Chapter 4.

Summary, Conclusions and Policy Recommendations

Production and use of biofuels – mainly ethanol based on cereals and sugar crops, and biodiesel based on vegetable oils such as rapeseed or canola oil – have grown rapidly over the past few years and are expected to further double in the decade to come. The United States and Brazil remain the largest ethanol producers while biodiesel production is particularly relevant in the European Union, but a large number of other countries have begun or are considering promoting biofuel production and use.

Most production chains for biofuels, however, show costs per unit of fuel energy significantly above those for the fossil fuels for which they aim to substitute. Despite the important increase in crude oil prices and hence in the costs for gasoline and fossil diesel, the cost disadvantage of biofuels has widened in the past two years as agricultural commodity prices soared and feedstock costs have increased. In consequence, the sometimes predicted improved economic viability of biofuels with higher crude oil prices so far has not been realised, and biofuels in most countries remain highly dependent on public support.

This support is being provided in a large range of forms affecting all stages of the biofuel production and use chain. Three general groups of measures can be distinguished:

- **Budgetary support** comes either as tax concessions for biofuel producers (refiners), retailers or users, or as direct support to biomass supply, biofuel production capacities, output, blending, specific infrastructure or equipment for biofuel users. All these measures directly affect the public budget either in the form of foregone tax revenues or of additional outlays, and hence create a transfer from taxpayers to biofuel producers.

- **Blending or use mandates** require biofuels to represent a minimum share or quantity in the transport fuel market. While these measures generally are neutral for public budgets, the higher production costs of biofuels result in increased fuel prices for the final consumer who thus makes a transfer to biofuel producers.

- **Trade restrictions**, mainly in the form of import tariffs, protect the less cost-efficient domestic biofuel industry against competition from lower-cost foreign suppliers and result in higher domestic biofuel prices. These measures limit development perspectives for more competitive suppliers from other parts of the world. Trade restrictions generate a transfer from users to producers of biofuels.

A range of reasons are behind the public interest in, and public support for, biofuels. Prioritising these policy objectives is difficult and varies by country, over time and across government ministries. With increased concerns about climate change, however, the reduction of greenhouse gas emissions can safely be counted among the prime reasons to support biofuel production and use. Other objectives relate to fossil energy savings and energy security, other environmental benefits, and rural development.

The environmental performance of current biofuels tends to vary a lot, and for many biofuel chains it is not easy to get a uniform picture of their environmental performance from the many studies that have been published on this matter. Measuring the environmental performance of biofuels requires the consideration of the full life cycle of these products, *i.e.* from agricultural production and its use of various inputs to the conversion of agricultural feedstocks to liquid fuels and to the use of the biofuel in combustion engines. Recently, additional consideration has been given to the effects of land use changes either directly (*i.e.*, where land not used for agricultural production gets converted to produce biofuel feedstocks) or indirectly (*i.e.*, where land not used for agricultural production gets converted to produce agricultural commodities in response to biofuel-driven displacement of commodity production in a different region, country or even continent). While direct land use changes are partially considered in a small number of studies, indirect land use changes generally are not and require the combination of economic modelling with the analysis of carbon stocks in areas affected from land use change.

Generally speaking, and without land use changes taken into account, all studies available agree on fairly positive greenhouse gas reductions for ethanol based on sugar cane of 80% or more compared to the use of fossil gasoline. Rates above 100% are possible due to the energetic utilisation of the bagasse and electricity sales. Reduction of GHG emissions of cereal-based ethanol and of oilseed-based biodiesel compared to their respective fossil counterparts is found to be significantly lower, and studies give much more diverging results due to regional and data differences, but in particular because of methodological differences *e.g.* with respect to the allocation of GHG emissions between the biofuel and by-products. On average, these improvements rates for wheat, corn, sugar beet and rapeseed based biofuels can be taken to be 30%-55%, 10%-30%, 40%-60% and 40%-55%, respectively. On the other hand it seems likely that second-generation biofuels (both cellulose-based ethanol and BTL-diesel) could generate rates of GHG avoidance similar or even above those for sugar cane-based ethanol. Similarly, first-generation biodiesel made from used cooking oils or animal fats could provide significant GHG savings.

