Road map for biofuels in Europe

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Trafikdage på Aalborg Universitet
28-29 august 2006

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Introduction and abstract

Declining oil reserves, difficulties of achieving CO_2 emission reductions in the transport sector and agricultural considerations have led to increased attention for biofuels in the EU. The EU has therefore commissioned the project REFUEL to make an overview of the technical and economic possibilities for increasing the use of biofuels in EU 25+.

REFUEL is a large EU research project designed to encourage a greater market penetration of biofuels. To help achieve this goal, it will develop a biofuels road map, consistent with EU biofuel policies and supported by stakeholders involved in the biofuels field. Starting early 2006, the project involves seven renowned partners and will take 24 months to complete. REFUEL is financed by the European Commission under the 'Intelligent Energy - Europe' programme.

The road map will pave the way for an "ambitious, yet realistic" target share for biofuels in the fuel mix for EU transport in 2030, and propose policies to get there. The target share will be in the order of 25 % of the total transport fuel consumption. A least-cost biofuel mix meeting this target will be calculated based on identification of biofuels production chains, conversion technology, and biomass feedstock potentials and cost in the EU25+. The impact on the main drivers will be assessed: Reducing greenhouse gas emissions, increasing security of supply, and socio-economic impacts, especially in agriculture. Key stakeholders, their motives, the actions required from them, the barriers they will meet, the optimal timing of their actions will be identified and analysed, and policies needed to mobilise stakeholders, create incentives and reduce barriers will be formulated. The resulting road map will consist of a systematically described set of actions to be taken, coherent in task allocation and timing.

This paper builds on the preliminary results from the REFUEL project, most importantly "A preliminary Road Map for Biofuels" (www.refuel.eu). The paper focuses primarily on the overall set-up of the project and the socio-economic analyses.

EU policy framework

The driving forces behind EU initiatives regarding biofuels are partly related to energy and environmental concerns and partly to agricultural concerns.

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During the 1990s the production and use of biofuels started in several European countries and expanded significantly. At the same time, policy at a European level was initiated, mainly from the viewpoint of security of energy supply. EU policy focussed on the possibilities for tax exemption, but Commission proposals were not approved by the Member States. In 1997 the White Paper 'Energy for the future: Renewable sources of energy' discussed a target for biofuels in 2010. The 2000 Green Paper 'Towards a European strategy for the security of energy supply' proposed a more comprehensive policy, in which biofuels should contribute to a proposed ambitious target of 20% alternative fuels (biofuels, natural gas, hydrogen) in 2020. A 2001 communication on alternative fuels (COM(2001)547) indicated a 8 % share for biofuels by 2020 and various other targets have been mentioned. In the Biofuels Directive (Directive 2003/30/EC of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport) indicative biofuel targets were set as reference values, for 2005 at 2% and for 2010 at 5.75 %.

In 2005 it became clear that the aim of the Biofuels Directive of 2% would not be met, but would fall short at approximately 1.4%. In February 2006, the European Commission released a communication comprising an EU strategy for biofuels (COM(2006) 34 final) based on the Biomass Action Plan (COM(2005) 628 final). This biofuels strategy aims at:

- Further promotion of biofuels in the EU and developing countries.
- Preparation for large-scale use of biofuels by improving their cost-competitiveness.
- Support of the research into second-generation biofuels.
- Exploration of the opportunities for developing countries for the production of biofuel feed-stocks and biofuels.

In 2006 the Commission will bring forward a report on the implementation of the Biofuels Directive with a view to a possible revision of the Directive. In order to bring the 5.75% target for 2010 closer to realisation, this report will address the issues of setting national targets for the market share of biofuels and using biofuels obligations. Moreover, only biofuels whose production in the EU and third countries complies with minimum sustainability standards will count towards the targets (European Commission, 2006).

At the meeting in March 2006 of the European Council, when discussing the main targets for the future energy policy, the council approved the promotion of environmental innovation and technology and loss of biodiversity. It suggests that the Commission analyse how in general the existing 2010 targets for renewable energy can be reached, and increase the use of biofuels in the transport sector to 8 % before 2015. This should be dealt with in dialogue with the oil industry, promote research in second generation biofuels and the efforts should be based on cost effectiveness regards.

