PROCEEDINGS

Experts Workshop

3 - 4 May 2006
Brussels - Belgium

"Availability and Cost of Biomass for Road Fuels in EU"

Report on the Biofuels Availability Workshop,
3-4 May 2006, Borschette Center, Rue Froissart 36, Brussels.

Authors

R. Edwards	JRC / IES
V. Mahieu	JRC / IES
J-F. Larivé	CONCAWE
D. Ryckeard	CONCAWE
P. Rouveirolles	EUCAR / RENAULT
H. Hass	EUCAR / FORD

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European Commission
Directorate-General Joint Research Centre
Institute for Environment and Sustainability

Contact information
E-mail: infoWTW@jrc.it

http://ies.jrc.ec.europa.eu/
http://www.jrc.ec.europa.eu/

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INTRODUCTION

This workshop was convened by the European Commission's Joint Research Centre, Institute of Energy Studies at Ispra, Italy, in co-operation with CONCAWE and EUCAR, the co-authors of the joint European well-to-wheels study **[A3].**

The second edition of the well-to-wheels study was released in May 2006 and is available on the JRC web site (http://ies.jrc.ec.europa.eu/WTW).This contains detailed evaluations of energy and GHG balances, costs and availability for a wide range of alternative fuel/vehicle pathways. Compared with the first issue of the study, increased attention has been given to biofuel options, in view of the current high level of activity in this area.

A high degree of confidence has been established in the figures for energy and GHG balance related to current and future biofuels. Detailed estimates of cost and availability have also been made, using a careful methodology, and using the most accurate and reliable input data available. In the course of the study, it became clear that the estimated figures for biomass and biofuel availability vary widely between different published studies. Also, in our calculations, there were some input variables where little or no reliable information was available.

Consequently, it was felt valuable to gain input and discussion from other expert groups, including authors of other recent studies, to compare information, test the reliability of the assumptions on the JEC study (JEC: JRC-EUCAR-CONCAWE), and find new information to reduce the existing areas of uncertainty. Invitations to the workshop were issued with these objectives in mind. More than 40 people attended the workshop, including representatives from the JRC, EUCAR and CONCAWE, the European Commission, and a wide range of experts from several European countries.

The Meeting was chaired by Vincent Mahieu (JRC) and Robert Edwards (JRC), taking on the technical leadership of the discussion, assisted by Jean-Francois Larivé (CONCAWE), who are the authors of this part of the JEC study.

These notes record the main outcomes of the discussions, and new information that was offered by the participants.

The notes are structured in the same way as the agenda, covering the seven key areas where input data and methodology were to be evaluated. For each topic, there was an explanation by Robert Edwards of the JEC methodology, its rationale, and the areas where clarification was needed. This was followed by comments and discussion from the group. For background information on the questions discussed, the JRC explanation slides are attached in the report.

OUTPUT SUMMARY

There was a full and active participation by the attendees in the discussion, and several literature studies and new contacts identified that could help refine the estimates. These will be very helpful in the ongoing work of the JEC study.

Although some people were initially surprised by the availability and cost figures, there was very little disagreement when the input assumptions were examined. Differences between studies are mostly due to the different scenarios which were being studied: including or not including existing uses, time-frame, point on the cost-supply curve, use for biofuel or bioenergy/heat. In the case of biogas, the differences result from JEC study considering the whole WTW pathway (including distribution and use in the car) and not just biogas production.

Advice from the experts was that obtaining definite figures in many areas of data uncertainty data would be very difficult. No-one could improve directly on the input data used in the JEC study, although there were helpful suggestions for literature to be followed up. There remain some areas, such as the impact of land use changes, which are very difficult to assess.

Smaller scale follow-up meetings are envisaged to address specific topics:

- JRC plans a workshop of invited experts on straw availability in October 2006

- During 2007 (tentative) digestible wastes, wood.

1. *Soil Carbon Release.*

- **Can we refine our estimates of the GHG payback time for biofuels crops grown on former grassland ?**
- **Can we define some areas of EU where the soil carbon effects of expanding biofuels onto grazing land would be acceptable from the soil C point of view ?**
- **What are the soil carbon implications of growing dedicated energy crops (wood farming, miscanthus, switch-grass…) on present GRASSLAND or conventional forestry land ?**
- **What proportion of the carbon in forest residuals would be sequestered in forest soils, if the residuals are NOT removed?**

1a. SOIL C LOSS DUE TO CHANGE IN LAND USE

- e.g. change from grassland to arable biofuel crops:
  - one-off, but **large**, release of soil C
- (woodland is between grassland and arable land)
- Huge uncertainty
- USUALLY IGNORED in WTW studies

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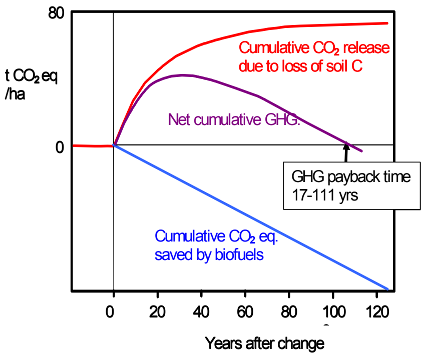


1b. Rough estimate of GHG payback times for biofuels on EU grassland

GHG payback time (years) = $\frac{CO_2 \text{ released from change in land use}}{CO_2\text{-eq. saved per year by biofuel from the crop}}$

- Expansion of EU area for crops would come mostly at the expense of grassland
- **CO2 released from change in land use**
  - "IPCC 1996: revised guidelines for national GHG inventories/reference manual" seems to recommend assuming a reduction of 20 tonnes of C/ha = **73 tonnes CO2 /ha** (in top 30cm of soil) **going from grassland to crop-land**.
  - ECCP came to the same conclusion, also for forest-to-crop-land
  - ECCP say "+/- >50%"
  - (Rothamstead data suggests the change takes about 20 years)

CO2-equiv saved per year by biofuel from the crop =

(crop yield: tonnes/ha)x(GJ biofuel / tonne biomass)x(CO2-eq. saved per GJ biofuel)

EU average yields (but actually it would be much lower on marginal land)

most common biofuel process-yield, from WTW survey

WTW result for most common biofuel process, from WTW survey

1c. Rough estimate of GHG payback times for biofuels on EU grassland

Crop	Feed Wheat	Sugar Beet	Rape seed	Sun flower	Farmed wood
Example pathway	WTET1	SBET1	ROFA1	SOFA1	WFSD1
EU av. yield (t/ha)	8.0	61.2	3.0	1.8	11.1
GJ biofuel per ha per year	73	124	42	27	76
GHG saved per GJ biofuel (kgCO2eq/GJ)	9	36	36	58	64
kg CO2eq. saved per ha per year	660	4429	1505	1545	4806
Total C stock change as tCO2/ha +/-50%	-73	-73	-73	-73	0 to -73
Years for GHG to break-even +/-50%	**111**	**17**	**49**	**47**	**0 to 17**

- order-of-magnitude estimate
- very approximate figures for soil carbon
- no account taken of geographical variations in soil carbon stock, etc.
- can't grow rapeseed every year
- ? soil carbon under SRF and energy crops…..