The quantitative analysis of biofuel policies and markets suggests that despite the assumed persistence of oil prices around USD 100 per barrel, biofuel production and use remains dependent on public support to a significant degree. This is even more so for biodiesel than for bio-ethanol. A removal of global support to biofuels would substantially affect the (private) profitability of biofuel production and use particularly in those markets where production costs are very high; biodiesel markets in general and bio-ethanol markets in Europe would be much more affected than bio-ethanol in the US. Bio-ethanol production in Brazil is largely competitive with fossil gasoline as long as sugar prices do not increase dramatically above current and projected levels.

There has been much debate recently about the impact of biofuels on global food prices. Indeed, the baseline as presented in the 2008 OECD/FAO Agricultural Outlook projects future agricultural commodity prices to rise significantly above their historical

levels. However, if biofuel quantities were to remain at current levels in all countries, rather than growing at their projected rates under current policies, medium-term coarse grain and sugar prices would remain 13% and 23% lower than currently projected, respectively. [1] The baseline does not include the impact of the recent US Energy Improvement and Security Act (EISA) and the proposed EU Directive on Renewable Energies (DRE). As these initiatives will provide further stimulus to biofuels, a scenario in which biofuel production was kept constant at 2007 levels would in reality have even more pronounced price-dampening effects in terms of reducing agricultural commodity prices. This indicates that the growth in the global biofuel industry is responsible for an important share of the increase in projected price levels compared to the historical average. Not all of this price impact of further biofuels growth, though, is a result of current and future biofuel policies. Even if these policies were eliminated, production and use of biofuels would continue to grow somewhat. The basis for that future growth in biofuel production has to some extent been laid by biofuel support in the past (and indeed in the case of Brazil over a long period of time).

Current biofuels support policies, in the form of budgetary support, mandates and tariffs, provide substantial stimulus for further growth of biofuels sectors. The medium-term impacts of biofuel policies in place in mid-2007 on agricultural commodity markets are therefore noticeable, but should also not be overestimated. These policies are estimated to increase average wheat, maize and vegetable oil prices for the 2013-2017 period by about 5%, 7% and 19%, respectively. Prices for sugar and particularly for oilseed meals are actually reduced by these policies – a result of slightly lower production of sugar cane-based ethanol in Brazil and significantly higher biodiesel-related oilseed crush. The new US and EU initiatives are estimated to further increase commodity prices by a similar amount in the medium term. Depending on how much of the feedstock biomass will be produced on land otherwise used for food production, about half of this additional price increase for cereals and oilseeds may come from the second-generation biofuel parts of the programmes.

Apart from the price effects, however, it is important to note that existing support to biofuels – and even more so for the new legislation recently enacted (USA) or currently discussed (EU) might have important implications for global land use and are likely to accelerate the expansion of land under crops particularly in Latin America and large parts of Africa. While on the one hand this may provide additional income opportunities to generally poor rural populations it bears the risk of significant and barely reversible environmental damages. This might include substantial release of greenhouse gases, but also the loss of biodiversity and the risk of runoff of nutrients and pesticides.

Current support policies in the US, the EU and in Canada tend to reduce GHG emissions by much less than expected. An elimination of budgetary support, mandates and tariffs for biofuels under current policies (not considering the new US and EU initiatives) would increase net GHG emissions in 2013-2017 by between 15 and 27 Mt of CO_2-eq. – equivalent to no more than 0.5%-0.8% of the emissions from transport in these countries estimated for 2015. This does not even assume any GHG emissions from land use changes, which depending on the type of land converted may worsen the GHG balance of the biofuels supported. Similarly, fossil fuel use would increase by less than 1% for most of these transport sectors, but by between 2% and 3% in the EU diesel sector. These relatively modest effects come at considerable costs in terms of transfers from taxpayers and consumers of some USD 25 billion on average for the 2013-2017 period, equivalent to between USD 960 and USD 1 700 per tonne CO2-eq. saved, or of between USD 0.80 and USD 7 per litre of fossil fuel not used.