The Common Agricultural Policy, CAP, was reformed in 2003, when the principles for subsidies for agricultural production were adjusted, in light of considerations for the developing countries. Earlier subsidies were dependent on production and increased with

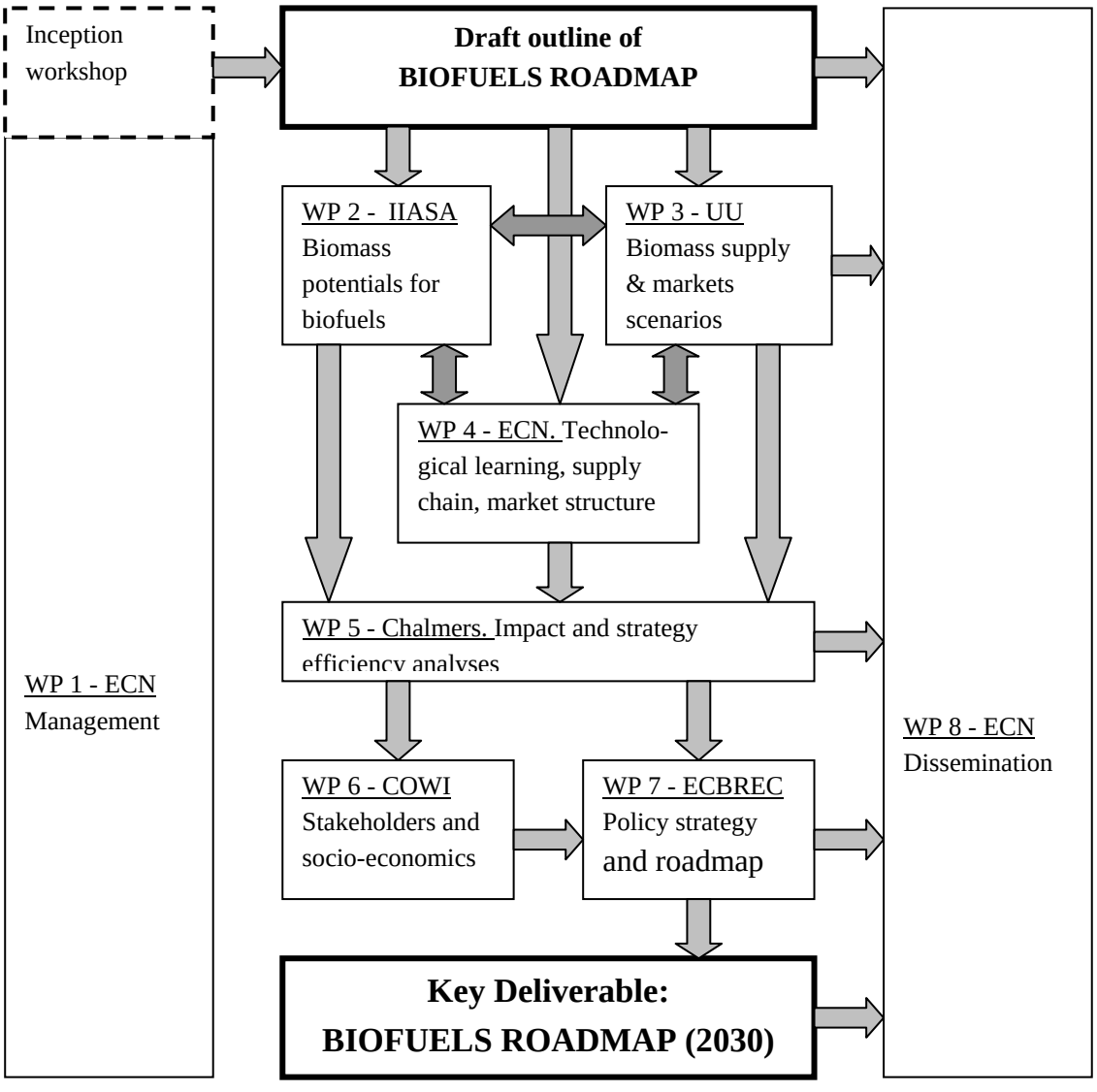
production, but instead subsidies are now given individually to farmers as a subsidy per ha. This change in the subsidy regime has impeded the conditions for especially the small farmers. There is therefore a pressure for promotion of biofuels by supporting energy crops in order to secure the economy of EU farmers.

From an environmental point of view air pollution problems related to especially diesel cars and problems related to biodiversity are in focus with respect to biofuels.

The REFUEL project

The REFUEL project covers EU-25 plus Romania, Bulgaria, Croatia, Ukraine, Norway and Switzerland. It is carried out by a consortium led by Energy research Center of the Netherlands (ECN) with six partners: IIASA, University of Utrecht (UU), Chalmers, COWI, EC Baltic Renewable Energy Centre (EC-BREC) and Johanneum Research. The project is divided into 7 work packages (WP) and organised as illustrated in the diagram below. Stakeholder workshops and dissemination are important aspects of the study.

