



Rudolf STROHMEIER
Deputy Director-General

Bioethanol in the context of the European Bio-based Economy Research and Innovation Strategy

2nd European Renewable Ethanol Policy Conference 2012

De Warande, Zinnerstraat 1, 1000 Brussels

26 September 2012, 17.30-18.00

Contact persons: [REDACTED] K3

TABLE OF CONTENTS

1. INTRODUCTION

1A) SCENE SETTER

1B) OBJECTIVE

2. SPEECH/SPEAKING POINTS

3. DEFENSIVE POINTS

4. BACKGROUND INFORMATION

Commonly used terms

The European Bioenergy Industrial Initiative

JTI Bio-based industries

R&D support on Bioenergy in the EU and other countries

EU legislation with impact on biofuels

Impact on prices - the international food security debate

Indirect land use change (ILUC)

EU biofuels market

EU Bioenergy industry – comparison with competitors

The National Renewable Energy Action Plans (NREAPs)

5. ANNEXES

Programme of the Conference

List of participants

INTRODUCTION

1A/ SCENE SETTER

ePURE represents the European ethanol producers at the EU-level. The ePURE conference is an annual policy conference organised for ePure members. It is a free to attend but by invitation only. The conference programme is focused on the contemporary market and policy issues that are affecting the sector.

The conference is attended by bio-industries, particularly the bioethanol/biofuels industry, and other industries such as oil, farming, etc. and stakeholder groups. The conference will be attended by approximately 150 people, a large proportion of whom will be from ePURE member companies.

1B/ OBJECTIVES

The aim of your speech is to underline the support of the European research and innovation strategy to the bio-based industries as a way of decarbonising the European economy and to the advanced biofuels, including bioethanol, for meeting the EU energy and climate targets while avoiding the competition with food and feed and limiting the impact on the environment and the developing countries.

SPEECH/SPEAKING POINTS

Ladies and Gentlemen,

I am very pleased to be here with you today as a host to this important Conference on the policy aspects related to bioethanol.

With the world population approaching 9 billion by 2050 and natural resources finite, Europe needs renewable biological resources for secure and healthy food and feed, as well as for materials, energy, chemicals and other products.

The European Commission adopted in February this year a strategy to shift the European economy towards greater and more sustainable use of its biological resources. The Commission's strategy and action plan, "Innovating for Sustainable Growth: a Bioeconomy for Europe", outlines a coherent, cross-sectoral and interdisciplinary approach to the issue. The goal is a more innovative and low-emissions economy, reconciling demands for sustainable agriculture and fisheries, food security, and the sustainable use of renewable biological resources for industrial purposes, while ensuring biodiversity and environmental protection.

In addition, EU 2020 Strategy and the 2050 Energy and Low-Carbon Economy Roadmaps address the challenges of resource efficiency, climate change and energy security.

The EU bioeconomy already has a turnover of nearly €2 trillion and employs more than 22 million people, 9% of total employment in the EU. It includes agriculture, forestry, fisheries, food and pulp and paper production, as well as parts of chemical, biotechnological and energy industries. Each euro invested in EU-funded bioeconomy research and innovation is estimated to trigger €10 of value added in the bioeconomy sectors by 2025.

Biofuels, including bioethanol, are currently the main outcome of the bioeconomy with clear benefits in terms of sustainability and security of energy supply.

But the ultimate goal of the bioeconomy is optimising the use of biological resources beyond a specific application and in a manner that reconciles food security and industrial applications, while ensuring environmental protection.

Biorefineries are a cornerstone to achieve this goal as they maximise the value of biological inputs in the production of broad array of bio-based products, biofuels and bioenergy while optimising the overall sustainability of the whole process.

Europe is already engaged in setting-up biorefineries. For instance, the Inbicon Biomass demonstration refinery at Kalundborg in Denmark is already producing more than 5 million litres of cellulosic ethanol, which Statoil sells in about 100 petrol stations in Denmark.

The world's largest cellulosic ethanol biorefinery will start operations in Crescentino, Italy, run by the M&G Group and using Novozyme enzyme technology. The plant will have an expected production of about 50 million litres of ethanol per year.

Having recognised the crucial role of the biorefinery development, the Bioeconomy Strategy supports the creation of networks of integrated and diversified biorefineries, including the necessary logistics and supply chains for a smart use of biomass and waste streams. Its implementation would be support by a public private partnership on bio-based industries.

