Deutsche Bank Research

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Current Issues

Energy Special

Bioenergies after the petroleum age

- The petroleum age is nearing its end. Recent increases in the price of crude oil and natural gas as well as heating oil and fuels are but a foretaste of things to come in the energy markets. However, while the new renewable energy carriers like solar and wind energy have attracted much public attention, the "old renewables" lead a shadowy existence, although bioenergies will play the more important part as we look ahead.
- Bioenergies are the all-rounders among the renewables, since only biomass is equally suitable for the generation of electricity and heat as well as the production of fuels. Thanks to their versatility, bioenergies today constitute the lion's share of over 60% in the energy supplied from renewables.
- Making better use of the potential of bioenergy can improve the energy mix markedly. This is a pressing issue, not least in Germany because of the current debate over the reduction of agricultural subsidies and a possible governmental change in Berlin, which could give rise to a "new energy policy". Biomass is, of course, also included in the preferred energy mix of a CDU/CSU-led government.
- Bioenergies could contribute a good 4% to power generation by 2010 (2004: 1.6%). Presently, subsidisation is still relatively high, ranging from 8.4 cents/kWh to 21.5 cents/kWh. Owing to the technological progress, the cost of producing one kWh of power should fall to 7.5 cents for biogas and 6 cents for solid biomass by 2030.
- The prospects for bioenergies are especially positive in the heat market, where they already contribute more than 90% to the provision of heat from renewable energies. Pellet units, in particular, which utilise handy-sized bio-materials, have great potential. Thanks to alternative heating systems, homeowners no longer have to rely on oil and gas. Moreover, biomass heating plants with small district heating systems are an interesting alternative for municipal and commercial heat supply.
- Biofuels are no longer a niche product. Biodiesel has become increasingly attractive, thanks to policies to promote its use. In addition, the promotion of bioenergies could also yield the competitive edge needed to export the products to the emerging markets in the future. Should the oil price rise to USD 100/barrel and beyond, biofuels would become competitive, even at the current technological stage. In the heat market, pellet heating would then be clearly superior to oil and gas.
- The business segment of renewable energies offers an interesting alternative source of income for traditional farmers. If established farmers and forest managers became modern "energy managers", two birds could be killed with one stone. Biomass, the energy of the future, would get the necessary professional support and income prospects in rural areas would be stabilised.

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Hopes are pinnend on renewable raw materials

Fossil fuels like oil, natural gas and coal have the disadvantage of being non-renewable. Of course, various utilisation paths are conceivable and also likely. But in the end, all fossil fuels share the characteristic of depletion. In addition, the combustion of fossil fuels goes hand in hand with the emission of CO_2, a greenhouse gas.

The disadvantages of fossil fuels are boosting interest in the excellent properties of bioenergies. Last year's amendment of the Renewable Energy Sources Act (EEG) promotes a broad definition of biomass, including – along with energy crops and forest wood – biogas, gas from landfills and sewage treatment plants as well as bio-degradable matter from household and industrial waste. These waste products had not been covered in the previous legislation.

Like fossil fuels, biological energy resources are depletable. They would, however, have to be used excessively, as – unlike fossil fuels – bioenergies are basically renewable; stocks of it can be maintained despite use. An intelligent energy policy should therefore ensure that the exploitation rate of the fundamentally renewable raw materials does not permanently exceed the natural regeneration rate. If this rule of use is heeded, a practically inexhaustible resource will be available.

With the petroleum age nearing its end[1], renewable raw materials are well suited to – at least partly – close the prospective gap, which is opening up between globally rising energy demand and the uncertain expansion of energy supply. By increasingly resorting to renewable raw materials as an energy source, fossil fuels can be used more economically and will be exploited less rapidly. This will help to conserve scarce fossil resources, which are highly valuable as important basic raw materials for non-energy uses like the production of synthetics[2] and can hardly be substituted in the short-term.

Emissions trading

As part of the implementation of the Kyoto Protocol, the EU launched trading in emission rights on January 1, 2005. The emissions trading system creates an economic basis on which to reduce emissions of the (climate-damaging) greenhouse gas CO_2 in the most cost-efficient way. Ecologically effective behaviour is thus put into economic practice. Business sectors, and every industrial plant affected, are assigned specific reduction targets and allocated corresponding emission certificates free of charge for the first trading period. Being tradable, the certificates serve as a kind of currency. If a company meets its targets through cost-effective CO_2 reduction measures of its own, it can sell the certificates it does not need in the market. Alternatively, if its own reduction methods would prove too expensive, the company has to purchase additional certificates in the market.