Diagram 1: The design and organisation of the REFUEL project



The main result of REFUEL will be the biofuels roadmap. In REFUEL a variety of complementary techno-economic market models will be applied that will generate the following, more detailed direct outcomes:

- A spatially detailed REFUEL land resources database for EU25+
- A detailed long-term assessment of technical and economic biomass production potentials for the EU25+, incorporating economic factors, land-use, energy and agricultural policy in a coherent manner
- An analysis of key drivers and barriers for developing and exploiting biomass production potentials for biofuels
- An assessment of the impact of the biofuels target on biomass production schemes
- Costs and potentials for conventional and advanced biofuels and the required market structure and supply chain
- A socio-economic cost-benefit analysis for biofuels and a corresponding methodology
- A review of current EU25 biofuels policies, their drivers and effectiveness
- Dissemination, closely focused on relevant policy makers and market actors, and differentiated for various target audiences. For example: a website and REFUEL project folders

Main efforts are presently being put into updating and calibrating the very detailed modelling framework. A central model is the techno-economic market model Biotrans, which was, developed within the EU project VIEWLS, and which will be upgraded to a Biotrans 2 version.

The Biotrans model selects the most cost-effective biofuel production chain:
Biomass feedstock, potential and costs -> Production -> Trade and transport -> Conversion -> Biofuel -> Transport and trade -> Biofuel vehicle characteristics (efficiency and costs).

Inputs of Biotrans are detailed country level biomass potentials and their costs, technology parameters and their costs and support policies. Outputs are biofuel costs, biomass and biofuel traded volumes and trade flow between countries. Assessment of Well to wheel green house gas emissions will comprise an important element.

An agro-ecological zonemodel, developed by IIASA, will be used for assessing the biomass potentials.

Furthermore, a model for optimal allocation of biomass between biofuels and stationary application (heat, power) will be further developed. This model, baptised PEEP, will be the follow-up of the ChalmersVIEWLS model developed in VIEWLS.

Analytical target

The socio-economic analysis will comprise a cost-effectiveness approach as well as a cost-benefit approach.

First, the most cost-effective biofuel production chain will be identified, using all available data. For this purpose, it is important to identify a biofuels target for 2030, and several sources have been investigated to identify an "ambitious, yet realistic" target share for biofuels. Biofuels targets can be defined in a number of ways, e.g. in terms of:

- Volume-to-volume share of biofuels in the total fuels mix
- Energy-based share of biofuels in the energy end-use of the transport sector
- Reduction target for the net emissions of greenhouse gases from the transport sector

The EU biofuels directive (2003/30/EC) defines the reference targets for 2005 and 2010 on the basis of energy content, and as a share of total gasoline and diesel use for transport. Targets could also be set in terms of net greenhouse gas emissions, stimulating biofuels with a better greenhouse gas balance. However, the key drivers of biofuels introduction are not only greenhouse gas emission reduction, but also improvement of security of supply and the support of agriculture and rural development. Therefore setting a target on the basis of energy content is most appropriate. In addition, it avoids the risk that biofuels become a replacement for fuel efficiency standards in cars, since biofuelled cars will also need to be efficient.

Based on the review of sources, a baseline biofuels target in the order of 25% for 2030 is used in REFUEL to reflect the "ambitious, yet realistic" target. This is in line with the Biofuels Research and Advisory Council (BIOFRAC) 2030 vision document in which a share of ca. 25% is foreseen. Key issues in these predictions are, inter alia:

- The availability of biomass feedstock and related land
- The balance between imports and domestic production of feedstock and biofuels
- The development of 2nd generation biofuels

Furthermore, the project will also evaluate the effects of using a less ambitious target (say 20%) and a more ambitious one (30%).

Supply curves and socio-economic analysis

A main element in a social cost-benefit analysis is setting up the base scenario, i.e. the development in central parameters including the main target, which could be expected with no further initiatives taken. A number of international studies have been scrutinized and screened for assumption and data regarding energy, transport, biomass production, food demand, agriculture, forestry, land use, set-aside land, nature preservation, agricultural productivity, vehicle adaptation, etc. and it presently being processed.

Based on these basic data and on biomass feedstock and costs assumptions cost-supply curves for selected energy crops will be produced for each country and for groups of countries, and related to costs of conversion technologies for biofuels (such as cold-pressing, fermentation, distillation and gasification). The development of the lowest-cost biofuels mix over time will then be assessed using the Biotrans 2 model. Being a linear programming model, it optimises over time a biofuel mix to lowest total cost, given the biofuels target share. Biotrans will generate full-chain costs of all proposed biofuel chains, specified in feedstock, conversion, distribution, etc. On this basis, the model calculates an optimal, lowest-cost mix of fuels. Trade options for feedstocks and fuels will also be included.