Public-private partnerships established during FP7 have proved effective in leveraging industry and Member States resources for research and innovation. The **public-private partnership for bio-based industries** will aim at developing competitive and sustainable bio-based industries in Europe by improving the technological base across the whole value chain, from crop development to consumer uptake of bio-based products. Sustainability in this context is to be understood as environmentally, economically and socially beneficial compared to conventional industrial product and

process alternatives. The initiative will primarily focus on the use of non-food crops, agricultural/forest residues and municipal biowaste.

In parallel, under the Strategic Energy Technology Plan – the so called SET-Plan, there is an ongoing public private partnership - the **European Industrial Initiative on Bio-energy** or the EIBI with a main objective to make advanced bioenergy commercially available by 2020 and to strengthen EU technology leadership. The EIBI has set the objective of achieving the production of advanced biofuels up to 4% of EU transportation energy needs by 2020. The core activity of the Industrial Initiative is to realise industrial projects of European relevance with a potential for large scale deployment. The focus of this initiative is on advanced biofuels and one value-chain is focusing on ethanol production from lignocellulosic feedstock. This is complemented by supporting research on sustainable biomass feedstock supply and longer-term research and development in cooperation with EERA – the European Energy Research Alliance.

The EIBI and the potential Bio-based industries PPP will be implemented in a coherent and coordinated way avoiding duplication of efforts and to maximizing their impact.

One key challenge for the development of the bioeconomy is the production of sufficient biomass for all uses in a sustainable manner. This major challenge is now addressed by the European Innovation Partnership "Agricultural productivity and sustainability" which puts the emphasis the ecological intensification of agriculture and on technological transfer from science to farming practice. It will also serve as a catalyst to enhance the effectiveness of innovation-related actions supported by Rural Development Policy as well as the Research and Innovation policy.

You have heard that the European Commission is preparing a revision of the Renewable Energy Directive in which it is proposed to limit the production of first generation biofuels to mitigate their impact on the indirect land use change. This implies for the EU to put even more effort for the development of the new industrial processes for production of advanced biofuels from non-food crops,

agricultural/forest residues and municipal biowaste. The successful commercial deployment of advanced biofuels will profit from and be based on the experience and infrastructure of the first generation bioethanol industry.

To conclude, I want to reassure you of the determination of the European Commission to reach the EU 2020 goals for smart, sustainable and inclusive growth. We want to build a more competitive low-carbon economy that makes efficient, sustainable use of resources, while protecting the environment, reducing emissions and capitalising on Europe's leadership in developing new green technologies. Research and Innovation are instrumental for solving these challenges. Biofuels and notably bioethanol have a key role to play in achieving our 2020 and 2050 targets. The European Commission will ensure that these will not be at the expense of the environment or the developing countries. We are counting on all stakeholders to strongly support the transformation of the EU industrial and energy system into a low carbon energy system and on their involvement in implementing the EIBI and the other relevant initiatives in the context of the bioeconomy.

DEFENSIVE POINTS

The proposed 'ILUC amendment' to the RES Directive is detrimental to the existing installations and will reduce the market opportunities for the EU farmers

The Commission has been studying the possible effect of EU biofuels policy on indirect land use change (ILUC). Although, it is not possible to conclude on the exact ILUC factor of a ton of biofuels produced because of inherent uncertainties of the global models, the Commission concluded that a precautionary approach should be undertaken. This is why, the Commission is putting forward a proposal which is going to limit the ILUC impact of the EU biofuels policy. Whereas the Commission has put provisions to safeguard the market of existing installations, the Commission is of the view that in the period after 2020 biofuels should only be subsidised if they lead to substantial greenhouse gas savings (when ILUC related emissions are included) and are not produced from crops used for food and feed.

Is there sufficient biomass for the advanced biofuels?

The EIBI has a target for at least 14% bioenergy in the EU energy mix by 2020 while guaranteeing greenhouse gas emission savings of 60% for bio-fuels and bio-liquids under the sustainability criteria of the new Renewable Energy Sources Directive. Bioenergy has currently the largest share, about two-thirds, in renewable energy consumption in the EU. 98 Mtoe of biomass was consumed in the EU in 2007. The impact assessment done for the energy and climate package and the Biomass Action Plan estimate that 165-195 Mtoe of biomass would be needed for the 20% target. In 2006, the European Environmental Agency estimated that sustainably produced biomass without competing with food and feed in Europe would be able to contribute 265 Mtoe to energy purposes in 2020. In a recent impact assessment¹ the Commission strengthens its position affirming that between 2020 and 2050 the availability of land for biomass energy and of also forest biomass will continue to increase, because the population in Europe is projected to decrease, the consumption of food is saturated, while the efficiency of agriculture is projected to increase.

