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JRC SCIENCE FOR POLICY REPORT

Appendix 1- Outcomes of stakeholders consultations

Definition of input data to assess GHG default emissions from biofuels in EU legislation

Version 1c – July 2017

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Title: *Appendix 1 – Outcomes of stakehodlers consultations. Definition of input data to assess GHG default emissions from biofuels in EU legislation*

Abstract
The EC Joint Research Center (JRC) is in charge of defining input values to be used for the calculation of default GHG emissions for biofuels, bioliquids, solid and gaseous biomass pathways. An update of the GHG emissions has been carried out for the new Proposal of a Directive on the Promotion of the Use of Energy from Renewable Sources (COM(2016)767 - RED-2) for the post-2020 framework. In order to guarantee transparency and ensure the use of the most up-to-date information and data, the JRC with the support of DG ENERGY organised workshops and consultations with recognised experts and stakeholders in three occasions.
Stakeholders and experts had the opportunity to send detailed comments and ask for clarifications on the draft reports circulated before the meetings in May 2013 and September 2016 and the data presented during the workshops. This Appendix contains the detailed list of questions and comments received by the Commission from experts and stakeholders in 2016 and 2013 and the related JRC answers.

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Introduction

In order to guarantee transparency and ensure the use of the most up-to-date information and input data, the JRC with the support of DG ENERGY organised workshops and consultations with recognised experts and stakeholders in three occasions:

- Experts workshop in November 2011 in Ispra (IT);

- Stakeholders workshop in May 2013 in Brussels (BE);

- Experts and stakeholders workshops in September 2016 in Brussels (BE).

The main report describes the review process undertaken by the JRC in Chapter 7 and it summarizes the main outcomes of the meetings.

Stakeholders and experts had the opportunity to send detailed comments and ask for clarifications on the draft reports (circulated before the meetings in May 2013[1] and September 2016) and on the data presented during the workshops.

The comments were collected by the JRC and taken into consideration to finalise the current version of the dataset and calculations.

This Appendix contains the detailed list of questions and comments received by the Commission in 2016 and the related JRC answers.

The questions/comments are grouped by stakeholders and listed in light brown font, while the JRC responses are in black font.

The comments in this Appendix were based on the JRC draft report circulated before the workshops in 2016[2], and JRC's replies refer to the final version of the main report.

[1] The comments and questions received in 2013 and JRC's replies are reported in a previous version of the JRC report: 'Edwards, R., O'Connell., A., Padella M., Mulligan D., Giuntoli, J., Agostini A., Koeble R., Moro, A., Marelli L., 2016. 'Definition of input data to assess GHG default emissions from biofuels in EU leglisaltion, version 1a, December 2015'. JRC Sciency for policy report, EUR 26853 EN. JRC's replies were based on the changes made in version 1a of the report. Therefore, some of them are out of date and do not take into account the final changes and updates made by the JRC after the experts and stakeholders workshop in Sempteber 2016 for the final version of input data and report.

[2] Edwards, R., O'Connell., A., Padella M., Giuntoli, J., Koeble R., Moro, A., Marelli L., 2016. 'Definition of input data to assess GHG default emissions from biofuels in EU leglisaltion, version 1b, August 2016'. JRC Sciency for policy report.

1. List of stakeholders' questions and answers (Expert and Stakeholder Workshops Septemeber 2016)

AGPM (Association Générale des Producteurs de Maïs) and CEPM (European Confederation of Maize Production)

Q1) **Accuracy , reduced uncertainties, with the GNOC model**

The CEPM understands the drivers to change the methodology to calculate the N2O emissions from the field and we acknowledge that the science can make some progress useful to be implemented. The answers to Q6, Q9, and Q144 are giving several consistent reasons to change the modelling approach of N2O emissions but science. The consideration made were already on the table in 2008 and one can wonder why DNDC was taken into account given the discrepancies already known regarding the use of this model, and its geographical limitations to EU15.

Considering that any parameters gets its own uncertainties that interact with the others, CEPM would find interesting to get any information about the statistical range of validity of the N2O emissions calculated with GNOC, compared to the IPCC tier1. Il would help to assert the consistency of the new model.

JRC: A discussion of the uncertainties of the Stehfest and Bouwman method results compared to IPCC TIER1 can be found in Stehfest, E. & Bouwman, L. (2006)[3].

A more detailed discussion of the uncertainties with regard to potential biofuel crops and different applications of the Stehfest and Bouwman method is given in Smeets et al. (2009)[4]. The GNOC approach for **direct N2O emissions from mineral fertilizer N and manure application** corresponds to the "zero N input" reference land use system given in Smeets et al. (2009).

A discussion of different models to assess N2O fluxes from agricultural soils is given by Leip et al. (2011)[5].

See also answer to one of the questions received in 2013 (Q11, reported in Appendix 3 of JRC report, version 1a[6]) and copied here..

> ***Q11:*** *In the publication Leip, A. et al. (2011) N_2O emission results from 10 different models for 6 European countries/country groups are compared. The figure below*

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[3] Stehfest, E. & Bouwman, L. (2006). N2O and NO emission from agricultural fields and soils under natural vegetation: summarizing available measurement data and modeling of global annual emissions. Nutrient Cycling in Agroecosystems, 74 (3), 207–228. doi:10.1007/s10705-006-9000-7

[4] Smeets, E.M.W., Bouwman, L.F., Stehfest, E., Van Vuuren, D.P. & Posthuma, A. (2009). Contribution of N 2 O to the greenhouse gas balance of first-generation biofuels. Global Change Biology, 15 (1), 1–23. doi:10.1111/j.1365-2486.2008.01704.x

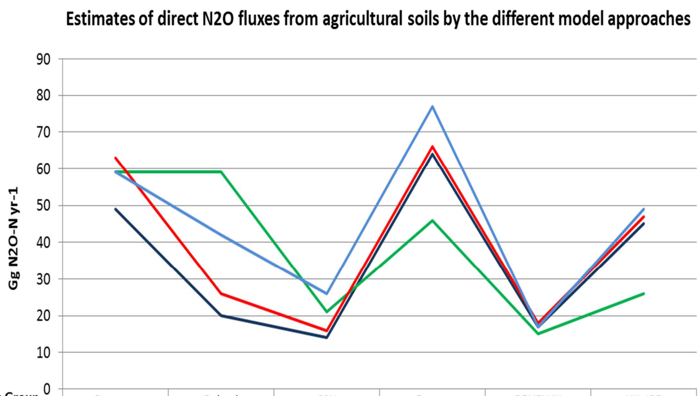
[5] Leip, A, M Busto, M Corazza, P Bergamaschi, R Koeble, R Dechow, Suvi Monni, and W De Vries. 2011. "Estimation of N2O Fluxes at the Regional Scale: Data, Models, Challenges." Current Opinion in Environmental Sustainability 3 (5): 328–338. doi:10.1016/j.cosust.2011.07.002.

