative economics of many alternative energy systems, creating an added stimulus for their development. After all, higher oil prices make alternative sources of energy more profitable.

Energy security

For centuries, the adequate availability and affordability of energy has been inextricably bound up with sustainable economic growth. Without fundamental changes in energy policy, future energy supply may not be secured. Economic and population growth will boost global energy demand, with the most robust growth expected among the emerging economies. The smaller average size of households, which increases the number of cars and household appliances used, and growing consumerism also add to rising global energy demands. Global energy needs will surge more than 50% by 2030 and energy prices will rise considerably if capacity is not significantly increased (see figure 1). Unless we drastically reduce our fossil fuel consumption (such as oil, natural gas and coal) and substitute these sources with alternatives, fossil fuel energy will continue to account for the largest share (approximately 75-89%) of the world's primary energy mix at least up to 2030 (IEA/OECD, 2005). Furthermore, the growth of China and India as large consumers of energy, coupled with insufficient and unaffordable alternatives to oil and natural gas, has resulted in the power to ensure access to international energy resources shifting away from energy consumers to energy producers (mainly OPEC and Russia)[2].

The idea that oil was in oversupply has led to two decades of under-investment in the oil industry, resulting in undercapacity. This means that the capacity that there is, is at an extremely high utilisation rate at the moment and prices have become more volatile. Proven reserves of oil and gas are mainly concentrated in the Middle East, Russia, Nigeria and Venezuela. As a result, political events, such as violence in the Middle East, ethnic tension in Nigeria and strikes in Venezuela, have had a more direct effect on prices in the past year than might have been the case if stock levels were higher. In addition, hedge funds and other speculators betting on the possibility of higher prices have themselves wilfully exacerbated price pressure in the market. A more controversial concern is the so-called 'peak oil' theory: the idea that the world has reached the natural limits of oil exploration and that there is little more to be found in the ground, whatever the price. Be that as it may, the current run-up in energy prices has improved the relative economics of many alternative energy sources, creating an added stimulus for their

Figure 1: World primary energy demand
according to World Energy Outlook's Reference Scenario, in million tons oil equivalent (Mtoe)



Source: IEA/OECD (2005)

2 For example, the recent interrupted gas supplies from Russia to Ukraine (and Europe) underscore the shift towards the ability of energy producers to exert pressure on countries dependent upon them for supplies.

development. After all, higher oil prices make alternative energy sources more profitable. Having said that, increasing fossil fuel prices also improve the relative economics of more expensive fossil fuel reserves.

Environmental quality

In recent decades concern has grown about the environmental impact of fossil fuel combustion. The huge boost in energy demand has also lead to increasing concentrations of greenhouse gases (GHGs) that accelerate the rate of climate change. Fossil fuels burned to run cars and trucks, heat homes and businesses and power plants are responsible for huge emissions of greenhouse gases[3]. Global emissions are expected to grow by just over half between now and 2030, with the bulk of the increase coming from developing countries.

Governments have taken action to mitigate global warming by introducing regulatory acts and legislation. Emitting GHGs is no longer free of charge. Legally binding targets, such as those outlined in the Kyoto Protocol and the European Union (EU) Emission Trading Scheme, and CO_2 policies in Japan and Canada are forcing developed countries to reduce their emissions of GHGs by at least 5.2%, compared with 1990 levels, between 2008-2012. These environmental regulations have transformed carbon dioxide from an irrelevant by-product of fossil fuel combustion to a valuable and tradable commodity. Not only the countries under consideration are affected by these regulations, but limits have also been set on the amount of carbon dioxide companies in certain energy-intensive sectors may produce. A whole new market has come into existence.

Other environmental regulations and efficiency standards are also rapidly transforming the business world. Just one example is the EU directive making it mandatory to blend biofuels into fossil fuels. As a result, more and more corporations are incorporating extra financial parameters into the business equation. This development is, above all, business driven. Companies are waking up to the fact that resource efficiency is essential to keeping the cost of production low, to minimise extra financial costs (imposed by environmental legislation) and to keep their customers satisfied. Individuals in industrialised countries are increasingly aware of the role they play in climate change. This leads to a preference for green power, energy efficient appliances etc.

Now that a price has been put on CO_2 emissions, differences in the carbon intensity of fuels such as coal and gas are affecting the way power companies run their power plants. The new carbon markets exert a global influence on other parts of the economy and society at large. For affected companies, GHGs emissions can and need to be managed like any other strategic asset or liability on the corporate balance sheet.

Fossil fuel energy

Up to 80% of global primary energy needs is currently supplied by natural gas, oil and coal. As apparent from figure 1, without drastic energy policy changes, fossil fuels will remain the most important energy source for at least the next decades. Fossil fuels are formed by the remains of animals and plants and are finite, non-renewable energy resources because it takes millions of years to form them. Below, we discuss the pros and cons of the three main (fossil fuel) energy sources.

Oil: the world's dominant energy source, but supplies are running low

The biggest demand for oil occurred with the development of the automobile. Besides fuelling vehicles, however, a significant property of oil is its versatility: it can be burned for electricity generation and used in the manufacture of e.g. plastics and chemicals. A drawback of using oil as an energy source is its significant contribution to carbon dioxide emissions

3 Increased agriculture, deforestation, landfills, industrial production, and mining also contribute a significant share of emissions.

and hence global warming. New technologies have been developed to stimulate more efficient oil use, resulting in lower emissions. However, these efforts are hardly a match for the current skyrocketing global oil consumption and corresponding CO_2 emissions (70 kg/GJ)[4]. The growing global demand for oil, short-term extraction and refinery capacity constraints, instability in areas where most oil is extracted, signs that supplies may be running low and oil import dependency of the principle oil-consuming countries all continue to put pressure on oil supply.
The problems of oil availability may be partly self-dissolving, however, as the run-up in oil prices makes the development of alternative energy sources more profitable.

Coal: revival, but success depends on the commercialisation of clean technology

With a share of 50%, Asia (and in particular China) is the world's biggest producer and consumer of coal, followed by North America (24%) and Europe (20%). While Asia's coal consumption has risen, the demand for coal in Europe has stabilised. Even though, ultimately, coal supplies are limited, the resources are well spread around the world and proven reserves are abundant and considerably larger than those of oil and gas. This is important from a security of supply point of view. These attributes could make coal the fossil fuel of the future. On the other hand, coal also produces more greenhouse gas emissions for the energy it produces than any other major fuel (94 kg/GJ compared to 55 and 70 for gas and oil respectively). Coal-based electricity releases up to 1 kg of CO_2/kWh in countries such as India and China, compared to 0.4 kg/kWh for a modern gas-fired power station. In addition, coal results in other bi-products, such as fly ash, slag and sulphur dioxide (SO_2). Coal's highly polluting reputation may be about to change, however, owing to a clean coal derivative produced through a process called 'coal gasification'. This gas can be liquefied and burned as a fuel in motor vehicles or power stations, and used to make chemicals and fertilizer.

Despite these positive features, this technology is still rather expensive and the secondary energy products remain CO_2 intensive. Carbon capture and storage (CCS) is the most popular method of dealing with emissions from coal-gasification plants. CCS involves capturing the carbon dioxide, preventing the greenhouse gas from entering the atmosphere, and storing it deep underground. But this begs the question: why should we use coal if cleaner alternatives are available at competitive prices? Wind power, for instance, is already as competitive as coal.
The feasibility of coal as a clean energy source very much depends on the commercial success of new techniques to harness the power of alternative energy sources.

Natural gas: cleanest fossil fuel

Gas is an important energy source for power generation and industrial production. Its contribution to total primary energy demand is projected to rise from the current 21% to 25% by 2030. In compressed and liquefied form, gas is also used as a vehicle fuel. Most of the gas reserves are located in the same regions as the bulk of the oil reserves (Middle East and Russia). It is quite conceivable that in the near future, once-stranded gas exploration investments (discovered, but unusable for either physical or economic reasons) will become available to the world market due to Liquefied Natural Gas (LNG) technology. Liquefying natural gas allows for much more efficient storage. LNG provides a safe and efficient way of transporting natural gas over long distances, particularly from gas producing nations with insufficient pipeline infrastructures to consuming countries. Environmentally speaking, natural gas is the cleanest fossil fuel, which means low carbon energy (it releases up to 55 kg of CO_2/GJ). Natural gas and oil are both subject to the same shortcomings: future supplies will dry up and a small number of regions control the majority of supplies. Moreover, the price of natural gas is linked to the oil price, as a result of which political instability in these areas will have an adverse effect on the affordability of natural gas.

4 A gigajoule (GJ) is a metric term used for measuring energy use. 1 GJ is equal to 277.8 kWh of electricity.

Sustainable energy

Without a faster transition towards renewable energy resources and higher energy efficiency rates, fossil fuels will remain the dominant energy source at least until 2030 (see figure 1).
The IEA predicts an increase of renewable energy supply by 1.8% per year from over 1,400 Mtoe in 2003 to almost 2,300 Mtoe in 2030, an increase of more than 60% (see figure 2). In this scenario, the share of renewables in global energy supply will remain largely unchanged at 14%. Other renewables (including geothermal, solar and wind) will increase most rapidly at 6.2% per year, but because they start from a very low base (0.5% share in 2003) they will still be the smallest component of renewable energy in 2030, with a share of only 1.7% of global energy demand. Fossil fuels are finite, however, and the combustion of these fuels is, to a large extent, responsible for emissions of greenhouse gases and hence a degradation of our environment. It is therefore likely that both public and private sector parties will put more effort into the transition to a clean and efficient energy basis for the economy, especially as these technologies become more competitive and affordable.

Sustainable energy sources are usually assumed to include all renewable sources, such as bio-energy, solar power, wind power, wave power, geothermal power, tidal power, and others. These energy forms, except for geothermal energy, ultimately all depend on solar radiation.

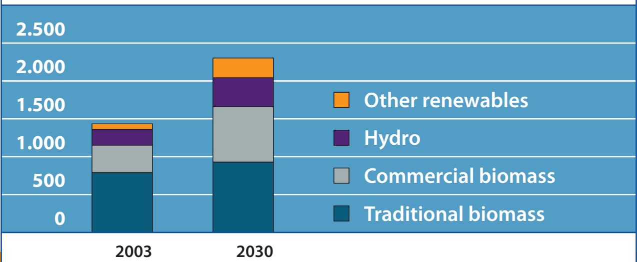
Energy efficiency

When considering a future sustainable energy system, the very first thing that must be addressed is energy efficiency. No matter how energy is produced, it is often cheaper not to use it in the first place. The world could be brought onto a much more sustainable growth path by reducing our global energy consumption using energy-efficient technologies, improving fuel efficiency and using more efficient home appliances.