What is the SET-Plan doing to increase the available biomass for biofuels?

Sustainable supply of biomass feedstock is a precondition for achieving the aims of the SET-Plan's European Industrial Bioenergy Initiative (EIBI). Therefore, in its first implementation plan, the EIBI included this issue under the complimentary activities. The Member States, the Commission and Industry representatives are working together to identify possible research gaps, which need to be addressed to allow the sustainable and sustained supply of biomass for bioenergy production. The issues fall under three broad categories: increasing the availability of biomass, developing reliable and sustainable supply chains, and prevention of excessive disturbances in agricultural

¹ Impact assessment. Commission Staff Working Document accompanying the Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling, SEC(2010) 65

and forest commodity markets and certification issues. The identified gaps will be supported by EU and joint research actions.

In the 1990s, Europe invested millions in ethanol research but the patents were bought and used outside Europe. Now, Europe is planning again big investments in biofuels but what will the EC do to stop patents leaving Europe?

We cannot stop patents being sold and used outside Europe. However, the EU is striving to create through the Single Market the best business environment so companies invest in Europe. Despite the progress made since its creation in 1992, its growth potential is not yet fully realised. This is why, the European Commission adopted in April 2011 the Single Market Act. It contains 12 key areas for growth, competitiveness and social progress to revive the Single Market by 2012. Amongst them for example is the proposal for a unitary patent in the EU, the further simplification of the regulatory environment, and the simpler procedures to those who manage public procurement, allowing them to support socially responsible and environmentally friendly approaches.

Why do you impose sustainability criteria on biofuels?

The promotion of biofuels through the Renewable Energy Sources Directive is done because of i) biofuels contribution to security of energy supply; and ii) because biofuels can contribute to climate change goals. If we want biofuels to really have a share in climate change mitigation, we need to ensure that their production and use save greenhouse gas emissions. This is done through the sustainability scheme. The implementation of sustainability standards will require an extra effort from the producers but will ensure that use of biofuels will not contradict environmental goals.

Why not a more comprehensive sustainability scheme in the RES Directive?

The sustainability scheme indeed does not address the sustainable use of biomass for other energy uses or social sustainability of increased biofuels use. However, the Commission is following closely impacts of increased biomass use for energy and if they prove to be important the Commission will propose corrective actions as indicated in the Directive.

For example, in the "Report on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling" COM (2010) 11, the Commission provides recommendations to Member States concerning sustainability criteria for solid biomass and biogas. The impact assessment shows that binding criteria would impose substantial costs on European economic actors, bearing in mind that at least 90 % of biomass consumed in the EU comes from European forest residues and by-products of other industries. Hence, the report concludes that at this stage, more detailed legislation is not necessary. A review is foreseen in order to assess whether the scheme needs to be modified, including through the introduction of some mandatory standards.

BACKGROUND INFORMATION

Commonly used terms:

First generation biofuels: biofuels produced using "food or feed" biomass feedstock (sugar, starch and oil bearing crops or animal fats)

Second generation biofuels: biofuels produced using "non-food/feed" biomass feedstock (cellulose, hemicellulose or lignin)

Advanced biofuels: [used in the EIBI context] high-energy liquid transportation biofuels based on advanced technologies derived from: low nutrient input/high per acre yield crops; agricultural or forestry waste; or other sustainable biomass feedstocks including algae.

The European Bioenergy Industrial Initiative

In the EU, the main RTD&D challenges and objectives have been expressed in the EIBI Implementation Plan:

1. To enable commercial availability of advanced bioenergy at large scale by 2020, aiming at production costs allowing competitiveness with fossil fuels, and advanced biofuels covering up to 4 % of EU transportation energy needs by 2020.
2. To strengthen EU technology leadership for renewable transport fuels, serving the fastest growing area of transport fuels in the world

The underlying idea is that there are in the EU several technologies that have been proven at pilot or demonstration scale, which could achieve commercial maturity within the next years through a series of demonstration & first-of-its-kind projects. Emphasis is put on this kind of projects.