[6] Edwards, R., O'Connell., A., Padella M., Mulligan D., Giuntoli, J., Agostini A., Koeble R., Moro, A., Marelli L., 2016. 'Definition of input data to assess GHG default emissions from biofuels in EU leglisaltion, version 1a, December 2015'. JRC Sciency for policy report, EUR 26853 EN.

shows the estimates of direct N_2O fluxes from agricultural soils by the 4 models entering into the discussion in the context of the question by BDBE.

The new approach proposed for calculating N_2O emissions from biofuel cultivation corresponds to "SuB-FIE-JRC" results in the graphic below (and in Leip et al 2011). "SuB-JRC" is the application of the Stehfest and Bouwman method in a strict sense to calculate N_2O emissions, N_2O emissions from the reference land use "unfertilized managed grassland" are subtracted. Also, results from emissions modelled with DNDC are given. However, it is a DNDC run different from the one used for the actual RED default values and no reference land use is subtracted. Results named "UNFCCC" are taken from the "Annual European community greenhouse gas inventory 1990–2008 and inventory report 2010 (Submission to the UNFCCC secretariat, European Environment Agency; 2010). These are the emissions reported by the countries based on the methodology described in the revised IPCC(1996) guidelines.

Except for Germany, the results based on the proposed new approach (dark blue line in the graphic below) fits best with the emissions reported by the countries to UNFCCC (red line). DNDC (green line) gives remarkably higher emissions for Poland and remarkably lower emissions for France and UK/Ireland compared to the UNFCCC country submissions. The Stehfest and Bouwman method applied in a strict sense with reference land use managed grassland (light blue line) is in line with UNFCCC for UK/Ireland, BENELUX and Germany, but results in higher emissions for the rest of the countries or country groups.



Country or Country Group	Germany	Poland	CSH	France	BENELUX	UK_IRE
SuB-FIE-JRC (corresponcs to the new methodology proposed for the RED default values)	49	20	14	64	17	45
DNDC (different from the model run to derive the current RED default values)	59	59	21	46	15	26
UNFCCC	63	26	16	66	18	47
SuB-JRC (Stehfest and Bouwman model with reference land use unfertilized managed grassland)	59	42	26	77	17	49

CSH = Czech Republik, Slovakia and Hungary, UK_IRE = UK and Ireland

Graphic based on data given in Leip, A, M Busto, M Corazza, P Bergamaschi, R Koeble, R Dechow, Suvi Monni, and W De Vries. 2011. "Estimation of N_2O Fluxes at the Regional Scale: Data, Models, Challenges." Current Opinion in Environmental Sustainability 3 (5): 328–338. doi:10.1016/j.cosust.2011.07.002. [*http://linkinghub.elsevier.com/retrieve/pii/S1877343511000595*](http://linkinghub.elsevier.com/retrieve/pii/S1877343511000595)

Q2) **Vegetation "effect value (EV)", P55**

I've noticed that Maize, a cereal, is classified as "Other" whereas "rapeseed, after a specific review, is in the "cereal" box. This may not be neutral to the N2O emissions because the EV for cereal is zero and the one for Other is 0,442, which in my mind means that emissions will get an upward correction.

CEPM then is interesting to get some technical explanations regarding why maize is not in the cereal box. Considering the statistical model which depends on the statistical measurement plots, is a biais possible?

JRC: Looking at the measurement data, on which the Stehfest & Bouwman method is based, we realized that the mean/median emissions (in kg N20-N per kg of fertilizer N input) from rapeseed cultivation is closer to the mean/median emission factor from the "cereals" group than to the mean/median emission factors of the "other group", while we could not observe this for maize. The following table shows the mean and median emission factors for the "cereals" group, the "other crops" group, maize as well as rapeseed.

Looking at the emissions from fertilized crops minus the emissions from the unfertilized crops (fertilizer induced emissions) we can still observe higher emissions from maize plots than from rapeseed plots, however the number of measurements for which data was available for the same plot under fertilized and un-fertilized conditions is limited.

For the calculation of mean and median values all measurement sites with a minimum measurement period of 200 days on mineral soils and fertilizer inputs <500kg/ha have been selected. The original Stehfest and Bouwman data set underlying their model is publicly available at: http://www.pbl.nl/en/publications/2006/N2OAndNOEmissionFromAgriculturalFieldsAndSoilsUnderNaturalVegetation)

	Emissions from fertilized crop			Emissions from fertilized crops minus emissions from unfertilized crop		
		Mean	Median		Mean	Median
	No. of measurements	kg N2O-N / kg N input	kg N2O-N / kg N input	No. of measurements	kg N2O-N / kg N input	kg N2O-N / kg N input
Cereals	73	0.024	0.016	29	0.010	0.007
Other crops	97	0.032	0.022	42	0.017	0.011
Rapeseed	26	0.020	0.014	12	0.015	0.010
Maize	22	0.025	0.022	8	0.017	0.019

Q3) **GNOC consistency with regulation and calculations**

As a matter of, the GNOC calculator is just a mean to come back to the IPCC guidance with a tier2 approach for mineral soils by taken into account more environmental parameters at smaller scales. Even with a tier2 approach, the EU15 producers would face considerable change in default value for agriculture, detrimental to their ability to pass the GES thresholds. In a way, this new set of data and this model is saying that the DNDC model was not consistent for regulatory applications.

One may ask the same question for the GNOC calculator and its S&B statistical approach.

If GNOC parameters are used to calibrate a new GHG "biograce" N2O value, is this value consistent for all geographical perimeter given the fact it was actually not allowed for DNDC values even if they have been used for GHG Nuts calculations.

Can the tier1 approach still be used to calculate actual values?

JRC: For the purposes of the Commission's legislative proposal for the recast of the Renewable Energy Directive, GNOC is applied in a consistent way for all biofuel feedstock and all regions in the world. It is not clear what is meant by the second part of the phrase "If GNOC parameters are used to calibrate a new GHG "biograce" N2O value, is this value consistent for all geographical perimeter **given the fact it was actually not allowed for DNDC values even if they have been used for GHG Nuts calculations**".

If the TIER1 approach will be still an option in future will be clarified after the negotiations of the Co-legislators on the EU legislation for the time period after 2020.

Q4) **Agri GHG default values**

Considering the debate on N2O emissions, wouldn't it be more practical to cut the agri default value in N2O default value and another default value for the remainder?

JRC: N2O emissions are shown separately from cultivation emissions in the Commission proposal for a recast of the Renewable Energy Directive '*Proposal of a Directive on the Promotion of the Use of Energy from Renewable Sources'* COM(2016)767 (RED-recast)[7].

Q5) **Methodology consistency for inputs data**

CEPM considers that consistent methodologies to design the inputs data will strengthen the Annex V data.

For example, if the marginal approach is used for one data, it must be explained why it is relevant to apply this methodology and why it not elsewhere, especially for the fossil fuel energies and electricity.

JRC: The recently published proposal for a recast of the RED - COM(2016)767 describes the methodology applied for the calculation of typical and default values in Annex V (part C) and defines the fossil fuel comparator. For the fossil fuel inputs, the emissions factors are consistent with the GHG intensities reported in Directive 2015/652. They have been updated in the report accordingly (see section 2.1 of the report).

