GreenFacts
Facts on Health and the Environment

Scientific Facts on

Forests & Energy

Source document:
FAO (2008)

Summary & Details:
GreenFacts

Level 2 - Details on Forests & Energy

1. **Introduction – What role can forestry and agriculture play in energy production?........2**
2. **What are the trends and prospects of energy supply and demand?........2**
   - 2.1 How is the use of renewable energy projected to evolve?........3
   - 2.2 How much is wood-based energy used worldwide?........4
   - 2.3 Which factors will determine future energy choices?........5
3. **How is bioenergy produced?........6**
   - 3.1 How is solid wood used to produce bioenergy other than biofuels?........6
   - 3.2 How are liquid biofuels produced?........7
4. **How much can forestry contribute to future energy demand?........8**
   - 4.1 Which factors does wood energy development depend on?........8
   - 4.2 How much can different sources of wood contribute to energy production?........8
   - 4.3 How do different biofuels compare in terms of competitiveness and greenhouse gas emissions?........9
5. **What are the implications of increased use of bioenergy? 10**
   - 5.1 How will poverty, employment and prices be affected? 10
   - 5.2 What will be the impacts on land and environment? 11
6. **How should bioenergy policies be developed?........12**
7. **Conclusions........13**

This Digest is a faithful summary of the leading scientific consensus report produced in 2008 by the Food & Agriculture Organization (FAO):
"Forests and Energy, Key Issues"

The full Digest is available at: https://www.greenfacts.org/en/forests-energy/

This PDF Document is the Level 2 of a GreenFacts Digest. GreenFacts Digests are published in several languages as questions and answers, in a copyrighted user-friendly Three-Level Structure of increasing detail:

- Each question is answered in Level 1 with a short summary.
- These answers are developed in more detail in Level 2.
- Level 3 consists of the Source document, the internationally recognised scientific consensus report which is faithfully summarised in Level 2 and further in Level 1.

All GreenFacts Digests are available at: http://www.greenfacts.org/

1. Introduction – What role can forestry and agriculture play in energy production?

See also our Forest 's Digest [see https://www.greenfacts.org/en/forests/index.htm]

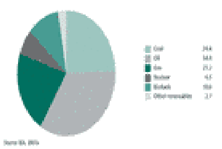
As the global demand for energy is soaring, high fossil fuel prices, increasing greenhouse gas emissions and concerns over energy import dependence are prompting a major shift in the sources from which energy is derived. Alternative forms of energy are receiving considerable interest as a means to reduce fossil fuel consumption and limit greenhouse gas emissions. For instance, biomass such as wood, crops and agricultural by-products can be used as a renewable source of energy, known as bioenergy. This bioenergy could help reduce dependence on fossil fuel imports and lower energy price while emitting less greenhouse gases than fossil fuels.

Energy sources in which new plants replace those harvested are only considered renewable if biomass growth equals or exceeds harvest. The net benefit in terms of CO_2 emissions depends on the balance between CO_2 captured during plant growth and CO_2 released when producing, processing, transporting and burning the fuel. Bioenergy can contribute to climate change mitigation if the net CO_2 releases are lower than those from the energy form it replaces, notably fossil fuels. Some countries have large forested areas which, if sustainably managed, can be used as a source of bioenergy. In developing countries, traditional bioenergy such as fuelwood, charcoal, dung etc. are still widely harvested and used in an unsustainable and unsafe way for cooking and heating purposes. However, large-scale modern facilities now exist that can effectively convert wood and forest residues to heat and power.

Recently, first-generation liquid biofuels made from oil-palm, sugar cane, maize, rapeseed, soybeans, wheat and other agricultural products have gained popularity as alternative ways to power vehicles. The expansion of agricultural production for bioenergy will very likely increase pressure on land and result in increased deforestation and associated carbon emissions; these arguments are used to question the actual role of liquid biofuels in mitigating climate change. Furthermore, because fossil fuel energy is usually used to grow, harvest, process and transport crops and biofuels, the net carbon benefit may be small – even negative – in some cases. In addition, there is evidence that the use of these crops for biofuels instead of food has contributed to increased food prices. Yet, it is expected that technology will soon become available for the production of wood-based second-generation liquid biofuels that would not compete with food crops and would be much more efficient both in terms of energy conversion and greenhouse gas emissions.

In coming years, global energy use is set to climb steeply and fossil fuels are likely to remain the most economically viable sources of energy. The extent to which energy sources are likely to change in the future depends, among other things, on energy prices and dependence on fossil fuel imports, the cost and mitigation potential of alternative energy sources and the degree of commitment to climate change mitigation.

2. What are the trends and prospects of energy supply and demand?



Fuel shares of world energy supply
[see Annex 6, p. 18]

The vast majority of the world's energy is generated from non-renewable sources, specifically oil, coal and gas. In 2004, just over 13% was derived from renewable sources, 10.6% of which come from bioenergy (including 3.2% of traditional biomass such as woodfuel, charcoal, dung etc.). Renewable sources of energy derived from the sun, the wind, the tides, the dams, and the Earth's internal heat only make up the remaining 2.7%.

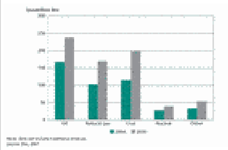
In the coming years, the world’s population growth and economic development are expected to result in considerable increases in the demand for energy. From 2004 to 2030, energy market projections were made covering power and heat generation as well as transportation. These projections did not take into account traditional biomass such as fuelwood, charcoal, dung etc. which is not formally traded, but still largely used in developing countries for cooking and heating.

In 2004, on energy markets, the consumption of developing countries accounted for less than half of the world’s energy use. By 2010, however, developing regions are predicted to consume more energy than industrialized regions, and account for 58% of the world’s energy consumption by 2030. Per capita consumption figures are, nevertheless, likely to remain well below those in developed countries.

In the world, about half of the increase in global energy demand will be for power generation and one fifth for transportation.

Rapid economic growth in Asian countries, particularly China and India, will account for much of that increase. Indeed, Asian countries are projected to experience, by far, the world’s highest rates of growth in energy demand. By 2030, Asia will have more than doubled its current energy use. The increased demand for energy will likely be less noticeable in industrialized regions, where national economies are mature and population growth is relatively low.

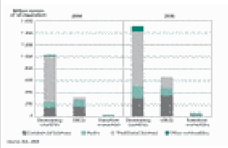
Fossil fuels are predicted to meet most of the increased demand for energy over the next 20 years. However, in terms of percentage, the energy sources that are likely to show the greatest increases are gas and coal by 2030 (see Figure 3 [see Annex 7, p. 18]). Ultimately, policy will heavily influence the sources of energy that are tapped, and in what amounts, to satisfy the world’s needs.