Change from grassland to arable crops gives a one-off, but large, increase in carbon emissions. Depending on conditions, JRC estimates it could take 17-111 years of biofuel production to offset this emission **[A3]**. The wide variation reflects the uncertainty in the science. However, considering that even the lower limit gives a quite a long payback time, the JEC team chose not to consider converting grassland to grow biofuels.

If planted on arable land, SRF or miscanthus are reported to increase soil carbon. However, they will probably still reduce soil carbon to some extent if planted on grassland. ECCP assumes equilibrium soil carbon stocks are similar for grassland, forest and perennial crops. However, recent data from Ispra soils measurements show that 40yr-old poplar plantations have soil carbon levels closer to arable land than to that in nearby natural forest.

Brazil sugar cane (a perennial crop) is claimed to increase soil carbon in the pasture land onto which it is liable to expand.

Discussion

It was clear from the discussion that this is a challenging subject, and none of the guests felt really expert in this area. (several invited soil experts were absent at a simultaneous but unannounced ECCP meeting).

NREL May have data on energy crops. US people working on soil. Maybe worth investigating. Shell **(**A. Voss) can help with references **[A1][A4][C2][C3]**

Wageningen (Alterra) are the experts in EU.

Noted that permanent forest slowly sequesters some carbon (Ispra heard a figure of 20% of forest residuals end up sequestered). The rest decomposes if not removed. This would have impact for forest residues (considered later)

- METLA commented that there are GHG emissions at the beginning of composting process. Soil type also important.

R Fritsche noted that residual wood removal is important for fire protection in southern areas.
Recent workshop on this (Spain).

Paul Hodson (DG TREN) noted the need for scientific facts to back up what should be done with grassland. This has practical importance for the Biofuels Directive if 'certification' is introduced to encourage the most environmentally beneficial biofuels. Need for information on imported products, for example palm oil, as well as EU produced biofuels. He also asked what would happen if meat production moved to developing countries.

Mr Fritsch noted the trend towards conservation goals in directing land use; there may be potential for a 'mid-way' approach where conservation can be combined with some energy extraction.

The soil carbon release seems to be related to the initial ploughing of grassland, so methods that avoid ploughing could mitigate the impacts. However, the overall impression of the discussion was to urge strong caution before bringing grassland (or forest) into biofuel production.

Alterra (B Elbersen) explained that the term 'grassland' generally refers to long-term pasture, so carbon release effects need to be taken into account. Short term leys are usually included in arable land.

2. Bio-energy Crops (SRF, switch grass, miscanthus, herbaceous)

- **What data is available on the current yield of bioenergy crops compared to cereals grown on the same land?**
- **How much improvement in yield can we expect in the future?**
- **In some regions water is the limiting factor. How can we deal with this?**

The JRC methodology compares yields of different energy crops with the yield of cereals from the same land. This is because yields vary enormously from area to area (e.g. factor 7 for fields sown with wheat in EU), and trials of SRF on different soils in Germany showed factor 29 yield variation. This means that “average yields” are usually meaningless. However, the *ratio* between yields of various crops are much less variable and a better parameter to use. Since over 86% of EU arable land is currently used for cereals, cereals yields make a large and reliable basis. This is important because energy crops will tend to be grown on poorer soils than food crops (e.g. farmers set aside their less valuable land).

This method was used in the estimates of availability of crops in JEC WTW analysis.

Although there are many reports on the attainable yields of new energy crops, almost none of these states what cereal yield would be attained from the same land. More information is needed on yields for alternative crops (compared with cereals).

In the JEC analysis, for short-rotation forestry the ratio of dry wood yield to conventional cereals yield was taken to be 1.57.

Alterra provided information on grasses (see ref A5). This estimates energy crop yields under real farming conditions, for good medium and poor soils in different climate regions in EU. More work is needed to correlate this data with cereals yields.

B. Kavalov offered to forward data from the US that may be helpful. Alterra noted that for any comparison to be meaningful, climate conditions need to be similar. P Klintbom advised that the RENEW report included figures for individual countries **[A6]-** RE noted that the report does not give the cereal figures for comparison: PK will get these from the contractor. DG TREN commented that biomethane processes can use a wide variety of feed materials, and this could open up some new crop opportunities. Overall there is a broad range of plant options available but R&D is needed to best match crop and climate / water availability. By its nature, such work can take considerable time.

NOTE: VIEWLS were not able to attend the meeting, but they use the same contractor and similar methodology to RENEW. The approach is to look at available hectares, then choose suitable crops - opposite approach to JRC who looked at cereals as a reference, and then compared these with other crop yields.

Alterra commented that water availability is a limiting factor in the south. A project is under way in Spain to assess crop suitability and potential in these conditions. L. Knur advised that in dry regions trees can be grown in areas where arable crops cannot (deeper roots). Brandenburg University has a study on Robinia yields versus water availability. B. Kavalov mentioned a report from CRES (Greece) that calculated yields as a function of water supply - Alterra will send what is available. JF. Larivé noted that if irrigation is needed, the associated energy needs affect the WTW balance. Reports on water availability are available (Alterra, P Boisen).

A study of Prof Venturi (Univ Bologna) was briefly presented. It discusses recent trends of increased temperatures and projects higher incidence of drought in Mediterranean areas. Alterra believe irrigation of energy crops is unsustainable, but a positive feature of dry climates is that the biomass requires less drying.

A further study, from J. Fernandez, (Univ Madrid) discusses yields in Spain for different crops, with and without irrigiation, including Cynara (a thistle type crop that tolerates dry conditions).

Mr Fritsche advised study of 'double cropping' where immature crops are harvested twice per year to increase biomass yield. He believes biogas deserves more attention (because of its flexiblity with respect to feed material). Biogas is also believed to give the highest yield per hectare, and residue can be returned to land to preserve fertility.

3. Forest Residuals

- **What are the ecological limitations on collecting forest residuals?**
- **Should we ever take stumps?**
- **Is it OK to cut whole trees for energy?**
- **How much of the residuals outside Scandinavia could economically be brought to plants of 100- 200 MW scale?**
- **Is it true that the wood industry uses all its waste already?**
- **How can we deal with imports?**

The METLA study is considered as the major reference, and is the basis for the JEC study. METLA estimates forest residuals (branches, tops..) from felling for non-energy use, together with additional ("complimentary") felling for energy use.

- However, note that METLA estimate the *total* wood available for energy, including that already used. JEC looks for the *additional* quantities that could be used *economically* for *conversion to transport fuels*.

To assess wood residuals availability, JRC looked separately at:

1-availability of forest residuals at pulp mills, where it can be converted to transport fuel by replacing the black liquor which is gasified.