Source: Federal Ministry for the Environment

Use of renewable raw materials is climate-friendly

Although biomass releases CO_2 into the atmosphere when combusted, the amount released does not exceed the amount the crop absorbed while growing. Therefore, bioenergies are CO_2-neutral if the entire lifecycle of plants or trees is balanced. This is another advantage, as the reinforced use of bio-resources – unlike that of fossil fuels – does not have an adverse impact on the global climate. Conflicts with the goals of a sustained economic policy should only arise if – in unfavourable cases – the widespread development of ecologically undesirable monocultures or excessive use occurred. Of course, the soil is always a limiting factor.

As they are both CO_2-neutral and renewable, regenerative raw materials will very likely play a positive part in achieving the energy policy objectives of environmental protection and securing the supply. Naturally, in the individual case, the actual or potential contribution is conditional upon the natural conditions of the specific regions and countries. Ultimately, parameters like the quality of the soil and climatic conditions (e.g. temperature, precipitation levels) are key determinants of the economic efficiency of the respective raw materials for biological energy.

Resource characteristics of energy carriers

	Depletable	Non-depletable
Renewable	Renewable raw materials	
Non-renewable	Natural gas Crude oil Coal Uranium	Tidal power Solar energy Hydro-energy Wind energy

Source: DB Research

[1] See. Auer, J. (2004). Energy prospects after the petroleum age. Current Issues, December 2, 2004. Auer, J. (2005), Energiestrategien für die Zeit nach dem Öl. In dowjones/vwd, energy weekly, No. 1, 7. January 2005, p. 6-9.

[2] See Walter, N. (2005). Chemieindustrie sollte erneuerbare Energien als Chance sehen. In Chemanager, energy, June 2005, p. 1.

Renewable raw materials – the all-rounders among the renewables

The possible uses of bioenergies by far exceed those of most other regenerative energies. While hydro-energy, wind power and photovoltaics are used solely to generate electricity, renewable raw materials are not only suitable for power generation but also for generating heat and producing fuels. A crucial advantage of bioenergies is that they – unlike photovoltaics and wind power – can be stored and made available as needed.

Buoyant growth of biomass

In Germany, 96% of primary energy consumption in 2004 was satisfied by the conventional energy sources petroleum, natural gas, nuclear energy, lignite and hard coal. While primary energy consumption stagnated in 2004, the share of renewable energies was lifted to 3.6%, from 3.1%. The gain in share is by no means solely due to an expansion of the new renewables like wind and solar energy, but can also be attributed to the renaissance of probably man's oldest source of energy, the biomass.

Biomass has a far greater significance for the energy mix in Germany than is often assumed. In 2004, for example, it accounted for the lion's share of 61% of total renewable energy output (electricity, heat, fuels). Biomass benefits from its manifold uses. According to the statistics of the German BioEnergy Association (BBE), bioenergies constituted an overall share of 2.3% of primary energy consumption in 2004 (of which power: 0.6%, heat: 1.4%, fuels: 0.3).[3]

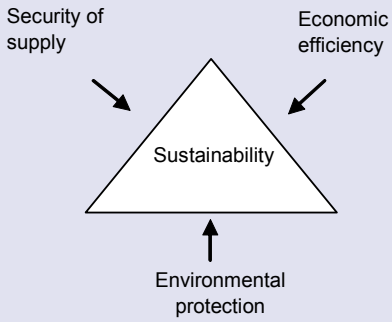
- Biomass is the only important renewable source of fuels in volume terms. Last year, its share of final energy consumption for transport came to 1.6%, up from 0.9% in 2003.
- Biomass is the dominant renewable energy source used for heat generation. Its share of the German heat market rose slightly in 2004 to 3.9% (2003: 3.8%). The only other renewables worth mentioning in the heat sector are solar thermal and geothermal energy, holding shares of 0.2% and 0.1% respectively.
- It is only in power generation that biomass does not take the lead among the renewables. There, hydro-energy and wind power play the most important role, with wind power only outpacing hydro-energy, the front-runner for many years, in 2004 owing to heavy subsidies. Still, the biomass share of power generation climbed from 1.2% (2003) to 1.6% in 2004.