Total global marketed energy consumption by source in 2004 and projected for 2030 [see Annex 7, p. 18]

2.1 How is the use of renewable energy projected to evolve?

About three-quarters of renewable energies are consumed in developing countries, particularly in Africa and Latin America. In Africa, this is largely due to consumption of woodfuel for heating and cooking (traditional biomass). In Latin America, it is due to the high use of renewables in Brazil, where 45% of all energy consumed comes from renewable sources such as hydropower, wood or ethanol derived from sugar cane.



World renewable energy consumption by region [see Annex 8, p. 19]

While fossil fuels will continue to provide most of the world’s energy in coming years, the use of renewable energy is expected to grow slightly faster than global energy consumption over the next decades (approximately 1.9% each year). In terms of percentage, the global share of marketed renewable energy (not including traditional biomass) is thus expected to grow by a mere 0.2% between 2004 and 2030, from 7.4% to 7.6% of total energy use.

The biggest growth in renewable energy production (other than traditional biomass) is expected to occur in North America, Asian developing countries and Central and South America. This predicted growth will result from increased energy demand in Asian countries, whereas in Central and South America it will result from a particular focus on renewable energy and existing economically competitive alternatives to fossil fuels.

The World Alternative Policy Scenario presented by the International Energy Agency (IEA) in 2006 showed how the global energy market would change if various policies were enacted to reduce carbon emissions and maintain the energy supply. The scenario predicts that the share of traditional biomass in the global energy consumption would decrease, while the overall share of renewable sources of energy would remain largely unchanged, with rapid increases in the small shares of geothermal, solar and wind power.

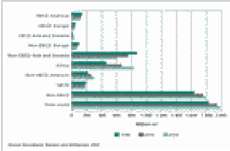
Table: Global Increase in renewable energy in World Alternative PolicyScenario
[see Annex 10, p. 20]

The recent long-term strategy of the European Union sets the following goals for 2020: increasing its proportion of renewable energy to 20% of total energy use, increasing its proportion of biofuels in transport to 10%, and reducing its greenhouse gas emissions to 20% below 1990 levels. The success of this and other strategies will depend on fossil fuel prices and on the development of government programmes to support alternative energy. Countries that provided economic incentives for bioenergy consumption, such as Germany, Italy, the United Kingdom, the United States and Brazil, experienced increases in the proportion of bioenergy in total energy use between 2000 and 2005. However, in countries such as China and India, which are among the largest users of biofuels, the rapid economic growth led to an increase in energy consumption that outpaced the increase in biofuel use, in spite of rising fossil fuel prices.

Renewable energy sources are used for heat, power, and transportation. Over the next 25 years, they will continue to be used primarily for heating and cooking. However, the power sector, which accounted for about a quarter of the world's renewable energy consumption in 2002, is expected to spearhead the global increase in the use of renewable energy. By 2030, the power sector will likely account for 38% of the world's renewable energy consumption. The share of renewables in fuels used for transport is expected to rise from less than 1% to 3% over the next 25 years.

2.2 How much is wood-based energy used worldwide?

Since the discovery of fire, wood has been an important source of energy for cooking and heating. Today, wood-based energy is also used in developing countries for commercial activities such as fish drying, tobacco curing and brick baking, and in developed countries mainly as a source of power for the forest industry.



Woodfuel consumption for OECD and non-OECD countries 1990, projections for 2010 and 2030 [see Annex 2, p. 16]

Recently, several countries have begun to explore wood-based systems of energy generation as an environmentally friendly alternative to fossil fuels. New technologies have been developed to improve the efficiency and economic feasibility of energy generation from wood, particularly in heavily-forested countries.

The United States, Canada, Sweden and Finland are among the largest users of wood energy in their industries, relying predominantly on the by-products of wood processing, such as the black liquor generated from wood pulping. In addition, 65% of the world's supply of **roundwood** –logs in their raw, natural state – is produced in industrialized countries. On the other hand, **fuelwood** – small pieces of wood used primarily for heating and cooking – is produced and consumed primarily by non-industrialized countries such as India, China and Brazil.

The use of fuelwood is increasing in all African regions, but only in Southern Africa is it used significantly in industrial applications. The production of fuelwood may be higher than reported, as the vast majority is traded informally and used in private homes.

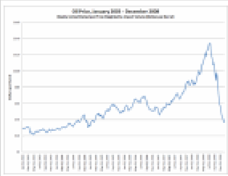
Overall, the global consumption of **woodfuel** – a term that encompasses both fuelwood and charcoal – is increasing, largely reflecting an increasing consumption in African and

South American countries due to population growth. Per capita woodfuel consumption, however, is decreasing in all regions of the world except in OECD Asian and Oceanic countries (i.e. Japan, South Korea, Australia, and New Zealand). This fall in consumption is the result of rising incomes, urbanization, declining availability of wood sources and increasing availability of alternative sources of energy that are preferred to woodfuel.

Recent data suggest that the number of people using **biomass** as their primary fuel for cooking will increase in the future, especially in Africa and Asia (except China).

However, accurate information on woodfuel consumption is difficult to obtain and care is required when interpreting data.

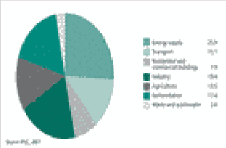
2.3 Which factors will determine future energy choices?



Price of oil (2003-2008)
[see Annex 9, p. 20]

Future energy choices will depend on the price of fossil fuels and the availability of alternatives, as well as on the weight given to different, competing goals. For example, policies directed toward reducing climate change will focus on reducing carbon emissions through the use of clean sources of energy, while policies directed toward reducing energy dependence will promote the use of certain fuels because of supply location.

2.3.1 The **price of oil** increased more than six-fold between 1999 and mid-2008, when the price per barrel peaked well above the US$100 mark. Even though prices are expected to remain well below this peak for most of the next 20 years, uncertainty regarding the future supply may elevate prices prior to 2015. Higher oil prices will likely encourage the use of renewable energies, but may also prevent developing countries from investing in them by hindering their economic growth. Developing economies are therefore especially sensitive to changes in global energy supply and demand.



Global greenhouse gas emissions in 2000 by sector (%)
[see Annex 3, p. 16]

2.3.2 The energy sector alone is responsible for one fourth of the **world's greenhouse gases**, about twice as much as the transport sector. Together, agriculture and deforestation account for about a third of all emissions. Given the considerable importance of deforestation in global greenhouse gas emissions, care is required to ensure that production of biofuels does not result in losses of terrestrial carbon through forest removal.

The use of **fossil fuel** represents the single largest human influence on climate, estimated to account for more than half (56%) of all greenhouse gas emissions. Despite the current focus on oil and transportation, **coal** is by far the most polluting fossil fuel and the greatest contributor to greenhouse gases. With large reserves widely dispersed around the world, coal is expected to provide an increasing share of the world's energy in future years. China and India together are estimated to account for two-thirds of the increase in world coal demand.

2.3.3 The use of various types of renewable energy will also be greatly determined by the degree to which each country **depends on fuel imports**. Current efforts in Europe and North America to promote biofuels explain why these regions show smaller differences between imports and exports.