Today, the global energy efficiency of converting primary energy to useful energy is about two thirds. In other words, one third of primary energy is dissipated in the conversion process, mostly as low-temperature heat. Further significant losses occur at the end-use level. Numerous and varied economic opportunities exist for energy efficiency improvements, particularly in the final step of converting useful energy to energy services. Taking advantage of these opportunities, which have received relatively little attention, offers a large potential for further cost-effective efficiency improvements. It would mean less costly energy services and lower energy-related pollution and emissions (UNDP, 2004). Over the last three decades, industrialised countries have already significantly reduced their primary energy use per unit of GDP. Major OECD countries taken together used a third less primary energy to generate a unit of GDP in 2000 compared to 1973 (IEA, 2005). The decline in energy intensity has been driven largely by improved energy efficiency in key end-uses such as vehicles, appliances, space heating and industrial processes. More substantial savings can still be made in end-use applications, however. Savings from liquid fuels would equal more than half of today's global oil consumption (IEA/OECD, 2006a). While energy use is rising in industrialised countries as a whole, it is rising more slowly than would have been the case if end-use energy efficiency improvements had not been realised.

Nevertheless, growth in population and income, greater demand for energy services, and other factors such as technological innovations are, in general, driving up energy demand to a greater degree than efficiency improvements are constraining demand. In addition, energy sources are not evenly distributed across the world. As a result, 2.4 billion people, who cannot afford to buy imported fossil energy, rely on traditional biomass as their primary source of energy, and 1.6 billion people do not have access to electricity (UNDP, 2005). Renewable energy technologies can provide energy services for sustainable development based on

Figure 2: Renewable supply by energy source
2003-2030, in Mtoe



Source: IEA/OECD (2005)

indigenous sources, with almost no net emissions of greenhouse gases. Therefore, besides economising on our energy consumption and actively promoting the development and implementation of more efficient end-use applications, increasing the availability and use of affordable clean energy options is crucial for a sustainable energy future.

Non-fossil energy sources

Below, we discuss different types of non-fossil energy sources. Next to nuclear power, these include various renewable sources of energy: hydropower, solar, wind, geothermal, hydrogen, ocean energy and bio-energy. There is controversy as to whether nuclear power should be regarded as sustainable because of the waste problem. As it is difficult to class this energy form, we discuss nuclear energy separately from renewable energy sources.

Nuclear

Nuclear power is the result of the fission of atoms. Heat is released when heavy atoms are split apart to form smaller atoms. The fuel most widely used for nuclear fission is uranium, which is a non-renewable, finite resource. Nuclear power generation has by-product wastes: radioactive waste and low temperature heat. However, it does not emit carbon dioxide into the atmosphere. In contrast with nuclear fission, nuclear fusion is a renewable resource. In atomic fusion, energy is released when small atoms (such as hydrogen or helium) are combined or fused together to form a larger atom. The main distinction between fusion and fission is that fusion power produces no high-level radioactive waste (though activated plant materials still need to be disposed of). Research is making steady progress, but has also run into many new difficulties. It remains unclear at this point whether an economically viable fusion plant is feasible. In conclusion, nuclear energy is still controversial due to the waste problem, nuclear accidents, and the link with nuclear weapons.

Renewable energy sources:

Hydropower

Hydropower in general is produced from the movement of a mass of water and is the cheapest source of power. For decades, large scale hydropower is a proven technology and currently covering 16% of the global power generation en approximately 2% of primary energy use. Because appropriate locations are limited and social and environmental consequences of large scale hydropower projects using storage reservoirs, there's little room for growth. However, this does not apply to small scale 'run of the river' projects. Power generated with small hydro station can be used for agro-processing, local lighting, water pumps and small businesses.

Solar energy

Sunlight, or solar energy, can be used directly for heating and lighting homes and other buildings, for generating electricity, heating water, solar cooling, and a variety of commercial and industrial uses. Using solar power to produce electricity is not the same as using solar power to produce heat. Solar thermal principles are applied to produce hot fluids or air. Photovoltaic principles are used to produce electricity.
A solar panel (PV panel) is made of the natural element silicon, which becomes charged electrically when subjected to sunlight. A promising new development is photovoltaics made from 'organic' materials that consist of small carbon-containing molecules, as opposed to the conventional inorganic, silicon-based materials. The materials are ultra-thin and flexible and can be applied to large surfaces.
The advantages of solar energy are several: it is free; it does not require fuel and produces no waste or pollution; in sunny countries, it can be used when there is no easy way to get electricity to remote regions and it is useful for low-power appliances such as solar-powered garden lights and battery chargers. As with most renewable energy systems, there are initial costs that make setting up these projects quite expensive. The savings made on electricity bills in the long-term, however, should make up for this and, year on year, the costs are falling, which will make solar energy more widespread. As a result, the technology now needed is 90% cheaper than it was in the 1970s. Houses with solar roof tiles can, in fact, generate more electricity than is needed at certain times in the day, and this excess can be sold back to local electricity companies.
In 2003, solar energy represented 0.039% of the world's total primary energy supply. Due to a very low base in 1971 and to recent fast growing developments, solar energy experienced a growth rate of more than 30% per annum between 1971-2003 (IEA, 2005).

Wind energy

Wind power is now a mainstream energy resource, the fastest growing form of electricity generation in the world and at the point of dramatic take-off. Energy can be extracted from the wind by transferring the momentum of passing air to rotor blades. Energy is concentrated into a single rotating shaft. The power in the shaft can be used in many ways: for example, large modern turbines convert it into electricity. Wind power is now mature and as competitively priced as many conventional energy technologies, although costs vary, depending on whether a turbine is located onshore or offshore, with the latter being more costly. Because of the variability of wind power, the simultaneous development and implementation of back-up or storage systems is crucial. Growth in the last five years exceeds the growth of hydropower in its first five years and has been double the growth of the nuclear industry.

Hydrogen

Hydrogen is a secondary energy carrier that can be derived from both fossil fuels (shift reaction) or by separating water using electricity (electrolysis). This electricity has to be produced either using fossil fuels or using renewable energy. And there are losses along the way. Whether hydrogen can be regarded as a sustainable energy carrier depends on the inputs and the losses that occur during production. Hydrogen itself is the smallest and most abundant element in the world. Found in organic matter and in water, it makes up about 70% of the earth's surface. Once separated from another element (such as oxygen or carbon), hydrogen can be burned as a fuel or converted into electricity. When hydrogen is burned, some nitrogen oxides (NOx) are formed, but even so, burning hydrogen produces less air pollutants than burning the same amount of fossil fuels.

Geothermal

Geothermal is renewable heat energy from deep in the earth and is used for a variety of purposes, including electric power production and the heating and cooling of buildings. Heat is brought to the near-surface by thermal conduction and by intrusion into the earth's crust of molten magma that originates from great depth. A drawback is that geothermal energy is site specific and therefore has limited scope.

Ocean energy (tidal, wave)

Ocean energy draws on the energy of ocean waves, tides, or the thermal energy (heat) stored in the ocean. In favourable locations, wave energy density can average 65 megawatts per mile of coastline. Energy can be captured by exploiting the pressure difference at the boundary between freshwater and saltwater (salinity gradient).

Bio-energy

Bio-energy is energy from biomass: plants and plant-derived materials, like wood, food crops, plants, residues from agriculture or forestry, and the organic component of municipal and industrial wastes. At the moment, bio-energy is the most important non-fossil resource, as it accounts for 13% of global energy consumption. For the most part, this is traditional use for cooking and heating in rural areas based on chopped wood, which is obviously not sustainable. Sophisticated use of biomass is, however, particularly suitable for the production of transportation fuels. In addition, biomass can be used for power generation or producing chemicals (for making plastics and other products that are typically made from petroleum. Taking into account certain conditions, biomass energy can be regarded as a sustainable energy source.
Because it can be stored and used when needed, bio-energy can also provide a constant, reliable supply of electricity. In the short term, biofuels are particularly suited to replace fossil fuels in the transport sector, currently one of the main contributors to global carbon emissions.

In the next chapters, we will focus on bio-energy. This focus is not meant to imply that other renewable energy resources, such as solar, wind, and geothermal, are less worthy of attention. We promote a suite of complementary renewable energy and energy-efficient technologies, all of which contribute to a more sustainable and equitable energy future.

Bio-energy: a growing business

What is bio-energy?

Bio-energy is energy derived from biomass. This definition encompasses a range of materials, including wood, food crops, residues from agriculture or forestry, livestock manure and the organic component of municipal and industrial wastes (table 1).

There are a range of processes for the conversion of biomass into energy. These can be broadly categorised into traditional and modern usage.

Traditional usage encompasses the use of firewood, charcoal or agricultural waste for household cooking and heating, and the use of biomass in the processing of products such as tobacco, tea, bricks and tiles. The bulk of traditional use takes place in developing countries, where biomass can often be the primary source of energy for much of the population.

So-called modern usages are largely, but not exclusively, industrial processes that exploit a range of technologies to convert biomass either directly into energy (via combustion) or into some sort of gaseous or liquid fuel that can subsequently be burned to produce heat and electricity or can be used as a motor fuel. Table 2 provides a simple guide to such processes. Some are already commercially proven (biomass combustion, ethanol and biodiesel production), while others are considered to have potential but are not yet in widespread commercial use (biomass gasification, pyrolysis).

Table 1: Biomass resources classified by supply sector

Supply sector	Type	Example
Forestry	Dedicated forestry	Short rotation plantations (e.g. willow, poplar, eucalyptus)
	Forestry by-products	Wood blocks, wood chips from thinnings
Agriculture	Dry lignocellulosic energy crops	Herbaceous crops (e.g. miscanthus, reed canarygrass, giant reed)
	Oil, sugar and starch energy crops	Oilseeds for biodiesel (e.g. rapeseed, sunflower, soybeans, palm oil, jatropha, castor)
		Sugar crops for ethanol (e.g. sugar cane, sweet sorghum)
		Starch crops for ethanol (e.g. maize, wheat)
	Agricultural residues	Straw, prunings from vineyards and fruit trees
	Livestock waste	Wet and dry manure
Industry	Industrial residues	Industrial waste wood, sawdust from sawmills
		Fibrous vegetable waste from paper industries
		Food industry waste (recycled fats for biodiesel production)
Waste	Dry lignocellulosic	Residues from parks and gardens (e.g. prunings, grass)
	Contaminated waste	Demolition wood
		Organic fraction of municipal solid waste
		Biodegradable landfilled waste, landfill gas
		Sewage sludge

Source: www.eubia.org

In recent years a number of developments have combined to create a surge in interest in bio-energy. These are:

- The desire to diversify energy sources, in order to enhance energy security and as a response to a strong increase in the price of fossil fuels in recent years
- The need to respond to the challenge of climate change by adopting energy generation processes with reduced CO_2 emissions
- The importance of developing new sources of growth for rural economies, in order to generate investment and employment, and (in some cases) to offset any reduction in rural incomes that may come about as a result of declining support for more traditional agricultural activities

In the following section we briefly quantify the current contribution of bio-energy to global energy supply, and we provide some indications of the extent of the possible expansion of bio-energy in response to the drivers outlined above.

Current and future scope of bio-energy

Current scope

Bio-energy is estimated by the International Energy Agency (IEA) to account for around 10% of global energy supplies. However, the use of non-commercial fuel wood in developing countries accounts for a large share of this figure. For example, table 3 indicates that in Africa, combustibles (overwhelmingly firewood) account for close to 50% of total primary energy supply.