Biopower stimulated by EEG amendment

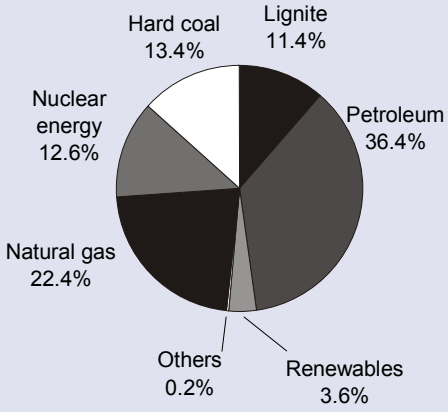
The objective of the amendment to the EEG, which came into force in August 2004, is to increase the renewable energies' share of total German electricity production to 12.5% by 2010 and to 20% by 2020. Moreover, it served to transpose the September 2001 European Union directive on the promotion of renewable energies in the electricity sector into German law. The amendment is a milestone for the access to the grid, transmission and distribution of electricity from renewables. Unlike the previous EEG, its amendment promotes a broad definition of biomass, which also includes organic waste.

On balance, the subsidisation of bioenergies will rise noticeably as a result of the amendment. Nonetheless, basic compensation rates for other renewables are higher yet; power from photovoltaic systems,

Triangle of objectives in energy policy

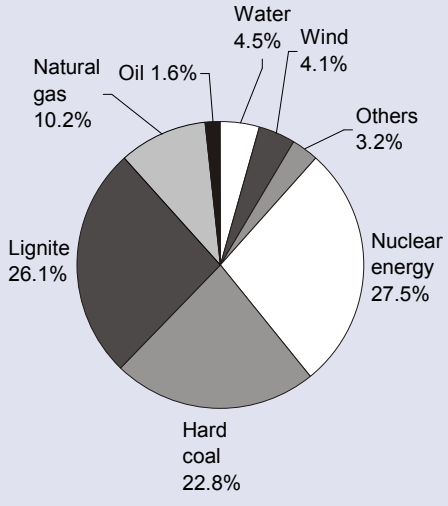


Primary energy consumption in Germany, 2004



Source: AGEE

Energy mix in power generation in Germany, 2004



Sources: Energiemarkt Deutschland, DIW

[3] See BBE. Daten und Fakten zur BioEnergie.

for example, is much more heavily subsidised. The amount of compensation depends on the year of commissioning. To promote technological progress, greater efficiency and lower costs, compensation amounts are to be reduced by 1.5% annually for new installations. Before the amendment came into force, compensation was scaled down by only 1% per year.

The compensation rates are payable for a period of 20 years and depend on the capacity of the installations, which has been broken down into various categories. Smaller installations receive a higher compensation, in order to promote the development of a mass market and to enable the operators of the installations to achieve economies of scale. In addition, compensation varies depending on inputs (e.g. scrap wood, renewable raw materials) and technologies (e.g. electricity generation by combined heat and power systems).

Compensation rates for new plants under the EEG amendment

Segment	Compensation rate (cents/kWh)
Biomass	3.90 - 21.50
Gas from landfills, sewage treatment plants and mines	6.65 - 9.67
Electricity from solar energy	45.70 - 62.40
Hydro-energy	3.7 - 9.67
Geothermal energy	7.16 - 15.00
Wind onshore	8.7 / 5.50*
Wind offshore	9.1 / 6.19*

* Initial/final compensation

Source: Federal Ministry for the Environment

Bonus system to regulate the market

Last but not least, a new bonus system is to regulate the energy sector.

- In order to boost the use of energy crops and forest wood in energy production, a bonus has been introduced for fuels made from renewable raw materials: 6 cents/kWh for up to 500 kW and 4 cents/kWh for up to 5 MW. In addition, the list includes manure and/or urine, straw from farm animals and agricultural distillers' wash, but not waste from domestic animals or bioethanol plants. If power is derived from wood burning, a bonus of only 2.5 cents/kWh is paid, which forest managers might see as a discrimination of sorts.
- Power generation by means of combined heat and power (CHP) is considered particularly efficient. Therefore, a CHP bonus (efficiency bonus) of 2 cents/kWh has been introduced for plants with a maximum capacity of 20 MW.
- Furthermore, a bonus of 2 cents/kWh for innovative technologies may be granted, which, however, is only paid in combination with a CHP bonus and if a particularly new and innovative CHP technology is employed.

