Biofuels – the new oil for the petroleum industry?

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Abstract

We conclude that there exist strong general driving forces for diffusion of biofuels at the EU level, in the form of various problems, directives and other policies converging towards diffusion of biofuels as a joint solution. At the EU member-state level, however, the driving forces have been less clear, due to large asymmetries in the national policies established for implementing EU policies. Nevertheless, by late 2005, most key member states appear to have adopted policies that will clear the way for growth in biofuel diffusion. We have noted more specific driving forces and obstacles for involvement by major oil companies in biofuel activities. Inter-company variation in biofuel investments may be explained by variation in business focus (upstream vs. downstream focus), by attitudes towards diversification in general, by response strategies to the climate-change issue, as well as by variation in political and business pressure caused by geographical differences in the companies' core downstream business spheres. As political pressures grew more similar across the EU member countries in the course of 2005, variation in pressure on the companies tended to be weaker. Hence, as of early 2006, the driving forces working for greater involvement in biofuel diffusion appear stronger than those working against such involvement by the European upstream oil industry. Thus, we must conclude that recent political changes at the EU and member-country levels have removed major obstacles to the diffusion of biofuels in Europe. This should increase the future prospects for bio-energy in Europe and the pressure on oil companies to choose biofuels as 'the new oil' to lubricate the diversification strategy for the renewable energy products so highly profiled in the past decade. It remains to be seen, however, whether the companies have the will and ability to balance their upstream oil and gas focus with greater attention to developing activities further down the energy supply chain.

Key Words

biofuels, oil industry, European Union, renewable energy

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1 Introduction

In 2005, the diffusion of biofuels as an alternative to petroleum-based energy products was once again in focus, as a response to global climate-change concerns and heightened attention to national energy security amidst growing political unrest in key petroleum-exporting countries. The political pressure and the close substitute nature of biofuels and mineral-oil based energy products are posing new challenges to the international oil industry.

The close substitute nature of bio-energy and petroleum products has given the former the tag 'the new oil'.[1] Bio-energy can replace petroleum products in most end-uses. Various liquid and solid biofuels (wood chips and pellets, straw) can substitute for fuel oil in direct household heating and district heating, and biomass is also being used to substitute for fuel oil, natural gas and coal in electricity generation. Bio-ethanol and bio-diesel have always existed as potential substitutes for mineral-oil based petrol and diesel. In fact, both Henry Ford's first combustion engine and Rudolf Diesel's first diesel engine ran on biofuels, regarded at the time as the best solution in terms of fuel availability.[2] As time passed, the oil industry invested in infrastructure to enable long-distance diffusion of easily exploitable and thus cheaper petroleum resources, thereby halting the development of biofuels as alternatives to mineral oil-based petrol and diesel. After the oil crises of the 1970s, biofuels briefly gained new momentum, but interest declined when oil prices returned to lower levels. The notable exception has been Brazil, where biofuels have become a real alternative to mineral-oil based fuels.

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[1] The 'new oil' tag has been motivated also by similarities in technologies that can be used for distribution of biofuels and mineral oil-based fuels. This is true not only of liquid transportation biofuels but even of solid biopellets, which today can be easily transported by tank lorries, loaded and unloaded at customer premises with conventional pumping equipment.

[2] When Henry Ford designed his Model T automobile in 1908, he expected ethanol, made from renewable resources, to be the major fuel used. From 1920 to 1924, the Standard Oil Company marketed a 25% by volume absolute ethanol in gasoline in the Baltimore area, but high corn (maize) prices combined with storage and transportation difficulties terminated the project. Subsequent efforts to revive an ethanol fuel programme in the late 1920s and 1930s through federal and state legislation, particularly in the US Corn Belt, failed. Then Henry Ford and several experts joined forces to promote the use of ethanol, and a fermentation plant to manufacture 38,000 L/day of ethanol specifically for motor fuels was built in Atchison, Kansas. During the 1930s, more than 2,000 service stations in the Midwest sold this ethanol made from corn and called it 'gasohol.' Low petroleum prices closed the ethanol production plant in the 1940s, taking with it that business for America's farmers, and gasohol was replaced by petroleum. In 1979, ethanol-gasoline blends were reintroduced to the US market when oil supply disruptions in the Middle East became a national security issue and Americans had to wait in long queues to buy their gasoline. Alternative fuels became a solution. The American Oil Company and several other major oil companies began to market ethanol blends as a 'gasoline extender' and an octane enhancer (See *The Economist*, 12 May 2005).

The new political attention and the close substitute nature notwith–standing, most major upstream oil companies operating in Europe had by late 2005 paid scant attention to bio-energy, not least when compared to some high-profile flagging of investments in other renewable energy sources.[3] This is puzzling, given the underlying political signals in favour of bio-energy development in Europe since 1997, when the EU Commission adopted a White Paper that promised a doubling of the share of renewables in total primary energy consumption by 2010, and gave primary status to biomass-based energy for securing new volumes of renewables (Commission of the European Communities, 1997). This status was reconfirmed in 2003, when the EU Commission adopted its Biofuels Directive, urging member states to ensure a minimum 2% share of biofuels in total consumption of *transportation fuels* in 2005 and 5.75% by 2010 (Commission of the European Communities, 2003a).

The present report from Norway's Fridtjof Nansen Institute documents the rather hesitant position taken by major upstream oil companies in diffusion of biofuels relative to other renewable energy sources and the evolving inter-company differences. We see what *driving forces and obstacles* can explain this reluctant response and inter-company differences. We distinguish between *general driving forces and obstacles* affecting *all* industrial agents contemplating bio-energy investments, including the oil industry, and *the driving forces and obstacles that affect upstream oil companies specifically,* asking whether company variation in bio-energy investments by 2005 did reflect variation in company affectedness of the driving forces and obstacles.

Section 2 of this working paper introduces sources and current uses of bio-energy, to illustrate the range of opportunities for biomass to substitute mineral oil as a primary energy source. Section 3 surveys bio-energy activities reported by six upstream companies with major activities in Europe. Section 4 discusses general driving forces and obstacles for the diffusion of bio-energy in Europe, with reflections on the relative strength of factors that drive and that hold back bio-energy diffusion. Section 5 addresses factors that have given upstream oil companies *differing* incentives and opportunities in the bio-energy business. And finally, Section 6 briefly summarises the direction and pace of driving forces and obstacles. The major conclusion is that recent changes have served to increase the future

[3] A pilot study of six major upstream oil companies in Europe (BP, Shell, Exxon, Total, Statoil and Hydro, all with large oil and gas assets in the North Sea) showed that, except for Total, the companies gave little weight to bioenergy in their 'alternative' energy strategies. More attention was paid to solar and windpower as well as developing hydrogen as fuel (Eikeland, 2004b).

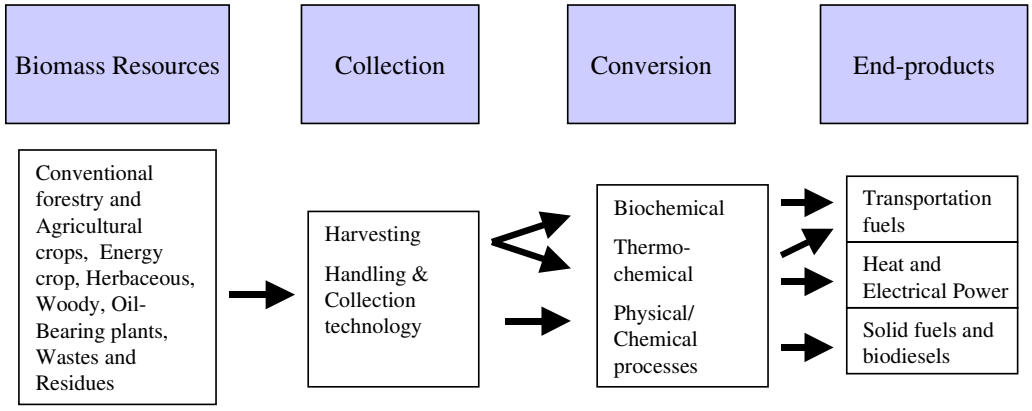
prospects for bio-energy diffusion in Europe, heightening the pressure on oil companies to choose biofuels as ‘the new oil’ in company investment plans.