Outside the developing world, the current contribution of bio-energy to total energy supply is relatively low, with modern forms of use pre-dominating over traditional forms of use. For example, renewable energy

Table 2: Technologies for biomass conversion to energy

Technical and chemical processes	Technical status	End products	Scale	Example
Combustion	Operational	Heat and electricity	Domestic, local community or industrial	Wood chip-fuelled power plants, straw-fuelled power plants, bagasse-based co-generation, small scale wood chip and pellet boilers
Gasification	Emerging	Gas for heat and electricity production	Local community or industrial	Small scale/pilot gasifiers have used wood, forest industry by-products, municipal solid waste as feedstocks
Pyrolysis	Emerging	Charcoal, bio-oil for use in combustion or engines, fuel gas	Industrial	BTL (biomass to liquid) diesel
Transesterification	Operational	Biodiesel	Industrial	Biodiesel production from vegetable oils and animal fats
Biological processes				
Fermentation (sugars and starches)	Operational	Ethanol	Industrial	Ethanol production from sugar cane, molasses, maize
Hydrolysis and fermentation (cellulose)	Experimental/emerging	Ethanol	Industrial	Ethanol production from woody biomass, agricultural waste
Anaerobic digestion	Operational	Biogas for heat, cooking and electricity production	Domestic or local community/small industrial	Biogas production from livestock manure, crop residues, municipal waste

Sources: UNDP (2000); European Commission (2005); Gallagher (2006); Risø (2003); Rabobank (2006) accounts for 6% of the OECD's total primary energy supply, 53% of which (equivalent to 3% of total primary energy supply) is represented by bio-energy and waste. A significant proportion of this figure is the result of contributions from biomass power enterprises in the forestry and forest product sectors of a handful of countries such as Finland, Sweden and the United States (US).

Indeed, on a global scale, the contribution of modern bio-energy (the principal focus of this document) to global energy supply is currently modest. For example, with regard to global electrical power production, bio-energy is currently estimated to make a contribution of 1% to global supply (figure 3).

Investment trends and outlook

Although the evidence today suggests that modern bio-energy is only a modest contributor to global energy supplies, the drivers identified above will ensure that the sector continues to grow strongly in the future. Figure 4 illustrates the rates of capacity growth of various bio-energy processes in recent years as a result of investment flows into the sector. During this period, biofuels in particular have seen a tremendous surge in capacity, with global biodiesel capacity rising spectacularly from a very low base in the late 1990s (global ethanol capacity, by contrast, was already significant at this time owing to the existence of well-established fuel ethanol programmes in Brazil and the US). The surge of investment in biofuels has largely been brought about by policy initiatives in a number of countries to encourage the use of cleaner fuels. In total, it is estimated (REN 21, 2005) that around USD 5 billion was invested in 2004 in bio-energy and geothermal energy systems combined.

Biofuels outlook

Looking ahead, it is likely that the momentum of the biofuels sector will remain undiminished. There is a growing list of countries that have implemented policies to boost biofuel utilisation. In addition, the introduction in Brazil of a new generation of vehicles capable of running on any blend of gasoline and ethanol – so-called flex-fuel vehicles – has had a profound impact on the outlook for the local ethanol fuel market which, along with the US, is already one of the two largest biofuel markets in the world. The outlook for biofuels is discussed in more detail in the case study at the end of this chapter.

Biomass power outlook

Many countries have also used policy measures and targets to boost the use of renewable energy, including bio-energy, in power generation. The measure usually applied is a so-called feed-in tariff, whereby electricity utilities are obliged to pay a minimum guaranteed price per unit of energy supplied by independent producers of renewable energy. As a result, biomass heating and power systems are expanding, albeit slowly, in regions where policy is supportive, such as the European Union (EU) and the US.

The use of biomass in conjunction with fossil fuels (co-firing) in conventional power plants provides a means of achieving targets in the use of renewable energy without introducing major changes in power sector structure and processes. Feedstocks used in co-firing include wood pellets, wood chips, wood dust, olive cake, palm oil, fatty acids, palm kernel shells and cocoa husks. Elsewhere, district heating systems based on biomass (usually wood) is already important in some European countries (Sweden, Austria and Germany), and continues to expand.

Table 3: Regional renewable energy indicators for 2003

	Renewables as % of total primary energy supply	Share in total renewable energy supply		
		Hydroelectric	Geothermal & solar	Combustibles[a] and waste
Africa	50%	3%	0%	97%
Latin America	29%	36%	1%	63%
Asia (excl China)	33%	4%	4%	93%
Non-OECD Europe	9%	41%	1%	59%
Former USSR	3%	70%	1%	29%
Middle east	1%	43%	24%	33%
OECD	6%	35%	12%	53%
World	**13%**	**16%**	**4%**	**80%**

a Includes solid biomass, biogas, liquid biofuels and municipal waste.

Source: IEA (2006)

As has been the case in the past, a significant share of new investment in biomass heat and power investments will be made by companies using the by-products of their processing activities as feedstock (REN 21, 2005). Typical examples are pulp and paper mills and sugar mills, as highlighted in the box below.

Co-generation in the sugar sector

Co-generation is a general term for the production of two forms of energy from one fuel. Typically one of these energy forms is heat, while the other is usually electricity or mechanical energy. Such systems are also referred to as combined heat and power (CHP) systems. Co-generation has considerable potential to raise the output of renewable energy from certain agricultural processors, because in these cases the waste product of processing is the fuel that powers factory operations. In the processing of sugar cane, for example, mills burn bagasse (the solid fibrous residue from cane milling) in their boilers in order to generate steam and electricity for use in the factory.

Efficient milling operations are often able to produce more electricity than they need to power their factories, creating an opportunity to sell surplus electricity to the grid. In the case of bagasse, such electricity is generated from a renewable resource, the burning of which releases far less particulates and CO_2 than fossil fuel alternatives.

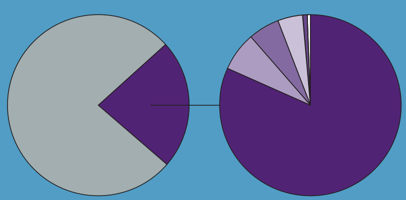
There are some downsides, however. In the majority of cases, sugar cane processing is a seasonal activity, meaning that in order to provide year-round electricity, all but the most efficient operations have to burn at least some fossil fuel. The greatest potential for cane-based co-generation lies in the world's largest cane sugar producing countries, Brazil and India. In both cases, the domestic cane sector is currently enjoying a period of expansion and investment in new capacity. Furthermore, energy demand in both countries is growing strongly, and changes in the regulation of both countries' electricity sectors have encouraged increased interest and investment in co-generation. The potential for such projects to receive funds via the Kyoto Protocol's Clean Development Mechanism has been a further catalyst for interest in cane-based co-generation.

First generation and second generation technologies

In the short term, investment and growth in bio-energy production is likely to take place through both the wider uptake of well-established 'first generation' technologies, such as the fermentation of agricultural crops to produce ethanol, and simple combustion of biomass to produce heat and power. In the longer term, there is considerable potential for expanding the output, efficiency and cost-effectiveness of bio-energy system through the uptake of 'second generation' technologies.

Second generation technologies include the biomass gasification and pyrolysis systems mentioned in table 2 (used only to a limited commercial extent at present), and also the use of non-food 'cellulosic' crops or waste materials for biofuel production, also featured in table 2. Estimates suggest that it could be at least five, maybe even ten, years before processes such as the production of 'second generation' ethanol from cellulosic sources (e.g. switchgrass, corn stover, wood chips and waste paper) is viable. This is already an area of intense research, and the US recently announced a target production of almost 1 billion litres of cellulosic ethanol by 2013.

Figure 3: Share of renewables and biomass in global power generation capacity

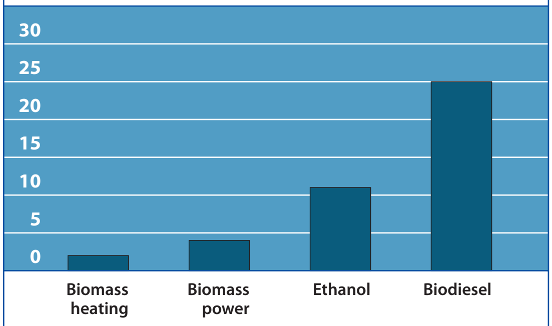


Non renewables	77,0%
Renewable	23,0%
Large hydropower	19,0%
Small hydropower	1,6%
Wind turbines	1,3%
Biomass	1,0%
Geothermal	0,2%
Solar & ocean	0,1%

Source: REN 21 (2005)

Figure 4: Global capacity expansion for selected bio-energy systems, 2000 - 2004

average annual growth rate



Source: REN 21 (2005)

The anticipated benefits of second generation technology include lower costs (feedstocks are waste products or low value purpose-grown energy crops) plus a number of environmental benefits, such as an improved balance of energy and CO_2 inputs and outputs. These issues are explored in more detail in the section of this chapter entitled The costs and benefits of bio-energy.

Bio-energy and international trade

A further consequence of the global growth in bio-energy is likely to be an increase in the global trade of feedstocks and biofuels. It has already been pointed out that a diverse range of feedstocks are used for co-firing in conventional power plants. For example, palm oil, olive cake and cocoa husks are all used for co-firing in Northern European power stations. Wood-based biomass products are also extensively traded in Europe and North America.

Meanwhile, the volume of biofuels entering international trade is also expected to grow in the future. In some cases, this will be because countries will seek to achieve levels of biofuel use that are beyond their own production capacities, and will need to seek supplies from abroad. For example, Japan may well become a major importer of ethanol from Brazil and elsewhere if it goes ahead with plans to introduce the blending of ethanol with gasoline. Furthermore, the economics of local biofuel production versus imports may encourage increased trade, as countries seek to achieve reductions in greenhouse gas emissions in the most cost-effective manner possible.

A key issue in the context of global trade in biomass is sustainability. Increasingly, public approval and support for bio-energy initiatives involving trade will have to demonstrate adequately that feedstock supply is generated without detrimental environmental, economic or social effects. Such effects might include deforestation, competition between biomass crops and food crops for land and water resources, and disputes over land rights, to name but a few. Under these circumstances, the extension of current certification schemes and the development of new systems, where appropriate, may well be required.

The costs and benefits of bio-energy

Most evaluations of the economic viability of bio-energy systems are based on comparisons with fossil fuel-based systems, and the outcome of these comparisons is often that bio-energy (and indeed most forms of renewable energy) is more expensive than fossil-based energy. However, such comparisons fail to take account of both the negative externalities of fossil fuel-based systems (e.g. climate change impacts, air pollution) and the positive externalities of bio-energy systems (e.g. rural development, cleaner air). It is heightened concern about these issues not just at government level, but also crucially amongst consumers, that has added a political dimension to this economic debate in recent years.