Medium and long term R&D is also considered important, both in support of the above mentioned projects, and to develop future biofuel technologies. This R&D will be supported by MS and the EC mainly through joint programming activities (EERA and other, to be further developed under Horizon 2020).

Finally, ensuring sustainable and affordable biomass supply is also considered a key challenge. R&D in areas such as crop improvement, biomass harvesting and logistics, biomass potential assessment, etc. is sought through a better coordination of relevant R&D programmes.

The technology roadmap estimates €9 billion RTD&D investment needs to achieve the above objectives.

JTI Bio-based industries

The potential PPP for bio-based industries is mentioned in the Bio-economy Communication and in the Commission proposal for Horizon 2020. It is currently under discussion with the industrial stakeholders. This partnership would primarily aim at developing competitive and sustainable bio-based industries in Europe by improving the technological base across the whole value chain, from crop development to consumer uptake of bio-based products. Sustainability in this context is to be understood as environmentally, economically and socially beneficial compared to conventional industrial product and process alternatives. The initiative will primarily focus on the use of second-, or third-generation biomass, meaning non food crops, agricultural/forest residues and municipal biowaste.

A group of industries have gathered around this initiative supported by a number of European technology platforms and European sector associations. The industry group delivered their vision document on 31 May 2012. The group is currently preparing the Strategic Research and Innovation Agenda, the advance draft of which is due end of September 2012.

R&D support on Bioenergy in the EU and other countries

FP7 and bioenergy

The Commission gives high priority to research into second generation biofuels, bio-products, industrial biotechnology, the biorefinery-concept, and production of new and improved high-yield biomass while avoiding negative impacts on biodiversity. In the 7th Framework Programme, biofuels are a key priority for research. They are supported by four Themes: "Food, agriculture, fisheries and biotechnology", "Transport", "Energy" and "Environment".

The Energy Theme is focus is on:

- Developing 2nd generation biofuels with better environmental and energy performance (e.g. algae and lignocellulosic ethanol).

The Energy Theme has spent or earmarked around € 250M FP7 funds for bioenergy R&D&D in the period 2007-2012 (14.5% of all non-nuclear energy budget). This gives an average of 41 M€ / year (similar to investment in FP6). The biggest share of this support was for research on second generation biofuels, followed by biorefineries. About 50% of this funding is targeting in one way or another bioethanol.

Energy Theme projects with focus on ethanol:

HYPE - High efficiency consolidated bioprocess technology for lignocellulose ethanol

SUPRA-BIO - Sustainable products from economic processing of biomass in highly integrated biorefineries

DEMA: Direct Ethanol from MicroAlgae (in negotiation)

PROETHANOL2G - Integration of Biology and Engineering into an Economical and Energy-Efficient 2G Bioethanol Biorefinery

SUNLIBB - Sustainable Liquid Biofuels from Biomass Biorefining

BABETHANOL: New feedstock and innovative transformation process for a more sustainable development and production of lignocellulosic ethanol

CANEBIOFUEL - Conversion of sugar cane biomass into ethanol

NILE: New Improvements for Ligno-cellulosic Ethanol (FP6)

BIOLYFE - Second generation BIOethanol process: demonstration scale for the step of Lignocellulosic hYdrolysis and Fermentation (ENER)

FIBREETOH - Bioethanol from paper fibres separated from solid waste, MSW (ENER)

KACELLE - Demonstrating Industrial Scale Second Generation Bioethanol Production - KAlundborg CELLulosic Ethanol plant (ENER)

LED - Lignocellulosic Ethanol Demonstration (ENER)

SUNLIQUID: sunliquid® large scale demonstration plant for the production of cellulosic ethanol (19.3 M€) (ENER)

COMETHA: 80,000 ton/y precommercial industrial scale demonstration plant on second generation lignocellulosic ethanol (17,9 M€) (ENER)

The Food, Agriculture, Fisheries and Biotechnology Theme is focused on:

- Improving current and developing new biomasses (including crops) for biofuel and bio-products;
- Application of industrial biotechnologies for sustainable production of second-generation biofuels and bio-products;
- Fully develop and incorporate life cycle analysis in biofuels and bio-based production practices; and
- Cutting edge bio-based technologies for biofuels and bio-products.