2- rest of wood availability from forestry, for which autonomous conversion plant would be needed to make transport fuels (e.g. Choren-type gasification and synthesis or wood to ethanol).

Our assumptions on top of METLA

1. BIOFUELS VIA BLACK LIQUOR GASIFICATION

- Forest residuals (or complimentary fellings) replace black liquor which is gasified for electricity or biofuels production.
- Comparing 2012 black liquor production country-by-country with METLA availability shows extra feedstock supply could cover up to ~90% EU black liquor production, without imports.
- [METLA 2004] and [Lundmark 2005] cost-supply curves in Finland and Sweden
- about **2.8 €/GJ** for this supply volume

= 325 PJ/year available for Black liquor routes to biofuels or electricity, at about 2.8 Eur/GJ wood (spreadsheet)

METLA says EU total **1008 PJ/year** of forest residuals + complimentary fellings

2. SO 683 PJ LEFT OVER FOR AUTONOMOUS PLANTS

- METLA says cheaper in Poland …and other New Member States(?)
- much more expensive in France …and other EU15 states (?)
  - Need a price like farmed wood, about 4.1 €/GJ to collect most of the residues
- **Dispersed: maybe 30% (??) available at the large plants needed to make liquid fuel synthesis economic (130 MW)**
- MUCH MORE AVAILABLE AT SMALL-SCALE PLANTS FOR HEATING OR CO-GENERATION

The JEC study links availability to cost of residuals. In Finland there is the world's largest power station fired with forest residuals collected in association with wood felling for a nearby pulp mill. They report a delivered cost of €2.8/GJ for forest residues, and METLA and [Lundmark 2005] costings confirm that 90% of the forest residues required for the replacement of EU black liquor could be obtained at this price.

JEC assume that 30% of the remaining forest residuals could be brought to large plants (and hence converted to transport fuels). This is based on a study for straw - wood transport likely to be more difficult.

Antti Asikainen outlined the METLA study **[A7]:**

> There is energy potential in branches and roots that are not currently used for saw-wood or pulp production. In addition, annual growth exceeds annual cut, so more trees can be felled. EU felling residues were estimated to total 173 Mm^3 annually, of which 63 Mm^3 would be technically available. In addition 9 Mm^3 stumps out of a total of 78 Mm^3 could be collected. Assuming 25% of the excess growth in commercial forests could be cut for energy, METLA arrive at a yearly total wood-for-energy of 140 Mm^3 (= 56 Mtonnes oven-dry-wood = 280 TWh = 24 Mtoe).
>
> These figures include current use, but do not include traditional firewood or industrial/secondary wood. Resources are not evenly distributed. Retaining some net growth may be desirable for ecological reasons.
>
> Current costs of wood are in the range € 15-30/m^3 (figures for Finland, Poland). Costs are influenced by competing markets - an interesting chart of cost versus availability for wood chips is included in the presentation. Large installations in Finland pay € 20-22/m^3,= € 50-55 /dry tonne = € 2.8-3 /GJ) but need a subsidy to survive. Finland and Poland can also find supplies at this cost, but in NL and France prices are higher. Key factors are labour costs and distance for transport.
>
> A critical factor in how much residual wood can be removed is the nitrogen balance of the soil (most important for northern areas, but it varies even within countries). If branches and needles are left, balance is OK, otherwise there is a short term shortfall (made up longer term by rainfall). Recycled ash can be used in some cases to restore nutrients to the soil, however Finland expect that a relatively small percentage will be recycled in this way. Fly ash should not be recycled because of potential heavy metal content, but grate ash is OK.

Lisa Knur (Eberswalde) noted that a certain amount of dead wood was needed for nature protection. On the other hand, leaving the residues in the forest could encourage insect pests and also forest fires; however METLA commented that this is not a problem with residuals left on the ground; where piles of biomass are stored, spring gathering should be avoided, otherwise it is not a problem - he felt that stumps might be more of a risk. Mr Fritsche warned that care needs to be taken; some exploitation may not be ecologically sound.

Choren noted that all the residues could be handled in a gasification process (no problem with high ash contents i.e. up to 3-5%). For cellulose to ethanol, some initial sorting might be needed (current focus of this process is corn stover, but Sweden are reported to be looking at sawdust).

The question of whether roots/stumps should be taken is complex, as it increases the risks for soil erosion and can release soil C. Some stumps come from non-forestry sources (e.g. road construction) or to prevent root rot transfer. Initial soil disturbance is significant, but after 1 year no different from normal soil preparation. In Germany, removal of roots is not allowed in 'certified' stands. Finland considers there are limitations in natural forest but it should be OK in SRF. Soil type is a factor - light soils are easier to handle, need to avoid pebbles soil in the recovered wood. One can leave some of the material for nutrient, but this is more expensive. There is not a lot gained by extracting the whole tree.

Whether whole trees will be cut for energy depends on the circumstances. METLA's estimate that 25% of trees could be harvested in this way is purely judgmental. There are ecological issues: root removal, gradient on soil (erosion), dead wood.

Price will govern: harvesting roundwood is more costly but it is typically worth 30 €/m^3 versus 10 €/m^3 for energy-quality wood. Quality of wood is important, e.g. pine is not good material for pulp. Much of forest is in small parcels, hence not easily available.

How much residue outside Nordic countries could be brought to market: a 200MW wood to fuel plant needs 0.5 Mt/a of wood. Pre-treatment (pyrolysis) could help transport to a central plant, but the cost of doing this makes it unlikely. The wood can be gasified directly, so there is not much gain.

A. Voss offered information on how much wood industry waste is already used. **[C4, C5]** Distinction needs to be made by what already goes to the wood mill (which is all used) versus what additional material could be gathered if needed. L Knur advised that mills use bark for heat and have fixed contracts with fibre-board industry for other residues. Choren advised that in Germany, all residues are used, application depends on price; particle board industry is struggling - however more resource exists in Eastern countries. From Russia is a realistic possibility also from Ukraine, Bielorussia.

NOTE: 'Residue' is a definition: e.g. bark separated in forest is a residue, but if it is separated in the plant it is classed as sawmill waste.

Question raised around imports: are they ecological; are they sustainable?

METLA considered that this was not so much an issue, it was more a security of supply question. It is cheaper to import from Russia than use local product. Choren believes that imports will continue to be important, but from a broader country base. They commented that at bio power plants in NL, 60-70% of the biomass is imported from outside Europe.

Will subsidies or high oil prices help? Survey of smallholders in NL showed they were not interested in engaging because of very limited economic benefits.

