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Biofuels: The European Experience

Melvyn F. Askew

INTRODUCTION

The trend towards national use of biorenewable resources is progressing with ever increasing impetus, involving all aspects of industrial production from biolubricants to pharmaceuticals and cosmetics to energy crops. Rate of change is variable according to geographical location and strength of political support or underpinning for initiatives or concordats. Common Agricultural Policy (CAP) involves some but not all crops producing such products. In European Union (EU-15) a number of legislative papers have been or are in the process of enactment. Their development process in EU-15 involves European Commission (EC), in effect the civil service of EU-15, drafting Proposals which, if agreed, become binding Directives. Member states then undertake to enact these Directives within their national legislative frameworks.

Bioenergy can be compartmentalized into heat and power units, which basically relate to electricity production and the liquid biofuels, for example bioethanol or biodiesel. **Feedstocks** vary but clearly primary emphasis needs to be given to economics and environment. Hence use of co-products (e.g. straw) gains enhanced significance, although new, specialist feedstocks from purpose-grown crops offer potential. In this latter instance the cultivation of short rotation coppice (SRC) using the willow (*Salix* spp.) has recently been rejuvenated. Selection of feedstocks may cause competition between different end users. Cereals or oilseeds both have end uses in the human food chain which are likely to have higher value than some of their potential non-food uses. Similarly there could be competition amongst end users within the non-food sector: wheat straw could be used for direct combustion, for paper making, or for bioethanol production.

Two pieces of legislation are discussed to exemplify the position of biofuels in EU-15.

ENERGY FOR HEAT AND POWER IN EU-15

Data presented in 1998 by EC showed that less than 6% of gross energy consumption came from renewables resources and that energy imports to EU-15 were approximately 50% and rising. EC proposed a 12% replacement of fossil energy use for combined heat and power (CHP) by renewables of all descriptions by 2010. In *Energy for the Future: Renewable Resources of Energy*, an EC White Paper, a strategy and action plan for the extension of renewable resources to achieve this 12% target was proposed. The position in terms of individual member states in EU-15 and production of heat and electricity from renewables from this White Paper is presented in Table 1. This White Paper also summarized renewable energy sources in 1995 and their projected share of the market by 2010 (Table 2). This data was further segmented to give separate analyses of current and projected markets for electricity in EU-15 (Table 3, 4).

The projection to produce a total of 135 million tonnes oil equivalent (mtoe) energy from biomass per annum is of course an enormously challenging task. If such energy was all from purpose-grown SRC it would require between 15 and 20 million ha of land (37.5 to 50 million acres). However a considerable proportion of this feedstock will derive from existing forestry, especially in Continental Europe where forestry occupies a much larger percentage of land area than in UK. Perhaps the greatest challenge will be integrating all of the biomass feedstocks into a meaningful supply and doing so in an environmentally sensitive way.

Table 1. Percentage production CHP from renewable resources by EU-15 member state.

	Production (%)	
Member state	1990	1995
Austria	22.1	24.3
Belgium	1.0	1.0
Denmark	6.3	7.3
Finland	18.9	21.3
France	6.4	7.1
Germany	1.7	1.8
Greece	7.1	7.3
Ireland	1.6	2.0
Italy	5.3	5.5
Luxembourg	1.3	1.4
Netherlands	1.3	1.4
Portugal	17.6	15.7
Spain	6.7	5.7
Sweden	24.7	25.4
United Kingdom	0.5	0.7
European Union	5.0	5.3

Table 2. Current and projected extent of renewable energy sources in EU-15.

Type of energy	Energy units	Share in the EU in 1995	Projected share by 2010
Biomass	mtoe[x]	44.8	135
Geothermal			
Electric	GW	0.5	1
Heat (incl. heat pumps)	GWTH[w]	1.3	5
Hydro	GW	92	105
Large	GW	82.5	91
Small	GW	9.5	14
Passive solar	mtoe	35	
Photovoltaics	GWp[y]	0.03	3
Solar thermal collectors	million m²	6.5	100
Wind	GW[z]	2.5	40
Other	GW	1	

[z]GW=giga watt
[y]GWp=giga watt photo
[x]mtoe=million tonne oil equivalent
[w]GWTH=giga watt thermal

Table 3. Current and projected generation of electricity from renewable resources in EU-15.