Once available on a commercial scale, second-generation biofuels may help to reduce the competition between food and feed production on the one hand and energy production on the other. This would be the case where biomass comes from wastes such as urban wastes, or where residues from agricultural or forest production (such as straw or forest residues) are used. In this case, competition may even turn into complementary conditions. For most soils, the extraction of a part of the residue biomass is not considered a problem. Care needs to be taken, however, that the supply of organic matter and nutrients to the soil is not overly reduced, and that soil fertility and ability of the soil to provide other ecological services (such as providing fauna habitat, carbon sequestration, water purification etc.) are maintained.

Where biomass for second-generation fuels is produced from dedicated crops, the impact on crop markets and land use strongly depends on the land used. Areas not otherwise used for crop production obviously provide the potential to minimise the area competition, but yields on marginal land tend to be much lower than on land currently in crop use, which may lead farmers to use crop land for biomass production. In addition, special care needs to be taken that sensitive areas are excluded from conversion to crop land or biomass production and that GHG emissions from existing carbon stocks in the soil are minimised. Both these concerns obviously apply independently of whether the converted land is used directly for the production of fuel-biomass or for food and feed commodities.[2]

The analysis also shows that with the increased relevance of biofuels, agricultural markets have become more sensitive to changes in energy prices. Oil prices have always had an impact on production costs in agriculture, and hence on agricultural commodity prices. But with the expansion of biofuels, oil prices additionally impact demand for feedstock commodities – an additional channel for the influence of oil prices on agricultural commodity prices. Some 20-30% of the impact of crude oil prices on agricultural commodity prices can now be attributed to biofuels – a link that has not existed to the same degree in the past.

Based on this analysis, a number of policy-relevant recommendations are offered:

- The objectives behind public support for biofuels are multifold, and so are the potential side effects of biofuel production and use. Tackling these problems requires differentiated and suitable policy approaches. "One measure fits all" is unlikely to give satisfactory results. Instead, a policy mix is needed that depends on countries' priorities and natural conditions. There are also global challenges, such as the increasing concentration of greenhouse gases in the atmosphere, which need internationally concerted action.
- The stated rationale for support to biofuels generally includes the reduction of fossil energy use. A priority focus therefore needs to be given to reducing energy consumption. This is especially important in the transport sector where the growth in energy use and related environmental problems is most pronounced. In particular, this includes the gradual move from highly energy intensive modes of transport to less intensive ones, and improvement in fuel efficiency in all transport sectors. Generally the costs of reducing GHG emissions by saving energy are lower than by switching to alternative energy sources, in particular biofuels. It should also be clear that, while the strong increase of GHG emissions in the transport sector is of particular concern, the costs of emission reductions are often substantially lower in other sectors, *e.g.* by better insulation of buildings.[3]