2 Biomass-based energy – sources and uses

'Biomass' refers to organic matter that can be converted to bio-energy or biofuels, whether in solid, liquid or gaseous forms. Major sources of biomass for energy purposes are the various by-products and residues from agriculture and forestry industries (straw, waste from pulp and paper production, sawdust, etc.), municipal and industrial organic waste, and deliberate cultivation of energy crops.

The process of bringing biomass into final energy products is sketched out in Figure 1. It involves planting and/or collection of primary biomass resources, followed by transport and storage of biomass at manufacturing plants, where the raw material is converted to fuels. These fuels are in the next round distributed to producers of electricity and district heat or directly to energy end-users (households, industries or vehicle owners).

Figure 1. Typical sources and uses of biomass for energy purposes



Source: IEA Bioenergy

A major user of biomass as energy resource is the forest product industry, as it enjoys ready access to cheap biomass by-products which can be converted into process heat and electricity. Also other industries – especially the chemical food-processing industries –produce thermal output and electricity from biomass, primarily from combined heat and power (CHP) facilities. In Europe, notably the Nordic countries and Austria, district heat- and electricity generators figure among the major users of biofuels (mostly solid fuels). Also households have traditionally been users of bio-energy, chiefly in the form of fuelwood, but in the Western world also in the form of manufactured pellets and briquettes for modern stoves. In these stationary energy-use applications, biofuels serve as substitutes for conventional fuels such as fuel oil and natural gas.

In some parts of the world, biofuels are extensively used in the transport sector. The prime example is Brazil, whose entire vehicle fleet runs on either a blend of 20–25% bio-ethanol or on pure bio-alcohol (flexible-fuel cars that can be run on 100% alcohol). Bio-ethanol represents approximately 1/3 of total vehicle fuels currently used in Brazil. Production was some 10 million tonnes in 2004, converted from roughly half of the country's sugarcane crop. Having been supported by a 25-year government subsidy programme, the Brazilian industry's current principal support lies in the statutory requirement for minimum levels of bio-ethanol in gasoline ('obligations'). All major international car manufacturers have adapted to the Brazilian obligation by setting up manufacturing plants to produce vehicles running on alcohol. The use of ethanol is rising as more and more flexible-fuel cars come on the market. Half the new vehicles sold in 2004 were able to use either pure ethanol or the blend.4 Most of Brazil's biofuel-blended gasoline is produced at the refineries of Petrobras, the state-owned petroleum company, based on alcohol produced from sugarcane at distilleries all over Brazil.

Against the Brazilian backdrop, transport biofuel production and use in Europe have been modest. In 2004, petrol and diesel blends of 5% were more common, unproblematic without vehicle adjustments, although there were also examples of 15% blends. Also unlike the case of Brazil, bio-diesel consumption constituted a higher share than bio-ethanol, a result of the generally higher share of diesel-engine vehicles sold in Europe. Annual bio-diesel production output in the EU-25 member countries was nearly 2 million tonnes in 2004, up from 1.5 million tonnes in 2003, while the corresponding figures for bio-ethanol were 446,000 and 491,000 tonnes. Some 80% of the EU's bio-diesel came from rapeseed oil, with soybean oil and a marginal quantity of palm oil making up the rest. Table 1 shows the geographical distribution of biofuel production in the EU in 2003 and 2004.

[4] Morgan 2005; Updated: 6:11 a.m. ET 18 June 2005, retrieved at: http://msnbc.msn.com/id/8262015/

Table 1. Biofuel production in EU-25 (tonnes), 2003 and 2004

	2003		2004		Total 2003	Total 2004
	bio-diesel	bio-ethanol	bio-diesel	bio-ethanol		
Germany	715,000	0	1,035,000	20,000	715,000	1,055,000
France	357,000	82,000	348,000	102,000	439,000	450,000
Italy	273,000	0	320,000	0	273,000	320,000
Spain	6,000	160,000	13,000	194,000	166,000	207,000
EU Commission	0	70,320	0	87,200	70,320	87,200
Denmark	41,000	0	70,000	0	41,000	70,000
Czech Republic	70,000	0	60,000	0	70,000	60,000
Austria	32,000	0	57,000	0	32,000	57,000
Sweden	1,000	52,000	1,400	52,000	53,000	53,400
Poland	0	60,430	0	35,840	60,430	35,840
Slovakia	0	0	15,000	0	0	15,000
UK	9,000	0	9,000	0	9,000	9,000
Lithuania	0	0	5,000	0	0	5,000
Total EU-25	1,504,000	424,750	1933,400	491,040	1,928,750	2,424,440

Source: EurObserver, 2005.

Biofuel production in the European Union was concentrated in countries hosting the major transportation fuel markets, notably Germany, France, Italy and Spain, with substantial volumes produced also in the Czech Republic, Austria, Poland, Sweden and Denmark. Even the European Commission was a major agent, buying alcohol within the framework of the common wine market management and transforming it into bio-ethanol intended for automobile fuel (EurObserver, 2005). On the other hand, Britain – another large fuel market –had negligible production. Newcomers on the scene were Slovakia and Lithuania, who started up small-scale production of bio-diesel in 2004.

Since most biofuels are currently produced from rather high-cost conventional agricultural crops, posing a challenge to any massive diffusion of biofuels in Europe and elsewhere, the 2005-released EU biomass fuel action plan highlighted the need for increasing the commercial and policy-making foci on 'second-generation' biofuels. These are typically manufactured by thermo-chemical conversion (gasification and Fischer-Tropsch[5] processing, for example). From the policy-maker's point of view, second-generation biofuels offer several advantages in addition to opportunities for utilising a wider range of lower-cost raw material, such as

[5] The Fischer-Tropsch Catalytic Process produces synthesis gas from biomass crops and hydrocarbon wastes that can be further processed into high-value chemical and plastic intermediaries, as well as liquid hydrocarbon fuels. The Fischer-Tropsch process for reforming natural gas into carbon monoxide and hydrogen (Syn-Gas) and using this gas to manufacture liquid fuels and chemicals is well known and has been in commercial use for over 50 years.

waste. These include lower well-to-wheels CO_2 profile, less environmentally intensive cultivation process (if any), and co-production with electricity.

3 Bio-energy activities reported by major European upstream oil companies

Several of the upstream oil companies chosen for this study reported activities in blending of and sales of conventional transportation biofuels (bio-ethanol and bio-diesel) in Europe, and some of them had taken steps to commercialise second-generation biofuels. Of these companies, however, only French *Total* flagged biofuel refining and sales as a top priority among its activities in renewable energy. By 2005, Total ranked itself as the market leader in France in refining and sales of technologically mature first-generation transportation fuels (bio-ethanol and bio-diesel), with some investments dating back to the mid-1990s. Total in fact produced the bulk of petrol additive ETBE (ethyl-tertiary-butyl-ether) synthesised from bio-ethanol and isobutylene and blended in concentrations up to 15% with petrol at its Dunkirk, Feyzin and Gonfreville refineries in France. Total ETBE output from the three refineries was 190,000 metric tonnes in 2004. In addition, Total held shares in the PCK Schwedt refinery in Germany, which produced 80,000 metric tonnes of ETBE in 2004. In Spain, Total's partner Cepsa was producing 100,000 metric tonnes (25% of total Spanish output) at the Algeciras and Huelva facilities. In Belgium, Total's Antwerp refinery started to supply ETBE from early 2005.

Total did not report on production of bio-diesel in 2005.6 The company was, however, deeply involved in blending bio-diesel (vegetable-oil methyl esters) into mineral-based diesel at its six refineries in France. In 2004, Total purchased around ¾ of annual French-produced volumes, which stood at 317,000 metric tonnes that year. In 2004, Total expanded bio-diesel blending to the Leuna and PCK Schwedt refineries in Germany. In 2005, Total reported that it was the world's leading distributor of automotive diesel containing rapeseed ester, with plans for the construction of new production plants in Africa and South America. Also in late 2005, Total signed a Memorandum of Understanding with the Finnish oil company Neste on evaluating the construction of a large-scale plant in France for the production of a hybrid first- and second-generation biofuel from 2008. Neste Oil is currently expanding its Porvoo refinery to use vegetable oil and animal fat as raw materials in a conventional hydrogenation process (using hydrogen produced at the refinery). The resultant NExBTL synthetic has the same fuel qualities as BTL, with lower investment but higher raw material costs (closer to conventional bio-diesel). The NExBTL 170,000-t/year plant at Porvoo is

[6] Biodiesel can be used pure in specially adapted vehicles or blended with automotive diesel to a concentration of 5%, or as much as 30% in vehicles in captive fleets.

due to come on stream in summer 2007 *(Green Car Congress,* 9 December 2005).