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[7] See also COM(2016) 767 final/2 of 23.02.2017 ANNEXES 1 – 12: Corrigendum of COM (2016)767.

RTFO (UK Renewable Transport Fuel Obligation Unit)

Main points

Our understanding is that the data in the report suggests that the default carbon intensity values of common biofuel production chains would increase quite significantly, and also implies a likely net increase for some actual value calculations. We would therefore be very grateful for clarification of the following before the report is finalised:

Q6) Will biofuel suppliers / producers seeking to report actual values still be able to use the average electrical grid GHG factor when calculating emissions e.g. they won't be forced to use the marginal fossil power values given in the new JRC report?

JRC: On 30 November 2016, the Commission has tabled the '*Proposal of a Directive on the Promotion of the Use of Energy from Renewable Sources'* (COM (2016)767, RED recast) for the post-2020 framework and it is now subject to the negotiations of the Co-legislators. The proposal describes the methodology for the calculation of the greenhouse gas emissions savings of specific biofuel production processes ('actual values') in Annex V part C. Point 11 of the annex contains the provision on accounting for the consumption of electricity which is the same as in the current Renewable Energy Directive (RED).

Q7) Are we correct to assume that the rest of the input emission factors will have to be used in actual calculations as in the JRC report (e.g. diesel, natural gas, methanol etc))?

JRC: No changes compared to current requiremetns of the Directive 2009/28/EU were proposed in the RED-recast, COM(2016)767. Actual calculation of GHG emission savings requires the assessment of the GHG emissions that actually occur. The values used by the JRC reflect the latest scientific insights of the carbon intesitiy of inputs. In any case, input values used for calculation of actual values have to be duly documented and correctly verified.

Q8) Should the new modules in the report be included in the calculation of actual values (e.g. wheat drying, missing transport distances)?

JRC: The methodology for the calculation of actual values is described in Annex V part C of the proposal of Directive COM(2016)767[8]. According to the annex, drying and storage of raw materials shall be included in the emissions from the extraction or cultivation process.

Q9) Is it intended that the use of weighted splits of transport modes should also apply to actual calculations? (we believe this would not be appropriate for actual emissions reporting, as consignments will have different GHGs depending on the mode and distance of travel – hence suppliers cannot take a weighted average value (can only mass balance after calculating individual chain GHGs))

JRC: No, the splits of transport modes should not be applied to actual calculations.

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[8] See also COM(2016) 767 final/2 of 23.02.2017 ANNEXES 1 – 12: Corrigendum of COM (2016)767.

Q10) Will fossil methanol combustion emissions have to be accounted for somewhere, either within the methanol carbon intensity (as currently), or within the "fuel in use" emissions, or by reducing the renewability of the FAME? It is clearly import that all relevant emissions are accounted for.

JRC: Yes, this is the same as in the previous calculations for RED Annex V.

For simplicity in implementation, the carbon content of FAME is considered 100% biogenic. Therefore, the carbon intensity of fossil methanol used in the transesterification process includes the combustion emissions of the methanol. So fossil methanol is treated in the same way as the input of fossil natural gas to the process. Consistent with this approach, if the glycerol by-product is used as a feedstock, its carbon content is considered biogenic.

Q11) Can we confirm that the JRC have interpreted the GREET model correctly, given the significant increase in corn ethanol yield and decrease in DDGS yield.

JRC: The GREET model is one of the source that JRC uses for the maize to ethanol pathway. Data from GREET 2014 (dry-mill) and from the California GREET 2015 (dry mill) are used in the updated version of the report. For a detailed description of the input data from GREET included in the updated version of calculations and report see section 6.2 of the report.

Q12) Why has the configuration of the CHP in the default chains changed so much?

JRC: In 2011 JRC organized a workshop where experts on biofuels and life-cycle analysis were invited to comment on the draft input data. The experts considered the CHP data used in Annex V calculations to be too optimistic, so they were replaced by the current data, which are slightly more conservative. However, the main reason that CHP emissions have changed is the change in methodology for accounting for electricity exports, from a 'credits' system to one based on allocation of steam by exergy, as specified in Annex V part C of the proposed Directive COM(2016)767.

Q13) Have the new N2O values arising from the Global Nitrous Oxide Calculator (GNOC) been sense-checked with real-world field test data, and to what level of detail (which regions, soil types, climate, crops and years?) - given the new N2O values are typically much higher than previously?

JRC: It is difficult to define what is "Real world data" in this context. Field measurements, depending which measurement method and experimental set up is used, might not capture the whole chain of N2O emissions related to fertilizer input.

The Stehfest and Bouwman "model" is a statistical regression of >1000 measurements in agricultural fields. Taking into account the variation in environmental conditions globally and the range of different management systems even 1000 measurements cannot cover all situations. However meanwhile more measurements became available and it would be desirable to include these new values in the assessment. However this cannot be done in a short term.

In the paper of Walter et al (2014)[9] comparisons between measurements and the Stehfest and Bouwman method results are given for cereals and rapeseed. In the JRC Report "Definition of input data to assess GHG default emissions from biofuels in EU legislation" a comparison of measurements in soybean cultivations and GNOC results are given.

Q14) Note that on Page 89 there is a reference to a Defra 2001 survey – there is a more recent dataset for the year 2014, published in 2015. We would strongly prefer to see these data used as they are much more up to date.

JRC: The Defra survey is not used in the default values calculation: it is only shown to demonstrate that, using 2020 data, the method that is used agrees reasonably well with reported data for the same year, where this is available. Incidentally, the 2016 Defra survey shows that UK lime use on tillage crops increased by 49% since 2010, indicating that we are underestimating emissions from liming.

Q15) Can you please clarify if there is any intention to update the fossil fuel comparator value in the RED?

JRC: Yes, the fossil fuel comparator has been updated in the new proposal of Directive recently published by the Commission COM(2016)767 – RED recast. The new fossil fuel comparator is 94 gCO2eq/MJ (Annex V part C, point 19).

Detailed points on (selected) biofuel production chains

Sugar Beet:

Q16) Water % for sugar beet changes from 75% in field to 76.5% at processing. Does not impact final result, but is inconsistent.

JRC: We understand this is confusing, but it is not a mistake. The water content of sugar beet varies, and different data sources assume different water contents. In order to show how our input data are derived from the raw data, necessarily from different sources, we show also the water content which is assumed for each input data. Several cultivation data derive from CAPRI model, and they assume 75% water, so we standardize on 75% water for cultivation. However, in the sugar beet mill data, the original data assume 76.5% water. This is reported in order to correctly calculate the input and yield per MJ of sugar beet. As the accounting unit inside the calculations is MJ of LHV in the dry part of the material, there is no inconsistency in bringing sugar beet from the cultivation to the processing step.

[9] Walter, K., Don, A., Fuß, R., Kern, J., Drewer, J. & Flessa, H. (2014). Direct nitrous oxide emissions from oilseed rape cropping - a meta-analysis. GCB Bioenergy. doi:10.1111/gcbb.12223.