3. How is bioenergy produced?

Open fires convert only 5% of the wood's potential energy
Credit: Roberto Faidutti

Bioenergy can be produced from wood materials by various processes, ranging from burning sticks and branches for cooking and heating to gasification of wood chips to produce transport fuel. These systems differ in terms of energy efficiency, installation cost, carbon emissions and labour intensiveness. National and local circumstances will largely determine whether each system is economically, environmentally and socially appropriate. To achieve the maximum climate benefits of bioenergy in terms of greenhouse gas emissions avoided, the amount of carbon dioxide released during biomass production, processing, transportation and use should be equal to or smaller than the amount that was absorbed by the harvested biomass.

3.1 How is solid wood used to produce bioenergy other than biofuels?

Solid wood has long been used for cooking and heating. However, the efficiency of wood as an energy source varies depending on how it is processed. For instance, an open fire only converts about 5% of the wood's potential energy. But this figure reaches from 36% for traditional wood stoves to about 80% for modern wood pellet stoves for residential use. Larger systems designed for industrial use – e.g. power boilers, combined heat and power systems (CHPs) and gasification systems – also vary widely with regards to cost- and energy-efficiency.

Steam-turbine power boilers can be used in sawmills to generate steam by burning bark and other waste products. The steam, in turn, can be used to generate the energy necessary to operate the mill. Similar recovery boilers can be used in pulp and paper mills. Power boilers generally harness about 40% of the available energy in wood. Financial incentives for installing such electrical generating capacity in mills have not been sufficient due to the historically low cost of fossil fuels and have often been passed over in favor of systems powered by historically inexpensive fossil fuels.

Combined heat and power systems (CHPs) are a highly efficient means of producing heat and electricity at the same time for large-scale industrial and residential use. Several technologies were recently developed to boost the efficiency of CHPs, resulting in systems that can harness as much as 80% of the total available energy from wood. A recent study found that a CHP power plant operating on wood chips released 7 times less CO_2 by unit of energy produced than a similar plant using natural gas.

Gasification – the process of heating wood to a very high temperature to produce gas – is a wood-based system of energy generation that is appropriate for smaller-scale industrial facilities and villages. This system is considered more energy-efficient and cost-effective than power boilers and, when integrated into a CHP system, can boost the efficiency of heat and energy production even further. However, gasification may prove challenging for smaller facilities, due to the difficulty of maintaining an adequate supply of wood. Thus, this technology appears to be a more economical option for medium-sized facilities.

Wood pellet furnaces, using the most advanced technologies for conserving and recovering energy, have become an attractive technology option, especially for home or small-scale use. The wood material that is burnt is formed from sawdust and other waste products of wood processing that are dried, ground and pressed into pellets. These furnaces serve the dual purpose of removing waste and generating energy.

3.2 How are liquid biofuels produced?

Recently, high oil prices, concerns over greenhouse gas emissions and reliance on foreign oil have boosted an interest in biofuels. 'First generation' biofuels, which are derived from food crops, have attracted the most attention because of their relatively lower prices and advanced state of development. However, technological developments are expected to increase future interest in 'second generation' biofuels, which are derived from non-food plant matter.

3.2.1 **First-generation biofuels** include bioethanol (made from sugars and starch) and biodiesel (made from oilseeds). The food crops used to generate them vary by geographical location. A variety of cereals are used in temperate regions, with about 90% of the world's biodiesel generated from rapeseed in Europe. In contrast, cane sugar and palm oil are predominately used in tropical regions, with the highest production occurring in Asian and Pacific countries.

The technologies for production of bioethanol from sugars and starch have been refined and developed over the years, notably in Brazil and the US. **Sugar cane** has the advantage that, besides the sugar which is fermented to produce bioethanol the cellulosic component of the plant's stalk – known as bagasse – can also be used to provide energy for the production of bioethanol, thus increasing overall energy efficiency.

Oilseed crops are used in the production of **biodiesel**, particularly in Europe. However, growing oilseeds requires optimal soil conditions, which may lead to forest clearance to make room for suitable agricultural fields.

The production of food crops for biofuel production can significantly contribute to global greenhouse gas emissions if they induce deforestation and land degradation. In Southeast Asia, one fourth of all oil-palm plantations are located on drained peat lands.

Recently, the use of other, more resistant oilseed plants for biodiesel production has been explored. Jatropha curcas, for instance, is a plant that grows well on marginal lands and can also be used to restore degraded lands, suggesting that Jatropha production, if carefully managed, may be expanded without directly competing with natural forests or high-value agriculture lands used for food production.

3.2.2 Within an estimated 10 to 15 years, **wood and low-cost agricultural residues** derived from the production of various cereals will likely be used to produce economically competitive **second-generation liquid biofuels**. At present, bioethanol is the second-generation liquid biofuel closest to commercialization.

Agricultural residues are likely to be among the lowest-cost liquid biofuel feedstocks. Currently, only a small share of such residues is available for energy generation but, as bioenergy production increases, agricultural residues may become more important biofuel feedstocks.

Forestry residues and wood from forest plantations are other potential feedstocks. Today, only a small proportion of liquid biofuels are forest-based, but forest biomass to produce cellulosic liquid biofuels for the transport sector could become widespread.

Currently, two basic technologies are being developed to convert wood to liquid fuels. In biochemical conversion, wood is treated using enzymes to release sugars that can then be further converted to ethanol. In thermochemical conversion, liquid fuels are produced through a process that involves heating wood and bark in the absence or minimum presence of oxygen.

The processes used in second-generation biofuel production will likely be more profitable when integrated into existing manufacturing facilities, such as paper mills.

4. How much can forestry contribute to future energy demand?

4.1 Which factors does wood energy development depend on?

Energy generated from the residues of forestry operations could be considerable

Supply and demand of wood energy will be affected differently by different factors across developed and developing countries. In general, the extent to which forestry will contribute to future energy production will be influenced by:

- the ability of wood-based energy to meet the objectives of recent energy policies;
- the socioeconomic and environmental costs and benefits of wood energy production; and
- the policies and institutions that determine forestry practices.

The development of wood energy largely depends on the effectiveness of **policies** designed to promote it and on how well these policies are implemented. High **fossil fuel prices** are an incentive for biofuel development, but if those prices are too low, namely due to abundant coal reserves, biofuel demand will only increase where policy is effectively implemented. In countries where domestic policies fail to draw interest away from fossil fuels, export markets could play a key role in bioenergy development.

The **ecological, economic and social aspects** of wood energy production will also be of importance. For instance, issues related to **climate change** and energy efficiency will influence how much wood products will contribute to energy generation, as will regional factors related to supply location, infrastructure, growth conditions and labor availability.

In many parts of the world, investments in plantation expansion for bioenergy may be hampered by such factors as conflicting land claims, risk of expropriation, ineffective governance, etc.

Investments in bioenergy often depend on subsidies and new technology developments. Developing countries with limited budgets will need to be particularly careful when assessing the risks and benefits of investing in bioenergy. The Kyoto Protocol offers incentives for establishing energy plantations and financing sustainable biofuel use and facilitates technology transfer to developing countries.