Dutch Shell, one of the upstream companies with the highest rating of investments in renewable energy (solar and wind power) had a far more modest flagging of bio-energy. Shell did not report on production of first-generation biofuels like Total in 2005, but there has been considerable involvement in developing second-generation biofuels. Shell has been engaged in experimental refining of bio-ethanol from lignin-cellulose, in co-operation with Canadian IOGEN. Another strategic R&D partnership with German CHOREN Industries has aimed at improving biomass-to-liquid processes, in which woody feedstock is first gasified and then converted into diesel fuel components using Shell's gas-to-liquids process technology.7 CHOREN Industries is currently developing a pilot plant (15,000 tonnes/year) in Germany, and the two companies are jointly planning a full-size prototype commercial plant in Germany with an annual capacity of 200,000 tonnes (Green Car Congress, 9 December 2005).

Shell's still modest emphasis on bio-energy activities stands in contrast to the company's far more comprehensive bio-energy strategy of the late 1990s. At that point, Shell had plans to establish a full business line in bio-energy supply, from biomass extraction at company plantations in Africa and Latin America right down to the production of heat and power based on bio-energy. Scandinavia and Northern Europe had been chosen as core investment areas for the company in Europe. However, these plans were later removed from the company's renewable energy profiling.

Like Shell, Britain's *BP*, another upstream company with a high-profile renewable energy strategy, failed to give any high-profile presentation of its bio-energy activities, unlike its flagging of solar energy and wind power activities. In its 2005 Alternative Energy business, BP announced the consolidation of low- and zero-carbon activities in the power sector (solar, wind, hydrogen power and gas-fired power technologies) and a strategy to invest $8bn and become a leading low-carbon power developer by 2015 – however, without any major focus on alternative transportation fuels. To be sure, BP was from 2004 involved in blending rapeseed methyl ester (RME) into diesel at its German Gelsenkirchen and Lingen refineries. Also other joint venture refineries in Germany in which BP had a share started production of RME diesel in 2004: PCK Schwedt, MiRO and Bayernoil. These moves in Germany followed unsuccessful attempts at selling ethanol-

[7] CHOREN Industries has developed its patented Carbo-V® biomass-gasification process to become a leader in the field of converting biomass – such as woodchips – into ultra-clean tar-free synthetic gas.

blended fuel at six service stations in Australia in 2002, which had been stopped due to low customer confidence in the fuel quality.[8] Like Shell and Total, BP has announced its involvement also in developing second-generation biofuels. In 2005, BP announced its strategic R&D co-operation with Toyota on cellulose ethanol from biomass waste in Canada (Green Car Congress, 16 July 2005). Against these companies, Norway's *Statoil* showed more modest involvement in transport biofuels. Statoil was involved in ethanol-blended petrol at 80 service stations in Sweden, without any direct involvement in production or blending of biofuels at its refineries. In addition, Statoil has gradually expanded its production capacity of bio-pellets in Norway and Sweden, seeking to retain its market share in a Scandinavian heating market that has gradually begun pulling out of fuel oil. By 2003, Statoil controlled about half of the wood-pellet market in Norway and Denmark, and around 10–20% in Sweden. *Hydro*, another major Norwegian upstream company in Europe, withdrew its production of biomass-based heating fuels in the late 1990s. Hydro was modestly diversified downstream in the oil supply chain and had as of 2005 no ownership interests in oil refineries. The company did not report any sales of biofuels as of 2005.

Neither did *Exxon,* the major US-based upstream company in Europe, make any mention of bio-energy in its business portfolio – perhaps not so strange, given the company's rather negative position concerning investments in renewable energy. In Germany, the European leader in production and diffusion of biofuels, Exxon actively sought to discredit the environmental merits of biofuels as compared to other fuels sold by the company.[9]

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[8] For details of the BP test-runs in Brisbane see http://www.bp.com.au/news_information/-press_releases/pr_ethanol_extend.asp.

[9] Der so genannte ‚Biodiesel' ist kein – wie die Bezeichnung vielleicht vermuten ließe – reines Naturprodukt. Er wird durch die synthetische Veresterung von Rapsöl mit Methanol hergestellt; das Methanol wird normalerweise mit aus Erdgas gewonnenem Methan produziert. Die korrekte Bezeichnung für dieses Produkt ist daher Rapsöl Methylester

(RME). http://www.esso.de/ueber_uns/energie_umwelt/-alternative_kraft_schmierstoffe/biodiesel/index.html. Ebenso wie beim ‚Biodiesel' ist auch der Ersatz mineralölbasischer Schmierstoffe durch Rapsöle nur in sehr begrenztem Maße möglich. Bereits die physikalischen und chemischen Gegebenheiten setzen hier enge Grenzen. Insbesondere die geringe thermische Stabilität pflanzlicher Produkte verhindert ihren Einsatz, z.B. als Motorenöle. Für begrenzte Einsatzzwecke ist die Verwendung von Schmierstoffen auf Rapsölbasis jedoch durchaus sinnvoll. http://www.esso.de/ueber_uns/energie_umwelt/alternative_kraft_schmierstoffe/pflanzenoel_schmierstoffe/index.html.

4 Driving forces and obstacles for increased use of biofuels in Europe

4.1 Energy and environmental policies at the EU level

Today, the most important driving force behind diffusion of renewables in general and bio-energy in particular in Europe are government policies established to make renewable fuels competitive with conventional fuels in stationary energy use (electricity and heat generation) as well as in transportation (Eikeland, 2006b forthcoming; Haas et. al, 2001; Reiche 2002; Morthorst & Jørgensen, 2005). Such renewable energy policies are in turn driven by deep-rooted and quite stable societal, technological and political factors. As of 2005, societal and political fears of future energy supply shortages top the European energy policy agenda, together with the potential threats of global climate change generated mainly by combustion of conventional fuels (coal, oil and natural gas). Energy security and threat of climate change constitute the major legitimating factors for an ambitious and stable renewable energy policy, at the EU and national European levels. As Europe is a major oil and gas import area, energy security problems have always lain under the surface of European energy policy, becoming more prominent in periods when geopolitical instability has threatened to block imports. Energy security has again assumed new momentum in the wake of serious political unrest in important petroleum export areas (primarily the Middle East), threatening the stability of world oil supply, combined with massive and still rising increase in oil and gas demand from China and other large developing countries.

With EU oil reserves in decline, imports from the Middle East have increased over the past decade, and, without political response, will continue to increase. With EU gas resources in decline, combined with import dependency aggravated after the 2004 inclusion of Eastern European countries into the EU, fears have extended to future gas shortages, although imports here come from generally more stable areas – notably Norway, Algeria and Russia. Nevertheless, even Russian supply stability is questioned, since the country has increasingly demonstrated its readiness to use its energy resources as a card in the geopolitical power game, in the wake of its loss of military superpower status – as epitomised by the early 2006 shutdown of gas supplies to Ukraine. With Ukrainian politics increasingly at odds with those of its mighty neighbour, the latter decided to cut supplies, formally legitimising the step by referring to Ukraine's unwillingness to accept current market prices for Russian gas. With vital gas infrastructure connecting Russian and the EU currently passing over Ukrainian territory, also EU countries felt a reduction in volumes supplied in early January 2006 *(Die Welt,* 3 January 2006).

Seeking to contain the increasing import dependency, the European Union has in recent years sought a range of policy options. The European Commission has, however, largely failed in adopting specific measures tied to joint management of oil and gas resources in the EU, due to harsh opposition by oil- and gas-producing countries (Eikeland, 2004a). Because of these failures, the only policies to retain any noteworthy level of agreement at the EU level have been those aimed at furthering the diffusion of indigenous renewable energy sources, unintentionally giving an extra impetus to the diffusion of biofuels.