Q17) Sugar beet pulp has an unspecified moisture content. Its LHV is given as 14.4 MJ/kg, so the co-product yield can still be calculated, but knowing the moisture content could be relevant for suppliers wanting to use this data to inform actual value calculations.

JRC: The sugar beet moisture content is now reported.

Q18) Text around Table 75 states that it is only used in FAME pathways, but it appears to be used in wheat ethanol & sugar beet ethanol pathways as well

JRC: Thank you for pointing this out. It has been corrected in this version of the report.

Q19) Caption at the top of Table 91 should be 'transport to filling station'?

JRC: Thank you for pointing this out. It has been corrected in this version of the report.

Q20) In Table 101, we are assuming that the inputs of calcium fertiliser are given in kg $CaCO_3$ / MJsugar beet not kg CaO / MJsugar beet. This is assumed, based on the units in Table 52, column 2, but could be a lot clearer in Table 101 what units are used (kg of $CaCO_3$ or kg of CaO). JRC report could in general be clearer with units.

JRC: Yes, it is kg of $CaCO_3$. The first column of table 130 'Sugar beet cultivation' of the new report describes the inputs and outputs of the process; units are shown in the third column of the same table.

Q21) For sugar beet and corn ethanol chains, it is not clear whether the Step 7 instruction on page 165 - that the same "ethanol depot distribution inputs" should be used as in the wheat ethanol chain - means that these chains should replicate the wheat chain in "transport to filling station" module or whether this module should remain as it was.

JRC: It means that data shown in the wheat pathway is used in the sugar beet and maize to ethanol pathways.

Wheat – NG boiler:

Q22) Uses 'light heating oil' for drying. States at the bottom of P47 that light heating oil = diesel but this is confusing

JRC: The composition of light heating oil, and its emissions in the refinery, are almost identical to diesel. Therefore the carbon embedded in light heating oil is estimated using the result for diesel. The sentence in question in the report has been rephrased: 'the consumption of heating oil (considered here to equal diesel fuel in carbon intensity)'.

Q23) LHV of wheat DDGS = 18.76 MJ/dry kg is different to that given in previous BioGrace sheet (general DDGS = 16 MJ/wet kg), which impacts on emissions allocated to DDGS. Please clarify what the LHV of the wheat DDGS is at 10% moisture content (currently we are calculating this in the sheets as 16.9 MJ/kg).

JRC: The method used to estimate the LHV of DDGS is now described in the report (table 92 'LHV of wheat DDGS by mass and energy balance'). The different LHVs definitions are also reported and explained at the start of section 6 ('Lower heating value (LHV) definitions' page 123).

Wheat – NG CCGT:

Q24) Not clear which emissions factor to use for displaced NG electricity. Emissions factor for natural gas assumes 33% 4000 km (Middle East); 33% 7000km (Russia) and 33% LNG. (We assumed a CCGT electricity emission factor based on this blend, and added in the HV and MV losses. This value of 131.4 gCO2eq/MJe is not stated explicitly in the JRC document).

JRC: The emission factor for the natural gas supply has been updated (see table 7 'Emission factor: natural gas provision (at MP grid)' in the report). The emissions are the ones reported in Directive (EU) 2015/652 (Part 2, point 5) for compressed natural gas EU mix, but without the emissions due to the compression of the gas which are taken from the JEC-WTT 4a report (3.3 gCO2 eq/MJ). These emissions are not included since the NG is considered at the level of medium pressure grid.

Corn ethanol:

Q25) Table 97 and the data below it states 0.711 kg moist DDGS / litre ethanol. This value is much lower compared to the original Biograce values and compared to the DDGS yield given in the stated reference (GREET). GREET gives 7.91 dry lb/ US gallon = 1.053 kg moist DDGS/litre ethanol, which is close to the original Biograce values. To be consistent with the increased ethanol yield given by the JRC we have assumed a DDGS yield value of 0.711 kg / L, but this does not match the reference and also results in a very significant change in allocated emissions. Even the value of 0.711 kg moist DDGS / litre ethanol does not match with the DDGS yield given in the Annex on P256, which is even lower.

JRC: The amount of DDGS has been updated in the current version of the report. An explanation on the 'adopted value' is added at the bottom of table 110 'Data used to calculate the 'adopted value' from various sources'. It is calculated using data from GREET, 2014 (dry-mill) and data from Pannonia Ethanol (2015) provided by Ethanol Europe in September 2016.

The DDGS yield given in the Annex was 'per kg of wet maize'; see Appendix 1 in the report for the updated value.

Q26) A different LHV for wheat DDGS compared to corn DDGS is given. This is a new approach to give specific crop DDGS LHVs, but seems appropriate given the different compositions. However, the corn LHV given on page 133 does not agree with the LHV given on page 255.

JRC: Thank you for pointing the reporting mistake. The LHV has been updated and correctly reported in the current version of Appendix 1 of the report.

Q27) JRC document would help avoid confusion if it consistently referred to either corn or maize (and clarified they are the same crop), rather than switching between names in different pages.

JRC: Thank you for pointing this out. It has been made consistent in the report.

Q28) Input of ammonia in Table 97 should be in kg/MJ ethanol NOT MJ/MJ ethanol.

JRC: Thank you for pointing the reporting mistake. It has been corrected.

FAME from waste vegetable or animal oil:

Q29) Potassium sulphate is listed as an output arising from esterification. It is assumed that no credit has again been applied for this output, consistent with the calculation of the original default values. However, this is not explicitly stated in the JRC report. (Note that this comment applies to all FAME pathways.)

JRC: Correct, no credit has been given for the potassium sulphate output, it cannot be burned and so has no LHV. According to Annex V (part C) of COM(2016)767, it can not have emissions allocated to it. An explanation is added to the report (in section 6.13). Potassium hydroxide is only considered as an input for the waste vegetable oil and animal oil pathways but not in other FAME pathways.

Q30) The efficiency of the 40 t truck given in the FAME chain details in the JRC document (Table 219, in t.km/MJoil) does not match up with the efficiency calculated from the general information given in Table 62 for the fuel consumption of a 40t truck. Implies a mistake in Table 219 or Table 62.

JRC: Table 229 'Transport of waste oil via 40 t truck over a distance of 100 km' of the current version of the report refers to distance, while table 70 'Fuel consumption for a 40 t truck' refers to fuel consumption for a truck, neither refer to efficiency.

Q31) The emission factor for Chinese grid electricity is not included in the JRC report.

JRC: JRC did not find this information, but we note the source of non-EU UCO has been modified from China to USA following industry consultation. As we do not have complete (including upstream emissions) electricity emissions data for countries outside EU, and since the contributions to the overall emissions of foreign electricity is typically very small, we approximate it to EU electricity.

Q32) The emission factor for Chinese natural gas is not included in the JRC report.

JRC: Please see above answer.

Q33) There is no electricity use assumed at the ports when transporting the refined oil 7000km (either at the port in Europe or in China), whereas other chains do include electricity use at both ports (e.g. when transporting unrefined palm oil from Malaysia to Europe).

JRC: True, we can include this in a future revision. However, the effect on emissions will be small.