Given that today's economics favour fossil fuel-based systems, governments have often had to implement policy measures that offset the higher cost of bio-energy, in order to encourage the development of bio-energy and other renewable energy systems. Typically these include:

- Measures influencing demand. Examples include the mandated inclusion of biofuels in blended fuel, and purchase obligations for energy distributors, which force them to source a proportion of electricity from renewable sources.
- Measures influencing supply. Examples include the reduction or elimination of motor fuel excise tax for biofuels, and the availability of capital grants to establish agri-energy projects.
- Measures influencing technology and market development, such as government funding for research.

The cost of such initiatives tends to be met either by the consumer, via higher prices for energy, or by the government (in terms of revenue forgone in the case of tax breaks, or extra outlay in the case of capital grants and support for research).

The use of agricultural resources for energy purposes also clearly creates opportunity costs, in that the resources become unavailable for alternative uses. In the case of crops grown for biofuels, there is an obvious trade-off. Even in the case of agricultural by-products and waste products, however, there are often uses for these products other than as energy sources. Waste crop material from maize and cane harvesting, for example, which, in theory, could be used as fuel, is often left in the field where it protects soil against erosion.

The cultivation of traditional annual (food) crops, such as wheat for energy purposes, have the advantage that farmers are already familiar with them. However, the level of inputs required for these crops is relatively high, and soil nutrient leaching is also encouraged by the need to plough annually. In contrast, 'second generation' biomass technologies may make more use of perennial woody plants and grasses as dedicated crops (such as willow, poplar, switchgrass and Miscanthus), which require lower levels of inputs and can be harvested year after year without ploughing and replanting. Furthermore, evidence suggests that the cultivation of these dedicated biomass energy crops can also achieve substantially better net reductions in greenhouse gas emissions compared to the cultivation of conventional food crops for energy purposes. Lastly, wastewater and other effluents can be used to provide water and nutrients to such crops without any danger that they might accidentally contaminate food products.

Food versus fuel?

The pronounced growth in biofuel initiatives across the world, driven by government implementation of pro-biofuel policies, has generated concern in some quarters that a sudden structural change in the nature of demand for energy crops will push up the price of these crops for the food sector. Anxiety has been expressed in this regard not just on behalf of developing countries dependent on food imports, but also by companies active in food processing in industrialised countries.

Two current examples serve as illustrations: the steep run-up in EU rapeseed oil prices appears to be at least partially related to the boom in EU biodiesel production; while a link has been established between global oil prices and world market sugar prices resulting from the dominance of Brazil as a sugar exporter coupled with the recent rapid introduction of flex-fuel cars into the Brazilian auto fleet. As Brazilian mills produce ethanol and sugar as co-products, millers' production decisions reflect a constant arbitrage of the two markets. Because the ethanol price is linked to the gasoline price, and ultimately to the oil price, the link between oil prices and sugar prices is made.

The true extent of this threat is difficult to assess, and to dismiss these fears out of hand would certainly be premature. Agricultural commodity markets have long been characterised by significant levels of volatility, not least because production is weather-dependent, and often relatively few producers account for a large share of global trade. However, it is also a characteristic of agricultural commodity markets that high prices tend to provoke a supply response in subsequent seasons, with corresponding consequences for prices. Furthermore, the prospect of sustained high prices may also trigger an increase in research and development activity geared towards boosting productivity. Moreover, in a number of cases, there are reasons to believe that crops grown for biofuel production need not necessarily compete for land with crops grown for food purposes.

In the developing world, there is arguably most potential for conflict between food needs and energy needs. Food security is often of paramount importance, but many developing countries are energy importers that are significantly impacted by escalating energy prices, which may also encourage an acceleration in the non-sustainable use of domestic fuelwood resources. Yet research suggests that even under these circumstances, there are instances where bio-energy systems can be established without impacting on the availability of (food) crop land.

In India, for example, there are more than 60 million hectares of wasteland that are unsuitable for the production of food crops. At least part of this land could be used to grow energy crops such as jatropha, which can survive under harsh conditions. The oil produced from the seeds of the jatropha plant is inedible, but can be used to produce biodiesel. It is estimated that about half of the wasteland in India is suitable for jatropha production. Whilst the Indian authorities are keen to exploit this opportunity, much effort in research and development, field trials, appropriate policies, infrastructure and so on is required in order to make such an initiative viable.

In the next chapter (Access to energy in developing countries), we discuss the potential benefits of bio-energy for developing countries.

In the EU, a large area of agricultural land has been classified as so-called 'set-aside' land, where the production of food crops has been actively discouraged so as to prevent the build-up of excessive supplies. Legislation introduced in the 2003 reforms to the Common Agricultural Policy created specific incentives for the production of energy crops on set-aside land. In this case, there would appear to be no conflicting requirement for food and fuel within the EU, at least until the point is reached where demand for energy crops exceeds the availability of set-aside land.

In the longer run, the ability to generate second generation biofuels from agricultural waste and by-products should dramatically reduce the concern that has recently been expressed about the wisdom of using food crops, particularly cereals and oilseeds, as raw material for energy production.

Case study: biofuels

Biofuels currently represent the only means by which renewable energy can be utilised by the transport sector – a significant contributor to global warming. Earlier in this chapter we illustrated that biofuels are currently at the leading edge of a new investment wave in renewable energy.

This appears to be because the first generation technology for the industrial production of biofuels is already well established, and in most cases biofuels can be integrated reasonably easily into the existing motor fuel supply chain. It has further proved relatively simple for governments to take action to encourage the use of biofuels, either by adjusting rates of motor fuel excise duty or by signing legislation on blending (in some cases mandated blending) into law.

It should be pointed out that vehicle emissions can be materially reduced by means other than the use of biofuels. Hybrid cars (cars powered by a combination of a fuel combustion engine and an electric motor), available in a number of countries, are certainly capable of contributing to transport sector emissions reductions, because the use of the electric motor reduces overall fuel consumption.

The market for hybrid cars today is extremely small, although it is projected to grow quickly. Ultimately, though, the market appeal of hybrid cars appears to be restricted by the cost relative to conventional cars: according to IRIS (2006) hybrid vehicles currently sell at a premium of between USD 3,000 and USD 8,000 over conventional cars in the US and Europe. Furthermore, IRIS believes that a price premium for hybrid vehicles will remain for the next ten to 15 years, although competitive pressure may erode the amount of the premium over time.

This is not to say that there is no role for hybrid cars in contributing to the reduction of transport sector emissions. It simply highlights the fact that, as is also the case with fuel cell technology, the possibility of wide-spread uptake of hybrid vehicle technology in the near future is small.

Thus, in the short to medium term at least, we expect the momentum of the biofuels sector to remain undiminished. We have therefore chosen to end this section on the outlook for bio-energy with a deeper examination of biofuel developments.

Key developments in the biofuels sector

Ethanol

- Brazil has a long history of fuel ethanol use, through both the mandated blending of ethanol with gasoline and the development of cars powered purely by ethanol. Supply problems in the 1980s diminished consumer enthusiasm for these ethanol-powered cars, and their numbers have been in a long-term decline. From 2003, however, a new generation of cars capable of running on any blend of ethanol and gasoline (flex-fuel cars) has been introduced, and quickly captured

Table 4: review of global biofuels initiatives

Country or region	Initiative	Comments
European Union	EU legislation: indicative blending targets, to reach 5.75% by 2010. Possibility for tax reduction. The newest CAP-reform provides opportunities for farmers to grow energy crops under two support schemes.	Implementation differs considerably across member states ranging from no support to tax reductions, mandatory blending, quotas or penalties. Rabobank believes that mandatory blending will become the predominant solution in most countries. There is a bias towards biodiesel – primarily based on domestically produced rapeseed, although the ethanol sector has started to grow strongly. Oil companies generally favour biodiesel due to logistics and the fact that Europe has short supplies of diesel, and diesel consumption continues to grow.

Country or region	Initiative	Comments
United States & Canada	Mandatory use under Energy Bill in the US. Renewable Fuel Standard stipulates use of 7.5 billion gallons ethanol in fuel by 2012. Specific blends (B2, B5, etc) being implemented at state levels. Tax credit higher for vegetable oils (USD1 per gallon) than recycled fats and oils (USD 0.5 per gallon). Canada's government is considering a mandatory 5% blend for biofuels.	The US initiatives are mostly orientated towards ethanol, with consequent increase in corn demand and DDGS output. Biodiesel is gaining momentum, leading to higher demand for (mostly) soybean oil. Demand for canola oil will increase due to specific properties, suitable for the US climate. Legislation in Canada to be passed during 2006 and expected to be in place through 2010.
Argentina, Brazil & Mexico	Argentina: passed legislation in April 2006. B5 and E5 blending requirement by 2010. Brazil: Mandatory blend in place for ethanol. Mandatory biodiesel target as of 2008 (B2) and as of 2013 (B5), including tax breaks. At the moment there is speculation about advancing the target dates for specific blends. Mexico: recently passed legislation on biofuels.	Argentina: biodiesel initiative focuses on soybean oil. An export tax differential (higher for soybean oil and lower for biodiesel) further stimulates biodiesel manufacturing targeted at export markets. Brazil: strong history (30 years+) supporting cane-based ethanol production and distribution. Introduction of flex-fuel cars has created a large new source of demand for ethanol. Brazils's biodiesel initiative will include specific provision for niche crops such as castor and palm to support smallholders in rural areas, especially in the North and North East. Although soybean oil does not receive the same level of support, this oil will also be used for biodiesel. Mexico: initiative focuses on ethanol.
Malaysia/ Indonesia	Malaysia: The National Biofuel Policy was released in 2005, and the Biofuels Act (known as the Biodiesel Act) is expected to pass in August 2006. Indonesia: planning legislation and looking into incentives. B10 already allowed.	The Ministry of Plantation Industries and Commodities is setting up three pioneer biodiesel plants through the Malaysian Palm Oil Board (MPOB) in partnership with the pr term. A large part of production is aimed at the EU. Indonesia is lagging somewhat behind Malaysia. Will focus on both palm oil and jatropha. Some subsidies in place destined for biodiesel plant constructions based on jatropha.
Rest of Asia	Thailand has a B5 target based on palm oil and some initiatives with jatropha. Thailand also plans to phase out 95 octane and 91 octane gasoline in 2008 and 2012, respectively, replacing these fuels with a 10% ethanol/gasoline blend. The Philippines is working on biodiesel initiatives based on coconut oil. Primarily for domestic use. Legislation on ethanol blending scheduled for consideration in 2006. India will introduce mandated blending of ethanol with gasoline (5%) from October 2006. India is also preparing legislation on biodiesel and support to cultivation and commercial activities, based on jatropha. China does not have a concrete biodiesel policy or industry, but focus on renewable energy. Ethanol blending has been mandated in a number of provinces.	The coconut initiatives of the Philippines could influence the coconut price. Impact mitigated by higher availability of palm and palm kernel oil. Initiatives in India (and in China in the future) are focused on jatropha and other inedible crops. India's ethanol programme is based on molasses.
Australia	The federal government has set a production target of 350 million litres (ML) of biofuels by 2010. Biofuels are exempt of excise duties via a duty levy which is rebated, until the 1st of July 2011. Thereafter the current import restrictions for fuel ethanol will be removed, and an incremental excise duty will be applied to reach 50% by 2005/16. Feedstock for ethanol facilities is primarily sugar and grains (wheat, sorghum).	Feedstock for biodiesel facilities is primarily recycled oil and tallow, however, there are some very small scale facilities using canola and there are palm-based facilities under construction.

