Environmental Assessments of Transportation Biofuels in Europe: A Survey

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Structure of presentation

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2. Methodology
3. The European market of transportation biofuels
4. Environmental impacts
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Scope

To assess:

- the European market of transportation biofuels
- the environmental impacts of these biofuels

METHODOLOGY

For the study a search has been carried out in:

- sources of scientific evidence and information related to environmental impacts of biofuels
- data provided from several associations and governmental bodies (European Biodiesel Board, DEFRA, European Bioethanol Fuel Association etc)

TABLE 1: MAIN BIODIESEL PRODUCERS IN EU-27 (000 tonnes)

	2002	**2003**	**2004**	**2005**	**2006**	***2007***
Germany	450	715	1 035	1 669	2 662	*2 890*
France	366	357	348	492	743	*872*
Italy	210	273	320	396	447	*363*
Austria	25	32	57	85	123	*267*
Denmark	10	40	70	71	80	*85*
UK	3	9	9	51	192	*150*
Czech Rep.	-	-	60	133	107	*61*
Greece	-	-	-	3	42	*100*
Others	1	8	34	284	494	*925*
Total	***1 065***	***1 434***	***1 933***	***3 184***	***4 890***	***5 713***

TABLE 2: MAIN BIOETHANOL PRODUCERS IN EU27 (000 000 litres)

	2004	**2005**	**2006**	***2007***
France	101	144	293	*539*
Germany	25	165	431	*394*
Spain	254	303	396	*348*
Poland	48	64	161	*155*
Sweden	71	153	140	*70*
Italy	0	8	78	*60*
Czech Rep.	0	0	15	*33*
Others	27	76	79	*132*
Total	*526*	*913*	*1 593*	*1 731*

TABLE 3: TRANSPORTATION BIOFUELS CONSUMPTION IN EU-27 (2006-2007)
(TOE)

	2006	***2007***
Biodiesel	4 073 904	*5 774 207*
Bioethanol	871 673	*1 166 243*
Other	656 141	*753 617*
Total	*5 601 718*	*7 694 067*

TABLE 4: THE EUROPEAN MARKET OF TRANSPORTATION BIOFUELS (2007)

	Capacity	Production	Consumption
Biodiesel (000 tonnes)	10 200	5 713	6 481
Bioethanole (000 000 litres)	5 175	1 731	2 135

The European Market of Transportation Biofuels: capacity vs. imports

- The existing capacity is enough to cover the EE-27's needs for transportation fuels. However, a significant part of this capacity is idle.

- Instead, large amounts of transportation biofuels (especially biodiesel) are imported in Europe. In many cases, biodiesel is produced in an European country and then is exported to the USA in order to receive subsidies from the US government. Finally it is returned in the same or another European country (*splash and dash system*).

Environmental Impacts (continued)

The contribution of transportation of biofuels to greenhouse gas emissions and, therefore, to climate change is very doubtful and in some cases is negative due to:

- Complicated logistics needed for biomass collection and distribution and in biofuels distribution. In these systems conventional transportation fuels are used in common with biofuels

- Direct or indirect CO_2 emissions from the deforestation of land in order to be used for biomass cultivation. In many cases, this negative impact occurs in a long distance from the place where biofuel is consumed (Indonesia, Brazil, Malaysia etc)

Environmental Impacts (continued)

GHG emissions savings from rapeseed biodiesel

Reference	Emissions (Kg GHG/l biodiesel)	Benchmarking (Kg GHG/ fossil diesel equivalent of 1 litre of biodiesel)	Saving (Kg GHG/l biodiesel)	savings %
Levington (2000)	1.2	3	1.80	60
ADEME (2002)	0.65		2.35	78
El Sayed (2003)	1.3		1.70	57
JRC (2003)	1.75		1.25	42
DEFRA (2003)	1.1		1.90	63

Environmental Impacts (continued)

GHG emissions from bioethanol

Raw material	Country	GHG emission savings (Kg CO_2 / ha yr)
Bagasse	India	2 500
Wheat straw	Great Britain	3 000
Corn stover	USA	4 000
Molasses	South Africa	300
Molasses	India	2 500
Corn	USA	4 200
Sugar beet	Great Britain	10 500
Sugar cane	Brazil	28 000

Environmental Impacts

GHG emissions from bioethanol in a case of wheat (grain) cultivation

Kg CO_2-equiv/GJ of harvested grain

Cultivation system	**CO_2 fossil fuels**	**N_2O land**	**N_2O N fertiliser manufacturing**	**Total**	**CO_2 change of land-use**	**Total**
Cultivation on ‘‘normal” arable land	10	9.2	5.7	25	0	25
Cultivation on grass-covered mineral soil				25	11	36
Cultivation on grass-covered peat soil				25	210	230

Environmental Impacts (continued)

Variation in transportation biofuels LCIA results

There is a big variation in LCIA results for transportation biofuels. Reasons:

- The different way each system's limits are set
- The different biomass cultivation techniques
- The different biofuels' production methods and techniques
- Differences between local climates
- Direct or indirect changes in the use of land

Environmental Aspects (continued)