FAME from palm oil (methane capture at oil mill):

Q34) Transport of Empty Fresh Fruit Bunches back from the mill to the field has not been included (50km distance), but the amount of EFB compost has increased significantly, so the back transport is not insignificant.

JRC: Indeed transport of EFBs back to the plantation should slightly raise the cultivation emissions. However, EFBs are spread on the nearest plantations so the transport distance is less than that of FFBs. So the contribution to overall emissions is very small.

Q35) The emission factor for Malaysian grid electricity is not included in the JRC report.

JRC: Please see answer to Q31).

Q36) In Table 199, the LHV for Palm kernel meal is stated as being 16.4 MJ/wet kg at 10% moisture content, but then as 16.7 "LHV of dry part per wet kg"? If this is the MJ/dry kg, these values are not consistent, and if something else, JRC need to explain what the "LHV of dry part per wet kg" refers to.

JRC: Additional explanation on the LHV definitions has been added at the start of section 6 of the report (page 123 'Lower heating value (LHV) definitions'). A reference to the definitions is then consistently made in Chapter 6 for each pathway.

HVO from palm oil (methane capture at oil mill):

Q37) The emission factor for nitrogen is not included in the JRC report.

JRC: Thank you. It has been added in the report (see table 34 'Supply of nitrogen').

Q38) The distance for transport by pipeline is not given, apparently at any point in the report, other than 5km in Table 78 which seems much too short for HVO plant to depot.

JRC: The distance assumed is 5 km. Where HVO is moved from production plant to depot by pipeline, our information suggests this assumption is reasonable. For example Neste's Porvoo HVO plant is situated within an oil refinery which is also a fuel distribution terminal.

Other detailed points

Q39) Emissions factors for electricity given in Table 40 do not match up exactly with those calculated from Tables 2, 3, 4 & 5.

JRC: The emission factor for electricity has been changed in this version of the report (see tables 2 'EU mix electricity supply (based on actual averages) emissions', table 3, 4 and 5).

Q40) Pg 24. Sentence: "K2O fertilizer production and transport." – is this an incomplete sentence?

JRC: The comment has been deleted; the emission factor of K_2O has also been updated with 2014 data from Fertilizers Europe (see table 9 'Supply of K_2O fertilizer').

Q41) Pg 26. Sentence: "The total emission factor to produce 1 kg of CaO as process chemical is 1 100.0 gCO2. eq/kgCaO." – what is '1 100.0'? Is there some punctuation missing? There are several instances of this in document, we would recommend having a thorough check (E.g. pg 30, 31, 32, 33 etc…..)

JRC: It means 1,100: we used a space instead of a comma for thousands.

Q42) Table 23 – half un-populated. Delete extra lines if not needed.

JRC: Deleted.

Q43) Pg 40: "There is much scope for producers to reduce emissions by choosing a good fertilizer" – we don't understand this sentence. This section seems to be about fertiliser manufacture, and the sentence is referring to end user. Also please define what is a 'good fertilizer'?

JRC: The wording has been made more precise: 'There is much scope for producers to reduce emissions by choosing fertilizer from a low-emission factory' (see section 2.3 of the report).

Q44) Pg 67 – only attributing half manure emissions. We think this is not the correct approach. Whilst we agree that the manure is not laid for the purpose of increasing crop yields, it is applied none the less and is therefore part of the system and the practice undertaken. This makes this practice look 'not as bad' but the other emissions are lost and are not accounted for.

JRC: In section 3.8, we estimate that farmers use about twice as much N in manure as is needed for optimal yield. So we think that half of the manure should be accounted for in the cultivation of crop, and the rest should be in the system for livestock production.

Please note that your view is opposite to that of biofuel producers (see comments from ePURE below).

Q45) Pg 79/80 – we note the lime data is only reliant on 1-2 studies.

JRC: The two studies on lime which are discussed are only a check of the accuracy of the global model we use for estimating lime consumption per crop. As most countries do not report use of lime by different crops, we are forced to use a model. The model starts with the reported national totals of agricultural lime use, and then allocates it to different crops and grassland according to:

- which soil-types they grow on, according to the geographic distribution of crops within each country in the year 2000.
- agricultural liming recommendations as a function of crop, soil type and pH.

The allocation is scaled so that the total lime use corresponds to the national total use of agricultural lime.

Q46) Some of the sources for transport seem very old, are JRC able to source more recent data?

JRC: For trucks, the data is not for the very latest trucks but the trucks fleet is not all new vehicles. Furthermore many trucks are from cheaper manufactures, and are less economical than the model assumed. For shipping, IMO have recently published a more recent report but unfortunately this new report does not present the data in a way we can use.

ePURE (European renewable ethanol)

Questions received before the workshop

Q47) **Executive Summary**

- The JRC report aims to update the default values presented in the RED. The purpose of these values is to reduce the administrative burden for economic operators, who can use predetermined values instead of calculating actual ones through the methodology laid down in RED Annex V.C from the cultivation to the combustion of the biofuels.

- The JRC 2016 report is mostly an update of data inputs, with a methodology already presented in 2013.

- Nonetheless, most of the modelling choices made by JRC in 2013 (for example N2O emissions model) failed to adhere to the principles that should guide any update of these values, namely representativeness, transparency and consistency. These models, once again presented in the 2016 report are introduced without the authors clarifying how they are representing any scientific or technical progress.

- Consequently, most of the comments the industry made following the JRC 2013 report are still relevant.

- A study ePURE commissioned to LCA experts North Energy[10] on the JRC 2013 report concluded:

"Taking the findings of these assessments, this critical review concludes that, although a considerable amount of information and results from modelling have been assembled in the JRC proposal, most of the data presented are not suitable for regulatory purposes since they are not strictly representative and, hence, do not provide a sound basis for the derivation of typical and default values."

After a careful review of this updated report this conclusion is still fully accurate.

JRC: The current version of the report has been updated and improved compared to the previous version. Additional information and sources provided by industry and stakeholders before and after the workshops in September 2016 have been taken into account. The reporting has been improved as well.

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[10] Deliverable 1 - Critical Review of the JRC Proposal- North Energy 2014 http://epure.org/media/1426/20160916-north-energy-review-of-the-methodology-contained-in-annex-v-of-the-renewable-energy-directive-and-annex-iv-of-the-fuel-quality-directive-critical-review-of-the-jrc-proposal.pdf

JRC had dedicated a long time searching a wide variety of sources for the relevant information used in the input data. It would be desirable to have all data for the EU average available for all processes from a single up-to-date source. Unfortunately, such a source does not exist. Official statistics and real-world data are used whenever these are available on the appropriate geographical level.

We wish to reiterate that the JRC always elicited new and more representative data to industries representatives, and have been always open to any discussion.

1. General input data for pathways [Section 2.]

Q48) **Fossil fuels provision [Section 2.1]**

EU Electricity and Natural Gas mix. A typical ethanol plant uses both natural gas and electricity. As a result, the carbon intensity of incoming gas and electricity flows through to the final product. To date, Annex V values have used average gas and electricity values. The Report tries to use marginal electricity, as combination of different fossil fuel sources, with essentially 50% coming from coal and 50% coming from natural gas.