The socio-economic analysis will summarise the total costs and mitigation costs in Euro per tons CO_2 avoided of the proposed least-cost biofuels mix. It will be based on cost inputs and technical specification regarding environmental impacts (land use, emissions, energy consumption). In order to assess the extent to which the economic and social costs of promoting biofuels can be justified by the economic and social benefits to society (the CBA analysis) it is necessary to a) valuate all effects on the cost side to the extent possible and b) to assess the benefits. In addition to the costs related to the least costs supply curve it will be necessary to assess the external costs and the costs of political instruments.

The table below indicates which effects will be included in the socio-economic assessment.

Type	**Element**	**Monetised**
Direct effects	Net production costs	Yes
	Costs of political instruments	Yes
	Other costs	Yes
Indirect effects	GHG emissions	Yes
	Air pollution	Yes
	Security of supply	No
	Regional development	No
	Industry competitiveness	No
	Biodiversity	No
	Landscape effects	No
	Other environmental effects	No

The unit prices to be used are expected to be EU up-dated cost estimates being prepared in the ongoing EU project HEATCO (Developing Harmonised Approaches for Transport COsting and Project Assessment), which incorporates previous relevant projects such as ExternE and UNITE. It also considers important methodological aspects such as decision criteria, external costs, risk and uncertainty, value transfer and income adjustment. The external costs will comprise increased costs in terms of emissions, land use, etc. from the production of biofuels as well as reduced costs in terms of reduced emissions, etc. from the substituted fuels. Since

many of these data contain considerable uncertainties, an extensive sensitivity analysis will be included. The analysis will also include to an assessment of other environmental impacts, e.g. on emissions to soil and water, to air, and biodiversity impacts, although all effects may not be quantifiable. To the extent possible, the costs of political instruments will also be considered, since it will be part of the road map to consider and suggest political instruments necessary to realise the road map.

Another main output is an assessment of the distributional aspects and consultations with stakeholders. Stakeholders will typically be organisations or institutions from sectors such as food and feed, oil, and transport, as well as primary producers of agricultural and forestry biofuel feedstocks. These will be affected positively or negatively by the roadmap and such effects should be identified in the distributional analysis. It will most likely not be possible to exactly pinpoint in quantitative terms the gains and losses in economic terms, but the main effects will be identified.

The large-scale introduction of biomass-based fuels for transport will also entail impacts on the application of biomass in the stationary sector (i.e. for the production of heat and power), and on total energy use in the EU25+. Extensive use of lignocellulosic feedstocks for transport biofuels production may lead to increased feedstock prices and thereby lead to a shift in the fuel mix in the electricity sector. On the other hand, expansion of co-generation units producing heat and biofuels via the biomass gasification route may become a path for substantial increases in the production of biomass-based heat. Also, the stationary sector may serve as an important initial market for lignocellulosic biomass, inducing development and cost reductions in lignocellulosic biomass supply to the benefit of other prospective options not yet commercially available (such as transport biofuel production). These more complex impacts of the projected biofuels mix will be systematically assessed by the previously mentioned PEEP model.

Stakeholders

REFUEL will analyse the barriers for reaching the biofuels target and investigate the viewpoints of stakeholders. Workshops will be held with stakeholders from the agricultural sector, the energy sector, the oil industry and the car industry. An inventory of potential barriers will be made, taking a starting point in the VIEWLS ("Clean Data for Clean Fuels") project, where a number of barriers were identified and investigated. The most important types of barriers were:

Economic: Production and cost of biofuels, lack of R&D and investment support
Technical: Availability biomass and/or biofuels, conversion technology of second generation biofuels, and need for vehicle adaptation
Social/institutional: Lack of implementation of EU directives, lack of commitment to Kyoto, lack of interest from large industries, lack on information on biofuels

REFUEL will takes the identified barriers into account when creating the road map. Specific links between identified barriers and the supply chain will be established in order to search for solutions. Innovative solutions may include competitive implementation strategies, such as co-production of biofuels, heat and power, power, and regulatory measures designed to provide incentives for optimal behaviour of producers and consumers towards realizing the biofuel perspectives.

Result

The result of the project will be a road map for biofuels, i.e. an overall plan for promotion of the economically and environmentally most attractive biofuel technologies, including overview of biomass potential, market structure, supply chains and political instruments.