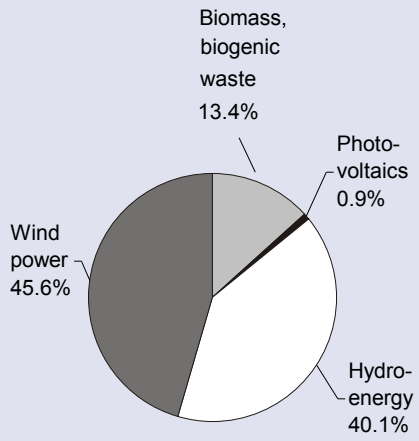
The bonuses are not scaled down and can be combined. The maximum amount is payable for a small installation (of up to 150 kW) that converts renewable raw materials by means of innovative CHP processes. In this case, the respectable sum of 21.5 cents/kWh is granted.

Effectively, the EEG primarily encourages the use of renewable raw materials and the construction of new biogas plants, as these are in general smaller installations, which are eligible for high basic compensation and favourable bonuses for renewable raw materials. 95% of biogas is used in cogeneration units to produce electricity and heat, while only 5% of the plants generate solely electricity.[4]

By contrast, EEG subsidies and thus the use of solid biomass, particularly forest wood in biomass cogeneration units, are less favourable, as both the bonus for the combustion of wood and the basic compensation (large plants) are lower.

As a result of the EEG, the biogas sector is expanding strongly. The relatively low fuel bonus granted for wood, on the other hand, has a dampening effect on forestry investment and thus the realisation of the large unexploited forest wood potential. Still, market expansion is likely thanks to heat customers in favourable locations, as plant operators there may benefit from the CHP bonus (possibly together

Renewable power generation, 2004



Sources: VDEW, Energiemarkt Deutschland

[4] See Landwirtschaftliche Rentenbank. Geschäftsbericht 2004, p. 27.

with the technology bonus). Looking forward, it would be helpful if a mixed fuel bonus regulation were implemented for solid biomass, which provides that forest and scrap wood (e.g. industrial and sawmill residuals) is to be remunerated on a pro-rata basis. New investment would thus become profitable.

In Germany, some 2,100 agricultural biogas plants with an installed capacity of 430 MW were in operation at the beginning of 2005 (1999: 850). Owing to the EEG, the number of plants is likely to double to 4,000 by year-end (capacity: 800 MW). Although the subsidies are lower, the prospects for solid biomass plants are also positive. In 2004, around 100 biomass cogeneration units existed, which had a capacity of 475 MW. For 2005 a rise to 700 MW is to be expected, which is likely to be followed by an increase in the lower double-digit percentage range in 2006. Liquid bioenergy carriers account for only 0.3% of biomass power. Therefore, the 160 cogeneration units operating on vegetable oil are of minor importance.

By 2010 the share of biomass in power generation could be up to a good 4% (2004: 1.6%). The BBE believes that the biomass market share could rise to roughly 10% in 2020 and roughly 18% in 2030.

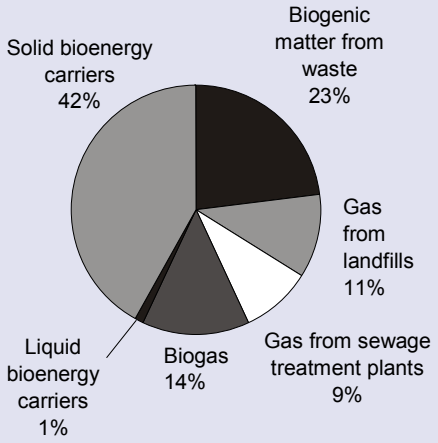
Technological progress contributes to market success, as a recent study published by EWI/Prognos on the trend in energy markets up to 2030 shows.[5] In the medium term, the cost of producing one kWh of power in biogas plants with an output of 1 MW will range from 7.5 to 12 cents. For solid biomass, production costs of large 20 MW heat extraction plants will likely be between 6 and 9 cents/kWh in the medium run, depending on the type and price of fuel used. Owing to the EEG compensation scheme and thanks to achievable economies of scale, these large plants will replace the presently dominant installations with a maximum capacity of 5 MW.