Source: Rabobank analysis (2006)

around 75% of total new car sales. Consequently, fuel ethanol demand in Brazil is projected to grow rapidly (nearly doubling in less than ten years) in the medium term (Rabobank, 2005b).

• Ethanol's use as a fuel additive in the US began in a small way in response to the oil shock in the 1970s, and was bolstered in 1990 by two key amendments to the Clean Air Act, namely the Reformulated Gasoline Program and the Oxygenated Fuels Program. The widespread phasing out for environmental reasons of the use of MTBE (methyl tertiary butyl ether), another fuel oxygenate, has helped to further bolster demand for fuel ethanol. The sector's development has been given an enormous boost as a result of the long-awaited signing into law of a Renewable Fuels Standard as part of the 2005 Energy Bill. This legislation stipulates a near doubling of use of ethanol in fuel from current levels by 2012.

• The EU adopted guidelines for biofuels utilisation from 2003, although the targets set were voluntary rather than mandatory. Nevertheless, a number of individual member states (including Spain, France, Germany and Sweden) have vigorously pursued fuel ethanol programmes, and EU production has risen dramatically in recent years, though it is still dwarfed by the output of Brazil and the US. Rabobank's own estimates suggest that production will rise to over 4 billion litres by 2010, compared to 0.9 billion litres in 2005.

• In addition to the developments highlighted above, which represent the largest influence on fuel ethanol demand in the medium term, a number of other countries have taken active steps to promote the use of fuel ethanol. Among these are Canada, China, Colombia, India, the Philippines, Thailand, Mexico and Venezuela.

Biodiesel

• The EU, led by Germany and France, has historically been the primary producer of biodiesel in the world, with the US the only other larger producer. Although biodiesel plants are now being built all over the world, the EU still controls about 80% of current biodiesel manufacturing capacity, and is likely to control up to 70% of global expected capacity in 2010.

• Major investments in production capacity are taking place in the US, and will also increase in Asia (particularly in Malaysia), South America (Brazil and Argentina), Canada and Australia, to a small extent, as the different support programmes go into effect.

• Today, the biodiesel sector is predominantly a local or regional market, and the sector is highly fragmented. There is no dominant producer except on a very local basis, and the scale of plants range from a few thousand tonnes managed by a farmers co-op to the newer, large-scale, modern, multi-feedstock plants of up to 250,000 tonnes. Generally

Table 5: Common feedstocks for ethanol and biodiesel production

Region	Primary feedstock for production	Other feedstock for production
Biodiesel		
North America	Soybean and canola oil	Waste oils, animal fats
South America	Soybean, castor, and palm oil	
Europe	Rapeseed oil, increasingly also soybean and palm oil	Waste oils, animal fats
Asia	Palm oil, some jatropha and coconut oil	
Australia	Waste oils, animal fats	Canola, palm
Ethanol		
Brazil, Colombia	Sugar cane	
US	Maize	
Europe	Wheat, maize, sugar beet	
India	Molasses	
China	Maize	Cassava
Thailand	Molasses, cassava	
Australia	Sugar and grains (wheat, sorghum)	

Source: Rabobank analysis (2006)

speaking, biodiesel plants are stand alone projects, but a number of new biodiesel plants are entering into vertical integration with oilseed processing.

- Biodiesel will probably remain a predominantly regional business in the medium term; however, more biodiesel trade is expected to develop as production and competition increases, in particular intra-EU trade and exports from Malaysia to the EU, if the Malaysian biodiesel sector becomes as large as the government hopes.

Table 4 provides an overview of biofuels initiatives around the world.

Biofuel policies and economics

It is clear from table 4 that a supportive legislative and policy environment has been crucial in kick-starting the biofuels sector worldwide. Tax concessions have generally been required in order to make production and utilisation of biofuels commercially viable. This is because without such assistance, biofuel production cannot compete against fossil fuels. Mandated blending has, in some cases, also been used to force motor fuel producers and distributors to adopt biofuels. In general, there seems to be a gradual move on a global basis towards greater use of mandated blending.

In practice, there is a wide spectrum of costs for biofuel production using today's first generation technology. This is in large measure because the inputs (mostly agricultural crops or by-products such as molasses) tend to be relatively high in value (in the case of biodiesel, feedstock represents about 80% of production costs). In the ethanol sector, cane-based ethanol production in Brazil is currently regarded as the most cost-competitive production system. In the case of biodiesel, the use of animal fats rather than vegetable oils confers a substantial cost advantage, although there are disadvantages with regard to quality, reliability of supply and scope to increase scale that are also associated with the use of animal fats. In addition, there may be resistance to the use of animal fats as a feedstock in some markets for cultural reasons. Table 5 provides an overview of the most commonly used feedstocks for biofuel production.

Competition between biofuel producers can be influenced by government intervention at both an international and a national level. The competitive threat from imports is influenced by whatever import tariff is levied on biofuel from abroad. At a national level, France and Belgium have implemented a production quota system, with production quotas allocated to specific players, and non-quota production ineligible for tax relief. It is also possible that the adoption of specific technical standards for a biofuel in one market can create a barrier to trade, if imported biofuel made from different feedstocks tends to exhibit slightly different technical characteristics.

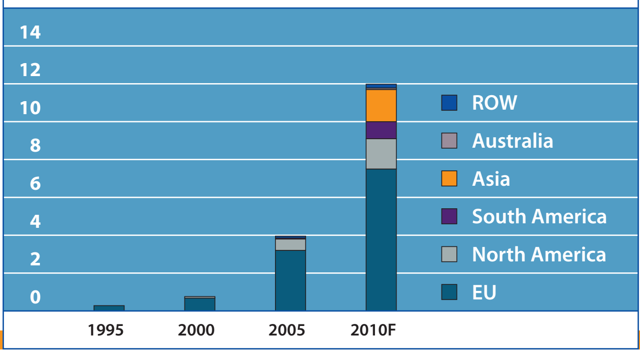
Biofuels outlook

Figures 5 and 6 illustrate our current medium-term projections for global biodiesel and ethanol production respectively. By 2010, we expect global biodiesel production to be three times the estimated output in 2005, while we expect global fuel ethanol production in 2010 to be close to double the estimated output in 2005.

Our expectation is that the vast majority, if not all, of this new production will employ first generation technology, and agricultural crops will continue to account for the bulk of feedstock used by the sector. We expect that significant output from second generation technologies (cellulosic ethanol and biomass-to-liquid biodiesel, foe example) will only enter mainstream commercial production after 2010.

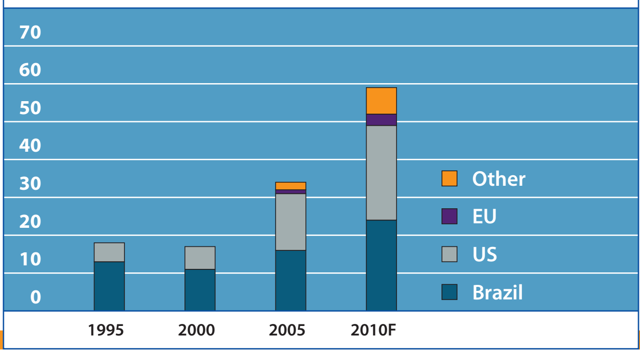
The implication of these diagrams is that there will continue to be very robust investment flows into biofuels in the coming years. In the next chapter, we consider the financing options for the players that will bring this new capacity into production.

Figure 5: Global biodiesel production, 1995 - 2010
in million tonnes



Source: Rabobank (2006)

Figure 6: Global fuel ethanol production, 1995 - 2010
in billion litres



Source: Rabobank (2006)

Financing options

The previous chapter (Bio-energy: a growing business) illustrated that the world has witnessed a wave of investment in bio-energy projects in recent years. Concerns about climate change and energy security have pushed governments to implement policies designed to foster the development of a cleaner and more diverse energy base. This chapter also illustrated how biofuels are leading this investment wave. This is due to the fact that the technology for industrial production of biofuels is already well established, and in most cases biofuels can be integrated reasonably easily into the existing motor fuel supply chain. It has also proved relatively simple for governments to take action to encourage the use of biofuels, either by signing legislation on mandated blending into the law, or by adjusting rates of motor fuel excise duty.

Given the degree of investment activity in the biofuels sector today, this chapter focuses on risk analysis and financing options specifically for biofuels projects. As such it is an example of how a broader range of bioenergy projects might be approached from a banking perspective.

Global investment requirement

At the individual project level, there is considerable variation in the investment required to establish a new biofuel facility. For example, a bio-diesel investment may simply comprise of a processing plant to convert vegetable oil into biodiesel. In contrast, a Brazilian ethanol producer will usually invest in a mill that will produce both sugar and ethanol, and may well also invest in land resources dedicated to producing at least a proportion of the mill's cane supply (although a common alternative to reduce investment costs is to rent land).

As explained in the previous chapter, Rabobank expects tremendous growth in the biodiesel and ethanol sectors in the years to come. This means that, collectively, the capital that needs to be invested in order to bring about this expansion is enormous. Although we expect agribusiness players to be the main investors in this expansion, it is clear that players in related sectors, such as the energy and automotive sectors, are becoming actively involved in biofuel projects.

Growth in ethanol production – and related capacity expansion – will primarily take place in Brazil, the United States (US), the European Union (EU) and India. Biodiesel projects, in turn, will primarily develop in the EU, the US, South East Asia, Brazil and Argentina, while India is a potential future larger player. Indirect investments, primarily in oilseed crushing, palm oil processing, and refining to deliver feedstock, are spun off for the most part in the EU, Canada and Malaysia.

In the case of ethanol, the investments required by the sector leaders are substantial. Rabobank's own analysis suggests that the Brazilian cane industry will have to invest around USD 8 billion (EUR 6.5 billion) over the coming six to seven years in order to meet projected demand for both ethanol and sugar. Meanwhile, over the same period in the US, it is estimated that USD 6 billion (EUR 5.0 billion) will be invested in the expansion of ethanol production. These represent only the very largest investments in individual countries. Substantial investments are also expected to be made in the EU, where the European Bioethanol Fuel Association estimates that as much as EUR 7 billion will have to be invested if the EU is to achieve the guideline blending percentages established by the EU Commission for 2010.

Based on the development in global biodiesel demand, Rabobank expects that biodiesel capacity will most likely expand by the equivalent of 95 plants (assuming an average capacity of 100,000 tonnes) in the coming five years, at a total investment value of at least EUR 2.4 billion. As biodiesel projects most often require supplementary investments in acquisition of land, storage, infrastructure and logistics, and that additional crushing and refining capacity is needed to supply sufficient volumes of (vegetable) oil, the total amount to be invested directly or indirectly in this sector will be much higher.