There has, however, been another important legitimising factor for a quite ambitious EU-level promotion of biofuels and renewable energy more generally: this is the fact that the EU decided in the late 1990s to take a lead position in international work to stabilise greenhouse gases (Wettestad, 2003; Wettestad & Sæverud, 2005). Under the threat of global climate change, indigenous European coal resources have become less attractive. Also the neo-liberal energy market reforms in the 1990s, instilling competition into European energy markets, made coal less attractive, since the costly European coal reserves were non-competitive to imported coal and therefore in need of market-distorting state support, which was seen as problematic from the perspective of a single energy market. To be sure, also most renewable energy technologies require state support. So far, however, such support has been accepted as more legitimate, with reference to infant industry arguments and the fact that subsidies of renewable energy can be seen as equivalent to imposing an externality tax on conventional energy sources.

Adding the disputes over nuclear power that have prompted a halt in commissioning new plants in most countries and even phase-out decisions in Sweden and Germany, plenty of political arguments have circulated the past decades in favour of policy support for renewables. We can surely speak of a re-vitalisation of political sentiment experienced after the oil crises in 1973, prompting increased diffusion of renewable energy sources.

Policy instruments established at the EU level include the indicative target set in the 1997 renewable energy White Paper, to double the share of renewables in total primary energy consumption from 5.4% in 1997 to 12% by 2010 (Commission of the European Communities, 1997). They also include the more specific 2001 Renewable Electricity Directive that set the target of increasing the share of renewables in EU electricity production from 14% in 1997 to 22% by 2010 (Commission of the European Communities, 2001a). Both policy instruments were neutral concerning sources of renewables but indicative on the leading role of biomass as primary energy source. The 2003 Biofuels Directive, by contrast, specified

targets for biomass-based fuels, to reach a share of 5.75% of all transportation fuels consumed in the member states by 2010. An intermediary target of 2% was set for 2005 (Commission of the European Communities, 2003a).

For long time now, calls have been made in the EU system (among Euro MPs, environmental NGOs and renewable energy industry associations) for a separate renewable heating and cooling directive which could boost further diffusion of bio-energy in Europe. The issue was addressed by the Commission in its 'Biomass action plan' adopted in late 2005 (Commission of the European Communities, 2005). Here, the Commission notes that, although technology for biomass use in residential and industrial heating is simple and cheap, biomass is growing more slowly in heating than in the electricity and heating sectors. It concludes that legislation on renewable energy in heating 'is the missing piece of the jigsaw', and that it will work towards such moves in 2006 (Commission of the European Communities, 2005, p. 7).

Adding to these supply-oriented directives, the Commission Directive on the taxation of energy products (Commission of the European Communities, 2003b) gives the member states a legal framework for differentiated taxation between biofuels and conventional fuels – a measure essential to increase demand and make biofuels competitive with conventional fuels. Further policy measures established include R&D support for renewables and more general policies to mitigate climate change, such as the Emission Trading Directive established in 2003 (Commission of the European Communities, 2003c), which supports all low- and non-carbon energy sources through the price mechanism.

4.2 Other relevant EU-level sector policies – the case of the Common Agricultural Policy

With the renewable energy directives providing indicative and binding targets for diffusion of biofuels, also other EU-level policies are essential for reaching the targets set. Notable here are efforts at reforming the Common Agricultural Policy (CAP). The agricultural policy framework finally adopted will decide the availability of land area on which bio-energy crops can be cultivated. Conversely, failure in CAP reforms may present obstacles to further diffusion of biofuels, in that the area needed for crop cultivation is simply not available. Import of biofuels is an alternative option, but has been criticised for not producing the intended effects of reducing energy imports and reducing global greenhouse gas emissions, due to long-range transport using conventional fuels.

The CAP is a system of European Union agricultural subsidies dating back to the 1960s. It originally guaranteed producers minimum prices and direct payment for certain crops, representing about 44% of the EU's spending (€49bn scheduled spent for 2005).[10] The CAP represented harmonisation of state support systems to the agricultural sectors, seen as a mode adhering to the Common Market principles of removing obstacles to internal free trade in agricultural products, while still accepting the strong state intervention wanted by some member states, France in particular. (Indeed, the CAP is often explained as the result of a political compromise between France and Germany: German industry would have access to the French market; in exchange, Germany would help pay for France's farmers.)

The CAP has been under constant pressure from internal disputes over distribution and subsidies between member countries and the level of subsidies leading to higher food prices than under a fully free-market system. Some EU countries have large agricultural sectors – notably France, Spain and Portugal – and consequently receive more funding under the CAP. Other countries make net contributions, such as Germany and the Netherlands (the biggest per capita contribution in the EU budget). In 1984, Margaret Thatcher successfully negotiated a special annual UK rebate. The UK has later offered to waive some of this rebate, provided that funds released benefit the poorer new member states of the EU.[11] The popular view in the UK is that if the rebate were reduced with no change to the CAP, then Britain would be paying to keep an inefficient French farming sector in business – and to many Britons, this would be seen as grossly unfair.[12]

The CAP has always been a difficult area of EU policy to reform, above all because unanimity is needed for any serious reforms. This enables member states in favour of extensive subsidies, with France in the lead, to block changes. In the recent decade, however, changes have been more forthcoming, due not least to increased external pressure from the GATT and WTO systems and the intrusion into CAP affairs by other members of the EU policy framework, like consumer-advocacy working groups and the environmental departments of the EU. In 1992, catalysed by the need to pacify external trade partners in the Uruguay Round of GATT, some major reforms were created to limit rising production, while at the same time adjusting to the trend toward a more free agricultural market. These reforms reduced levels of support and created 'set-aside' payments to withdraw land

[10] Data from Wikipedia, at http://en.wikipedia.org/wiki/Common_Agricultural_Policy).

[11] Since 2004, France has been receiving 13% more of CAP funds than the UK. This is a net benefit that France gets compared to the UK of €6.37bn. In comparison, the UK budget rebate for 2005 is scheduled to be approx €5.5bn.

[12] Also on this point see Wikipedia (note 10 above)

from production, payments to limit stocking levels, and introduced measures to encourage retirement and afforestation.

In 2003, EU agricultural ministers adopted a fundamental reform of the CAP, based on almost entirely 'decoupling' subsidies from a particular crop (though member states may choose to maintain a limited amount of specific subsidy). A new 'single farm payments' arrangement has been introduced. This sets a maximum amount of subsidies payable to any single farm, and is aimed at making more funds available for environmental, quality or animal welfare programmes by reducing direct payments for large farms. The reforms entered into force in 2004–2005 but member states may apply for a transitional period delaying the reform in their country to 2007 and phasing in reforms up to 2012.[13] Through these reforms, the main subsidies become explicitly linked to compliance with EU standards covering the environment, public and animal health and animal welfare. Member states are required to inspect a sample of farms each year on a systematic basis, to ensure that standards are met. (DEFRA (2005).

The CAP reform provides several arrangements aimed at increasing the incentives for farmers to step up biofuel production. The system of setting aside of land has been retained, freeing arable land for alternative bio-energy crop production. The basic compulsory set-aside rate was in 1999 stipulated to 10% for the period 2000–2006, but producers may set aside more than 10% ('voluntary set-aside') up to a maximum left for member states to decide. Under the 2003 reformed system, 'single farm subsidies' will be paid only if the agreed land is kept in set-aside, although rotation is allowed. Certain energy crops (including short rotation coppice) are still allowed to be cultivated on the set-aside land. In addition, the new reform provides for an aid or 'carbon credit' of €45 per hectare of arable land used to produce energy crops (biofuels and biomass used to produce electrical and thermal energy). A cap of 1.5m hectares of EU land eligible for support has been set, with aid decreasing for crops cultivated on area beyond the cap. By December 2006 the Commission is to report on implementation of the scheme, taking into account progress with the EU biofuels initiative.