FAB Theme projects focusing on biofuels

2007-2012: Development of energy crops and assessment of biomass sustainability (7 projects: 22.5 M€)

2007-2012: Algae biofuels (1 project: 3M€)

2007-2012: Second generation biofuels (3 projects: 12M€)

2007-2012: Biofuels sustainability and certification (1 project: 1 M€)

2012: New or improved logistics for lignocellulosic biomass harvest, storage and transport (3 projects, € 10M) – DG RTD.K + RTD.E

2013: Support to the sustainable delivery of non-food biomass feedstock at local, regional and pan-European level – DG RTD.K + RTD.E

Biofuels have also been featured in the Transport Theme, and where particular attention is paid to biofuels use in aviation.

From the perspective of the Environment Theme, research is clearly needed to reduce the impact of biofuels on biodiversity and to achieve a thorough understanding of their environmental costs of production and use.

Joint Call Biorefinery

2009: Energy –KBBE- NMP – Environment. 3 collaborative projects and 1 CSA. EU contribution of 52 million Euro. The number of industrial partners at nearly 50% of the consortia. They look at the use of biomass of different sorts for 2nd generation biofuel (including aviation fuel), and the production of a range of chemicals, including polymers, oils and speciality molecules.

Member States and bioenergy research

No exact data is available regarding the R&D&D investment of other actors (MS, industry); however the following figures (referring to liquid biofuels R&D&D investment) may give provide orientation:

- JRC estimated the total 2007 investment at ca. 350 M€, of which: 4% from EU, 19% from MS public funds and 77% from industry
- From the IEA statistics of 2009 it can be estimated that the public investment was above 150 M€. Extrapolating the above percentages this gives a total investment (public + private) above 650 M€ on liquid biofuels only.

MS investing most are the Scandinavian countries, FR, UK, DE, NL, AT.

Since 2003, the total investment in the EU has increased following a linear trend. However the investment on bioenergy R&D&D is likely to explode in the next years, thanks to the ambitious initiatives that are underway (NER 300, EIBI).

Other countries and bioenergy reserach

In 2009 the **US** invested ca. 895 M€ public funding on Bioenergy, of which 738 on liquid biofuels. This represents an explosion with respect to previous years (six-fold increase with respect to 2008). This high investment level was maintained in 2010 (ca. 600 M€).

In 2009, **Japan** invested ca. 52 M€ (around 88% public) public funding on Bioenergy, comparable to FR or UK, of which only 1 M€ on liquid biofuels. This represents an explosion with respect to previous years (four-fold increase compared to 2008). This high investment level was maintained in 2010.

In 2009 **Korea** invested ~5.7 M€ in biomass research (mostly public), a level comparable to CZ or CH. However in 2010 Korea created the Advanced Biomass R&D Center (ABC), a consortium of universities, institutes and industry funded by the Government with an investment of more than \$200 M over nine years (i.e. a

yearly investment comparable to DK or FI). Research will focus on lignocellulosic feedstock and algae. A strong cooperation strategy is set, involving mainly the US.

EU legislation with impact on biofuels

- **The RES Directive** requires by 2020:
 - 20% overall share of renewable energy in final energy consumption;
 - 10% share for renewable energy in the transport sector
- The **Fuel Quality Directive** requires 6% reduction in greenhouse gas intensity of the actual EU fuel mix used in transport by 2020.
- In a revision of the **Energy Tax Directive**, the European Commission proposes to base the taxation of fuels on energy content and CO₂ emissions. Biofuels will be exempt from the CO₂ component so long as they fulfil the sustainability requirement of the RES Directive.
- **Proposal for a Directive** to amend the RES Directive and the Fuel Quality Directive (in ISC at the moment) to **address the issue of ILUC**

Indirect land use change (ILUC)

If biofuel feedstock is produced on land directly converted from another status, this is considered in the sustainability criteria. However, if it is instead cultivated on existing agricultural land, it may then displace other crop production some of which ultimately may lead to conversion of land into agricultural land. This can lead indirectly to land use change. This indirect effect manifests itself through a change in demand for agricultural commodities, and their substitutes, in global markets.

Indirect land-use change emissions cannot yet be observed or measured at the micro-level, but are estimated through macro-economic modelling at the global scale that aims at replicating international trade flows and land use related decisions. In its report from December 2010, the Commission outlines the key results of the analytical work carried out. This acknowledges the existence of indirect land use change as well as various deficiencies and uncertainties associated with the modelling.