As a result, the total global financing requirement of biofuels projects in the medium term is likely to exceed EUR 21 billion.

Assessment of business risks

New projects carry an array of potential risks for owners and financiers. In the case of banks and other financial players approached with a proposal, careful analysis of these risks is an essential step in determining whether a project is bankable, and whether there are measures that can be taken to further reduce risk and enhance the viability of the project.

Of course, some well-capitalised players have no need to tap banks or the capital markets in order to raise funds for their own investments. However, even these players may well seek external finance in the case of new joint ventures. Thus, most new projects have a requirement for external finance.

The most common issues that are usually considered in the assessment of a project and the identification of appropriate financing structures are summarised in table 6.

Input and output volume, and price

A key issue for many biofuel projects is that the input is often an agricultural crop primarily used for food production, while the output is a fuel, linked ultimately to the oil market. In practice, this means that there is often no direct correlation between the input and output of biofuel enterprises, as figure 7 indicates.

In a few cases, the strong growth in demand for biofuels appears to have at least temporarily forged a link between energy prices and specific agricultural commodity prices (e.g. oil, ethanol and sugar in the case of Brazil), but for now such cases remain the exception to the rule.

It is imperative that projects have a clear and efficient strategy in terms of the sourcing of raw materials, the sale of the end product, and the management of the respective (uncorrelated) price risks. There must be some mechanism in place to manage these risks. For stand-alone finance of biofuel projects, some degree of long-term supply and off-take contracts with strong parties and sponsors are required to create a bankable project. Generally, off-take contracts are available for longer tenors than feedstock supply contracts, implying that complete certainty over long-term feedstock supplies cannot be guaranteed. The ability to source feedstock from a number of different regions, all exhibiting a reliable history of crop production, should help to mitigate concern regarding crop failure risk.

Meanwhile, price risk management strategies are required to mitigate the threat to margins posed by volatile and uncorrelated markets for inputs and outputs. Price risk management instruments and strategies are discussed in more depth later in this chapter.

By-products

Like most agribusiness processes, the production of biofuels generates by-products. Depending on the project, segment and region, by-products

Table 6: Common risk factors for biofuels projects

Risk factor	Main issues
Input/ suppliers	• Feedstock: type(s), sourcing strategy, crop failure risk, price risk management
Output/ Off-takers	• End-product: contracts, price risk, transportation costs, distribution
By-products	• Expected quality and sales price, contracts, distribution channels
Location & logistics	• Plant location (e.g. port or origination area), strategic advantages, logistics
Legislative environment	• Support measures and subsidies in place such as quotas, tax advantage, targets, mandatory blending, penalties, import restrictions, technical restrictions • Domestic and export market
Competitive environment (market risk)	• Market size, growth, current and future capacity in competing markets, scale and location of competing plants, competitive strength, sector outlook, cost structure
Technology and plant constructor	• Technology and constructor used: proven track records, fixed price in contract, penalties, quality of performance guarantees
Shareholders & management	• Track records, involvement, relation to the business, guarantees, investment size, commitment

Source: Rabobank analysis (2006)

may have a significant impact on a business case, so the off-take and price risk of by-products must be managed accordingly. An example is glycerine, the major by-product of biodiesel production. Revenues from glycerine sales formed a significant part of profitability in early biodiesel projects; yet, the surge in biodiesel production has decimated the price of crude glycerine from about EUR 900 per tonne to virtually zero in just five years time. In the case of glycerine, what was once a source of revenue is now on the way to becoming a cost. Other important by-products are meal from oilseed crushing, and DDGS[5] from cereal-based ethanol production. Meal and DDGS may both be ingredients in compound feed production, and to a certain extent are substitutes for one another and for soybean meal, another key ingredient in compound feeds. As the biofuel sector grows, the volume of rapeseed meal and DDGS on the market is also growing, and this has already put pressure on the prices of both products.

Location and logistics

These are significant factors in determining the overall competitiveness of an individual operation, since they have an influence on input costs and net ex-factory revenues. The threat that adequate volumes of feedstock cannot be procured, owing to competition from other processors or the unwillingness of local growers to continue production, may also be worthy of investigation. Location and logistics also have an influence on the flexibility of operations. Players able to utilise a range of different feedstocks, or able to source a single feedstock from a range of origins (e.g. as would be the case with a plant located in a major port), may well enjoy a competitive advantage over less flexible players.

Legislative environment

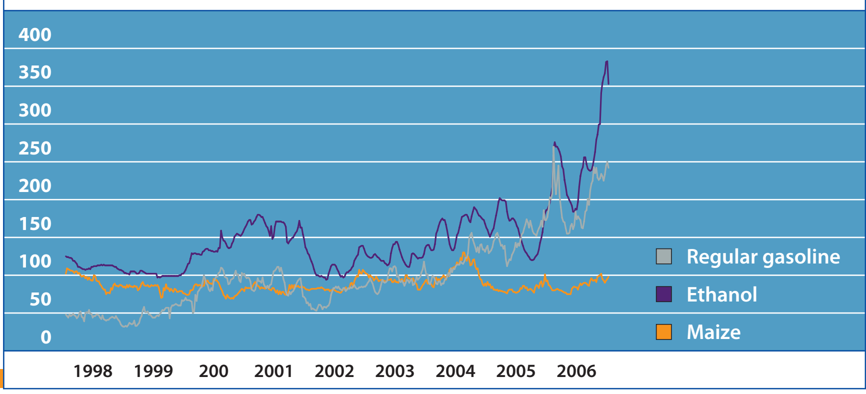
Legislative support is another essential factor to take into account in risk assessment. The primary reason is that the production cost of biofuels, in general, is higher than those of regular fuels. Financial incentives or other supportive measures are therefore still required to make production economically viable in most of today's markets. Legislative support may include one or more of the following: tax reduction (e.g. Germany), mandatory blending (e.g. Brazil, some EU countries and American states, most likely India and Malaysia during 2006), penalties for not achieving targets (e.g. France), a production quota system (e.g. France, Belgium), import restrictions (e.g. the US and the EU for ethanol), subsidies for producing energy crops (e.g. the EU), capital grants for the establishment of biofuel factories (e.g. the EU), and equity participation (e.g. Malaysia). In some cases, there are restrictions on the type of raw material that may be used to receive subsidy (e.g. due to fuel standards), which can lead to (temporary) effective protection of a local market.

While the various support schemes provide obvious opportunities for the biofuel sector, they also create a degree of dependency, since they are often pivotal to maintaining a favourable business environment.

Competitive environment

Two key elements of market risk, namely price risk and legislation, have already been discussed. A third and equally crucial element is the projected growth of the market and the intensity of competition between market participants. With the booming interest in biofuels and the associated capacity expansion, understanding the competitive environment and major market trends is key. For example, it is not enough to analyse the current and expected future competition within the German biodiesel market when evaluating a proposition. Although biodiesel production is primarily a local business, a more international market will develop in the longer term. For German biodiesel producers, a future risk (besides competition from other EU countries) lies in palm oil-based biodiesel produced in Malaysia as a result of the Malaysian government's biodiesel ambitions.

Figure 7: US – maize, ethanol and gasoline prices, 1998 - 2006
Fuel prices in US cents per gallon, maize prices in US cents per metric ton



Source: Bloomberg

5 Dried Distillers Grains and Solubles.

Technology and construction

The involvement of a 'blue chip' technology provider with a proven track record will be a reassuring element in a project proposal. In addition, agreements that establish fixed prices and limits for cost overruns, in combination with performance guarantees and a penalty system also provide comfort with regard to potential problems with either the technology itself or the construction process.

Management and shareholders

Finally, an evaluation of the company's shareholders and management takes place. For all related parties, a proven track record and sector expertise is of vital importance. On the shareholder side, deep pockets and various kinds of corporate or personal guarantees can provide additional comfort for a project's external financial sponsors. Cases where suppliers and/or off-takers have an equity stake in the project will also have an enhanced appeal.

Sources of capital

Risk assessment is critical in determining the access to capital for a given project. In very general terms, there is a spectrum of financing and financial backers that is available for projects, depending on the degree of risk associated with the project. In a reflection of the most fundamental law of finance, the greater the degree of risk perceived in a project, the higher the cost of financing.

Financing from banks is appropriate for projects that score well in terms of risk assessment, and funding may be available for as much as 65% of project costs. The repayment schedule must be in line with the market outlook, and, as a rule, banks would at the most provide finance for a period of two years of construction and five to seven years after completion of the plant. In general terms repayment will tend to be 'front-loaded', meaning that a substantial part of the debt is required to be repaid within the first years of operation.

Projects with a higher risk profile have a larger equity requirement to provide a higher level of comfort. In general terms, a minimum of 35%-50% equity is required. High risk projects may be able to access more expensive forms of financing (subordinated debt, for example). As a result of the buoyant market outlook for biofuels, private equity houses and venture capital groups have also emerged as potential backers of biofuel projects. Perhaps unsurprisingly, venture capital players are reported to have taken a particularly keen interest in projects based on second generation technology.

With the increasing depth of global capital markets, companies have access to an ever-increasing range of financing options. The number of investment funds following a 'green' or 'alternative' energy theme has been growing strongly, and in recent years players in markets spanning the US, EU, Brazil and Australia have all launched initial public offerings (IPOs) to raise capital for growth and expansion.

Structured finance products

A number of so-called 'structured' products can be used by banks and their clients to enhance the financial performance of biofuel producers, traders and end-users. Examples include ownership-based inventory finance, receivables finance and structured trade finance. Many of these products are particularly suited to reducing a company's working capital requirement and cost of funds through the use as collateral for the commodities being bought and sold.

Price risk management

As mentioned above, the volatility of agricultural commodity prices and energy prices plus the general lack of correlation between such prices together provide a compelling rationale for price risk management to be an essential part of any biofuel business plan. This section discusses a number of price risk management instruments and strategies that may be appropriate for new projects and existing enterprises, and presents a view on possible developments in instruments and strategies in the future.

Price risk management instruments

Fixed price supply contracts

The simplest form of price risk management is establishing a physical supply contract that involves a fixed price. This is certainly feasible for biofuels players, for example, Brazilian millers may fix forward prices for ethanol with domestic fuel distributors. However, such arrangements are generally rather short-term in nature, often covering only one production season. They may also only cover a fraction of supply.

Derivatives

Where long-term or short-term prices cannot be fixed in supply contracts, the use of derivatives to hedge price risks may represent an alternative price risk management strategy. In the context of biofuels, the derivatives of greatest interest are those linked to the price of agricultural commodities used to produce biofuels, such as maize, rapeseed, or soybean oil, and those linked to the prices of either the biofuels themselves (e.g. ethanol) or the fossil fuels that biofuels replace (e.g. gasoline, diesel).

There are two distinct groups of derivative contracts, namely exchange-traded derivatives and over-the-counter (OTC) derivatives. Exchange-traded derivatives are standardised derivative contracts such as futures and options that are transacted on an organised futures exchange. OTC derivatives are contracts that are traded directly between two parties, without going through an exchange or other intermediary. Commodity price swaps, for example, are traded in this way.