As of late 2001, 5.6 million hectares of land had been set aside under compulsory or voluntary programmes. This represented a potential of 7–14

[13] The 2004 EU expansion increased the number of farmers from 7 to 11 million, increased agricultural land area by 30% and crop production by 10%–20%. The 2004 EU entrants have immediate access to price support measures (export refunds, intervention buying). However, direct payments will be phased in over 10 years (2004–2014), starting at 25% of what existing countries get. The new 2004 members have access to a rural development fund (for early retirement, environmental issues, poorest areas, technical assistance) with a €5bn budget.

million metric tonnes per year of renewable biofuels,[14] or the equivalent of 2.5–5% of the automotive fuel in Europe (USDA 2005). This is still short of reaching the EU goal. However, if properly implemented, CAP reform set-aside land will expand, and, aided by tax incentives and a rise in CO_2-emission permit prices, should promote a further massive production of biofuels. The European Environmental Agency, in a preliminary briefing report (EEA 2005), estimates the 'environmentally compatible' energy biomass potential in Europe by 2010 to be 180 Mtoe, well above the 130 Mtoe needs estimated for reaching the target of 12% renewables in primary energy consumption in 2010. The potential is estimated to increase to 230 Mtoe in 2020 and 300 Mtoe in 2030, under the assumption of a further 20% reduction in CO_2 emissions by 2020 and a 40% reduction by 2030 by EU-25 member countries.

4.3 Summing up policies at the EU level – diffusion of bio-energy as joint solution to various energy policy problems

The salient political problems to be solved at the EU level seem to converge around diffusion of bio-energy as a joint solution, creating momentum for energy system transformation. The targets set for the future share of renewables in total primary energy consumption and electricity production in the European Union cannot be reached unless biomass resources are taken into use. The Biofuels Directive and the 2005 Biomass Action Plan target bio-energy diffusion directly. The current topicality of the issue of energy security adds force to the further diffusion of bio-energy, as it is one of Europe's available indigenous energy resources. (However, it should be noted that key political actors have also spoken of the re-vitalisation of nuclear power as an option.)

Contemporary climate-change policy instruments adopted by the European Union would appear to add backing of biofuels as solution, notably the 2003 Emission Trading Directive and the 2003 Directive on the Taxation of Energy Products. The latter allows member states energy tax exemptions on biofuels.

Preliminary investigations from the European Environmental Agency show that biomass resources could be converted to energy products on a massive scale without compromising other environmental qualities or future food production in the EU. Moreover, the re-focus after the 2003 CAP reforms from support of products to producers in order to reduce overcapacity in food and fodder, and new incentives for energy crop production, provide

[14] for typical yields of 2 to3 metric tonnes/hectare for ethanol and 1 to 1.5 metric tonnes/hectares for biodiesel

opportunities for further increasing the biomass resource potential in the European Union. Hence, a range of newly established EU-level policies converges in signalling investments in bio-energy as a business less risky than before.

Adding to the list of driving forces are industries outside the Union, awaiting a boost in market conditions for international trade in biofuels. Imports into Europe would certainly press down the costs of implementing the Biofuel Directive. On the other hand, competition from imports could also dampen production in Europe, thereby neutralising an important legitimisation of EU policies: expectations of a new industry and new employment within the EU. For several reasons, large-scale imports could attack the key legitimising factor: that biofuel diffusion is promoted for environmental reasons. First of all, long-range transport of biofuels would reduce their climate-change mitigation effect. Moreover, imports from regions where energy crops are cultivated on lands cleared of rainforests or where crops have been genetically modified to increase productivity, would definitely put strain on the strong advocacy coalition for biofuels currently emerging in Europe.

4.4 Policies in EU member states – driving forces and obstacles for biofuels

Despite the many forces currently interacting positively for bio-energy at the EU level, there are also forces that work both for and against short-term diffusion at the member-state level. First of all, implementation of EU legislation at the member-state level can be time-consuming and uncertain. EU policies will be filtered at the member-state level in the implementation process. Signals from the EU become moulded with national interests and institutional factors, often producing sizeable variation among member states in national policies (Eikeland, 2004a). Variations are allowed to evolve since much EU legislation gives member states considerable discretion and since EU institutions have limited capacity to enforce implementation in the area of energy policy (Eikeland, 2004a). As of 2004, the EU was still struggling to reach the targets set for renewables in its 1997, 2001 and 2003 policy documents and directives. In 2003, half-way into the commitment period, the share of renewables in total energy consumption was recorded at 5.48%, a standstill from 1997 despite the goal of increasing the share to 12% by 2010. The share of renewables in *electricity generation* had grown by less than 1% in the period, with a further 7% to go until 2010 (EurObserver'ER, 2004). Concerning the intermediary target for 2005 in the Biofuels Directive, there will be a shortfall of some 0.6% (Commission of the European Communities, 2005, p. 9).

A major reason for asymmetric implementation (asymmetries in time schedule for transposition of EU policies and extent of national targets and use of instruments) is that member states have interests that are not fully compatible with those of the common EU energy policy. Whereas EU policies seek a balance between aggregate member-state interests, national policy-makers often have *additional salient interests* that are incompatible with those of the EU and other member states.

Typical are the well-being of national *energy industries* and the ability of national businesses more generally to compete against other European and global rivals to create national economic development and employment. In the competitive free-trade environment established in Europe, the expansion of some national industries may well take place through the decline of other national industries. This is hard for politicians to accept, given the traditional role of energy industry companies as national champions that have borne heavy responsibility for national energy security, as well as being key figures in terms of output, employment, R&D, etc.

The idea of 'national champions' is still far from forgotten in many European countries. On the contrary: large national energy companies are still seen as necessary for ensuring national energy security in the worldwide competition for energy resources. Let us take recent example from the German public debate: on 3 January 2006, the influential daily *Die Welt* commented on Russia's gas embargo against Ukraine by urging 'the new German Government to remember that only strong companies can guarantee energy security in the looming worldwide competition for energy' (this author's translation).

4.4.1 National interests and implementation of the Biofuels Directive

Enthusiastic and extensive implementation of EU biofuel policies is most likely in member states where biofuel diffusion serves the interests of the incumbent industry and/or is seen as an instrument for future industrialisation, economic development and employment. Less enthusiastic and extensive implementation can be expected in countries where biofuel diffusion represent a threat to the well-being of vital national energy industry interests and/or where biofuel diffusion does not represent any particular opportunity for industrialisation, economic development or employment – as is the case in countries that lack biomass resources. Additional factors include the degree of national energy security and political position, and ambitions in environmental policies – climate change policies in particular. We may expect countries that pursue an ambitious climate change policy but fail to meet their goals by other means to be more enthusiastic about renewable energy. Eikeland (2006b, forthcoming) largely confirms that the degree of enthusiasm in implementing the EU's renewable energy goals

reflects the degree of convergence of national energy-related problems around diffusion of renewable energy as a joint solution. Obviously, such convergence also increases the likelihood of seeing strong advocacy groups lobbying for ambitious implementation.

More specifically concerning the 2003 Biofuels Directive, member states were required to report their measures for implementing the EC directive in country-specific legislation by late 2004 (i.e., mechanisms for implementation and enforcement) and submit a national status report (due 1 July 2004) including a definitive target for 2005. No reporting on the 2010 target was required before 2006. As of March 2005, as many as 19 countries had still not informed the Commission on their legislative measures. Five had yet to submit their national reports; four member-states had not reported indicative targets, and several others submitted 2005 targets below the stipulated 2% *(Green Car Congress,* 20 March 2005).

The many delays in implementation indicated a lax drive for biofuels in many member states. In order to push the pace, the European Commission sent letters of formal notice to member states who had failed to communicate 2005 biofuel targets. Then, in July, it escalated to the next administrative level, sending Reasoned Opinions and more letters of formal notice to Estonia, Finland, Greece, Italy, Luxembourg, the Netherlands, Portugal and Slovenia for still not having informed the Commission of measures taken to implement the Directive; and to Italy, Luxembourg and Slovenia for failure to submit national reports. The Commission also responded to the reasons provided by eight member states (Denmark, Ireland, Finland, the UK, Hungary, Portugal, Poland and Greece) who had failed to comply with the 2% target for 2005, rejecting their relevance and correctness *(Green Car Congress,* 6 July 2005).

As can be seen in Table 2, by late 2005, Italy and Luxembourg had still not submitted reports to the European Commission, and Cyprus, Estonia, Malta and Slovenia had not set any indicative 2005 targets. Denmark, Finland, Greece, Hungary, Ireland, Poland, Portugal, and the UK had retained lower targets than indicated by the Directive. On the other hand, there were also countries that had set national targets that complied with the Directive (Belgium, France, Germany, Latvia, Lithuania, the Netherlands, Slovakia and Spain) or had even set higher targets than indicated for 2005 (Austria, Czech Republic, and Sweden). Several member states had already indicated a 5.75% target to be reached by 2010 (Austria, Belgium, France, Latvia, Lithuania, Poland and Slovakia).