Scientific work indicates that ILUC related emissions can vary substantially between feedstocks and can negate some or all of the greenhouse gas savings of individual biofuels relative to the fossil fuels they replace. The aim of the current proposal for a Directive to amend the RES and Fuel Quality Directives is to start the transition to biofuels that deliver substantial greenhouse gas savings when also estimated indirect land-use change emissions are taken into account. The aims of the current proposal are to:

- limit the contribution that conventional biofuels from food crops (with a risk of ILUC emissions) make towards attainment of the targets in the Renewable Energy Directive (to 5% of the 2020 levels or roughly the current consumption level);

- encourage a greater market penetration of advanced (low-ILUC) biofuels by allowing such fuels to contribute more to the targets in the Renewable Energy Directive than conventional biofuels (counting twice the lignocellulosic biofuels and four times biofuels from wastes and residues);
- improve the efficiency of biofuel production processes (reducing associated emissions) by raising the greenhouse gas saving threshold for new installations to 60% with immediate effect (from 35% until 2017 in the current directive) in order to improve the overall greenhouse gas balance of the biofuels and bioliquids consumed in the EU as well as discouraging further investments in installations with low greenhouse gas performance;
- protect existing investments until 2020. But they still need to show at least 50% GHG saving as of 2018.

However, the Commission is of the view that in the period after 2020 biofuels should only be subsidised if they lead to substantial greenhouse gas savings (when ILUC related emissions are included) and are not produced from crops used for food and feed.

Impact on the biofuels market

As 1st generation biofuels typically have higher emissions due to the emission from intensive crop cultivation in comparison to 2nd generation biofuels, this ILUC legislation can be expected to accelerate the shift towards advanced, low-impact biofuels on one hand, but on the other hand it will also drive the development and deployment of new transport technologies competing with the common combustion engines in vehicles. Speed of technological progress in the two systems will determine what role agriculture and forestry will play in the future in supplying feedstocks for biofuels.

Reaction of the lobbies

Not surprisingly the lobbies, for example COPA-COGECA and European Biodiesel Board, started already complaining about the new proposal because it will effectively reduce their market opportunities.

EU biofuels market (in Mtoe)

The development of an emerging European biofuel industry in the last years has been most remarkable. Biodiesel production has grown from 55.000 tons in 1992 to 9,5 million tons in 2010. Bio-ethanol expansion has also been very significant from 47.500 tons produced in 1993 to 4,3 million tons in 2010.

	Consumption	Production	Prospects 2020
Biofuels	~10 (2008)	~8,8 (2008)	29,6
	~12 (2009)	~10 (2009)	
	13,5 (2011)		
Bioelectricity	8,5 (2010)		20
Heat & cool	50 (2005)		90

The EU is the World's main biodiesel producer (57% of total), but only 3rd ethanol producer (5% of total, after US and Brazil).

About 80% of EC consumption is biodiesel, and 20% ethanol.

In 2009, about 9% of the biofuels consumed were "second-generation" according to RED (mainly biodiesel from waste oils).

The main EU biofuel producing countries (of both ethanol and diesel) are DE, FR, ES.

Estimated biofuels share in EU transport fuel consumption was ~4,5% in 2011

Net imports in 2008 were around 15%, but have decreased since. 2/3 of these imports are biodiesel, mainly from Argentina (50%), and 1/3 is ethanol, mainly from Brazil (40%).

EU Bioenergy industry – comparison with competitors

1G ethanol

Ethanol is produced in the **EU** mainly from cereals, but also sugar beet and corn. Production costs are higher in the EU than in the US and BR. Some of the main European producers are Abengoa (ES), Tereos (FR), CropEnergies (DE).

The US is the World's first producer (~60%) and consumer of ethanol. It is produced mainly from corn (production cost ~30 c\$ per liter). It depends on subsidies and is socially/ environmentally contested. Some large players are Archer Daniels, Aventine, Cargill, VeraSun and Abengoa.

Brazil is the 2nd ethanol producer (30%), mainly from sugar cane. Brazilian ethanol is the only biofuel industry in the World that is environmentally and economically sustainable, at 0,22 \$ per litre and 5-6 times more energy efficient than corn.

There is a large potential for growth and is a flexible business model, able to swift from sugar to ethanol depending on market conditions. It also produces an electricity excess that is sold to the grid.

Independent mills associated in UNICA produce about 60% of the bioethanol. EU, Japan and the US are investing massively in this industry (e.g. Shell).

Biodiesel

The EU is the World first biodiesel producer. It is produced from oilseeds such as rapeseed or soya, palm oil, which are often imported. Residual oils are also used.