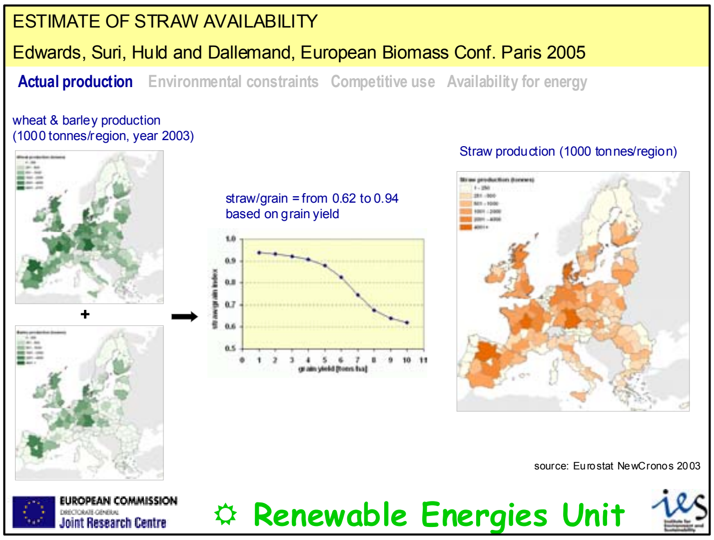
Forestry Stewardship Council (FSC) labels were discussed. The conclusion was that even if they are used is, the FSC requirements are not sufficient to assure sustainability.

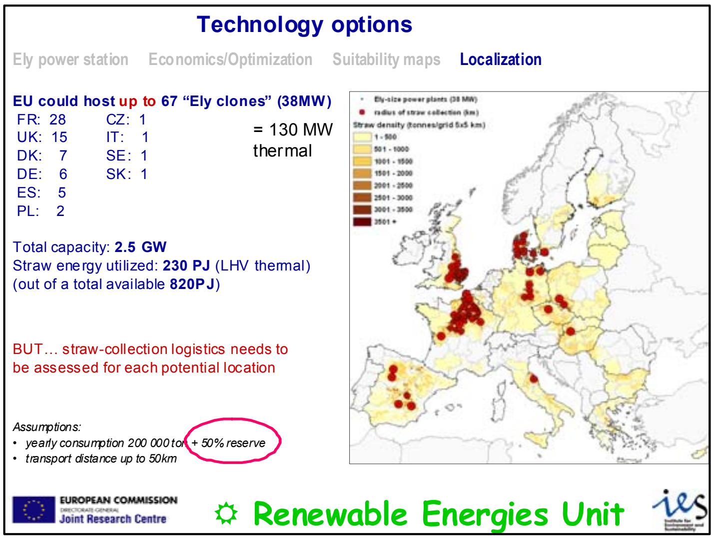
Where are residuals being produced in EU? EEA already have a good GIS database on which one could build. However, this is not yet published in their reports **[A2].**

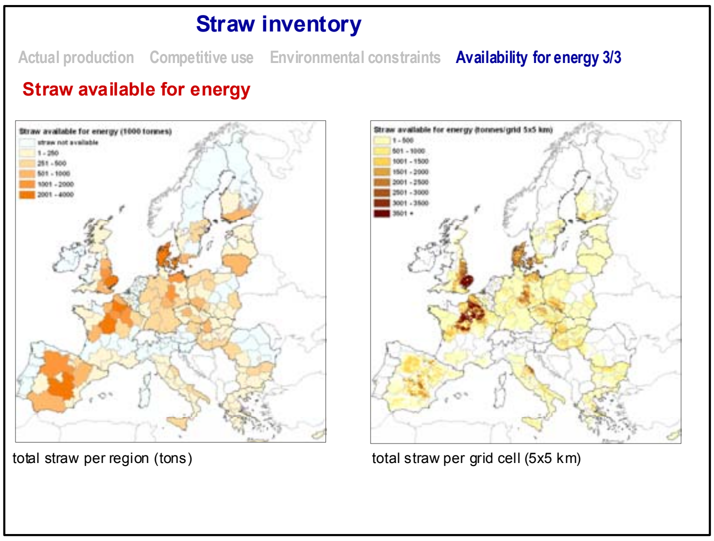
Small-scale heating or CHP plants could utilize more of the potential resource than biofuel plant, but there is an issue of pollutant emissions from small scale installations.

4. Straw and other Agricultural Waste

- **In practice, how much reserve of supply would a large waste-consuming plant require, to ensure security-of-feedstock-supplies?**
- **How much waste is available besides cereal straw?**
- **Is there any justification for considering wastes which are used for animal feed?**







JRC **[A9]** starts with grain yield then predicts straw availability from grain/straw ratio. Problem is that resources are dispersed. JRC looks at the potential to reproduce an 'Ely' type straw power plant (38 MWe, 130 MW_{th}). Based on straw availability at a competitive price, up to 67 Ely clones could be built (France and UK have biggest opportunities). Calculation assumes a 50% reserve of straw availability to assure supplies: the existing Ely plant has a larger reserve. These plants would use about 30% of the available straw capacity (much is already used e.g. for cattle rearing). If smaller plants could be made cost-effective, more of the straw could be used. By comparison, a BTL plant would have to be big, so opportunities more limited.

Mr Fritsche advised that a dedicated straw power plant is not viable, and co-firing is a more promising approach. Also, logistics may not be such a problem: e.g. in USA material is transported long distance; large plants can import. A. Voss advised to distinguish those processes that need a dedicated feedstock versus those that are more flexible (this affects the amount of reserve that is needed).

Regarding other wastes, P. Boisen advised that 25 Swedish cities have biogas plants using a range of feedstocks - in principle any waste can be used. D. Rickeard asked about waste oils for biodiesel production (e.g. cooking oils, fish oils etc). Hydrogenation processes may overcome product quality concerns of these resources. Longer term, there may be interest in using wastes that are suitable for animal food. Choren have been approached by RME plants who believe the market for animal feed may become saturated.

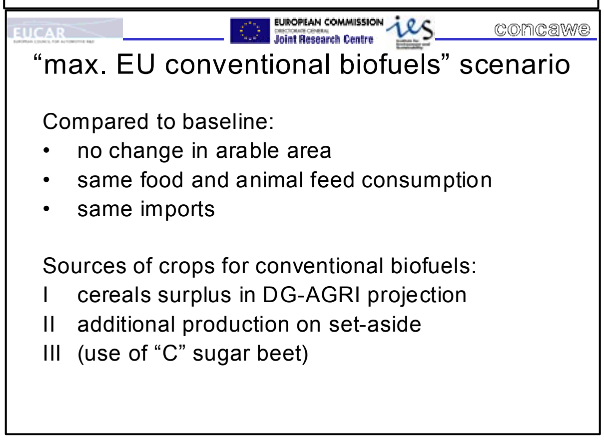
5. Agricultural Crop Potential, Prices, Market / Imports Effects

- **How much crops could be grown on rotational and voluntary set-aside land ?**
- **Are there better estimates for the market flexibility of cereals and oilseeds ?**
- **How much do transportation and shipping costs influence the calculations ?**
- **What are the rotational and land-suitability limits on rapeseed, and other oilseed, production in EU (for e.g. 10% increase in price?) ?**
- **How will yields increase beyond 2012 ?**