We note that most countries with really large potential biofuel markets had a good record of implementation by late 2005. In the course of the year, also

the other key member states had given political signals indicating a boost for biofuel use. In November 2005, British Transport Secretary Alistair Darling announced that 5% of all motor fuel sold in the UK would have to come from renewable sources by 2010.[15] This requirement comes through the Renewable Transport Fuels Obligation (RTFO). Under the RTFO, oil companies will receive certificates to demonstrate how much biofuel each has sold. If a company sells more than its 5% obligation, it may sell those certificates to other companies that still need to meet their obligations. Oil companies and importers are being called upon to ensure that a growing proportion of their fuel sales come from a renewable source, (*Oil and Gas Journal*, 11 November 2005).

Table 2. Targets set for share of biofuel in total transportation fuel consumption

	Biofuel target 2005	Biofuel target 2010
Austria	2.5%	5.75%
Belgium	2%	5.75%
Cyprus	No target set	No target set
Czech Republic	3.7% (2006)	4.5% (set in 2004 report 14.5% (set in 2005 report)
Denmark	0	No target set
Estonia	No target set	No target set
Finland	0.1%	No target set
France	2% (2006)	5.75%
Germany	2%	No target set
Greece	0.7	No target set
Hungary	0.4–0.6%	No target set
Ireland	0.06%	No target set
Latvia	2%	5.75%
Italy	No report submitted by late 2005	
Lithuania	2%	5.75%
Luxembourg	No report submitted by late 2005	
Malta	No target set	No target set
Netherlands	2%	No target set
Poland	0.5% (2005) 1.5% (2006)	5.75%
Portugal	1%	No target set
Slovakia	2%	5.75%
Slovenia	No target set	5%
Spain	2%	No target set
Sweden	3%	No target set
UK	0.3%	

[15] Darling announced the change on 10 November, during an environmentally friendly vehicles conference in Birmingham, UK, where representatives from international governments and industry met to discuss ways to promote greener vehicles.

In France, the government promised in late 2005 at a Government/Industry Biofuel Roundtable[16] to accelerate its efforts to develop alternative energies in order to reduce national oil consumption and limit France's energy dependence. This followed a 1 September speech by Prime Minister Dominique de Villepin, where he announced: 'We have entered the post-oil era, and I intend to do whatever is necessary in order to give a real boost to energy-saving measures and to the use of renewable energies'. The roundtable developed a set of action items and commitments to advance the use of biofuels in France, including sizeable increases in the direct use of ethanol in blends and in E85 flex-fuel vehicles, and support for a broader range of approaches to bio-diesel production. Among the key elements of the plan was to revise upward the European standards for biofuel-petrofuel blends established in 1998: these allow only a 5% blend, not seen as compatible with that permitted for ethanol in France. The government also announced the possible adoption of a 10% limit in bio-diesel blend following the final validating test of the French Petroleum Institute (IFP) and automobile manufacturers and equipment suppliers in 2006. Furthermore, the action plan contained pilot projects for direct blending of ethanol into petrol, contrary to the current practice of blending petrol only with ETBE. The government announced that it wanted the industry to begin using direct ethanol blends starting in 2006 *(Green Car Congress,* 23 November 2005).

Hence, despite delays in implementation of the Biofuels Directive, high political commitment to biofuels has now emerged, setting the tone in EU energy politics. This is underscored by the overview of tax incentives

[16] Domenica Bussereau, Minister for Agriculture and Fishing, and François Loos, Vice-Minister for Industry in the Ministry of Finance, assembled executives from agriculture, oil and auto manufacturing to discuss how France could meet its biofuels target of 5.75% (set already for 2008), and new 7% target for 2010 and 10% for 2015. Among the companies and organisations participating in the roundtable were:

Oil industry: AGIP; Association des Indépendants du Pétrole (AIP); BP; Dyneff; Esso; ETBE Nord et Ouest; Fédération Française des Pétroliers Indépendants (FFPI); Institut Française du Pétrole (IFP); Lyondell; Siplec; Shell; Total; Union Française des Industries Pétrolièrs (UFIP); Union des Importatuers Indèpendants Pétroliers (UIP), Pètrovex (groupe Auchan), Carfuel (groupe Carrefour), Stè Pètroles et Dèrivès.

Auto industry: Comité des Constructeurs Français d'Automobiles (CCFA); Fédération des Industries des Equipements pour Véhicules (FIEV); FMC–Ford France; PSA Peugeot Citroën; Renault.

Agriculture: Association pour le Développement des Carburants Agricoles (ADECA); Association Générale des Producteurs de Blé et Autres Céréales (AGPB); Association Générale des Producteurs de Maïs (AGPM); Confédération Générale des Planteurs de Betteraves (CGB); Diester Industrie; Esterifrance; Fédération Française des Producteurs d'Oléagineux et de Protéagineux (FOP); Fédération Nationale des Syndicats d'Exploitants Agricoles (FNSEA); Ineos Enterprises; Jeunes Agriculteurs (JA); Saria Industrie; Syndicat Général des Constructeurs de Machines Agricoles (SYGMA); Syndicat de l'Industrie Française des Coproduits Animaux (SIFCO); Syndicat National des Producteurs d'Alcool Agricole (SNPAA).

(Source: *Green Car Congress,* 23 November 2005.)

provided for biofuel development in national policies among EU-15 member countries, as outlined in Table 3.

Table 3. Summary of EU member-state tax breaks for biofuel production, March 2005

Austria	Full exemption of €310/m3, for pure bio-diesel and blends up to 2%.
Belgium	Discussions to introduce full exemption underway.
Denmark	No measures currently in place
Finland	No measures currently in place
France	Partial exemption of €330 m,^{3} with quota of 317,000t. Only for blends of up to 0.5%, and pure bio-diesel is not covered by measure
Germany	Total tax exemption of €0.88/liter, until at least 2009.
Greece	No measures currently in place.
Ireland	No measures currently in place
Italy	Full exemption of €403m^3 up to a quota of 300,000t. Pure bio-diesel used for heating (rather than transport) can apply this measure.
Netherlands	Discussions to introduce full exemption underway.
Portugal	Discussions underway on incentives to introduce.
Poland	Full exemption and defined mandatory targets for biofuel market penetration.
Spain	Full exemption for biofuels.
Sweden	Full exemption of €365/m,^{3} until at least 2008.
UK	Partial exemption of €0.20 per litre on bio-ethanol and bio-diesel.

Source: USDA 2005.

Germany, Austria, Spain, Sweden and Poland have given full tax exemption for biofuels. Even Italy, although failing to report to the European Commission, has implemented full exemption within a pre-defined quota of 300,000t. From 2005, however, this quota has been reduced to 200,000 tones due to budget constraints. In addition, a re-allocation of tax relief has been made from bio-diesel (obtained mainly from imported oils) to bio-ethanol (obtained mainly from surplus distilled wines, as well as sugar beets and corn produced in Italy). This change in policy came after bio-diesel consumption had been growing rapidly in Italy – from 70,000 tonnes in 2000 to 310,000 tonnes (approximately 6,400 barrels per day) in 2004 – and had surpassed the amount capped for tax relief *(Green Car Congress,* 26 March 2005). Also France is operating with a total quota of fuel eligible for partial tax exemption.