Exchange-traded futures and options have the attraction of being backed by an exchange and clearing house, which effectively eliminates counterparty risk. OTC derivatives are usually bespoke deals traded between two counterparties without the support of a futures clearing system, therefore the credit quality of counterparts must be taken into consideration.

Exchange traded derivatives are standardised in terms of volumes, product quality and other characteristics, whereas there is scope for OTC contracts to be tailored to the needs of specific clients.

Exchange-traded derivatives offer only limited scope to extend price risk management into the future. At any one time, exchange-traded products typically offer coverage up to 18 months to two years into the future. However, even within this period, there is often very little liquidity in the more forward contracts. By contrast, OTC instruments can commonly offer price risk cover for five years or more into the future.

Key elements in constructing a price risk management strategy based on derivatives

- It is important to study the mechanism by which the prices of physical inputs and outputs are established. This is because for any instrument to be effective in managing price risk, it is obviously essential that there is a high correlation between actual sales or purchase prices and the respective derivatives employed to hedge the price risk.

- Less fundamental but also important is the fact that the treatment of hedging from an accounting and audit perspective may be different in cases where the degree of correlation between physical prices and derivative instruments is different.

- Even in cases where a seemingly appropriate derivative instrument is available to address price risk, the liquidity of the market for the derivative needs to be understood. Currently, this is an issue for both the Bolsa de Mercadorias e Futuros (BMF) ethanol contract in Brazil, and for the Chicago Board of Trade (CBOT) ethanol contract in the US. Low levels of liquidity can make it difficult to enter and exit the market in a timely and cost-effective manner.

- Counterparty risk is something that has to be evaluated by biofuels players using OTC instruments – how robust is the party offering to provide price risk management services?

Derivatives in action

In this section we highlight some examples of possible price risk management strategies in markets where growth in biofuel output is greatest.

- In the US, where maize is used to produce ethanol, OTC swaps can provide price hedges on corn purchases for periods of up to five years. Meanwhile, although the CBOT ethanol contract seems to be gaining credibility as a reliable price discovery tool, and liquidity is growing quickly, volumes traded are currently low. As a result, an OTC instrument based on the gasoline market may be a more appropriate tool for managing output price risk today. However, as mentioned above, this is only likely to be really effective if physical ethanol sales are sold against the gasoline reference price underlying the OTC instrument.

• Brazilian ethanol producers are something of a special case, since ethanol is generally co-produced with sugar in Brazilian cane mills. The ability of millers to arbitrage the markets for the two products has effectively created a link between Brazilian ethanol prices and world market sugar prices (Brazil is by far the world's largest sugar exporter). This has led some Brazilian producers to hedge the price of their ethanol exports to the US on the basis of a combination of two very liquid futures contracts, the New York Board of Trade (NYBOT) world raw sugar contract and the New York Mercantile Exchange (NYMEX) gasoline contract.

• In the EU, it is possible for biodiesel players to hedge rapeseed requirements for a period of up to two years ahead. However, players not crushing their own rapeseed (and who therefore purchase rapeseed oil as an input) may run considerable basis risk by using a rapeseed-based instrument, owing to the present lack of correlation between rapeseed and rapeseed oil prices, a trend exacerbated by the current biodiesel boom across the EU. Meanwhile, there are no exchange-traded or OTC instruments specifically for biodiesel at present, but this has not proved to be a barrier to the establishment of effective output price hedging strategies. In Europe there is a market in OTC swaps and options based on ultra-low sulphur diesel (ULSD), and the correlation between biodiesel prices and ULSD prices has proven high enough for these instruments to provide effective hedges for the price of biodiesel.

The outlook for price risk management in the biofuels sector

Derivative markets have seen explosive growth in both product offering and product complexity in recent years. This suggests that as the biofuel market expands and matures, there is every likelihood that exchanges will seek to develop appropriate derivative contracts, and financial institutions will create a range of OTC products in response to the bio-fuel sector's need to manage price risk. For example, it is quite possible that a number of price risk management instruments could be 'packaged' together into a single product designed to provide an effective 'margin hedge' for biofuel players.

Furthermore, this growth and proliferation of derivative markets has taken place alongside a surge in interest from money managers for new asset classes. Under these circumstances, the liquidity of derivative markets for biofuels and other commodities may well be boosted not only by the increased interest from players in the sector, but also from non-commercial financial players (usually collectively referred to as 'funds') keen to diversify their portfolios.

Strong growth in biofuel production, utilisation and trade coupled with the inventiveness of derivative specialists suggests that there will be no shortage of new approaches to price risk management for the biofuel sector in the coming years.

Access to energy in developing countries

Introduction

Energy sources are not evenly distributed across the world. Securing adequate and affordable energy is particularly important for developing countries, where future energy demand is predicted to increase the most. Dependence of some developing countries on imported fossil fuels depletes scarce foreign exchange and increases exposure to the balance of payment impact of oil price shocks. Financial exchange and other financial shocks will continue to undermine many developing countries' ability to service foreign debt and attract foreign investment, issues closely tied to the welfare of poor people in developing countries (UNDP, 2005). The consequences of climate change will affect poor countries with disproportionate severity, while these countries are unable to provide their populations with basic services like clean water, education, health care and energy. There is no explicit Millennium Development Goal on energy, although access to energy services, especially by poor people and communities, is essential for reaching all of the Millennium Development Goals. See the box below.

Access to energy and achieving the Millennium Development Goals:

1 Eradicate extreme poverty and hunger
Energy inputs such as electricity and fuels are essential for generating jobs, industrial activities, transportation, commerce, micro-enterprises, and agricultural outputs. Most staple foods must be processed, conserved, and cooked, requiring energy from various fuels.

2 Achieve universal primary education
To attract teachers to rural areas electricity is needed for homes and schools. After dusk study requires illumination. Many children, especially girls, do not attend primary school because they are carrying wood and water to meet family subsistence needs.

3 Gender equality and women's empowerment
Lack of access to modern fuels and electricity contributes to gender inequality. Women are responsible for most household cooking and water boiling activities. This takes time away from other productive activities as well as from educational and social participation. Access to modern fuels eases women's domestic burden and allows them to pursue educational, economic and other opportunities.

4 Reduce child mortality
Diseases caused by unboiled water, and respiratory illness caused by the effects of indoor air pollution from traditional fuels and stoves, directly contribute to infant and child disease and mortality.

5 Improve maternal health
Women are disproportionately affected by indoor air pollution and water- and food-borne illnesses. Lack of electricity in health clinics, lack of illumination for nighttime deliveries, and the daily drudgery and physical burden of fuel collection and transport all contribute to poor maternal health conditions, especially in rural areas.

6 Combat HIV/AIDS, malaria, and other diseases
Electricity for communication, such as radio and television, can spread important public health information to combat deadly diseases. Health care facilities, doctors and nurses, all require electricity and the services that it provides (illumination, refrigeration, sterilisation, etc.) to deliver effective health services.

7 Ensure environmental sustainability
Energy production, distribution and consumption have many adverse effects on the local, regional, and global environment. These include indoor, local and regional air pollution, local particulates, land degradation, acidification of land and water and climate change. Cleaner energy systems are needed to address all of these effects and contribute to environmental sustainability.

8 Develop a global partnership for development
The World Summit for Sustainable Development called for partnerships between public entities, development agencies, civil society and the private sector to support sustainable development, including the delivery of affordable, reliable and environmentally sustainable energy services.

Source: UNDP (2005)

Agribased energy and development

Renewable energy technologies are well suited for securing adequate and affordable energy services for those countries where there is an acute need for equitable and efficient provision of modern energy services. These technologies, using biomass, wind, solar, hydropower and geothermal energy sources, are based on indigenous sources, with almost no net emissions of greenhouse gases. Renewable energy technologies face the same challenges any new technology faces that attempts to displace a locked-in technology. For many years, industrialised countries have been locked into fossil fuel and nuclear-based technologies, and many secondary systems and networks have been designed and constructed accordingly. This prevents biomass technologies from replacing modern coal, oil and natural gas power plants. Just as some developing countries are bypassing construction of telephone wires by leaping directly to cellular-based systems, so too might they avoid building large, centralised power plants and grids, and instead develop decentralised systems (UNDP, 2004). The dialectics of progress enables developing countries to adopt efficient and clean technologies and processes at the early stages of development. The aim should be, whenever possible,for users to leapfrog directly from fuelwood to the most efficient end-use technologies and the least polluting and affordable energy forms available (including new renewables). In the case of biofuels, this implies developing countries leapfrogging directly to second generation biofuels.

Many people in developing countries (especially in Asia and Africa) still rely on traditional fuels – wood, crop residues and dung – for cooking, heating and productive activities (see table 7).

Table 7: Number of people relying on traditional biomass for cooking and heating in developing countries

	Million	% of total population
China	706	56%
Indonesia	155	74%
Rest of East Asia	137	37%
India	585	58%
Rest of South Asia	128	41%
Latin America	96	23%
North Africa/ Middle East	8	0,05%
Sub-Saharan Africa	575	89%
Total developing countries	**2.390**	**52%**

Source: IEA/OECD (2002)

Unsustainable use of traditional biomass fuels is associated with significant health and environmental costs. Therefore, the aim should be to transform agribased energy into a renewable source of high-quality fuels and electricity (UNDP, 2001). Bio-energy has a number of unique attributes that make it particularly suitable to climate change mitigation and community development applications. The three principal attributes are (World Bank, 2006): modern bio-energy systems and fuels are compatible with existing end-use technologies (vehicles, industrial machines, stoves etc.) and can therefore be used to substitute conventional forms of energy requiring no or minimal adaptation; bio-energy production systems are labour intensive, so can generate considerable agricultural and agro-industrial employment and income generation; agribased energy is readily available in most developing countries, particularly in rural areas, and does not have to be imported.

Public-private partnerships

Given the imperfect nature of energy markets, market forces alone cannot be expected to deliver energy services that are sustainable and meet the needs of the most vulnerable communities (UNDP, 2005). Transforming bio-energy into a renewable source of high-quality fuels and electricity will not occur without the establishment of a favourable policy environment. Governments from industrialised countries can support biomass energy production in developing countries by e.g. introducing mandatory blending and tax breaks for bio-energy, and reducing the import tariffs of biomass energy. Furthermore, adequate public and private sector investment is needed. Public financing from domestic resources and official development assistance, combined with private entrepreneurship and investment, are needed to develop energy services for the poor. New forms of risk sharing between the private and the public sectors should be developed under public-private partnerships as a way to attract private sector resources in the area of sustainable energy. Finally, the development of truly international markets for biomass may become an essential driver to develop biomass potentials, which are currently underutilised in many world regions, including developing countries (see Smeets et al., 2005).

In conclusion

The intensified adoption of modern bio-energy, if properly supported by industrialised countries, presents developing countries with an opportunity to boost rural productivity and employment, enhance energy self-reliance, increase access to modern energy services, and contribute to the amelioration of pressing local and global environmental problems.