Methodology: This approach would worsen the GHG emissions savings of ethanol plants, and there is no explanation for it other than for that purpose.

- If a marginal approach were selected in general, then there would be a proposal to use marginal oil also (which has recently been estimated at 115 gCO2/MJ[11]), but that would have a positive impact on ethanol.

- If a marginal approach were selected in general, then the same approach would be applied to all other renewables in transport, for example electric cars, which would be antithetical to the Commission's current proposals as explained below.

- The use of 50% gas and 50% coal is also not defensible since the stated goal is to capture marginal electricity, which would be expected to be gas in the current economic and technical reality, but scientific approach would require modelling;

- The split of 33% for 4,000 km gas pipeline, 33% 7,000 km pipeline and 33% LNG pipeline doesn’t seem to be based on any actual statistics or modelling forecasts. At the same time over 30% of EU gas consumption comes from the North Sea, which seems to be closer than 4,000 km to the major points of consumption.

Policy Coherence: If 209 gCO2/MJ was the correct number for marginal electricity at 380V across the European Union, electric vehicles would be far worse than fossil fuel, even after correcting for differences in efficiencies between electric motors and internal combustion engines. This would, in short, make the Commission's emphasis on electro-mobility entirely and unquestionably untenable from a climate perspective. We support an increasing role for electric vehicles and so call on the EC/JRC to resolve the controversy.

JRC: Section 2.1 of the report has been updated. The emissions associated to electricity and natural gas are shown in table 2 ‘EU mix electricity supply (based on actual

[11] “Greenhouse gas impact of marginal fossil fuel use” Ecofys 2014. www.ecofys.com/en/publication/greenhouse-gas-impact-of-marginal-fossil-fuel-use/

averages) emissions' and table 7 'Emission factor: natural gas provision (at MP grid)' respectively. As explained in the report, the GHG emissions considered for the supply and consumption of electricity correspond to the ones reported for the EU mix (actual averages) pathway in JEC-WTWv4a, 2014. The GHG emissions associated to natural gas supply are the ones reported in Directive (EU) 2015/652 (Part 2, point 5) for the compressed natural gas EU mix, without the emissions due to the compression of the gas which are taken from the JEC-WTT4a report (3.3 gCO2 eq/MJ). These emissions are not included since the NG is considered at the level of medium pressure grid.

1.2 Supply of process chemicals and pesticides [Section 2.2]

Q49) **P2O5 and K2O Supply**

Representativeness of the data sources: The Report uses a data source from 1997. Based on a Fertiliser Europe[12] report referencing the 2011 state of technology, we found the following values:

Fertilizer carbon footprint	Kaltschmidt and Reinhardt, 1997	Fertiliser Europe report, 2014	Difference
P_2O_5 g_{CO2eq}/kg of nutrient	1176	560	+110%
K_2O g_{CO2eq}/kg of nutrient	635	430	+48%

JRC: Thank you for providing this source; this information is used in the current version of the report (see table 8 'Supply of P_2O_5 fertilizer' and table 9 'Supply of K_2O fertilizer'). However, the previous source was used only for the amounts of the inputs, not for the emission factor which was estimated by the E3database. References for the input data and emission factors are more clearly reported in the current version of the report.

Q50) *Methodology:* In devising the LCA emissions of nitrogen fertilizer production, certain explanations in table 42 are methodologically questionable:

"Although EU nitric acid plants already surpassed the target savings, the excess savings will be sold under ETS, so other emissions become attached to nitric acid. Therefore, we consider the 2020 ETS target emissions, not the actual emissions from nitric acid. Although the savings in ammonia production emissions fall short of the 2020 targets (according to the latest available data), it is not necessary for producers to buy emissions savings from elsewhere before 2020. Therefore we consider the actual emissions for nitric acid."

We note that it is unclear if achievement or not achievement of 2020 goals refers to the state of the fertilizer industry as of 2011 or as of 2015.

Policy Coherence: From a methodological point of view, the sale of carbon credits in the EU ETS is irrelevant for an LCA analysis. For example, ethanol plants are part of EU ETS, so they receive a certain amount of free allocations, but they also have to purchase

[12] http://fertilizerseurope.com/index.php?eID=tx_nawsecuredl&u=0&g=0&t=1472637615&hash=ac3b2d9c1b5b9563d90026572cfaa10a28219141&file=fileadmin/user_upload/publications/agriculture_publications/carbon_footprint_web_V4.pdf

credits to fill the differences. The cost of these carbon credits is passed to producers with the price of electricity, as well as the price of renewable electricity through various national mechanisms. Carbon credits refer to actual emissions of combustion, not to life-cycle emissions of fossil fuel. However, should this approach be correct, it should be applied across the board, to all manifestations of EU ETS activity, which would be untenable.

JRC: Already in 2011, the nitric acid emissions were below the 2020 ETS benchmark. However, as ETS credits are much cheaper than the effective cost of CO_2 reduction in the transport sector, we have decided not to take into account the ETS credit sales. This avoids the possibility of cheap CO_2 credits being bought in to replace real emissions savings in the transport sector. We now use the actual emissions from nitric acid plant and not the ETS benchmark. Presumably this will also deal with your concern about the policy coherence.

1.3 Diesel, drying and plant protection use in cultivation [Section 2.5]

Q51) **1.3.1 Diesel use in cultivation [Section 2.5.1]**

Table 43 uses 2010/2011 average yields, which is not justified. To be consistent with International Fertiliser Association data, the 2011 yield should have been taken alone, as IFA explicitly states. Furthermore, these average yields from 2010-2011 are used to convert inputs data, such as N-Fertiliser, Diesel or Pesticides, from CAPRI 2004, which lead to overall inconsistency of the calculations.

JRC: Average yields have been updated for all crops with the latest available Faostat data (accessed in October 2016). We consider average yields of 6 years for the period 2009-2014.

Q52) We would like to ask the authors to clarify the meaning of "moist yield". FAO reports yields for commodity quality of crops, i.e. in case of corn at 14%-15% moisture.

JRC: The moisture content of crops and by-products is reported in the various pathways in the 'comments' section below the tables as well as in Appendix 1 of the report.

1.3.2 Crop Drying [Section 2.5.2]

Q53) Crop Drying: Some crops are dried in dryers after harvesting, and the energy used in such dryers should be accounted for in calculating ethanol's carbon intensity.

In the case of maize, the more Northern the harvest in Europe, the higher the moisture content at harvest. However, in the case of maize, the more Northern the harvest in Europe, the less likely that maize will be used for ethanol production. Most of the maize used for ethanol production in Europe is from Eastern Europe, and most of that is harvested mostly dry. Rather than drying maize artificially, Eastern European farmers usually allow it to dry in fields, which is why the maize harvest can last through November.