	Actual in 1995		Projected for 2010	
Type of energy	TWh[z]	% of total	TWh	% of total
Total	2,366		2,870[y]	
Wind	4	0.2	80	2.8
Total hydro	307	13	355	12.4
Large (incl. pumped storage)	(270)		(300)	
Small	(37)		(55)	
Photovoltaics	0.03	-	3	0.1
Biomass	22.5	0.95	230	8.0
Geothermal	3.5	0.15	7	0.2
Total renewable energies	337	14.3	675	23.5

[z]TWh=tera watt hours
[y]Pre-Kyoto

LIQUID BIOFUELS IN EU-15

A proposal to develop an EU-15 Proposal for a Directive was launched during 2001. This was fundamentally focused upon extending measures to promote liquid biofuels and was in essence the commencement of an EC strategy for security of energy supply. At the time of announcement of this initiative liquid biofuels in EU-15 were restricted to biodiesel production at a level of approximately 1 million t/annum (Table 5). Biodiesel is the generic title for esters of vegetable oils, the most commonplace being rape-methyl-ester (RME).

Whilst it seems likely that the long term objective will be for hydrogen-based systems to replace other liquid fuels, until then, more conventional biofuels are likely to develop. EC defined a number of liquid fuels in their paper *A Strategy for Security of Energy Supply*. They were: (1) **bioethanol:** ethanol produced from biomass and/or the biodegradable fraction of waste; (2) **biodiesel:** a diesel quality liquid fuel produced from biomass or used frying oils; (3) **biogas:** a fuel gas produced by the anaerobic fermentation of biomass and/or

Table 4. Current and projected heat production from renewable resources in EU-15.

	Heat production (mtoe[z])	
Type of energy	Actual in 1995	Projected by 2010
Biomass	38.04	75
Geothermal	0.40	1
Solar thermal collectors	0.26	4
Total renewable energies	38.70	80
Passive solar	--	35

[z]mtoe=million tonne oil equivalent

Table 5. EU-15: liquid biofuels production. Data sources: Eurostat.

	Petroleum products consumption	Petrol	Diesel	Biofuel (kt[y])	
Country	(transport) (ktoe[z])	(ktoe)	(ktoe)	1998	1999
Austria	5,923	2,130	3,224	16	298
France	47,237	14,554	26,063	319	344
Germany	61,351	30,080	24,834	100	130
Italy	38,647	17,880	16,138	96	96
Spain	29,401	9,018	16,215	--	50[x]
Sweden	7,288	4,021	2,374	--	50[x]

[z]kt=kilo tonne
[y]ktoe=kilo tonne oil equivalent
[x]Production in the year 2000.

the biodegradable fraction of waste that can be purified to natural gas quality; (4) **biomethanol:** methanol produced from biomass and/or the biodegradable fraction of waste; (5) **biodimethylether:** a diesel quality fuel produced from biomass and/or the biodegradable fraction of waste; and (6) **biooil:** a pyrolysis oil fuel produced from biomass.

National and international perspectives and opinions vary as to which of these should be developed but as a generality biodiesel and bioethanol are likely to be the main foci of attention as vehicle fuels. As indicated earlier biodiesel production is essentially alkali catalysed esterification whilst biethanol is a fermentation process, following a removal of lignin in the case of ligno-cellulosic feedstocks.

The EC initiative outlined above intends to produce a 20% substitution of liquid road fuels by 2020. This will be achieved in a series of milestones: (1) 2% of all diesel and all petrol by 2005; (2) 0.75% increments per year; and (3) 5% of all diesel and petrol by 2010.

These proposals offer huge potential to utilize primary crops as feedstocks, subject to cost; to exploit agricultural and forestry co-products; to change domestic wastes from being a cost to being a co-product of value. However in this last case in particular, some major logistical, economic, and environmental challenges must be overcome for success to be achieved.

CONCLUSION

Biofuels in Europe, as typified by European Union (EU-15), have been developing for more than a decade in both the solid and the liquid biofuels sector. The drivers for development have been diverse and often unlinked although all combine to give new uses for land, agricultural crops, products, or wastes. Considerable contribution to energy supplies can be made from forestry sources although the extent to which this occurs varies considerably from state to state. EU-15 energy policies are developing and "white papers" have set targets for achievement. These have a specified "biomass" component as well as wind, water photovoltaics, and other contributing components. An examination of such proposals, allied to analysis of other EU-15 policies (e.g. Common Agricultural Policy) and overlaid by wide overarching protocols and concordats (e.g. Kyoto; WTO) will explain how the current European position has been arrived at and those developments which are likely to come from it. It is to be noted that the regulatory/legislative systems in EU-15 run upon a two-tier system whereby the broad EU-15 regulation is implemented at member state level by national legislation. Hence the UK Energy Crops Scheme falls under European Council Regulations 1257/1999.

EC/EU-15 have developed ongoing initiatives to extend the use of renewables as energy sources. Whilst non-biomass renewables are significant in their potential contribution, biomass in all its forms has much to offer. The technologies for much of the processing needed for bio-energy production are well known and available but major challenges still exist in market organization, especially bulky feedstocks; in environmental and economic or fiscal terms.