4.2 How much can different sources of wood contribute to energy production?

Wood energy is among the most efficient sources of bioenergy in terms of quantity of energy released by unit of carbon emitted. When produced with efficient technology, it can already compete with fossil fuels. Besides, it can help countries with large forested areas increase their energy security. The two major sources of wood-based energy are forest plantations and wood residues.

4.2.1 Much energy can be generated from the biomass discarded by ongoing forest operations. Indeed, only a small portion of each harvested tree is converted to market products. In a few countries, the energy that could be generated from all the excess **wood residues** discarded by mills and harvesting operations could exceed the national demand in energy. In addition, efficient methods of harvesting and transportation could be used to collect wood residues left from harvesting operations in tropical forests to further reduce the cost and environmental impacts of power generation from wood residues, particularly in developing countries. However, care should be taken to leave an appropriate amount of residues on the ground, as they are necessary for maintaining soil and ecosystem health.

The social and environmental impacts of energy crop plantations, that require land to grow, could be averted by generating biofuels from agricultural and forest residues. Still, the number of plantations will likely increase, among others because the amount of available wood residue is expected to decrease in coming years due to reduced forest cover.

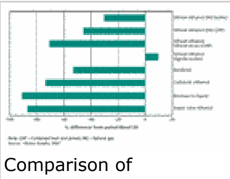
4.2.2 **Forest plantations** have long been used to produce wood for energy, predominantly for small, local consumption. In temperate zones, there are a number of fast growing tree species suitable for energy plantations. In Brazil, where large-scale production of energy from wood has been explored for decades, forest plantations have been used to generate heat and power for the steel, food, beverage, and other industries. Clear and consistent policies can help compensate for the cultural, economic and environmental downsides of increased investment in forest plantations. For plantations to be economically viable, high-productivity, efficient harvesting and good logistics are fundamental.

The advantage of generating energy from trees, as opposed to agricultural crops, is that trees do not have to be harvested each year, the harvest can be delayed when market prices are down, and the products can fulfil a variety of end-uses.

4.2.3 **Lesser used tree species** of no value for the timber industry could also be used for energy production, along with **secondary forests**. If adequately managed, those wood sources could lead to increased revenue and improve sustainable forest management.

4.2.4 Existing forestry operations are likely to supply most of the **wood used in future** bioenergy production. This may change if economically competitive technologies for the production of second-generation biofuels become available. Technological advancements could also improve the efficiency of woodfuel generation and provide significant amounts of wood energy worldwide. Globally, the demand for wood energy is expected to increase. As a result, demand for biomass will exceed supply in many regions, particularly if wood processing industries compete with the bioenergy sector for biomass.

4.3 How do different biofuels compare in terms of competitiveness and greenhouse gas emissions?

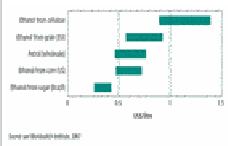


Comparison of greenhouse gas emissions from biofuels derived from various sources [see Annex 4, p. 17]

In terms of **greenhouse gas emissions**, studies estimate that the amount emitted during the production, processing, transport and use of second-generation liquid biofuels from crops and from forest and agricultural residues would be 75 to 85% lower compared with petroleum motor fuels. Second-generation liquid biofuels even have the potential to sequester more carbon than is released.

Different biofuels provide different degrees of efficiency improvements compared to fossil fuel use. For example, the use of wood-based bioethanol would improve energy efficiency by up to four times, while maize ethanol only conveys a slight improvement. The greatest decreases in greenhouse emissions result from the conversion of whole plants to liquid biofuels (biomass to liquid).

In terms of **market competitiveness**, sugar cane is the most economically attractive agricultural feedstock for liquid biofuel, before maize and other cereal and oilseed crops, and also before petrol. Currently, the costs of producing second-generation liquid biofuels such as ethanol from cellulose are higher than the costs of producing biofuels from cereal feedstocks. However, the potential for reducing production costs in the future appears to be much greater for such second-generation liquid biofuels, and by 2030 they could compete with sugar cane.



Competitiveness of biofuels by feedstock [see Annex 5, p. 17]

Should an economically viable production process for second-generation liquid biofuels be developed, forest biomass could become widely used in the transport sector, particularly in developed countries where the demand will likely be highest.

5. What are the implications of increased use of bioenergy?

Bioenergy is thought to have many advantages such as promoting economic well-being especially in rural areas and developing countries, allowing better use of unproductive land, increasing the energy security and reducing greenhouse gas emissions. However, the full potential of bioenergy can only be reached once problems associated with the large-scale production of biofuels have been addressed. The benefits and negative effects of biofuels must therefore be assessed case-by-case and must take the following factors into account:

- regional issues such as rural development, equity and poverty reduction;
- biodiversity and land and forest management;
- greenhouse gas emissions;
- water availability; and
- energy dependence and energy prices.

Growing demand for bioenergy could result in deforestation
Credit: Masakazu Kashio

It is important to note that energy production from biomass depends on the type of crop and its productivity among other things. For example, for a given amount of energy, corn requires twice as much land as sugar cane, and soybean more than ten-times as much. Replacing a fourth of the transportation energy by biofuels from sugar cane would require 17% of the world arable land (200% if using soybean). It is therefore unreasonable to expect that biofuels will ever completely replace fossil fuels. Instead, biofuels should be viewed as a potential energy source to be used in conjunction with others.

List of potential benefits and negative effects of bioenergy development [see Annex 1, p. 15]

5.1 How will poverty, employment and prices be affected?

Different studies present the production of biomass for bioenergy as a new source of income for developing countries leading to a reduction of poverty and increased food security. In reality, the expansion of bioenergy can have both positive and negative impacts on livelihoods.

On the one hand, the production of bioenergy will likely create more **jobs** than those required for the import of fossil fuel. But the number of jobs that could be created will depend on the type of crop, as some require more work than others.

Also, the development of bioenergy could make **energy available** to rural areas which often have limited access to other energy sources.

On the other hand, bioenergy development can also lead to **social conflicts** such as land disputes and human rights abuses. For instance, to reduce transport costs and increase economic viability, facilities that convert the harvested biomass into biofuel should be located near energy plantations, but when large energy plantations supply centralized conversion facilities, it can result in increased concentration of landownership and displacement of traditional farmers that can lead to conflicts. Such problems can be reduced by shifting from a centralized to a more local management and by providing incentives to invest in small farms.

In addition, increases in the **price** of biofuel crops would likely encourage farmers to convert food croplands to energy crops. Competition for land and agricultural products may in turn increase food prices and therefore improve the farmers' incomes – especially those who generate large surpluses. However, an increase in food prices would affect the poor especially in developing countries, the greatest impact being on those living in urban areas.