Transportation biofuels LCIA impact categories

IMPACT CATEGORY	Kaltshmit 1997, ethanol, sugar beet, wheat, potato, Germany	Puppan 2001, ethanol, sugar beet, winter wheat, potato, Germany	Reinhardt 2002, ethanol, sugar beet, wheat, potato, Europe	Hu 2004, ethanol, Cassava, China	Kadam 2002, ethanol, waste bagasse, India	Sheehan 2004, ethanol, corn stover, U.S.A	Tan and Culuba 2002, ethanol, agricultural cellulosic waste, Philippines	Reinhardt and Jungk, 2001, biodiesel, rapeseed, Europe	Kim and Dale, 2005, ethanol and diesel, corn, soybean, USA
Resource depletion	X	X	x	X	x	X	x	x	x
global warming	X	x	x		x	X	x	x	x
CO2			x	X				x	x
Acidification	X	x	x		x	X	x	x	x
SOx	X		x						x
NOx	X		x	X				x	
eutrophication			x		x		x		x
human toxicity		x			x		x	x	
CO			x	X					
PM			x	X					
eco-toxicity		x							
photochemical			x			x	x		
HC			x	X					
solid waste					x				
land use									
water use									
ozone depletion	x	x				x		x	
Odor					x				

Environmental Aspects (continued)

Transportation biofuels LCIA: land use as impact category

- Resource depletion and global warming are the categories most studied
- Land use has rarely been considered as an impact category
- When land use is considered as an impact category attention must be payed in the following parameters:
  - Definition of the system's boundary
  - Inventory data
  - Expression of land use impact indicators
  - Normalisation data expression

Environmental Impacts (continued)

OVERVIEW OF SOME INDICATIVE LAND USE IMPACT ASSESSMENT METHODS

Reference	Inventory			Indicators					Operational	
	Direct physical interventions	Land types	Resources	Ecosystem health (biotic natural and man made environment)					Characterisation factors	Normalisation factors
				Hemeroby	Biodiversity	Soil fertility	Hydrology	Exergy		
Brentrup et al., 2002		11 classes		Naturalness index					Yes	Yes
Lindeijer et al. (1998); Lindeijer (2000a, 2002); Weidema & Lindeijer 2001)					Vascular plant species density				Limited	
Lindeijer et al. (1998)		x								
Köllner, 2000; Goedkoop & Sprinsma, 1999		x			Vascular plant species density				Limited	
Milà i Canals, 2003	4 types					Soil organic matter			No	No
Cowell & Clift, 2000	Loss of soil mass		Soil static reserve life						Preliminary	No
Cowell & Clift, 2000	Added organic Matter					Organic matter			No	No
Cowell & Clift, 2000	Vehicle operation on land					Soil compaction			No	No
Heuvelmans et al., 2005	Water use		Dynamic water reserve life						No	No
Heuvelmans et al., 2005	Land use type						Changes in regional water balance		No	No
Wagendorp et al., 2006								Cooling capacity of an ecosystem	No	No
Muys & Garcia Quijano,									No	No
Mattsson et al., 2000									No, mainly qualitative description	No

Environmental Impacts (continued)

CO_2 EMISSIONS FROM TRANSPORTATION FUELS IN EU

- CO_2 emissions from road transportation fuels represent 71% of the total CO_2 emissions from transportation fuels in EU-27
- The second contributor is navigation transports followed by civil aviation and railways