- To the extent that a reduction of fossil fuel use and GHG emissions is intended to be achieved by means of alternative transport fuels, a clear focus needs to be placed on those alternative fuels that provide high improvement rates. Defining minimum criteria for these variables, as it has been done in the context of the US Energy Independence and Security Act and as foreseen for the new EU Directive on Renewable Energy, is an important step in the right direction. Given the uncertainties on, and the variability of, the performance of different biofuel chains, these minimum criteria should be set at rather ambitious levels and should be tightened over time to ensure the full deployment of technological progress in this rapidly developing area.
- Mitigating climate change is a global concern. Biofuels should, therefore, be produced in those parts of the world where they can make the most effective and efficient contribution to reducing GHG emissions. The improved production of first generation biofuels from tropical and semi-tropical countries should be looked at carefully. Despite the risk of deforestation and the unsustainable (at times, illegal) use of natural resources in those countries, the very high productivity of arable crops and biofuel production in these countries deserves particular attention. The potential environmental but also socio-economic impacts of biofuels expansion in African, Asian and Latin American regions should be assessed. A policy mix is needed to ensure that biofuel production occurs in an optimal way, thereby minimizing the risks of environmental drawbacks from land-use changes in carbon rich soils.
- Import tariffs on feedstock or biomass to protect domestic production impose an implicit tax on biofuels production by raising input prices. Tariffs are also applied to biofuel imports, distorting resource allocation and imposing a burden on users. In addition to other policy changes discussed here, opening markets for biofuels and related feedstocks would allow for more efficient and lower cost production, and at the same time could improve both environmental outcomes and reduce reliance on fossil fuels. It should, again, be remembered that the global nature of the climate change concern means that it does not matter whether biofuels are produced domestically or in other parts of the world: they should be produced where they can make the most effective and efficient contribution to reducing GHG emissions.
- The problem of land use changes resulting from biofuels expansion, both direct and indirect ones, deserves particular attention. Additional research is needed to better understand the environmental risks related to land use changes. This research needs to be of an interdisciplinary nature to capture the interrelationships between economic and environmental effects. The analysis in this report gives some indication as to the potentially significant magnitude of such problems, but clearly remains at too aggregate a level to provide conclusive answers. It should be clear, however, that the problem of land use changes is not only related to biofuels produced in sensitive areas themselves as indirect land use changes can create quite similar negative effects. Effective monitoring of land use trends and of environmental effects of cropping practices at field level – for energy purposes or not – is important to allow for a better analysis of policy impacts and to minimize their negative implications.
- A clear focus should be on the development of improved and new technologies in the production of biofuels. Both the commercial-scale development of advanced and second-generation biofuel technologies and the exploitation of the improvement potential of different first-generation biofuel chains will need

sustained R&D efforts. Biogas from organic waste or other biomass, an option not discussed in detail in this study, exhibits good energy efficiency and is produced in several countries today. The use of waste material for BTL fuels deserves attention as it provides feedstocks at potentially very low or even negative costs. Forest and crop residues could represent another relatively low-cost source of biomass for cellulose-based ethanol or BTL. Second-generation biofuels from dedicated biomass – annual and perennial crops – may offer higher energy yields. In any case, with lower pressures on land use and agricultural markets per unit of biofuels, the production of large quantities may well have an important impact that needs to be carefully monitored. The proposed EU DRE giving a double value to biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material is a step in the right direction. In the long run, however, innovations in electrical energy from other renewable sources, hydrogen fuel cells and other technologies, also offer much promise.

- Most biofuel chains clearly contribute to increasing food prices, yet the impact must not be exaggerated. Developments in the biofuels sector may thus contribute to food insecurity for the most vulnerable population groups in developing countries. This unintended impact is significant, relative to the modest benefits and high costs associated with current biofuels policies, and further review of alternative policy approaches is warranted.

Notes

1. The baseline underlying this analysis (see OECD, 2008a) projects e.g. international prices in nominal terms for wheat, maize and vegetable oils on average over the 2013-2017 period to be about 37%, 49% and 80% above their 2002-2006 averages, respectively. Without further growth in biofuel production, this price rise would be lower at 29%, 30% and 56% above this historical average, respectively. Note that, while it is clear that biofuel growth together with other longer-term factors also contributed to the price hikes observed in 2007 and 2008, these were also caused by a range of short-term disruptions in international commodity markets. The price effects discussed here therefore cannot be translated into estimates regarding the importance of biofuels in current price hikes.

2. For a full analysis of the implications second-generation biofuels could have, longer-term developments need to be taken into account that clearly go beyond the horizon of this study.

3. One may argue that measures to reduce overall energy and transport fuel use may (and in fact do) go in parallel with support to biofuel production and use, and that these measures are not in competition with each other. In reality, however, policy measures are subject to resource constraints (*e.g.* in terms of government budgets, or in terms of consumer charges).

Table of contents

Tables

Figures