Methodology:

- The Report extrapolates harvest moisture statistics for Germany (for 2000, 2001 and 2002) to the entire European Union. Germany produces far less than 10% of EU maize, is in a climate zone that represents maybe 15-20% of maize production in the EU, has no maize ethanol plants;

- The countries where maize largely dries in the fields (Romania, Bulgaria, Croatia, Spain, Hungary, Greece, Italy etc.) account for well more than half of all EU maize production; those countries could also be referenced to the US conditions where reported moisture at gravest is typically 16-18%

- We ask to clarify the 50%/50% split between Light heating Oil and Natural Gas the Report uses for the drying process.

- Unlike other crops, maize has a very prolonged harvest period. The timing of the harvest is mainly defined by how dry it is, allowing it to dry as much in the field, while taking other economic considerations into account. To harvest at certain moisture is an economic decision, not a climatic one.

Economics of maize production, while it was still EU-15 at the beginning of the century could have been drastically different, due to different market organization.

We understand that the JRC corrected the amount of energy required to dry the grains per 1% of moisture. However, we ask to:

Clarify how electricity, gas and diesel contribute to final calculation in section 6, i.e. whether is a sum of those or weighted/simple average.

- Confirm what the primary energy consumption is to dry 1 kg by 0.1% of moisture content. We consider the value 0.0231MJ primary energy to be significantly higher than the real value. In that context, please clarify the following:

"Therefore, JRC consider the sum of the primary energy sources which CAPRI assumes are needed for drying 1 kg grain by 0.1% moisture (0.0231 MJ primary energy). By dividing the total primary energy for drying per hectare by this sum, the average % of water removed from each crop according to CAPRI has been calculated."

JRC: JRC is aware that grain drying emissions vary enormously across Europe, which is why drying data have not been extrapolated from a single source for all EU. Instead, the CAPRI model has been used to find the average amount of water which must be evaporated per tonne of grain in EU, on the basis of climate and other data.

The average % of water removed from each crop for cereals has been updated in the current version of the report (see section 2.5.2). The figures used by the JRC from CAPRI were double-checked by the CAPRI expert (Markus Kempen) who participated at the expert workshop in Brussels in September 2016. He provided additional information to the JRC after the workshop and the figures have been updated accordingly.

As explained in the report, drying in France and Poland was set at zero. Also for many NUTS2 regions, drying is not needed according to CAPRI, and these are counted "zero" in the average % of drying that is needed. The final water content was set at 16%, on the basis that further drying for long-term storage can be reached by mixing in the store with drier grain, and by ventilation during storage.

As a result of these changes, the average % of water removed from each crop is substantially reduced: the results are shown in table 49 'CAPRI drying data' of the report and linked to the respective pathway (wheat, maize, rye, barley, triticale) in section 6 of the report.

In each pathway, the amounts of each input (light heating oil, natural gas and electricity) used in the drying process are shown. To estimate the fuel needed *per gram of moisture removed*, we used the lowest figure we found for European in the literature. The assumption that half of the fuel is NG and half is light heating oil is based on national experts' opinions, as no EU-wide data is available and no additional information has been provided to the JRC by ePURE or other stakeholders at any stage.

2. Soil emissions from biofuel crop cultivation [Section 3.]

2.1 General approach to estimate soil N2O emissions from cultivation of potential biofuel crops [Section 3.3]

We understand from answers given on the change of N2O assessment model that GNOC has been confirmed as policy choice and it has been used in JEC reports.

The purpose of this model is to allow more site-specific calculation. However, the outcome relies heavily on the access to sufficient data for the different crops in the different regions.

Methodology:

Regardless of the final results given by this model, scientific justification for the choice should have been provided:

Q54) While GNOC being publicly available, after limited search, we have not been able to find any scientific references to its validation, accuracy or any research performed using this tool, except for the works of JRC experts themselves. This does not add to the credibility of the instrument.

JRC: GNOC is not a newly invented method. It combines the approach developed by Stehfest and Bouwman (2006) for direct emissions from fertilizer and manure N input (TIER2) and IPCC (TIER1) for indirect emissions and emissions from crop residue N.

See also answer to questions received in 2013 (Q6, 7, 10 and 11, reported in Appendix 3 of JRC report, version 1a[13]) and copied here .

> ***Q6:*** *N2O methodology developed by the JRC has been largely explained in the report and during the workshop during which scientific progresse vs existing methods (e.g. IPCC) was lso explained in more detail.*
>
> *The revision of the existing methodology is proposed by the JRC in close discussion with the Commission for the following reasons:*
>
> *The current default values for cultivation of biofuel feedstock in the RED Annex V are based on 2 different methods.*
>
> *a. default soil N_2O emissions from potential biofuel crops grown in Europe (**wheat, rapeseed, sugar beet, sunflower**) result from the application of the soil chemistry model DNDC for **EU15**.*

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[13] Edwards, R., O'Connell., A., Padella M., Mulligan D., Giuntoli, J., Agostini A., Koeble R., Moro, A., Marelli L., 2016. 'Definition of input data to assess GHG default emissions from biofuels in EU leglisaltion, version 1a, December 2015'. JRC Sciency for policy report, EUR 26853 EN.

*b. default soil N_2O emissions from imported biofuel crops (**maize, soybean, sugar cane, oil palm**) were calculated according the **IPCC (2006) TIER1** approach as at a current stage the global application of DNDC is still a challenge because not enough data is available.*

Thus, the current default values for feedstock mentioned under a. do not account for possible differences in cultivation emissions in locations outside EU15 (e.g. Eastern Europe, US) and default values for feedstock listed under b. are based on a different methodological approach.

A further aspect for looking for an alternative methodology has been the fact that the DNDC model requires specific expertise of the user and it needs to be fed with detailed data (parameterization, daily meteorological parameters e.g.). This led to the situation that EU countries to fulfil their reporting obligations about average biofuel cultivation emissions on NUTS2 level (Article 19.2 of the RED) mainly based their calculation on the IPCC (2006) TIER1 approach. This resulted in methodological inconsistencies between the default values and the average soil emissions calculated on NUTS2 level. Biofuel producers wishing to provide their own emission data will face the same problem. In fact, tools (as e.g. version 4b BIOGRACE) providing assistance in calculating cultivation emissions also had to rely on IPCC(2006) TIER1 for the estimation of N_2O emissions from cultivated soils.

We defined the minimum requirements of a methodological approach suitable for an update of the default values in the RED as:

- *applicability at least to all major 1st generation biofuel crops covered by the RED*
- *applicability in all regions where biofuel feedstock can possibly be cultivated*
- *the impact of different environmental conditions on N_2O fluxes has to be taken into account (requested in RED Article 19.2)*
- *consistency with other greenhouse gas emission reporting obligations (e.g. Kyoto, UNFCCC)*
- *published and peer reviewed*
- *applicable by non-experts and/or possibility to provide assistance via spreadsheet or web-tools.*

The new methodology described in the report complies with all the requirements we identified.