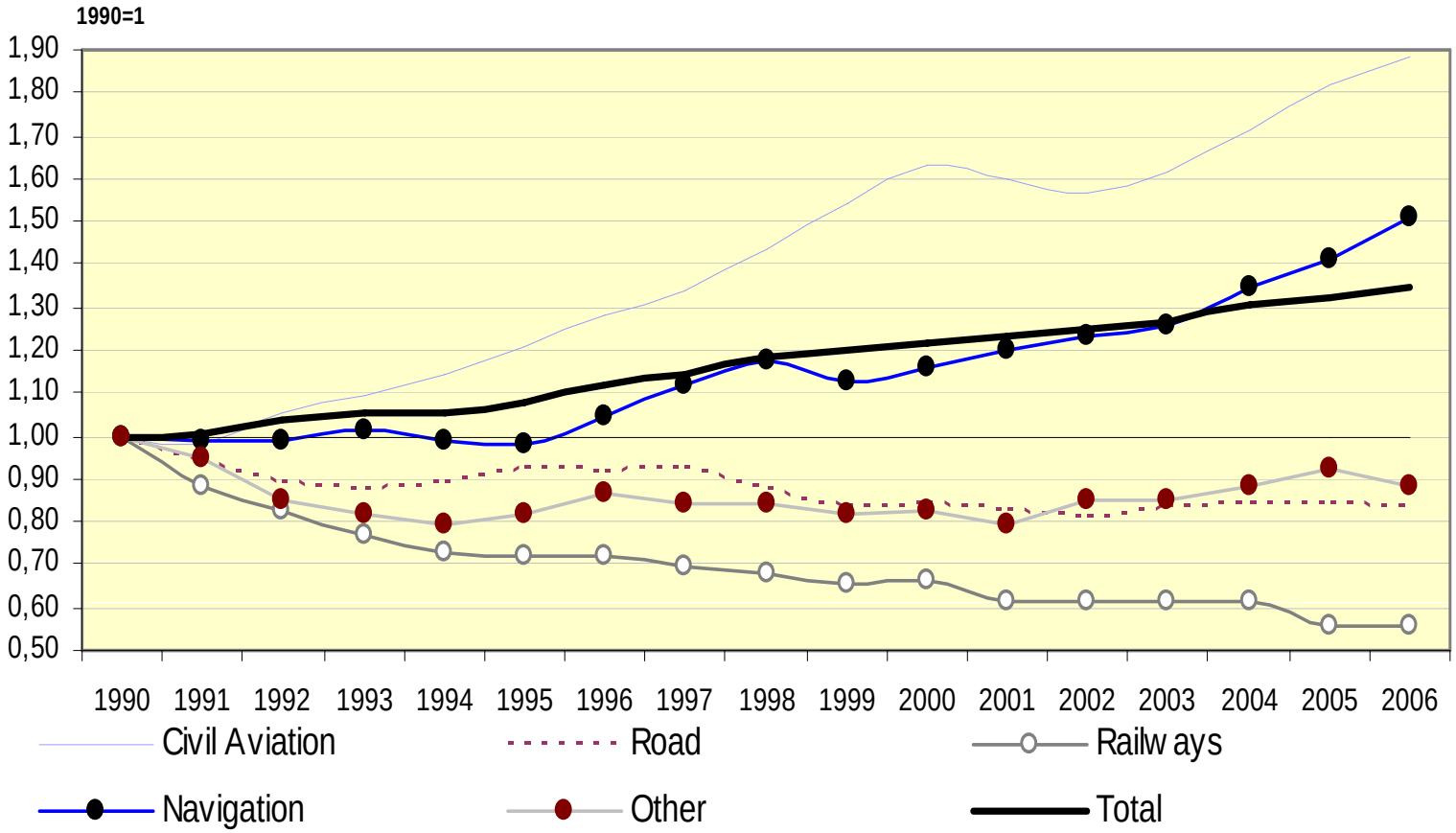
Environmental Impacts (continued)

CO_2 EMISSIONS FROM TRANSPORT IN EU-27 (2006)

	Road transportation	Navigation	Civil Aviation	Railways	Other	Total Transportation
CO_2 emissions (million tonnes)	902.0	194.6	155.4	7.8	10.1	1 269.9
% share of emissions of transportation fuels	71.0	15.3	12.2	0.6	0.8	100

Environmental Impacts (continued)

CO_2 EMISSIONS FROM TRANSPORT IN EU-27 (EVOLUTION)



CONCLUSIONS

- There is a requirement for an easy industrialized biofuel's production process from a sustainable feedstock in order to be achieved the EU 2020 target of 10% substitution of fossil fuels in transportations. Algae seems to be a good candidate (amongst others) for this purpose

- The introduction of biofuels' use in civil aviation and navigation could bring benefits in GHG emissions in Europe and globally

CONCLUSIONS (continued)

- Transportation fuels (biodiesel and bioethanol or their feedstock) imported in EU incur increased GHG emissions.They also incur “export” of some serious environmental negative impacts in the biofuels’ (or biomass’) countries of origin such as in the land use and ecotoxicity impact categories

- The more integrated a technological system of biofuels production the less the environmental impacts. This happens because the overall impact is subdivided and distributed to partial impacts for each product or by-product or process (as in the case of biodiesel production from imported in Europe palm oil, where palm residues are used to satisfy all thermal and electrical parasitic demands at a palm oil mill)

CONCLUSIONS (continued)

- There is a significant uncertainty in the parameters related to LCIA of biofuels. Results for end indicators of impact categories such as GHG emissions, resource depletion, eco-toxicity, land use etc are characterized by considerable uncertainty. Such uncertainty may be a consequence of a lack of understanding or knowledge or it may derive from randomness inherent in processes.

- It is important to note that all the environmental impacts of biofuels have an economic basis. Therefore each biofuels' LCIA must take into account the each time different values of parameters such as the transportation means of feedstock, their capacity, the average distance between biomass site and production plant, the productivity of the plant etc.

CONCLUSIONS (continued)

- The assessment of the land use impact category is insufficient. However, the examination of the sustainability of a technological system - such as the production and use of a biofuel - needs the evaluation of its performance in the land use category.

- Therefore, future LCIA studies of transportation biofuels must include the system’s performance in this category, at least in relation to some basic subcategories, such as biodiversity.

CONCLUSIONS (continued)

- Use of food products, such as vegetables or seed oils, as raw materials for the production of transportation biofuels is unacceptable from an ethical and rational point of view, taking into account that billions of people in the world are suffering from starvation.

- This is a political, not a market issue. The latter has led in the rise of market prices of food products, such as wheat, barley, corn, etc.

- In any case, certain limitation must be set by the global community to the use of food biomass for the production of transportation biofuels or, generally, for energy purposes.

Thank You

for your attention