5.2 What will be the impacts on land and environment?

Globally, there are significant **areas of land available** for growing bioenergy resources, but few are located in regions with the highest future energy demands. For example in some highly populated Asian countries, most of the cropland is needed for food production, thereby limiting land availability for biofuel production. Significant amounts of bioenergy could, however, be provided in those countries through the use of agricultural and forest wastes, efficient energy conversion technologies and a cultivation system combining agriculture and forestry where trees and shrubs are among crops (agroforestry).

Many developing countries consider using **degraded lands** for the expansion of bioenergy plantations. This is thought to reduce erosion, restore ecosystems, regulate water flow and provide shelter for communities and agricultural lands. However, large-scale growth of a single energy crop can potentially threaten biodiversity, limit the amount of food available to domestic and wild animals, reduce soil fertility, and cause soil erosion. Furthermore, increased water use can affect the irrigation of food crops and potentially reduce food supply. Increased biomass combustion may also cause air pollution.

With regard to **forests**, increases in the demand for bioenergy could make way for additional energy crops resulting in a higher deforestation rate, while the opposite may occur if wood becomes the main resource for bioenergy. Deforestation leads to the release of carbon dioxide and to biodiversity loss. Economic incentives to produce biofuels have been blamed for the clearing of rainforests – especially in Malaysia, where nearly 80% of deforestation occurs to make way for oil-palm plantations. Even large areas of degraded forests are at risk. For example, China has announced plans to convert several million hectares of degraded forests and croplands to bioenergy plantations by 2015. These forests, while not in perfect condition, still absorb large amounts of carbon and maintain high levels of biodiversity.

Carbon dioxide (CO_2) emissions are particularly high when plantations are established on **drained peatlands**. More than a quarter of the oil-palm plantations in Southern Asia are located in such areas. Indonesia holds the third place in terms of CO_2 emissions after the United States and China because of emissions resulting from high deforestation rates, peat fires and peat decomposition. European biodiesel has contained palm oil and contributed to this trend.

In light of the many **advantages and drawbacks** to bioenergy development, countries must consider the long-term impacts of various energy alternatives. In particular, the amount of greenhouse gas emissions and the environmental impacts associated with production, including land-use change, should be carefully considered. To avoid negative impacts and maximise benefits, well-enforced land-use regulations are needed.

6. How should bioenergy policies be developed?

In most countries, policies and programmes to promote bioenergy are still at their early stage**.** Most programmes focus on liquid transportation fuels, while little attention has been given to research and development, training, or to transfer of information from developed to developing countries. This transfer is however of considerable importance in achieving the objectives of bioenergy development in terms of climate change mitigation, energy security, and agricultural development.


Sustainable management and development should be part of forest and energy policies
Credit: Masakazu Kashio

Effective land-use planning is needed to counteract adverse socio-economic impacts (e.g. on food security and availability of wood products) and environmental effects (e.g. biodiversity loss, greenhouse gas emissions) from large bioenergy projects. National strategies should consider the environmental performance, the cost-effectiveness as well as the energy efficiency of wood- and crop-based energy sources. Given their limited financial resources, developing countries should invest in proven technology and readily available sources of biomass.

All countries should have a better knowledge of their wood resources. This information could then be used to:

- quantify the potential for local forest biomass to generate heat, power, or plant-based liquid biofuels;
- evaluate the contribution by each potential source of wood (e.g. forests, energy plantations, residues) to wood energy production; and
- analyse the advantages and drawbacks of various land-use patterns.

National goals must reflect the principles of sustainable development and sustainable forest management. The regional, national and international impacts of each goal, as well as the benefits and drawbacks of energy derived from wood, agriculture and other sources, should be considered. In particular, national forestry and energy policies should:

- address bioenergy as an issue that is relevant to different sectors – mainly the agriculture and forestry ones – and that must be integrated into the policies of these sectors;
- consider environmental, economic and social impacts on local, national and regional levels;
- ensure that information is readily accessible to all stakeholders to support informed decisions about the management of forest resources;
- consider areas such as land-use management, rural employment, and environmental protection to look for synergies and avoid negative impacts;
- support bioenergy development through research, education and training, and through transport and infrastructure measures;
- create the right balance between agriculture and forestry, as well as between domestic and imported sources of biomass;
- consider the impacts of bioenergy on other economic sectors to avoid market distortions.
- be monitored regularly to avoid negative environmental and social impacts; and
- prevent the destruction of natural resources and biodiversity.

In addition, wood resources should be sustainably managed and protected by various laws, regulations and policies.

The current situation represents a major opportunity for the forestry sector to contribute to increasing the security of energy supply and to mitigating climate change by reducing dependence on fossil fuels.

7. Conclusions

Soaring energy consumption, high fossil-fuel prices, increasing greenhouse gas emissions and concerns over energy import dependence are prompting global changes in the sources from which energy is expected to be derived in the coming years. Although fossil fuels are expected to account for most of the increase in energy supply, alternative forms of energy will also play a growing role in global energy supply.

Energy consumption is projected to increase at the highest rates in Asia.

Bioenergy, including wood energy, account for a large proportion of the current energy supply from renewable sources. In many of the world's developing countries, fuelwood and charcoal (traditional bioenergy) remain the primary source of energy. In industrialized countries and particularly countries with large wood processing industries, wood energy is used for both domestic and industrial purposes. This form of energy can only be considered renewable if produced sustainably and if biomass growth exceeds harvest. Its net benefit in terms of climate change mitigation depends on the balance between CO_2 captured during plant growth and CO_2 released when producing, processing, transporting and using the fuel.

Overall, the global consumption of wood as a source of energy is increasing, largely reflecting an increasing domestic consumption in African and South American countries due to population growth.

Wood energy is among the most efficient sources of bioenergy in terms of quantity of energy released by unit of carbon emitted. When produced with efficient technology such as combined heat and power technology, it is often already competitive with fossil energy.

Most current liquid biofuels are produced mainly from food crops and have low economic and environmental benefits. However, it is expected that technology will be available in the next decade for the production of second-generation liquid biofuels from wood and other cellulosic feedstocks that will be commercially competitive and generate dramatically less greenhouse gases compared to fossil fuels. In addition, such liquid biofuels from wood material rather than from food crops would reduce competition with food production.

At present, wood energy is most competitive when produced as a by-product of the wood processing industry, and wood residues have the greatest immediate potential for bioenergy generation given their availability, relatively low-value and the proximity of production to existing forestry operations. Another source of wood energy is forest plantations, which are established solely for the purpose of energy production and are becoming increasingly common in some countries.

With increasing demands on land from first-generation liquid biofuel development, pressure on forests is likely to increase around the world and could lead to forest clearance, which results in the loss of the CO_2 that was stocked in the forest. Therefore, the expansion of biofuel production will need to be accompanied by clear and well enforced land-use regulations. Also, it is imperative that bioenergy strategies are closely linked with, and integrated in, agriculture, forestry, poverty reduction and rural development strategies.