4.4.2 National policies and diffusion of biofuels

Recalling Table 1, section 2, we see considerable overlap between countries that provide generous tax incentives and national production of biofuels. As of 2004, the major bio-diesel producers in Europe were Germany, France

and Italy, with substantial production also in Denmark, the Czech Republic and Austria. The major bio-ethanol producers were Spain, France and Sweden. Poland experienced a decline from 2003 to 2004, because the Parliament did not ratify the 2003 bioenergy bill that would have given full tax exemption. Instead, tax exemptions are now decided annually. The high political willingness in Germany and Spain to provide tax relief coincides with the current dominant position of German and Spanish companies in European bio-diesel and bio-ethanol supply, respectively. On the other hand, the large tax exemptions in Germany have been under discussion by the new grand coalition government, which proposed instead a compulsory 5% blending with conventional diesel in oil refineries as a means of containing massive losses in government tax revenues.[17] The proposal met harsh opposition from the German bio-diesel producers' association VDB, who claimed it would set back biofuel market development, since the 5% share was already about to be met (Reuters, 8 December 2005). The opposition prevailed: the government later changed its plans and retained full tax exemption for biofuels.[18]

As of 2004, four of Europe's seven largest producers of bio-diesel were located on German territory. Three of these were German and fourth, Archer Daniels Midland Company, US-based. Two of the major companies were French, with Diester Industrie as the largest European producer. In the bio-ethanol industry, the primary European company was the Spanish Abengoa Group, with production of 226,000 tonnes (nearly half of total output) and another 325,000 tonnes output in the United States (where the company ranked fifth). The company has a total capacity of 340,000 tonnes, with another 160,000-tonne plant to be commissioned in Spain by late 2005 and with approval pending for the construction of another 180,000-tonne plant in France. The French Tereos Group has a production capacity of 48,000 tonnes, covering around 40% of the French market. Tereos is awaiting future production approval, under the French Biofuels Plan, to construct two new

[17] Estimates are that booming biodiesel sales mean Germany's government is losing between €900 million ($1.06 billion) to € 1 billion a year in tax revenues on conventional diesel

[18] Speaking before 750 participants of the 'Fuels of the Future 2005' symposium at the International Congress Centre in Berlin, Norbert Schindler, vice-president of der Deutsche Bauernverband, emphasised that he welcomed the new regulation included in the government's platform to require additives and tax the products accordingly. He said the clause requiring additives was not only motivated by taxation policies, but was also an outgrowth of the position of the petroleum industry, which in the past had taken too passive a role with regard to biofuel. As to marketing pure fuel, Schindler said that no changes would be made to the current situation. Tax privileges for pure biofuel will remain in place, as in the past. 'This was confirmed to me just prior to this conference in a conversation with Michael Meister, who participated in the negotiations on behalf of the Christian Democratic Union', Schindler said, (Government plans: All-clear for biofuels!, http://www.ufop.de/972.php.)

plants with total capacity of 360,000 tonnes. Otherwise, two Swedish actors were active in their substantial home market – Agroetanol AB (40,000 tonnes) and Svensk Etanolkemi (15,000 tonnes) (EurObserver, 2005).

Thus, we may conclude that European countries without domestic mineral oil resources are currently leading the way in political ambitiousness to create a market for domestic biofuel industry development – hardly surprising, since these countries also face high petroleum import dependency. On the other hand, countries with substantial petroleum resources of their own – notably the UK, the Netherlands, Denmark (and Norway in the larger EEA area) – have policy frameworks less favourable for promoting market demand for biofuels and the development of a national bio-energy industry. To be sure, in 2005 a boost appeared for biofuel production projects in the Netherlands, in response to skyrocketing crude oil prices that made biofuels cheaper than petrol and diesel. Henry Aberson, director of Dutch firm Solar Oil Systems that opened the Netherlands' first biofuel plant during 2005, reported prices as 65 cents a litre against diesel prices at about €1 ($1.24) per litre and petrol at some €1.3–1.4 at Dutch filling stations. To encourage greater production of biofuels made mainly from rapeseed, the Dutch government announced that it would introduce tax incentives in 2006, most probably exempting biofuels from excise duty (Reuters, 15 August 2005). Also in the UK, new political signals at the end of the year may encourage domestic biofuel production there as well. As of 2005, the major British biofuel producer D1, founded in 2002 to design and build a modular bio-diesel refinery for the UK transport industry, has turned its investment focus to sites in developing countries where primary feedstock prices are lower. Another green fuel start-up, Biofuels Corporation, announced in early 2005 that it was on track to bring Britain's largest 250,000-tonne a year bio-diesel plant into full production later in the year.

4.4.3 Recent changes in member-state policies driving biofuel optimism

To sum up, in the course of 2004 and 2005 most of the key EU member states moved towards more favourable policy frameworks for biofuel development. Hence, even though the 2% 2005 target for share of biofuels was missed by 0.6%, developments through the year provided more positive prospects for substantial near-term diffusion of biofuels in the European Union. And indeed, there is optimism in the expanding European biofuel industry. In February 2005, Javier Salgado, CEO of Abengoa Bioenergy, Europe's largest bio-ethanol producer, stated he was convinced that biofuels could be profitable without government subsidies once the right technological advances have been made, and that he expected them to compete with gasoline in 10 years, when budgeting with $28 per barrel crude. 'There will be a boom, an important boom, and there will be no ceiling', Salgado

said, indicating that crude oil would have to cost $70 a barrel for bio-ethanol to compete in Europe and $45 to $50 a barrel in the United States, where raw materials are cheaper. ‘In the US, ethanol has helped gasoline prices fall’, said Salgado (Reuters, 25 February 2005).

This optimism, and the fact that the biofuel lobby has grown quite strong in several member countries (notably where industrialisation has been strong), acts as a considerable driving force for further biofuel diffusion in Europe. That these countries are among the largest and politically most influential members of the European Union reinforces the development. Nor should we forget that the EU’s new Eastern European countries represent an extra asset for further expansion of biofuels in the European Union, with their large areas of arable land that would be available for energy crop production in the wake of rationalisation of agriculture. This applies also to Bulgaria and Romania, on the list for EU membership in 2007.

5 Driving forces and obstacles specific to the upstream oil industry

5.1 The generally hesitant position of the oil industry

In light of the resource potentials, the generally hesitant involvement in bio-energy production and sales by the upstream oil industry may be interpreted as a defensive strategy – to hold back engagement so as not to contribute to the development of close substitutes for mineral oil products. Such an explanation is strengthened by the fact that during the 1990s all major oil companies increasingly engaged in R&D and demonstration of hydrogen as fuel: here, natural gas is regarded the preferred fuel in the short- and mid-term future.

On the other hand, hesitant involvement in bio-energy could also be interpreted as a result of a mismatch between the resource characteristics of bio-energy and the business strategy characteristics of many upstream oil companies. Upstream control over resources has traditionally constituted the core business focus of upstream oil companies, although many of them are also vertically integrated in the oil product supply chain, in the refining and marketing of mineral oil products: petrol, diesel and other petrochemical products. In the biomass product chain, full upstream control is not easily acquired, since biomass resources are scattered and under ownership by a great many proprietors – unlike the case with upstream petroleum resources, which are often found in concentrated reservoirs. True, many oil companies have increasingly directed their business focus downstream in recent years, responding to the threats and opportunities generated by liberal energy market reforms, and providing energy customers with more power to choose the energy supplier and energy sources they prefer. Some oil companies have found it worthwhile to reduce the risk of losing customers and utilise economies of scope by marketing a diversified portfolio of energy products. As such, liberalisation and freer customer choice, not least in an atmosphere of climate change concerns, works as a driving force for oil industry downstream focus and engagement in the diffusion of renewable energy generally, and biofuels in particular. On the other hand, if competition becomes more intense, the companies may decide to withdraw from downstream operations and instead concentrate even more on their core business – the exploration, exploitation and wholesale of mineral oil products.

Recent EU events indicate that the oil industry, which has long pursued a defensive strategy concerning biofuels, may find such a strategy may no longer as fruitful. For some time now, the European Commission has been engaged in negotiations with the oil and car industries over ways to reduce

greenhouse gas emissions from the transport sector (the Oil Auto Programme). The major burden had long been swinging in the direction of the car industry, with demands that manufacturers develop new cars that could meet the target of 120 grams of carbon dioxide per kilometre by 2010. In recent moves, however, the industry seems to have convinced the Commission that meeting this target would make vehicles unaffordable while it would still not be enough for the EU to achieve its climate-change mitigation goals. This has automatically shifted attention towards the fuels side, with demands that the oil industry increase the amount of biofuel they mix with tradition petrol and diesel. Oil producers have reacted to this move by warning the Commission that fuel prices or subsidies may have to rise as a result, and by refusing to sign a communiqué for a top-level meeting of the CARS 21 group of Commissioners and industry chief executives. Instead, the industry has opted to force the Commission to carry out a detailed study of the costs and benefits before committing itself to biofuels.[19] The precise targets for carbon reduction by carmakers and the oil industry will thus not be set until after two impact assessment reports in spring 2006, but the Commission and automobile manufacturers want agreement on the principle of a shared burden with the oil industry as soon as possible. According to the *Financial Times*, one motor executive involved in the negotiations said he expected the two industries to split the reductions evenly, each being made responsible for eliminating 10–15g/km of CO_2. Nevertheless, the oil industry will face harder pressure than before in Europe for increased involvement in climate-change mitigation from the transport sector. This is likely to involve stronger pressure for involvement in the diffusion of biofuels, but may also imply some kind of burden sharing between the car and oil industry for the costs of maintaining the 120-g carbon emission target (*The Economist,* 7 December 2005).