	ACE[(1)]	Crop		Ethanol	Biodiesel
	Mt/a	Mt/a	PJ/a	PJ/a	PJ/a
I Diverted baseline cereal exports:					
From land released by sugar reform	9.3				
Fom improved yields	14.9				
II Maximum extra cereal from set-asides[(2)]	22.9				
Total spare cereals	47.1				
To feed-wheat for ethanol	22.4	25.4	376	202	
To oil seeds	24.7				
Equivalent oil seeds[(3)]	⇩				
Rapeseed	19.8	12.5	298		174
Sunflower	4.9	3.4	80		50
III Ethanol from "C" sugar beet		8.0	31	16	
Existing crops for energy in baseline[(4)]					
Rapeseed		5.6	133		78
Cereals		1.5	22	12	
Total				**230**	**302**
Gasoline/diesel market coverage				**5.75%**	**3.4%**
Total road fuel market coverage				**4.2%**	

[(1)] Average Cereals Equivalent (our measure of arable capacity)
[(2)] Excluding biofuels already grown on set-asides
[(3)] Assumes 80/20 rape/sunflower
[(4)] i.e. in the baseline scenario, including those grown on set-aside

•***Table 5.2.3-1 Upper limit of conventional biofuels production from EU crops in 2012, with set-aside abolished.***



The JRC analysis for JEC WTW study is based on the 2010 scenario from DG AGRI **[A8]**, and assumes no change in arable land area, same food, animal feed production and import volumes as today. The potential additional biofuel production comes from the cereals surplus, set-aside land and the use of non-quota sugar beet. For today's biofuels, JRC calculate that 4.2% of the road fuel energy could be made from biofuels in this way. Enough ethanol can be produced to meet the 5.75% indicative target, but oil seeds are limited, so that the maximum FAME production is estimated at around 3.4%.

Wolfgang Munch (DG AGRI) expanded on the background to the 2010 scenario. The scenario takes account of expected GDP and population increases and yield progressions.

He noted that growth in yields has recently been slowed by environmental requirements such as fertiliser limits. Real agricultural prices have declined since the 1980s, and this also impacts yields.

Supply flexibility (how much supply increases in response to a demand increase) is more important than demand flexibility - but there is a wide range of figures and more precision is needed. The impact of increased biofuel production on cereal prices is expected to be small, because there is a large global market. For oil seeds, precise estimates are difficult, but the price increase could be limited to around 10% provided imports are allowed to contribute to the total demand.

Regarding the estimates for biodiesel potential, Mr Munch cautioned that even meeting the 3.4% figure for FAME is optimistic, since it relies on frequent rotation of rape seed to achieve these volumes, pushing the agronomic limit of 1 in 3 or 1 in 2 crops. Such rotations are already happening in practice, but the recommended limit to avoid environmental problems is 1 in 4. If this were applied, the potential production would be lower. Rapeseed is restricted to northern Europe, with a total potential of 1-2 Mha. France believes is can expand by around 1 Mha, but Germany is already close to its limits of production. The north and west of Poland also has capacity to expand production. RE advised that the realistic scenario given the present trading rules is that most of the additional amounts of oil seeds needed will come from imports. EBB's estimate of potential production seemed at first rather higher than these figures, but on examination were not very different once figures were converted from tonnes of seed to tonnes of oil. Mr Munch commented that rape seed yields are currently rising faster than cereal yields.

P. Hodson (DGTREN) noted that the current EN14214 specification favours rapeseed oil only, and encouraged changing this to broaden the range of oils that can be used. However, DG-TREN is concerned that imports should not be produced in an environmentally harmful way (this will be addressed in the Biofuels Directive Review). DG-TREN's policy is not necessarily to maximise European production, and imports are seen as part of the total picture.

EBB commented that about 60-70% rapeseed oil is needed to meet EN14214. In 2005, about 13% of the rapeseed demand came from imports (1.6Mt). RE noted that there is also substitution from the food market which will be back-filled by imports, so the effective proportion of imports will be higher. Almost half EU food-oils are already imported.

Mr Heinz (DG-TREN) asked if biofuels increased rural employment. JRC replied that the answer depends on whether the biofuels crops are produced in replacement of food crops (reducing cereals exports) or on former set-aside land. In the former case the benefits would be caused only by the changes in crop prices, paid by the consumer. DG-AGRI stated that the effect is small, since the amount of labour needed does not vary much between different crops. Secondary effects might be more important. If farm incomes increase this could feed back into the broader economy. Also there could be some impact if set-aside land is brought back into production.

The development of yields after 2012 is an important question. If yields increase, less land is needed to meet food needs, so more is available for energy crops. Studies often extrapolate yield increases. Since the rate of yield increase is generally slowing with time, the result depends on the length of the extrapolation period. For example German groups **[A4]** assume increases of 1.5 to 3% per year in different EU countries. IEA use a generic figure of 0.8%pa whilst JRC follows DG-AGRI, who believes 1.5% is possible for oils seeds, lower (about 0.6%) for cereals.

A. Voss asked how yield affects the WTW figures. RE advised that geographically, higher yield fields generally need more fertiliser, so the effects broadly cancel out. However, DG AGRI commented that part of future yield improvement would come from better seed varieties with shorter production cycles and better pest resistance - this would give small incremental WTW gains over time.

Mr Munch noted that it was necessary to look at the whole crop rotation. How this is covered in the JEC study (e.g. increased cereal yield following an oil seed crop) is explained in the WTT report. Berian Elbersen (Alterra) called for the overall situation to be considered: demand for energy crops would lead to intensification of agriculture. EBB commented that energy crop production was no more energy intensive than food production.

6. By-products Issues

- **How much DDGS can the EU animal feed market absorb ?**
- **How much oilseed cake can the EU animal feed market absorb ?**
- **What would be the effect on prices if the biofuels directive targets are met ?**
- **What about alternative uses ?**
- **How much does exporting it cost ?**
- **What are the effects of the Blair House agreement ?**
- **What would happen to the extra glycerine production ?**
- **What price would raw glycerine reach ?**

The JEC study takes account of by-product impacts using a substitution methodology (allocation techniques, by their nature, cannot provide reliable estimates). Animal feed (DDGS from ethanol production, oilseed cake from biodiesel production) is a major by-product and must be properly accounted to understand WTW energy/GHG effects and costs. Meeting the 5.75% indicative target with conventional biofuels would generate enough by-products to supply approximately all the requirements for EU protein feed, if that were possible from the point of view of animal nutrition. The extra production would be equivalent to about 15% of the world oilseed cake market, so there would be a large decrease in price.

T. Gameson (Abengoa) noted that renewable electricity is another potential use for by-products, and demand for this could impact prices. In some cases the by-products can be the most valuable product. There was no disagreement with this overall evaluation.