Positive growth potential in the heat market

In Germany, bioenergies contribute more than 90% to the heat supply from renewables. With a share of over 90%, biogenic solid fuels (e.g. pellets, wood chips, firewood) are the dominant feedstock. According to the BBE, approximately 9 m small furnaces are used to produce heat (wood and coal-burning stoves, fireplaces), along with 1,100 biomass heating systems and 28,000 pellet units. Biomass heating plants with small district heating systems are a highly interesting alternative for municipal and commercial heat supply.

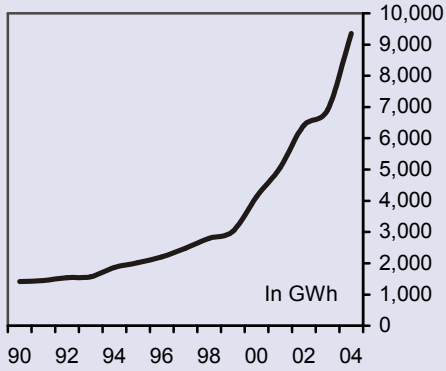
Pellet units are seen as particularly promising. By end-2005, the number of pellet heating systems should rise to 34,000; and in the medium term, a further 35,000 systems will likely be set up. In relation to the roughly 40 m dwellings in Germany, this would still equate to less than 0.2%. But the expansion will not only benefit the plant engineers. The 20 or so pellet producers will have to extend their capacities (currently: approx. 140,000 tons) to satisfy the dynamic rise in demand. In 2001 sales of wood pellets came to no more than 10,000 tons, in 2004 as many as 150,000 tons were sold. Some 330 pellet dealers have also benefited from the renaissance of wood as a fuel. An alternative to boosting production in Germany would be to increase pellet imports, for example from Austria. In the medium term, cut-throat competition is possible in the trade with pellets, resulting in greater concentration.[6]

Biogenic power generation, 2004 (9,356 GWh)



Source: BBE

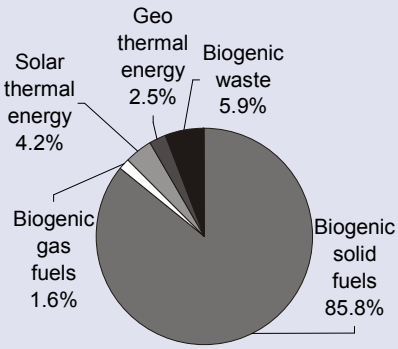
Power from biomass



Source: AGEE

Heat from renewables, 2004

Total: 62.1 TWh



Source: AGEE

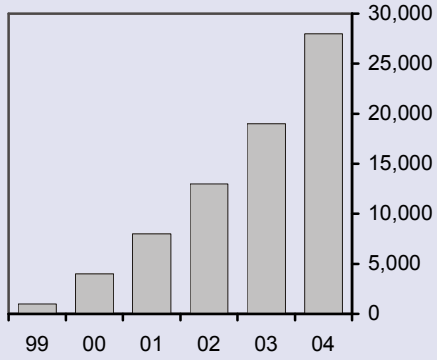
[5] See EWI/Prognos. Die Entwicklung der Energiemärkte bis 2030. Schlussbericht, April 2005, p. 108/109.

[6] See Holzpellets: Günstige Alternative zu Heizöl. In top agrar, 1/2005, p. 121.

Although modern pellet heating systems are still somewhat less convenient than oil and, in particular, gas heating (e.g. due to transport), they provide a similar heating comfort. Wood-fired boilers are already considered cost-effective alternatives. This is not only due to the absolute rise in oil and gas prices, which favours the price competitiveness of pellet units. Another important factor is that pellet prices are less prone to fluctuate, a boon for investors seeking better calculability and manageable risks. According to top agrar, the cost of producing one kWh of heat using pellets was just 2.8 to 3.4 cents at the beginning of 2005, only half as much as heating oil (5 to 6 cents/kWh); and since then the oil price has risen even further.