It appears then, that the general hold-back of investments in biofuels can be explained by opposition to biofuels and possible problems in aligning such involvement with an overall upstream focussed culture. On the other hand, the driving forces working in favour of increased involvement are strong. More liberal markets combined with increased political pressure for biofuels will mean that oil companies refusing to invest may lose downstream customers and political goodwill.

[19] Wilhelm Bonse-Geuking, president of the European Petroleum Industry Association and head of BP's European business, told the *Financial Times:* 'Our industry is saying that we want no decision without a business impact assessment. All we propose and beg and request is let's do an assessment before we go down a certain route on biofuels.' (Mackintosh, 2005).

5.2 Explaining variation between oil companies

A range of interpretations could be given for the variation reported between the companies in bio-energy involvement. It is well documented that some of them – notably Exxon, Statoil and Hydro – are generally less diversified beyond the oil and gas supply chains (Eikeland, 2004b; Eikeland, forthcoming 2006a). Hence, bio-energy investments may simply have fitted less well with the dominant business strategies of these companies than with those more diversified companies like Total, BP and Shell. Also clear is company variation in attitudes and responses to the global climate-change problem (Skjærseth, 2005; Skjærseth & Skodvin, 2003). Whereas Exxon has persistently has refused to accept a connection between man-made emissions and climate change, BP and Shell have not only accepted the problem but also taken substantial steps towards establishing company CO_2-reduction strategies. This indicates that with less climate credibility to maintain, less reason will exist for taking a front-runner position in renewable energy investments, especially if such investments appear to offer fewer short-term profits than oil and gas investments.

The variation could, however, also be interpreted as dependent on how political driving forces affect the companies. The companies differ in geographical location of their headquarters and dominant business spheres, and may therefore have experienced variations in the strength of political and market pressures. The French company Total's early move into biofuels fits in with the strong political drive, abundant resource situation for bio-energy and high willingness to subsidise agriculture in France. The far more reluctant position of BP and Shell is in line with the reluctant position of the British and Dutch governments in providing biofuel support policies. As British and Dutch policies underwent changes in the direction of more support in late 2005, however, we may expect greater activity also by BP and Shell. In the Nordic area, the reluctance of the Norwegian companies fits in well with the rather hesitant position of the Norwegian government in renewable energy policy, compared to the case in neighbouring Sweden. And finally, Exxon's outright denial of renewables as an investment object is very much in line with the US administration's laggard position in the entire issue of climate change.

The companies may also have faced variation in market pressure for biofuels due to variation in geographical presence in downstream oil activities. Some companies have their core downstream business located in geographical areas that have seen strong diffusion of bio-energy, whereas others may be more shielded in core markets still lagging behind. Table 4 shows the companies' geographical distribution of oil product service stations in EU-15, plus Norway, indicating their core downstream positions in Europe.

Table 4. Oil-product service stations in selected OECD European countries, 2005

	BP	Exxon	Hydro	Shell	Statoil	Total
Austria	560	160	0	350	0	0
Belgium	0	300	0	330	0	500
Denmark	0	0	350	230	260	0
Finland	0	200	0	n.a.	0	0
France	575	780	0	1,000	0	4,500[c]
Germany	2,700	1,350	0	2,200	0	1,200
Greece	1,600	0	0	n.a	0	n.a.
Ireland	0	350	0	n.a.	180	0
Italy	0[a]	3,000	0	1,200	0	1,400
Luxembourg	50	30	0	40	0	30
Netherlands	400	350	0	680	0	600
Norway	0	350	400	400	560	0
Portugal	300	65	0	0	0	200[e]
Spain	600	80	0	314	0	1,740[d]
Sweden	0	0	600	727	600	0
Switzerland	420	270	0	450	0	0
United Kingdom	n.a.	1,200[b]	0	1,000	0	1,400

Sources: Company annual reports and web sites

a) BP had 300 sales agents for marketing of lubricants, marine and aviation fuels and chemicals in Italy.

b) Exxon figures in the UK in the range 1,100–1,300 according to various sources.

c) 2003 figures, down from 5300 in 2001,which indicates strong rationalisation

d) Of which 1,700 were CEPSA service stations

e) Of which 150 were CEPSA service stations

Comparing Tables 3 and 4, we see that Statoil and Hydro were considerably sheltered from political pressure, with their relatively low level of vertical integration in the oil supply chain and with their core downstream business sphere located mostly in countries characterised as laggards in transportation biofuel diffusion (Norway, Denmark and Ireland). The exception is Sweden, which has been a front-runner figure. On the other hand, much of Statoil's bio-energy operations have so far been directed towards the Swedish market.

Total's major downstream business sphere included France, Spain, Germany, Italy and the UK, of which the four former count as major biofuel-producing countries and the three former also as political front-runners. Equally clear patterns are harder to detect for BP, Exxon or Shell. The relatively late political response in the UK may certainly have postponed BP decisions. On the other hand, as we noted in section 3, BP was the major downstream oil product company in Germany, and much of the company's biofuel activity has so far been concentrated there. BP has had a more modest presence in Spain and France, other leading countries in biofuel diffusion, and has not been present at all in Sweden. Shell and Exxon, the most extensively vertically-integrated companies, have been affected in

some markets and more sheltered in others. Also Shell has had a high focus on Germany in its activities related to biofuel diffusion, reflecting the company's strong downstream position there. Exxon's laggard position does not fit well with the company's degree of market affectedness in Europe, so its position on biofuels is best explained by the company's general attitude to the climate-change question and its laggard position concerning investments in renewable energy more generally.

To sum up, some oil company-specific driving forces have been working against and some for increased involvement in production and diffusion of biofuels. Variation in involvement between the companies may be explained by variation in business focus (upstream vs. downstream focus), by attitudes towards diversification more generally, by response strategies to the climate-change issue, as well as by variation in political and business pressure caused by geographical differences in core business spheres. As of late 2005, political pressure for biofuels appears to extend geographically, which also means that variation in pressure between the business spheres will be reduced.

6 Conclusions

In this report we have discussed the rather hesitant response shown by most major upstream oil companies in Europe to the new opportunities in biofuels, and have also looked at inter-company variation in bio-energy production and sales by late 2005. We may conclude that there exist strong general driving forces for diffusion of biofuels at the EU level, in the form of various problems, directives and other policies converging towards diffusion of biofuels as a joint solution. At the EU member-state level, however, the driving forces have been less clear, due to large asymmetries in the national policies established for implementing EU policies. Nevertheless, by late 2005, most key member states appear to have adopted policies that will clear the way for growth in biofuel diffusion.

We have noted more specific driving forces and obstacles for involvement by major oil companies in biofuel activities. Inter-company variation in biofuel investments may be explained by variation in business focus (upstream vs. downstream focus), by attitudes towards diversification in general, by response strategies to the climate-change issue, as well as by variation in political and business pressure caused by geographical differences in the companies' core downstream business spheres. As political pressures grew more similar across the EU member countries in the course of 2005, variation in pressure on the companies tended to be weaker. Hence, as of early 2006, the driving forces working for greater involvement in biofuel diffusion appear stronger than those working against such involvement by the European upstream oil industry.

Thus, we must conclude that recent political changes at the EU and member-country levels have removed major obstacles to the diffusion of biofuels in Europe. This should increase the future prospects for bio-energy in Europe and the pressure on oil companies to choose biofuels as 'the new oil' to lubricate the diversification strategy for the renewable energy products so highly profiled in the past decade. It remains to be seen, however, whether the companies have the will and ability to balance their upstream oil and gas focus with greater attention to developing activities further down the energy supply chain.

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