Exports could provide an outlet for surplus production, provided the markets are open. Abengoa noted that DDGS is transported over long distances in Spain, so export should be no problem (provided the DDGS is properly dried). P. Boisen noted that the flexibility of biogas pathways offer a further outlet, but others were not convinced the cost would be justified. METLA estimated that the value for energy use is around €50/tonne, based on an LHV of 16 MJ/kg, and by comparison with prices currently paid for wood. This is lower than present animal feed prices, but more than is paid for digestible waste.

JRC referred to the Blair House Agreement which is intended to protect US soya bean growers against subsidised oil-seed cake produced on set-aside. The agreement limits subsidized *production* on set-aside land but does not mention subsidized *consumption* of the oil. At present biodiesel prices it is not necessary to subsidize rapeseed production. Therefore it would appear that the agreement does not prevent expansion of EU rapeseed production for biodiesel.

Glycerine is an economically valuable by-product of FAME production. Where it is used to substitute synthetic glycerine it also makes a good contribution to the WTW balance, since synthetic glycerine requires 18 times its own energy to produce. However, biodiesel-glycerine is less pure, and purification costs €80/tonne. Synthetic glycerine production is now virtually stopped, and if biofuel production increases there will be a large excess. Over 2005, glycerine prices fell from €200/tonne to €130/tonne, however the market is naturally volatile, and too much should not be read into these figures.

The JEC study considers that substitution of synthetic glycerine is no longer a realistic scenario, Furthermore, vegetable glycerine is produced as a fixed ratio by-product of soap and detergent production. Therefore it cannot be replaced either. The study therefore considers two alternative options: as process chemical feed (largest GHG benefit) and as animal feed (smallest GHG benefit). EBB mentioned a process to convert glycerine into a gasoline component (as an ether). However this is still at the laboratory stage.

Dr. Angelika Voss (Shell Global Solutions International BV) reported after the workshop:

HOUSTON (ICIS news)--Breakthrough technology to convert natural glycerine into propylene glycol could be a commercial reality this year, research leader Galen Suppes said on Thursday.

Natural glycerine is a substantially cheaper feedstock than petroleum. High oil prices have driven the price of propylene glycol and other petroleum derivatives for industrial uses to above $1/pound while natural glycerine prices range from the low-30s to mid 40-s cents/pound, according to global chemical market intelligence service ICIS pricing.

Suppes, a professor at the University of Missouri, said the conversion rate is about 75% efficient in mass yields - a high rate for most chemical processes - with water as the only unavoidable by-product.

He said the natural glycerine feedstock could be of either vegetable or tallow origin. Suppes said the process technology might be used at existing glycerine refineries if they have hydrogen on site.

The process makes propylene glycol that is bio-based, non-toxic, and from renewable sources. The propylene glycol market is estimated at 150m pounds/year globally, much of which is demand for antifreeze.

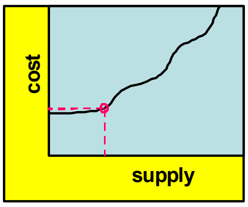
On Tuesday the Soap and Detergent Association and the National Biodiesel Board gave Suppes and his University of Missouri research team the 2006 Glycerine Innovation Award. It was the first time the two groups cosponsored the award.

7. Compressed Biogas: Manure and Organic Waste

- **What is the reference scenario (what happens without compost biogas) ?**
- **Is economical compressed biogas production capacity limited by the availability of organic waste accelerators ?**
- **Is it economically viable to produce biogas from crops ?**
- **How much animal manure in EU is produced in areas of high animal population density; suitable for large economic compressed-biogas plants ?**
- **Would these plants be connected to the NG grid ?**

Our approach to biogas cost-and-availability

- We chose the cheapest way to make compressed biogas at the moment
- It came out more expensive than conventional biofuels, but not in GHG terms
- We estimated the potential supply which matches those costs



Points for discussion:
1. Our costing assumptions
2. Our availability assumptions *for that cost*
3. Different points on the cost-supply curve.

Biogas from waste pathways have been included in the 2006 update of the JEC study. The pathway chosen was the one with are the cheapest production methods. The study considers a large plant of the size found in Denmark using 80% slurry (liquid manure) which should be available free for collection. Such a large, optimum plant requires the output from 8000 cows or 50,000 pigs, so can only be considered in areas with high animal concentrations. In order to be economic plants also require about 20% high- yield organic waste such as slaughterhouse waste, for which the biogas plants charge a gate fee.

However, the availability of organic waste is limiting the expansion of biogas capacity in Denmark. The existing plants are competing for it, and are therefore operating on the edge of profitability.

Even this cheapest route is expensive in terms of transport fuel replacement, although because of the high WTW GHG reductions, the cost per tonne of CO_2eq avoided is similar to conventional biofuels (around €150/tonne CO_2eq). These figures assume free manure and organic waste 'accelerator'.

EU biogas availability under these conditions is limited to very roughly 200 PJ/a. It would be possible to utilize a higher proportion of EU manure for biogas by using dry manure, produced in lower geographical concentrations, and therefore in smaller plants. However, this would be more expensive on the cost-supply curve. The same applies to biogas from purpose-grown energy crops.

With feedstock free, capital investment is the major contribution to the total cost. R Edwards commented that purpose-grown feedstocks at e.g. animal feed prices would double the cost of biogas production (not including compression and distribution costs). Nevertheless, pathways using purpose grown biomass are also of interest and will be included in future JEC study work. Reference was made to Austrian data **[C6].**

Mr Heinz (DG-TREN) asked about the scope to improve the efficiency of purification and compression. JF. Larivé advised that the technology is well established and it is the plant itself that is the critical item**.** P. Boisen quoted a purification cost of € 0.10-0.15/m^3 for a large facility. It was suggested to look at experience in Germany where both manure and other materials have been used for biogas production **[B1]**(e.g. Wuppertal). R Edwards commented that some German figures were amongst those considered in the JEC study (they roughly agreed with Danish and Swedish ones for the same scale). **Alterra referred to a recent conference where information on this topic was presented**.

A representative of the European Compost Network described progress in this area. A European Directive requires local authorities to segregate Municipal Solid Waste (MSW). Mixing MSW with manure slurry eases the digestion process, but MSW can be used in large biogas plants without mixing.

P. Boisen was surprised at the cost figures, stating that it was cheaper to produce biomethane than ethanol. JF Larivé clarified that the JEC study does not contradict this statement: the biogas only becomes more expensive than bioethanol when you take into account the higher costs of compression and distribution of biomethane as a transport fuel. To this the WTW study adds the extra cost of cars.

The JRC cost calculations are the "steady-state" of the distribution infrastructure for a scenario where 5% of the transport fuel is provided by the new fuel (biogas in this case). Hence the costs for fuel infrastructure assume about 20% of stations provide compressed gas. It was also noted that the JEC study uses a rate of return of 8%, typical of minimum acceptable in the private sector, corresponding to an annual capital charge of 12% of the invested capital (assuming no tax).