Future demand for bioenergy will depend largely on policy measures. The extent to which wood energy will contribute to future energy production is likely to depend on:

- the ability of wood energy to meet the objectives of recent energy policies;
- the socioeconomic and environmental costs and benefits of wood energy production; and
- the policies and institutions that determine forestry practices.

As far as climate change and energy security are concerned, it will be very important to ensure that developing countries also have access to advanced wood energy technologies.

List of potential benefits and negative effects of bioenergy development [see Annex 1, p. 15]

Annex

Annex 1:

BOX 6: Potential benefits and negative effects of bioenergy development

Potential benefits

- Diversification of agricultural output
- Stimulation of rural economic development and contribution to poverty reduction
- Increase in food prices and higher income for farmers
- Development of infrastructure and employment in rural areas
- Lower greenhouse gas emissions
- Increased investment in land rehabilitation
- New revenues generated from the use of wood and agricultural residues, and from carbon credits
- Reduction in energy dependence and diversification of domestic energy supply, especially in rural areas
- Access to affordable and clean energy for small and medium-sized rural enterprises

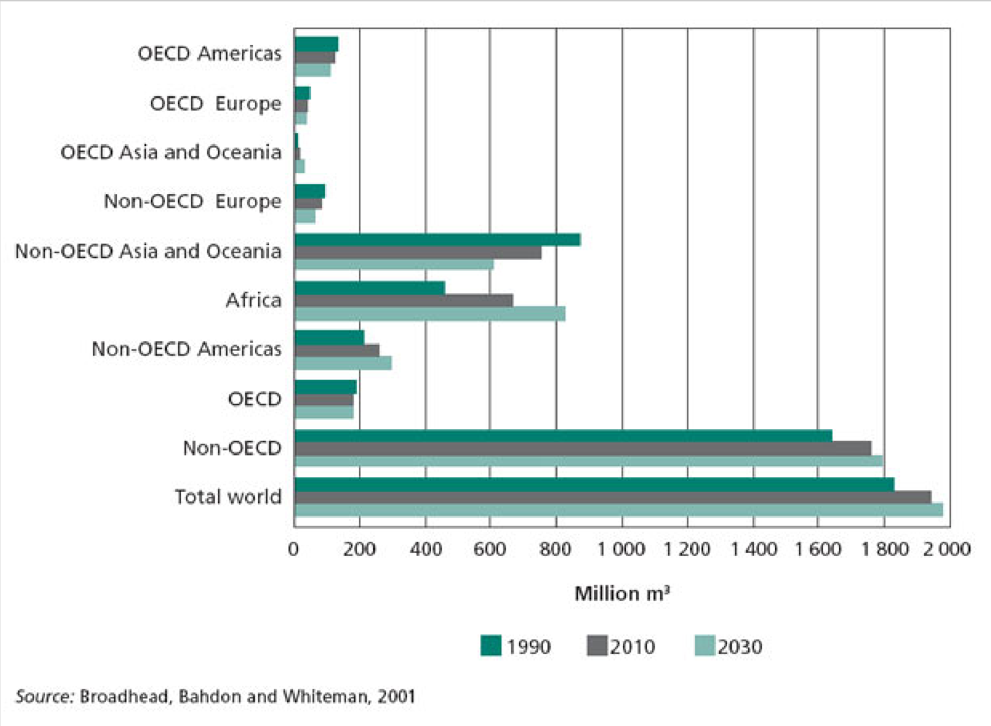
Potential negative impacts

- Reduced local food availability if energy crop plantations replace
- subsistence farmland
- Increased food prices for consumers
- Demand for land for energy crops may increase deforestation, reduce biodiversity and increase greenhouse gas emissions
- Increased number of pollutants
- Modifications to requirements for vehicles and fuel infrastructures
- Higher fuel production costs
- Increased wood removals leading to the degradation of forest ecosystems
- Displacement of small farmers and concentration of land tenure and incomes
- Reduced soil quality and fertility from intensive cultivation of bioenergy crops
- Distortion of subsidies on other sectors and creation of inequities across countries
-

Source & © Sources: FAO, 2000; UN-Energy, 2007; Perley, 2008]

Annex 2:

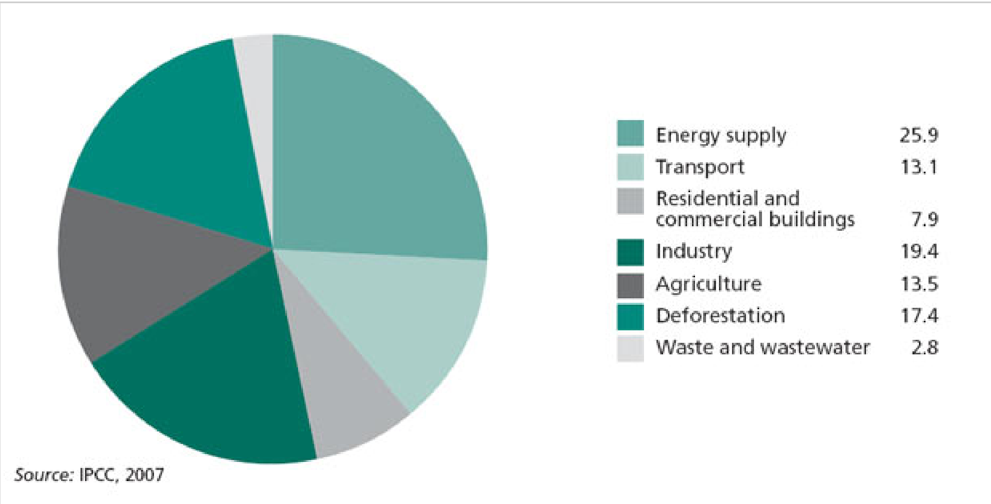
Figure 10. Woodfuel consumption for OECD and non-OECD countries 1990, projections for 2010 and 2030



Source: FAO, Forests and Energy, Key Issues (2008) [see http://www.fao.org/docrep/010/i0139e/i0139e00.htm], Energy supply and demand: trends and prospects, p. 16

Annex 3:

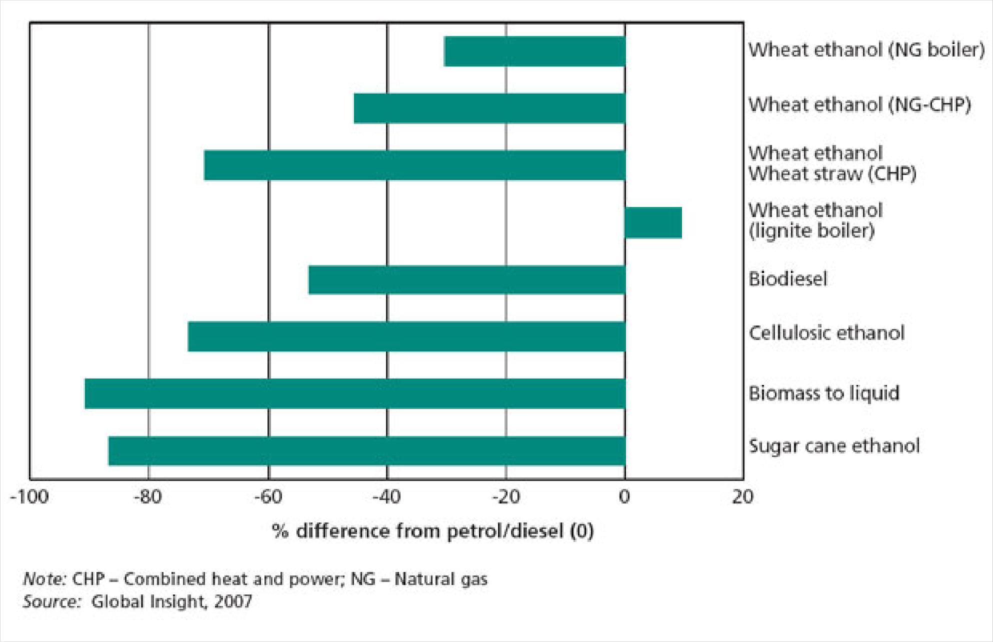
Figure 14. Global greenhouse gas emissions in 2000 by sector (%)



Source: FAO, Forests and Energy, Key Issues (2008) [see http://www.fao.org/docrep/010/i0139e/i0139e00.htm], Energy supply and demand: trends and prospects, p. 19

Annex 4:

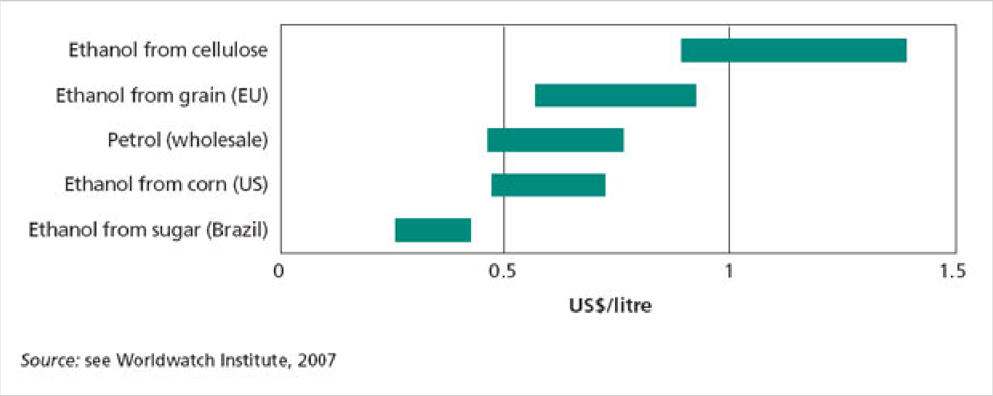
Figure 15. Comparison of greenhouse gas emissions from biofuels derived from various sources



Source: FAO, Forests and Energy, Key Issues (2008) [see http://www.fao.org/docrep/010/i0139e/i0139e00.htm], The contribution of wood energy to future demand, p. 34

Annex 5:

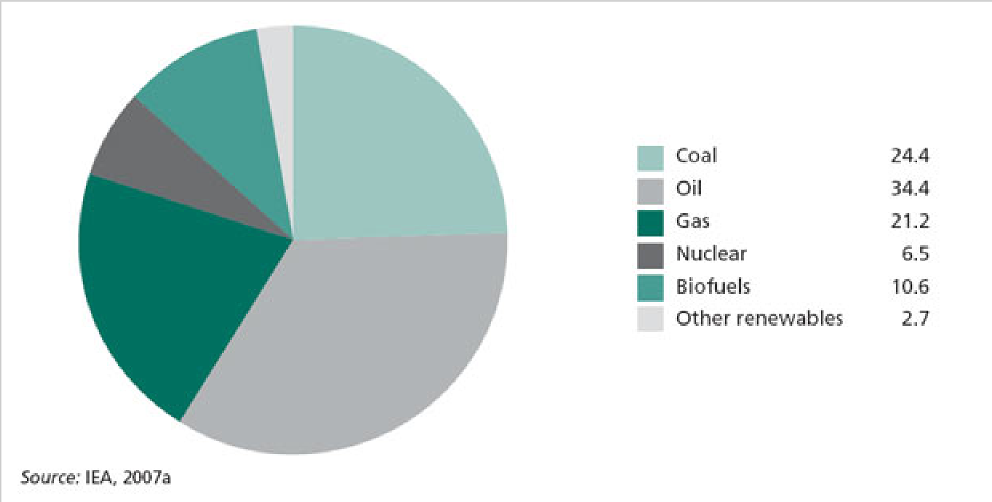
Figure 16. Competitiveness of biofuels by feedstock



Source: FAO, Forests and Energy, Key Issues (2008) [see http://www.fao.org/docrep/010/i0139e/i0139e00.htm], The contribution of wood energy to future demand, p. 34

Annex 6:

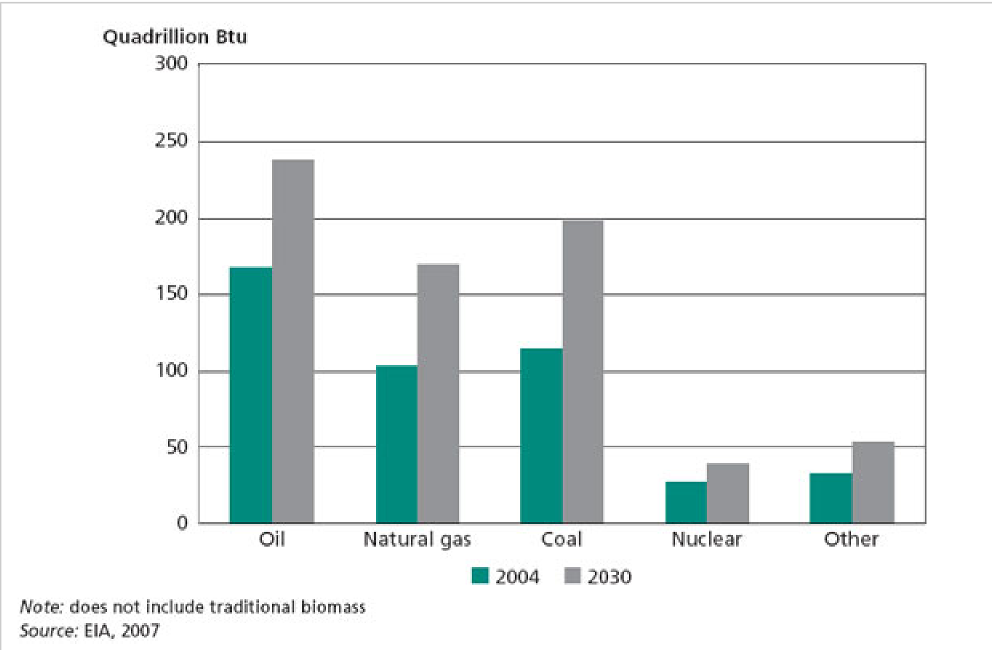
Figure 2. Fuel shares of world total primary energy supply in 2004(%)