In the future, substantial potential can be tapped through technological progress and new statutory regulations. The first biomass boilers have hit the market, which, along with wood, also burn straw and grass pellets as well as grain, an alternative which is especially interesting for farmers. Despite the new technology, however, statutory regulations are still lacking that allow the regular use of inferior parts of grain as a fuel.[7] Straw pellets, which today are still usually used in horse stalls, are becoming increasingly competitive owing to the rise in oil prices. Last but not least, forestry could benefit from the pellet boom by cultivating and marketing fast-growing trees like willows and poplars, while at the same time making a valuable contribution to the expansion of the bioenergy market.

Market growth of wood pellets
Number of installed plants



Source: BBE

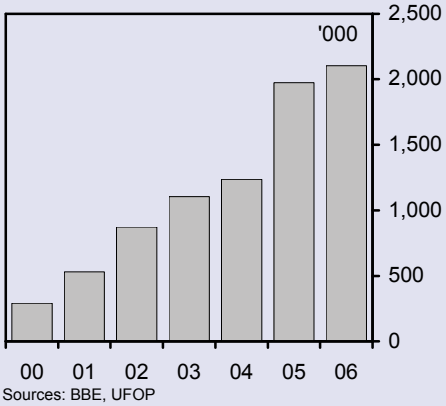
Fuels from biomass are moving out of the niche

Of the renewable energies, in Germany practically only bioenergies are used as fuel. The range of fuels is as wide as that of the raw materials used, including biodiesel, bioethanol, biogas, biomethanol, vegetable oil, and synthetic biofuels.

Compared with conventional fuels, biofuels are, of course, still a far cry from being competitive in terms of profitability. Production costs for 1 litre of biofuel range from EUR 0.5 to EUR 0.8, depending on the process and the raw materials used. Comparable fossil fuels are but half as expensive.

German policy-makers have crafted a number of instruments in order to promote the competitiveness of biofuels from domestic production. While these are aimed at raising the share of biofuels to 5.75% by 2010 in line with the EU objective, it is mostly considerations regarding national energy policy, environmental and agricultural policy which play a role: thus, biofuels and biofuel components are exempted from petroleum tax (and therefore also from eco-tax) until end-2009. Moreover, tariffs have been imposed on competitive products from abroad, which can be produced at a lesser cost (e.g. in Brazil). In agriculture, the reduction in agrodiesel compensation, which took effect in 2005, benefits biofuels. The bottom line is that conventional diesel costs around 10 cents more per litre than de facto subsidised biodiesel. However, the energy content of conventional diesel is 10% higher than that of rape oil-based fuels.

Biodiesel, production capacity, Germany (in tons/year)



Sources: BBE, UFOP

Biodiesel (rapeseed methyl ester, RME) is the dominant biofuel. It can be used in any modern (approved) diesel motor and can be mixed with diesel fuel from fossil sources at any ratio. Since 2004, demand from petroleum companies, which are allowed to add 5% biodiesel to conventional diesel, has surged. Thanks to this new second distribution channel, the admixture – in addition to pure diesel –, biodiesel sales climbed by one-third to 1 m tons in 2004.

[7] According to the BBE, grain is (so far) no regular fuel under the 1st Federal Immission Control Ordinance due to insufficient emission values.

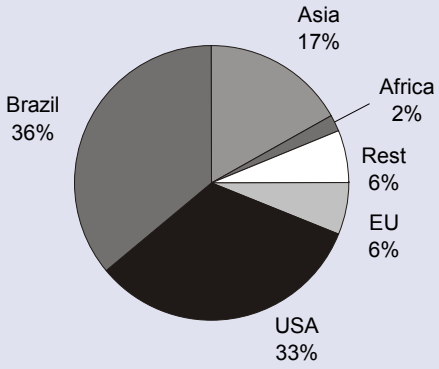
Sales are expected to rise further to 1.5 m tons in 2005 and to roughly 2 m tons in 2006, aided by a surge in production capacities to over 2 m tons in 2006 (2004: 1.2 m tons). Given the promising growth prospects, more and more petrol stations will supply biodiesel in the future; currently it is available at 1,900 out of 16,000 filling stations. Looking forward, a restrictive factor will be the limited area that can be used for growing rape, which, for reasons of crop rotation, is a maximum 2 m hectares in Germany.[8] Of the 860,000 hectares made available for growing rape in 2004, 650,000 were used for biodiesel.