D. Rickeard summarized the WTW conclusions: producing biogas from waste provided very high GHG avoidance.; however using compressed gas as fuel for the general vehicle population was not very attractive, and the cost figures reflected that. Regulatory measures that encouraged biogas production per se rather than insisting on its use in vehicles would be more appropriate, but beyond the scope of the study.

The reference scenario was discussed. At present manure is put onto fields as fertiliser, but the quantity is restricted in some countries for environmental reasons. In the case of wet slurry there is a large associated methane emission to atmosphere that is avoided if the slurry can be used for biogas production. An advantage of biogas production is that the residues after digestion can still be used as fertiliser.

Klaus Gröll of European Compost Network explained that at present most MSW, goes to landfill. For the future, the Waste Directive requires no more than 35% of waste to go to landfill. In this situation the best reference system for biogas production from MSW is not clear. One may need to include composting and incineration as alternative references. The cost of composting MSW is about €20/tonne (for a large plant in East Germany) to €80/wet tonne.

Composting is essentially aerobic digestion; if performed correctly little or no methane should be emitted (although this sometimes happens, due to poor control of the process).

Mr Heinz (DG-TREN) expressed interest in new energy crops as a source of biogas, referring to the 'double cropping' concept mentioned by Mr Fritsche. P. Boisen commented that compared with waste products, crops materials do not need pre-cleaning.

REFERENCES

A: Links to reports, studies and reference documents

A1

P I L O T A N A L Y S I S O F G L O B A L E C O S Y S T E M S
Grassland Ecosystems
ROBIN P. WHITE
SIOBHAN MURRAY
MARK ROHWEDER
Published by World Resources Institute
Washington, DC
This report is also available at http://www.wri.org/wr2000

A2

EEA Report No 7/2006 - ISSN 1725-9177
HOW MUCH BIO-ENERGY CAN EUROPE PRODUCE WITHOUT HARMING THE ENVIRONMENT?
European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark
Tel.: +45 33 36 71 00
Fax: +45 33 36 71 99
Web: http://www.eea.europa.eu/

A3
WELL-TO-WHEELS ANALYSIS OF FUTURE AUTOMOTIVE FUELS AND POWERTRAINS IN THE EUROPEAN CONTEXT

A joint evaluation of the Well-to-Wheels energy use and greenhouse gas (GHG) emissions for a wide range of potential future fuels and powertrains options, prepared by the consortium EUCAR/JRC/CONCAWE.

Contact: infowtw@jrc.it

Web: http://ies.jrc.ec.europa.eu/WTW

A4
SUSTAINABLE STRATEGIES FOR BIOMASS USE IN THE EUROPEAN CONTEXT
Institute for Energy and Environment et al.
http://www.bmu.de/english/renewable_energy/downloads/doc/37442.php
Contact: Dr Daniela Thrän – daniela.thraen@ie-leipzig.de

A5
A SIMPLE METHOD TO ESTIMATE PRACTICAL FIELD YIELDS OF BIOMASS GRASSES IN EUROPE
H.W. Elbersen, R.R. Bakker and B.S. Elbersen
Wageningen UR – Agrotechnology and Food Innovations / Wageningen UR – Alterra
Bornsesteeg 59, 6708 PD Wageningen

wolter.elbersen@wur.nl
berien.elbersen@wur.nl

A6
ENVIRONMENTALLY COMPATIBLE BIOMASS POTENTIAL FROM AGRICULTURE
Kirsten Wiegmann,Uwe R. Fritsche: Öko-Institut, Darmstadt (Germany)
In Cooperation with Berien Elbersen: Alterra, Wageningen (The Netherlands)

A7
T. Karjalainen et al.
ESTIMATION OF ENERGY WOOD POTENTIAL IN EUROPE
Working paper of the Finnish Forest Research Institute METLA, 2005. ISBN 951-40-1939-3
www.metla.fi/julkaisut/workingpapers/2004/mwp006.htm

A8
DG-AGRI: "Prospects for agricultural markets and income 2004-2011 and impact of enlargement "
http://europa.eu.int/comm/agriculture/publi/caprep/prospects2004b/index_en.htm

A9
R A H Edwards et al. "GIS-based assessment of cereal straw energy resource in the EU" Proc. 14th European Biomass Conference and Exhibition, Paris, 17-21 Oct 2005,

B: Links to websites

B1

Bio-gas production and feeding-in to the natural gas grid.

http://www.bio-kraftstoffe.info/

B2

METLA

Finnish Forest Research Institute

www.metla.fi

C: Links to experts and teams

C1
Dutch association for margarine, fats and oils (mvo). Information about the world production of vegetable oils and projections.

Frank Bergmans
bergmans@mvo.nl
Phone: +31(0) 70 319 51 50
Fax: +31 (0) 70 319 51 96

C2
Soil carbon issues. Soil carbon requirements assessment at different climate and soil conditions.
Nelson, R. G. Resource assessment and removal analysis for corn stover and wheat straw in the Eastern and Midwestern United States - rainfall and wind-induced soil erosion methodology. Biomass-and-Bioenergy , 349-63. 2002. Elsevier Science Ltd.
Kansas State University
Prof. Richard Nelson
rnelson@ksu.edu
Tel: +1 785 532 4999

C3
Soil carbon and nitrogen changes in corn/soyabean rotations:

Prof. John Kimble (former USDA-Nebraska)
Innovative solutions
Soilcarbon@aol.com

Studies in collaboration with NREL :Natural Resource Ecology Laboratory
Amy L. Swan
NREL, CSU
Fort Collins, CO 80523-1499
Phone Number: 970-491-3552
Fax Number: 970-491-1965
swan@nrel.colostate.edu

C4
Industrial wood waste. Scope includes also residual wood from industry.

Gerfried Jungmejer, Joanneum Research in Austria.
Chairperson of the COST action E31 on management of recovered wood
http://www.ctib-tchn.be/coste31/frames/f_e31.htm
Fax: +43 316 876 1320
Gerfried.jungmeier@joanneum.at

C5
Altena project BioXchange. Wood waste from industry.

Please contact the Dutch partner Probos, Nico Leek (Nico.Leek@probos.net).