Some relevant industrial actors include ADM, Cargill, Acciona.

2G biofuels

There is no industrial 2G sector, as no commercial plant exists yet in the World. In the EU such technologies are being developed by industries from other sectors such as pulp & paper, oil & gas, chemistry, etc.

2G technology leadership and comparative advantage (notably with the US) depends on the specific technology value chain:

Thermochemical

The EU has traditionally been leader in technologies like gasification, BtL or pyrolysis. However in the last years this advantage has been reduced, thanks to an increase of the investment in the US. This has encouraged a transfer of EU technology towards the US, and an increased collaboration of EU actors with US R&D institutions.

Thermochemical technologies are being developed mainly in Northern Europe (Germany, NL, UK and Scandinavia) by actors such as Chemrec, UPM, Lurgi or CHOREN (now bankrupt).

Biochemical

The EU has some of the leading technology providers (notably Novozymes) and 2G ethanol producers (Abengoa, Chemtex, Inbicon). However the US have an overall advantage in biochemical pathways. In addition, many of the above mentioned European companies have subsidiaries in the US and are transferring technology there, attracted by market conditions and subsidies.

Lignocellulosic technologies are being developed mainly in Southern Europe and Denmark.

Algae

Algae R&D&D is being done by many countries including notably Japan, Korea, India, China, Australia, the US and the EU. The US seems to have a predominant position in algae research, thanks to *inter alia* larger investment, and cooperation agreements with other countries and regions. Several big demonstration sites have been built in the last years.

Within the EU, broadly speaking, Northern countries are focusing R&D on macroalgae, and Southern countries on microalgae. Europe has some relevant academic actors (e.g. U. Firenze, U. Almería, U. Almería, U. Ben Gurion) and some active industrial actors (e.g. Repsol, Abengoa, AlgoSources, Dister). Spain and Israel are particularly active.

It should be noted that algae research does not only (or mainly) target biofuel. Other end products (food, feed, chemicals, pharmaceuticals, etc.) are usually sought.

Algal biofuels are far from being competitive and are not likely to become competitive in the short run.

Long-term technologies

Although the state-of-art is not well studied, the US seems to have some advance in fields like sugar catalytic processing (e.g. Virent's *Bioforming* process) or artificial photosynthesis.

Gas (CO, CO₂) fermentation is being explored both in the EU (e.g. INEOS) and in the US (e.g. Lanzatech). The state-of-art is unclear.

The National Renewable Energy Action Plans (NREAPs)

Each Member State was asked to adopt a NREAP by 30 June 2010. The national renewable energy action plans set out Member States' national targets for the share of energy from renewable sources consumed in transport, electricity and heating and cooling in 2020, taking into account the effects of other policy measures relating to energy efficiency on final consumption of energy, and adequate measures to be taken to achieve those national overall targets, including cooperation between local, regional and national authorities, planned statistical transfers or joint projects, national policies to develop existing biomass resources and mobilise new biomass resources for different uses, and the measures to be taken to fulfil the requirements of Articles 13 to 19.

According to Member States' projections in their National Renewable Energy Action Plans:

- Biomass is expected to contribute to more than 10% (140 Mtoe) of the EU total final energy consumption in 2020 (up to 85 Mtoe in 2010) and to more than 50% of EU renewable energy consumption in 2020.
- In 2020, biomass would contribute around 7% of final electricity consumption, around 17% of heating and cooling consumption, and around 10% of final transport consumption.
- This means an overall increase of bio-energy in all three sectors, amounting to more than doubling of bio-energy consumption from 2005 up till 2020, with the heating and cooling sector remaining the most important one for biomass consumption.
- Biomass from forestry would remain the main source of supply, but biomass from agriculture and fisheries would see the most significant increase in absolute term.

- Biomass imports from third countries are likely to increase in 2020 (in 2008, imports of wood and wood waste represented 5.5% of total EU primary production).

The NREAPs show that the contribution towards the 2020 targets from biofuels is expected to be significant, and essentially concentrated in 1st generation biofuels.

The expected contribution of advanced biofuels in NREAPs is 1% in terms of output. However,

- This figure should be multiplied by two vis-à-vis the 10% objective (as 2nd generation biofuels counts double);
- Early availability of 2nd generation technology at commercial scale may change the forecast;
- There is an increasing interest of the aviation sector, which is entering the ETS in 2012. The fuel quality requirements in this sector can be met essentially through 2nd generation technologies.