Bioethanol is produced from plants which contain sugar and starch such as sugar beets, wheat, rye and, in the future, also cellulose. It can be used as both a fuel and a fuel additive. Adding up to 5% of bioethanol to petrol does not cause any technical problems. In 2004, around 800, mostly smaller (distillery) plants produced only 34,000 tons of bioethanol. As it is now possible to admix bioethanol with petrol, a leap in sales is to be expected for 2005. The massive expansion of capacities with three new large bioethanol plants (Südzucker, amongst others) to 500,000 tons will thus likely meet with demand. It is external proctection against bioethanol imports (e.g. from Brazil), however, which ultimately makes domestic bioethanol products competitive.

BTL (Biomass-to-Liquids) are still in their infancy. These designer fuels are particularly pure. One advantage is that, although they are produced from a wide variety of feedstocks (e.g. energy crops, organic waste, straw), BTL are constant-quality fuels. Moreover, they do not require either new motors or a infrastructure of their own. However, BTL can only be produced in large plants. According to the Öko-Institut, the potential of BTL fuels by far exceeds that of vegetable oil and bioethanol in the long term.[9]

Ethanol production, world, 2004

(Total volume: 42 million m^3)



Source: Licht, F.O., World Biofuels

Bioenergies – two birds with one stone

With respect to the traditional objectives of energy policy, bioenergies stand to markedly improve the future energy mix in Germany, Europe and the world.

Power and heat from bioenergies are usually supplied via decentralised structures, providing at least local and regional protection against widespread power outages, like those that recently occurred in Northern America and Europe. Moreover, bioenergies reduce the vulnerability of entire economies to price increases in crude oil and natural gas as well as heating oil and fuels.

The promotion of bioenergies provides the opportunity for Germany and the EU to develop a competitive edge in technology. Furthermore, the investments into the future could become highly profitable, if a technology export were successfully organised to energy-hungry and populous countries like China and India, which are pushing the expansion of bioenergies. Here, the scope of products ranges from small furnaces for private households to efficient biodiesel production plants for the booming automobile markets in the emerging markets.

[8] See Landwirtschaftliche Rentenbank. Geschäftsbericht 2004, p. 25.
[9] See Öko-Institut. Bioenergie, May 2004, p. 23.

Conclusion

In the light of the ongoing discussion over agricultural subsidies in the EU and the world it is becoming clear that farmers will likely receive lower subsidies in the mid-term. As the use of bionenergies enjoys more widespread approval in the public, the business segment of renewable energies offers an interesting alternative source of income for traditional farmers. If established farmers and forest managers became modern “energy managers”, two birds could be killed with one stone. Biomass, the energy of the future, would get the necessary support and income prospects in rural areas would be stabilised. However, for the greater integration of bioenergies to be successful, policy-makers would have to create a framework which is reliable and objective-oriented in the longer term.

Last but not least, the competitiveness of bioenergies depends on the oil price. Even based purely on production costs and excluding subsidies, biofuels will become fully competitive, at the latest, when the oil price doubles (H1 2005: USD 50/bbl.). Pellet heating systems are already operating at lower fuel costs; in this case, a doubling of the oil price would prove far more costly than the disadvantage of higher start-up costs for the heating systems. It will take years for bio-power to become competitive. However, oil does not play a role in electricity generation in Germany. When the positive external effects of using bioenergies are taken into account as well, the economic valuation immediately becomes more advantageous.

Under favourable assumptions, the share of bioenergies in primary energy consumption could be in the double-digit range in Germany by 2030. This would be a significant jump (at present: 2.3%). However, a restrictive factor will be the limited availability of farming land and forest worldwide. Given the continued growth of the world population and the dietary trends (e.g. more meat), it seems little realistic, despite the technological progress in agriculture and forestry, that bioenergies will come close to doubling their share of global primary energy consumption in the forecast period.

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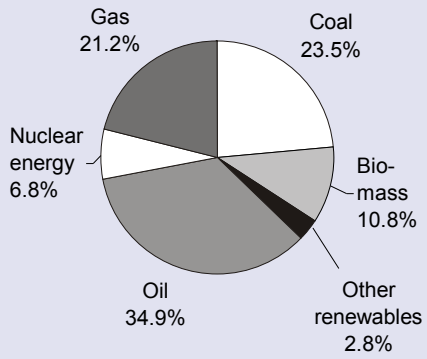
Primary energy consumption, world, 2002



Source: Federal Ministry for the Environment

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