Source: FAO, Forests and Energy, Key Issues (2008) [see http://www.fao.org/docrep/010/i0139e/i0139e00.htm], Energy supply and demand: trends and prospects, p. 7

Annex 7:

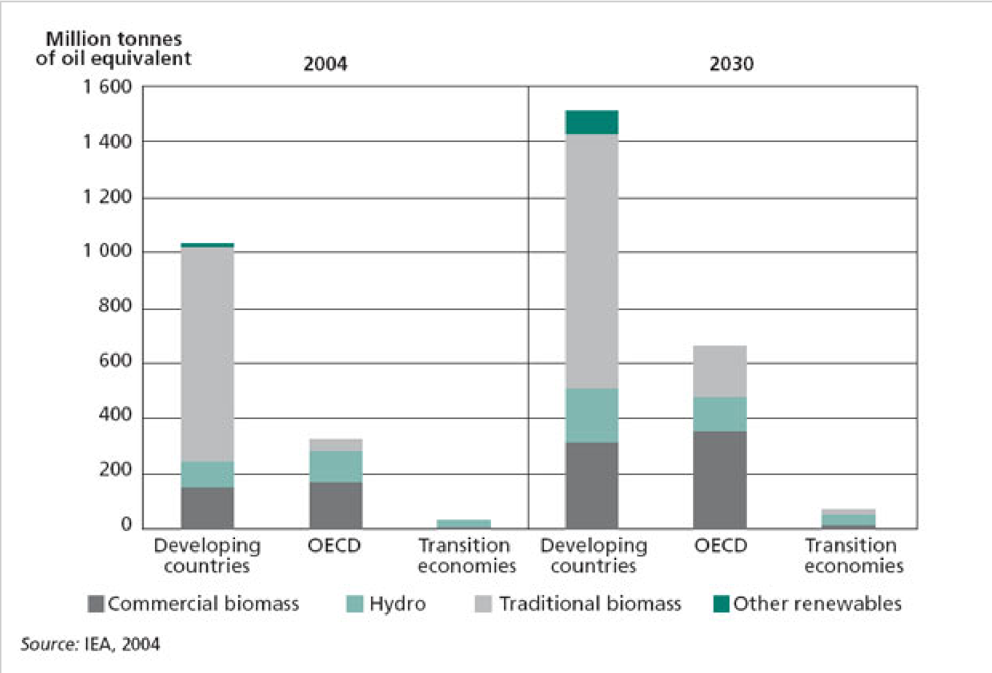
Figure 3. Total global marketed energy consumption by source in 2004 and projected for 2030



Source: FAO, Forests and Energy, Key Issues (2008) [see http://www.fao.org/docrep/010/i0139e/i0139e00.htm], Energy supply and demand: trends and prospects, p. 7

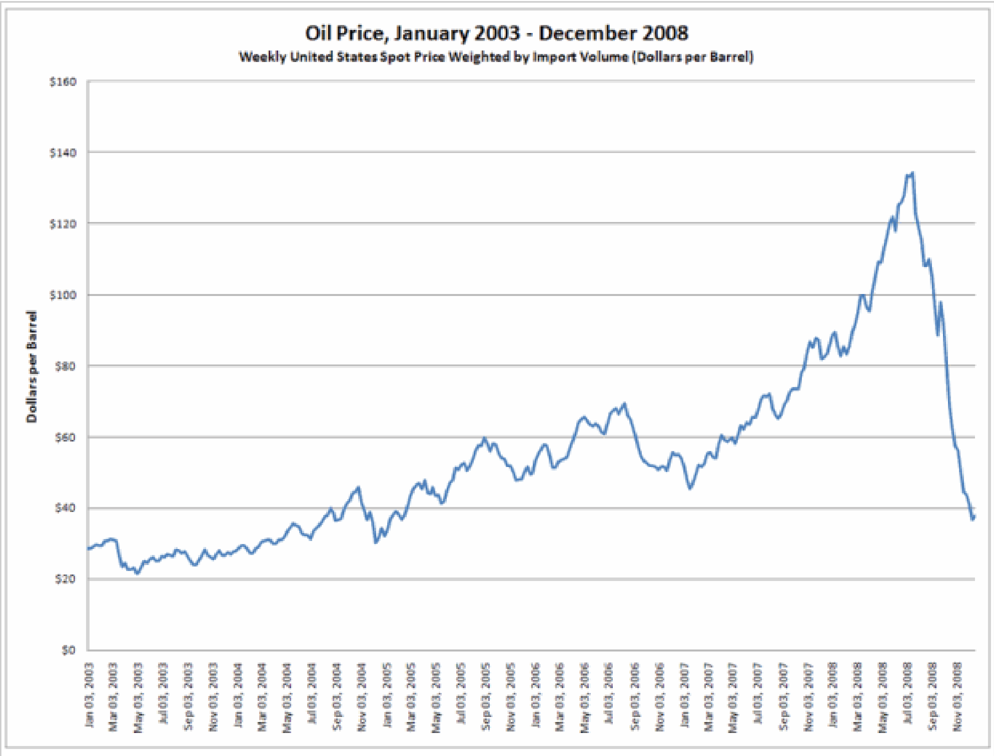
Annex 8:

Figure 6. World renewable energy consumption by region for 2002 and projected for 2030



Source: FAO, Forests and Energy, Key Issues (2008) [see http://www.fao.org/docrep/010/i0139e/i0139e00.htm], Energy supply and demand: trends and prospects, p. 11

Annex 9:
Price of oil (2003-2008)



Source: United States Department of Energy [see http://tonto.eia.doe.gov/dnav/pet/hist/wtotusaw.htm]

Annex 10:

Table 3. Global increase in renewable energy

Energy source	2004	2030	Approximate increase (times)
Electricity generation (TWh)	**3 179**	**7 775**	**>2**
Hydropower	2 810	4 903	<2
Biomass	227	983	>4
Wind	82	1 440	18
Solar	4	238	60
Geothermal	56	185	>3
Tide and wave	<1	25	46
Biofuels (Mtoe)	15	147	10
Industry and buildings (Mtoe)	**272**	**539**	**2**
Commercial biomass	261	450	<2
Solar heat	6.6	64	10
Geothermal heat	4.4	25	6
Note: TWh = Terrawatt hour; Mtoe = Million tonnes of oil equivalent Source: IEA, 2006; OECD/IEA 2006 cited in IEA, 2007a			

Source: FAO, Forests and Energy, Key Issues (2008) [see http://www.fao.org/docrep/010/i0139e/i0139e00.htm], Energy supply and demand: trends and prospects, p. 11

Partner for this publication

The Levels 1 & 2 are summaries written by GreenFacts in collaboration with the **Food and Agriculture Organization of the United Nations** (FAO) and with financial support from the **Swiss Agency for Development and Cooperation** (SDC).