Stichting Probos
Postbus 253
6700 AG Wageningen
Tel. 0317 - 466555
Fax 0317-410247
E-mail: mail@probos.net
Website: www.probos.net

C6
Biogas production from energy crops.
http://bokudok.boku.ac.at/bokudok/xsu_person.person_gesamt?sprache_in=en&person_id_in=8
Dr. Thomas Amon
Ao.Univ.-Prof.
Institut für Landtechnik
Department für Nachhaltige Agrarsysteme
Universität für Bodenkultur, Wien
=
Division of Agricultural Engineering,
Department of Sustainable Agricultural Systems
University of Natural Resources and Applied Life Sciences
Peter-Jordan-Strasse 82
A-1190 Wien
Tel. +43-1-47654-3502
Fax. +43-1-47654-3527
E-mail: thomas.amon@boku.ac.at

concawe EUROPEAN COMMISSION DIRECTORATE-GENERAL Joint Research Centre EUCAR EUROPEAN COUNCIL FOR AUTOMOTIVE R&D

LIST OF PARTICIPANTS

3-4 May 2006
Brussels - Belgium

A. BORSCHETTE CENTER, Rue Froissart 36, Room AB-1A

	Name	Organisation/Country	Phone n°	E-mail
1	Peter Boisen	ENGVA / Sweden	00.46.702.918307	peter@boisen.se
2	Berien Elbersen	Alterra / The Netherlands	00.31.653.728652	berien.elbersen@wur.nl
3	Beatriz Velazquez	Commission / DG AGRI	00.322.2921058	beatriz.velazquez@cec.eu.int
4	José Baro	REPSOLYPF / SPAIN	00.34.913486469	jmbaroc@repsolypf.com
5	Mark Hayden	Commission, DG ECOFIN	00.322.2993418	mark.hayden@cec.eu.int
6	Ian Hodgson	Commission / DG ENV	00.322.2986431	ian.hodgson@cec.eu.int
7	Klaus Gröll	European Compost Network	49(0) 25 22-960 341	info@compostnetwork.info
8	Boyan Kavalov	Commission / DG JRC Petten	00.31.224.56.54.78	boyan.kavalov@jrc.nl
9	Lisa Knur	Forestry Faculty / Germany	00.49.333.465.481	lknur@fh-eberswalde.de
10	Martin Lohrmann	Volkswagen AG, Germany	00.49.5361.9.46921	martin.lohrmann@volkswagen.de
11	Susana HUMANES	Commission / DG AGRI	00.322.295.25.05	susana.humanes@cec.eu.int
12	Monika Filipczynska	Commission / DG AGRI	00.322.296.27.67	monika.filipczynska@cec.eu.int
13	Patrik Klintbom	Volvo / Sweden	00.46.31.3224768	patrik.klintbom@volvo.com
14	Antti Asikainen	METLA (Forest RI) / Finland	00.358.10.211.3250	antti.asikainen@metla.fi
15	Angelika Voss	Shell / The Netherlands	00.31.20.630.28.14	angelika.voss@shell.com
16	Henrik Wilckens	Shell / Germany	00.49.4063244506	henrik.wilckens@shell.com
17	Michael Deutmeyer	CHOREN BioM / Germany	00.49.40.39.81.56.11	michael.deutmeyer@choren.com
18	Laurent Bontoux	Commission / DG JRC Bxl	00.322.2991363	Laurent.Bontoux@cec.eu.int
19	Uwe R. Fritsche	Oeko-Institut / Germany	00.49.6151.8191.24	u.fritsche@oeko.de
20	Kirsten Wiegmann	Oeko-Institut / Germany	00.49.6151.8191.37	k.wiegmann@oeko.de
21	Paul Hodson	Commission / TREN D 1	00.322.2991258	paul.hodson@cec.eu.int
22	Marc de Wit	Copernicus Insitute - Utrecht	00.31.30.2537610/0	m.p.dewit@phys.uu.nl
23	Tom Gameson	Abengoa BioEnergy / SPAIN	00.34.954937111	thomas.gameson@bioenergy.abengoa.com
24	Ulrike Eppler	U-Eberswalde/Germany	00.49.3334.657431	ueppler@fh-eberswalde.de
25	Pierpaolo Cazzola	International Energy Agency	00.33.1.40576789	pierpaolo.cazzola@iea.org
26	Kurt Könighofer	Joanneum Research / Austria	00.43.316.876.1324	kurt.koenighofer@joanneum.at
27	Luca Amatruda	European Biodiesel Board	00.39.335.6049715	l.amatruda@diesterinternational.com
28	Franziska Müller-Langer	Energy and Environment Inst.	00.49.3412.434.423	franziska.mueller-langer@ie-leipzig.de
29	Michael Grams	Commission / DG ECOFIN	00.32.229.62669	Michael.GRAMS@cec.eu.int
30	Wolfgang Munch	Commission / DG AGRI	00.32.229.62843	Wolfgang.Munch@cec.eu.int
31	Mary Brown	Commission / DG AGRI	00.32.229.53270	Mary.Brown@cec.eu.int
32	Mark Cropper	Commission / DG AGRI	00.32.229.54423	Mark.Cropper@cec.eu.int
33	Nicolas Dandois	Commission / DG AGRI	00.32.229.84492	Nicolas.DANDOIS@cec.eu.int
34	Maria Fuentes	Commission / DG AGRI	00.32.229.96220	Maria.Fuentes-Merino@cec.eu.int
35	Michele Lemasson	Commission / DG AGRI	00.32.229.59512	Michele.Lemasson@cec.eu.int
37	Alois Krasenbrink	Commission / DG JRC Ispra	00.39.0332.78.54.74	alois.krasenbrink@jrc.it
38	Giorgio Martini	Commission / DG JRC Ispra	00.39.0332.78.92.93	giorgio.martini@jrc.it
39	Heinz Hass	EUCAR/Ford, Germany	00.49.241.9421203	hhass@ford.com
40	Pierre Rouveirolles	EUCAR/Renault/Fance	00.33.1.76829005	pierre.rouveirolles@renault.com
41	David Rickeard	CONCAWE / Belgium	00.322.7222208	david.j.rickeard@exxonmobil.com
42	JF Larivé	CONCAWE / Belgium	00.322.5669167	jeanfrancois.larive@concawe.org
43	Vincent Mahieu	Commission / DG JRC Ispra	00.39.0332.78.93.05	vincent.mahieu@jrc.it
44	Robert Edwards	Commission / DG JRC Ispra	00.39.0332.78.56.12	robert.edwards@jrc.it
45	Giovanni De Santi	Commission / DG JRC Ispra	00.39.0332.78.94.82	Giovanni.De-Santi@jrc.it

European Commission

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Abstract

The second edition of the well-to-wheels study was released in May 2006 and is available on the JRC web site (http://ies.jrc.ec.europa.eu/WTW). This contains detailed evaluations of energy and GHG balances, costs and availability for a wide range of alternative fuel/vehicle pathways. Compared with the first issue of the study, increased attention has been given to biofuel options.

In the course of the study, it became clear that the estimated figures for biomass and biofuel availability vary widely between different published studies. Also, in our calculations, there were some input variables where little or no reliable information was available.

Consequently, it was felt valuable to gain input and discussion from other expert groups, including authors of other recent studies, to compare information, test the reliability of the assumptions on the JEC study (JEC: JRC-EUCAR-CONCAWE), and find new information to reduce the existing areas of uncertainty. Invitations to the workshop were issued with these objectives in mind. More than 40 people attended the workshop, including representatives from the JRC, EUCAR and CONCAWE, the European Commission, and a wide range of experts from several European countries.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.