Rabobank and bio-energy

Commitment to sustainability

Rabobank's ambition is to build on its reputation in the Dutch home market and become the leading global food and agri bank. Our focus is on acquiring, or participating in, existing rural banks in the world's major F&A countries. The increase in our international activities raises social and ecological questions that need to be resolved appropriately, which is why we have given prominence to sustainable development and corporate social responsibility (CSR) in our new strategic framework 2005-2010.

Financing sustainable development

By offering specialised financial products and services, Rabobank indirectly steers the activities of clients in the direction of sustainable development. Green loans, and project financing and funding aimed at promoting sustainable innovations are some of the products and services that we offer to motivate clients to undertake sustainable initiatives and investments. Products include the Project Fund (Projectenfonds), the Innovation Capital Fund (Rabo Innovatiekapitaalfonds) and the Herman Wijffels Prize for Innovation, an initiative to encourage entrepreneurs to implement sustainable and innovative business practices.

Food & Agribusiness Research and Advisory (FAR) has, over the last few years, built up extensive expertise in the field of biofuels and related matters. Given the raw materials used and the processes involved, bio-fuel production is considered part of the agribusiness arena. As a result, FAR's knowledge has been utilised in client contacts, deal teams, credit analysis, and internal and external advisory at a global level. Our expertise, and the active dialogue we hold with many prominent interest groups puts us ahead of our competition, and positions us perfectly to take advantage of future business development in this market.

Rabo Green Bank can look back on the most successful year in its ten year history. This growth can be attributed to our financing of wind turbines, energy (a.o. the largest photo voltaic solar roof in the world, and a retail photo voltaic leasing scheme in cooperation with Greenpeace) and resource-efficient greenhouses, district heating systems, waste-to-energy schemes and solar energy. Greenhouses still account for the majority of loans. Total outstanding green loans to date are EUR 2.3 billion

Depending on the regulatory environment, the overall risk profile of a project and the quality of the sponsors, financing can be provided from stand-alone project financing with only limited recourse to the sponsors up to near full recourse to sponsors and balance sheet financing. Rabobank has considerable experience in **structuring, arranging, and financing** of on- and off shore wind farms. We have been involved in financing more than 1,000 MW of wind turbines worldwide. In addition, we have a strong track record in energy and resource efficiency:

- several thousands of MW's in gas fired cogeneration worldwide (partly biomass co-generation);
- heat pumps and heat and cold storage systems in buildings, swimming pools and shopping malls.

In the last two years Rabobank has built up considerable knowledge and experience in the biofuels sector. Biofuels investment projects require substantial **equity investments**, particularly if operated and financed on a more stand-alone basis.

Leveraged Finance focuses on larger takeovers, in which the purchase price of the company exceeds EUR 50 million. In larger financings, the debt will be syndicated to other banks, with Leveraged Finance acting as arranger. Our principal customers are venture capitalists who mainly contribute their own capital.

On a global scale, Rabobank was one of the first financial service providers to recognise the importance of climate change and its relevance for clients. By way of example, Rabobank participated in the **Prototype Carbon Fund**, the first to conclude long-term contracts for the purchase of emission reductions from sustainable energy and energy-conserving projects in developing countries. In 2003, Rabobank was one of the first organisations to sign the **Carbon Disclosure Project**, which identifies the CO_2 risks of listed companies. Over the past few years, we have expended much energy and money developing specific products and services for our clients to reduce their risk exposure arising from emission regulations.

Rabobank International's **Commodity & Weather Derivatives Group (CWDG)** focuses on the management of CO_2 compliance risks and the risks of increasing volatility in weather conditions. This unit is also involved in the sustainable energy sector, and in biofuels in particular. The CWDG provides innovative hedging solutions to our global corporate F&A clients. These centre on soft commodities, notably feedstocks into biofuels projects, such as sugar, corn, rapeseed, energy (including off-take from biofuel projects with the energy players), weather risk and carbon emissions. The focus is on the less liquid parts of the market (for instance tailored OTC solutions), supported by the bank's core competencies in the F&A sector. The group leverages off its market insights and core capabilities to offer investor clients appropriate investment products. This is typified by the recently launched Rabo Agri Note, which allows investors to access the soft commodities likely to be impacted most by the continued growth of the biofuel markets via an exchange listed investment.

In 2003, Rabobank concluded an innovative two-year master contract with the Dutch government for the purchase of up to 10 million tonnes of CO_2 emission rights (Certified Emission Reductions or CERs) in developing countries. Unfortunately, the target was not reached due to the sharp increase in market prices for CO_2 rights from projects in developing countries in 2005.

New Values, a joint venture between Rabobank and TenneT, is an electronic trading platform for emission rights. In Europe, approximately 250 million tonnes of CO_2 were traded in 2005. New Values focuses on the spot market (immediate supply and payment), on which about 5% of the total volume is traded. In addition, New Values launched a successful auction for CDM (Clean Development Mechanism) rights (CER, Certified Emissions Reductions) in 2005.

Sustainable asset management received a considerable boost in 2005 thanks, in particular, to the successful introduction of the Robeco Sustainable Private Equity Fund of Funds (closed at EUR 200 million). The fund invests in funds that, in turn, invest in non-listed enterprises in sustainable sectors, such as energy, hydro and environmental technology. In addition, it invests in mainstream private equity funds that comply with the Responsible Entrepreneurship Guidelines developed by Rabobank. A number of large private equity funds have incorporated these first CSR guidelines for private equity into their own investment processes. Robeco and Rabobank believe that the time is right to deploy capital successfully in the clean tech market. For this reason, Robeco and Rabobank are in the process of launching Robeco Clean Tech Private Equity II (see box below).

Robeco Clean Tech Private Equity II

Over the past years, Robeco and Rabobank have become knowledge leaders in the clean tech private equity field. This is evidenced by the prestigious Pioneering Award we received from the Clean Tech Venture Network and the fact that Robeco and Rabobank were awarded Europe's first clean tech private equity fund-of-funds mandate.

Robeco and Rabobank are in the process of launching Robeco Clean Tech Private Equity II (the 'Fund'). The Fund will be managed by experienced investment professionals from the private equity department of Robeco Alternative Investments. To complement its own competencies, Robeco Alternative Investments will receive advice about sustainability and clean technology from the experienced professionals in Rabobank's Corporate Social Responsibility Department.

Robeco Clean Tech Private Equity II will consist of a basket of the most prominent clean tech funds in the world. These funds will act as a deal flow accelerator, enabling the Fund to cherry pick from the most attractive clean tech direct co-investment opportunities that these clean tech funds offer to Robeco and Rabobank. The attractive deal flow of Rabobank and Robeco itself will be another source of direct co-investment opportunities for the Fund.

Robeco Clean Tech Private Equity II has the objective of generating a long-term absolute net internal rate of return that is higher than the return on public equity investments, at least as high as the return on traditional ways of private equity investing, and potentially even higher due to the attractive investment climate for clean technologies and the superior growth potential of clean tech companies.
The Fund will seek to attain this objective by building an investment portfolio with the following types of investments:

- clean tech private equity funds
- clean tech direct co-investments

Biofuels and sustainability

Now that Western economies are increasingly looking for alternative energy sources, our traditional agri clients find that their products are not only suitable for the food industry, but for producing biofuels as well. First and foremost a clear relation exists between bio-energy and agribusiness, Rabobank's core focus. For example, bioethanol can be produced from a wide range of agricultural raw materials, like wheat, barley, maize and sugar beet (Brazil, as a comparison, uses sugar cane). By-products like molasses and C-starch have also proven to be feasible raw materials. Spain has been the leading EU producer of bio-ethanol, but Germany and France are catching up quickly.

Biodiesel is primarily produced from rapeseed oil in the EU, although other vegetable oils and even recycled fats can be used as well. In Germany, biodiesel is still mostly sold as PPO (pure plant oil), a 100% fuel, but since the introduction of blends in 2004, this segment shows the highest growth. Blends are more feasible given the adaptations that car engines require for pure biodiesel, but also to ensure large scale distribution.

Another link between the Bank and biofuels is sustainability. As biofuels can help reduce carbon emissions, this aligns well with Rabobank's strategy on corporate social responsibility and sustainability.
Besides bio-energy's obvious advantages, it still has some shortcomings, particularly in the area of large-scale biomass production for energy-generating purposes. If not treated in a sustainable manner, some major drawbacks could be: deforestation, a structural change in agricultural commodity markets, food shortages, degradation of biodiversity and soil conditions (by monoculture or irresponsible cultivation methods) and poor working conditions on biomass plantations and child labour.

The commitment to sustainability is fundamental to Rabobank. We have a strong code of practice that governs decisions on financing projects. Those with a strong environmentally positive aspect are welcomed, while those that are potentially damaging to or demanding of natural resources are rejected. Rabobank strives to help clients improve their sustainability awareness

The Rabobank recognised the sustainability issues associated with palm oil production in an early stage. In the absence of general guidelines or principles, Rabobank defined its own internal guidelines for palm oil plantations in 2001. The palm oil (PO) code called on all stakeholders to define a common approach:

"Rabobank recognizes the importance of a broadly supported code of conduct for the palm oil industry. An internationally recognized PO code must be the outcome of consultation among representatives of the palm oil industry, the governments of the countries involved (particularly Malaysia and Indonesia), investors, international and local NGOs (particularly environmental organizations and human rights organizations) and customers (processing industry and consumer organizations)…"

In 2003 Rabobank endorsed the establishment of a Roundtable on Sustainable Palm Oil (RSPO)[6] and signed the statement of intent. The RSPO acted as a platform for the major stakeholders in the palm oil industry (both private sector organisations and governments / NGOs) for discussions on sustainability issues. These discussions resulted in 2005 in the adoption of draft-RSPO principles and criteria. In the assessment of PO plantations, the Rabobank will take to both its own PO-code and the RSPO-criteria into account.

In the Netherlands, Rabobank is closely associated with defining sustainability criteria for biomass production. As a member of the Dutch government committee 'Commissie Cramer', Rabobank has taken an active role in initiating new sustainability proposals, including:

- Biomass producers must prove that biomass was produced in a sustainable manner (according to six criteria: greenhouse gas balance, competition with food, local energy supply, medication and building materials, biodiversity, welfare, wellbeing, and the environment);
- Introduction of a certification scheme, preferably based on a track-and-trace system. In order to check sustainability criteria, is it necessary to know the origin of the physical biomass flow.

To conclude

We believe that sustainable growth in prosperity and wellbeing requires the careful nurturing of natural resources and the living environment. We aim to contribute to this development with our activities. We respect the culture and traditions of the countries in which we operate, insofar that these do not conflict with our own objectives and values.

This report's focus on bio-energy is not meant to imply that other renewable energy resources, such as solar and wind energy, are less worthy of attention. We promote a suite of complementary renewable energy and energy-efficient technologies, all of which contribute to a more sustainable and equitable energy future.

6 See: www.rspo.org.

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Please contact Ms Anja Pater at the Food & Agribusiness Research department (Anja.Pater@rabobank.com) for more information about Rabobank publications on biofuels.

Colophon

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