Executive Summary

The 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 with 48% and 31% of global ethanol output in 2007, respectively, while the European Union accounts for about 60% of global biodiesel production. A large number of other countries' governments have begun, or are considering promoting biofuel production and use.

In most countries, biofuels remain highly dependent on public support policy. This report estimates support to the US, EU and Canadian biofuel supply and use in 2006 at about USD 11 billion per year, projected to rise to USD 25 billion in the medium term (all medium-term projections in this executive summary refer to the annual average for the 2013-17 period). Many different forms of support are provided at various stages of biofuel production and use but the three major categories of support are:

- **Budgetary support measures**, either as tax concessions for biofuel producers (refineries), 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 forgone tax revenues or of additional outlays.
- **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.
- **Trade restrictions**, mainly in the form of import tariffs, protect the less cost-efficient domestic biofuel industry from competition from lower-cost foreign suppliers and result in higher domestic biofuel prices. These measures impose a cost burden on domestic biofuel users and limit development prospects for alternative suppliers.

The high level of public support has placed biofuels policy at the centre of a debate about the expected environmental, energy and economic benefits. This report presents new economic analysis, provides policy recommendations and identifies areas where more research is necessary. The report focuses on liquid biofuels for transport derived from agricultural feedstocks or from biomass related to agricultural production.

There are many reasons for public interest in and 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 (GHG) emissions and fossil energy savings can safely be counted among the prime reasons to support biofuel production and use.

Ethanol based on sugar cane - the main feedstock used in Brazil - generally reduces GHG emissions by 80% or more over the whole production and use cycle, relative to emissions from fossil fuels. Current support policies in the US, the EU and in Canada target feedstocks that tend to reduce GHG emissions by much less. Biofuels produced from wheat, sugar beet or vegetable oils rarely provide GHG emission savings of more than 30% to 60%, while corn (maize) based ethanol generally allows for savings of less than 30%. Current budgetary support, mandates and trade restrictions (not considering the most recent US and currently discussed EU initiatives) reduce net GHG emissions by less than 1% of total emissions from transport. Fossil fuel use is also reduced by less than 1% for most of these transport sectors and by 2-3% in the EU diesel sector. These relatively modest effects come at a projected cost equivalent to about USD 960 to USD 1700 per tonne of CO_2-eq. saved, or of roughly USD 0.80 to USD 7 per litre of fossil fuel not used.

The sometimes predicted improved economic viability of biofuel production and use associated with higher crude oil prices so far has not materialised in many countries. Most production chains for biofuels have costs per unit of fuel energy significantly above those for the fossil fuels they aim to replace. Despite the rapid and substantial 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 thereby feedstock costs increased.

The medium-term impacts of current biofuel policies on agricultural commodity prices are important, but their role should not be overestimated. The price effects attributable to biofuel policies derive largely from increased demand for cereals and vegetable oils. With biofuel support policies in place in 2007, 12% of global coarse grain production and 14% of global vegetable oil production could be used for biofuels in the medium-term, up from 8% and 9% in 2007, respectively. But future policy developments matter: with full implementation of the recently enacted US Energy Independence and Security Act and the currently proposed new EU Directive for Renewable Energy, close to 20% of global vegetable oil production and more than 13% of world coarse grain output could shift to biofuels production.

Current biofuel support measures are estimated to increase average wheat, maize and vegetable oil prices by about 5%, 7% and 19%, respectively, in the medium term. 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 proposed EU initiatives could further increase commodity prices by a similar magnitude.

The price impact of second-generation biofuel production would depend on the amount of feedstock biomass that would be produced on current crop land. If the total production area is significantly expanded, the price effects would be reduced but concerns over negative environmental impacts on sensitive areas and high-carbon soils, including GHG emissions, water use and biodiversity losses, would increase.

Linked to the price effects noted above, existing and any additional support for biofuels 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 this might provide additional income opportunities to generally poor rural populations, care would need to be taken to avoid possible environmental damages, including accelerated deforestation, additional release of greenhouse gases, loss of biodiversity and runoff of nutrients and pesticides.

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

- The multifold objectives behind the public support for biofuels as well as the side effects of biofuel production call for differentiated and suitable policy approaches. Appropriate policy mixes will depend on countries' priorities and conditions. There is no "one size fits all" policy mix that meets all different objectives and minimizes negative effects.

- The primary focus for fossil energy saving needs to be redirected from alternative fuels towards lower energy consumption, particularly with respect to the transport sector. Generally, the costs of reducing GHG emissions by saving energy are much lower than by substituting energy sources. It should also be noted that while the strong increase of GHG emissions in the transport sector is a concern, the costs of emission reductions are often substantially lower in other sectors, *e.g.* by better insulation of buildings.

- With respect to alternative transport fuels, a clear focus needs to be placed on those biofuels that maximise the reduction of fossil fuel usage and GHG emissions. Minimum reduction criteria should be established, set at ambitious levels and tightened over time to enhance technological progress in this rapidly developing field.

- The type of land used for biofuel production affects the environmental performance of these fuels. Governments should favour the use of areas not currently used for crop production – either degraded or with low nature values – while use of environmentally sensitive land needs to be discouraged. The production of large biofuel quantities will have an important impact on land use that needs to be carefully monitored in order to ensure sustainable supply chains.

- 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. 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.

- Further development and expansion of the biofuels sector will contribute to higher food prices over the medium term and to food insecurity for the most vulnerable population groups in developing countries. Modifying current support policies along the lines outlined above would reduce this unintended impact. In addition, with a more liberal trade environment, increased biofuel production might be a viable option in some developing countries, thereby improving employment and income opportunities.

Some areas for **further research** have also been identified:

- The high productivity of first generation biofuel production from tropical and semi-tropical countries deserves further examination, in particular regarding the potential economic benefits relative to sustainable resource use.

- More generally, interdisciplinary research is needed to better understand the environmental risks related to land use change resulting from biofuels expansion and to capture the interrelationships between economic and environmental effects. Present analysis shows that problems can be significant, but clearly remains at too aggregate a

level to provide conclusive answers. The environmental problems of land use changes are not restricted to biofuels produced in sensitive areas. Indirect land use changes (where sensitive areas become converted to produce crops other than for biofuels due to biofuel-induced incentives) can create quite similar negative effects, and require effective monitoring at field level.

- Both the commercial-scale development of advanced and second-generation biofuel technologies and the exploitation of the improvement potential of different first-generation biofuel supply chains need – and indeed get – sustained R&D efforts over time. Biogas and BTL-fuels from organic waste or other biomass and cellulosic ethanol from crop and forest residues are options with potentially very low feedstock costs. Second-generation biofuels from dedicated biomass such as grasses and fast-growing trees may offer higher energy yields.

- Research and development should not focus solely on biofuels. In the long run, innovations in solar energy generation, hydrogen fuel cells and other technologies offer much promise.