***Q7**: Uncertainties in modelling N_2O emissions from agricultural soils are considerable, this however holds also for other methodological approaches, as e.g the DNDC model applied to calculate the current default values.*

*See also answer to **Error! Reference source not found.** and e.g. the publication: Leip, Adrian, Mirko Busto, and Wilfried Winiwarter. 2011. "Developing Spatially Stratified N(2)O Emission Factors for Europe." Environmental Pollution (Barking, Essex: 1987) 159 (11) (November): 3223–32. doi:10.1016/j.envpol.2010.11.024. http://www.ncbi.nlm.nih.gov/pubmed/21186068.*

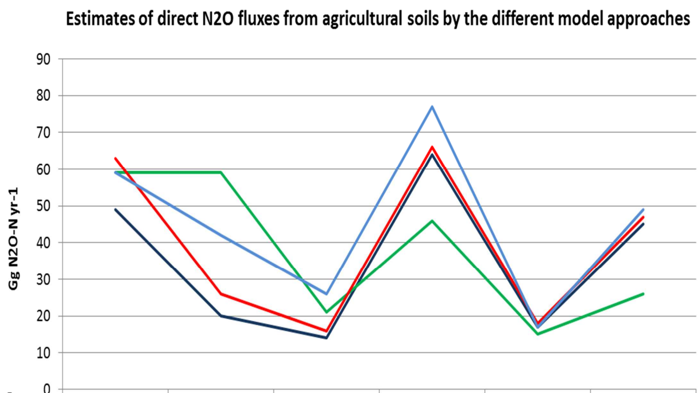
***Q10**: a) We already face the situation that the IPCC(2006) TIER1 methodology is applied on a local / regional level under the RED Article (19.2). Most EU countries based their calculations of average NUTS2 soil N_2O emissions from biofuel feedstock cultivation on IPCC (2006). Also the current version of the BIOGRACE tool (version 4.1) bases soil N_2O emission calculations on IPCC (2006), including indirect emissions. As outlined in answer to question **Error! Reference source not found.**, DNDC is a complex soil chemistry model and requires extensive data input* *as well as specific expertise to be applied. It is not a feasible option for emission reporting for non-EU countries / biofuel producers.*

The approach we are suggesting for an update of default values is published in peer reviewed papers (see literature references in the report e.g. Stehfest and Bouwman, 2006; Smeets et al., 2011). The IPCC (2006) TIER 1 emission factor for direct emissions from managed agricultural soils due to fertilizer application to the field is based on the same approach, globally averaged however. In order to take into account the influence of regional environmental and management conditions we (re-)disaggregated the global average emissions factor in IPCC(2006).

Q11: *In the publication Leip, A. et al. (2011) N_2O emission results from 10 different models for 6 European countries/country groups are compared. The figure below shows the estimates of direct N_2O fluxes from agricultural soils by the 4 models entering into the discussion in the context of the question by BDBE.*

The new approach proposed for calculating N_2O emissions from biofuel cultivation corresponds to "SuB-FIE-JRC" results in the graphic below (and in Leip et al 2011). "SuB-JRC" is the application of the Stehfest and Bouwman method in a strict sense to calculate N_2O emissions, N_2O emissions from the reference land use "unfertilized managed grassland" are subtracted. Also, results from emissions modelled with DNDC are given. However, it is a DNDC run different from the one used for the actual RED default values and no reference land use is subtracted. Results named "UNFCCC" are taken from the "Annual European community greenhouse gas inventory 1990–2008 and inventory report 2010 (Submission to the UNFCCC secretariat, European Environment Agency; 2010). These are the emissions reported by the countries based on the methodology described in the revised IPCC(1996) guidelines.

Except for Germany, the results based on the proposed new approach (dark blue line in the graphic below) fits best with the emissions reported by the countries to UNFCCC (red line). DNDC (green line) gives remarkably higher emissions for Poland and remarkably lower emissions for France and UK/Ireland compared to the UNFCCC country submissions. The Stehfest and Bouwman method applied in a strict sense with reference land use managed grassland (light blue line) is in line with UNFCCC for UK/Ireland, BENELUX and Germany, but results in higher emissions for the rest of the countries or country groups.



Country or Country Group	Germany	Poland	CSH	France	BENELUX	UK_IRE
SuB-FIE-JRC (corresponcs to the new methodology proposed for the RED default values)	49	20	14	64	17	45
DNDC (different from the model run to derive the current RED default values)	59	59	21	46	15	26
UNFCCC	63	26	16	66	18	47
SuB-JRC (Stehfest and Bouwman model with reference land use unfertilized managed grassland)	59	42	26	77	17	49

CSH = Czech Republik, Slovakia and Hungary, UK_IRE = UK and Ireland

Graphic based on data given in Leip, A, M Busto, M Corazza, P Bergamaschi, R Koeble, R Dechow, Suvi Monni, and W De Vries. 2011. "Estimation of N_2O Fluxes at the Regional Scale: Data, Models, Challenges." Current Opinion in Environmental Sustainability 3 (5): 328–338. doi:10.1016/j.cosust.2011.07.002. http://linkinghub.elsevier.com/retrieve/pii/S1877343511000595

Q55) In its previous work JRC used DNDC, a methodologically different model. The report contains no comparison of results achievable through DNDC vs GNOC, it focuses only on the result of GNOC versus the IPCC method. While it stressed that DNDC could have been used only for EU-15, JRC should have demonstrated difference in results from DNDC and GNOC for that region for different crops, except just for one. Regardless of application, the choice of model is always driven by relevancy and accuracy. N2O emission modelling is faced with large level of uncertainties. Thus reduction of this uncertainty could be one way to demonstrate scientific progress. However, the report doesn't contain a comparison of uncertainties in modelling using GNOC, IPCC and DNDC.

JRC: These issues have been raised by other stakeholders and the answers can be found in the report itself, section 2 of this appendix (e.g. answer to Q6).

A discussion of the DNDC, IPCC and Stehfest & Bouwman approach as well as results at regional level is given e.g. in Leip et al. (2011a[14] and b[15]).

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[14] Leip, Adrian, Mirko Busto, and Wilfried Winiwarter. 2011. "Developing Spatially Stratified N(2)O Emission Factors for Europe." Environmental Pollution (Barking, Essex: 1987) 159 (11) (November): 3223–32. doi:10.1016/j.envpol.2010.11.024. http://www.ncbi.nlm.nih.gov/pubmed/21186068

[15] Leip, A, M Busto, M Corazza, P Bergamaschi, R Koeble, R Dechow, Suvi Monni, and W De Vries. 2011. "Estimation of N2O Fluxes at the Regional Scale: Data, Models, Challenges." Current Opinion in Environmental Sustainability 3 (5): 328–338. doi:10.1016/j.cosust.2011.07.002. http://linkinghub.elsevier.com/retrieve/pii/S1877343511000595

A discussion of the uncertainties of the Stehfest and Bouwman method results compared to IPCC TIER1 can be found in Stehfest, E. & Bouwman, L. (2006)[16]. A more detailed discussion of the uncertainties with regard to potential biofuel crops and different applications of the Stehfest and Bouwman method is given in Smeets et al. (2009)[17]. The GNOC approach for direct N2O emissions from mineral fertilizer N and manure application corresponds to the "zero N input" reference land use system given in Smeets et al. (2009).

Q56) IPCC versus S&B based models uncertainty comparison can be found in scientific literature. For example, the following article "Quantifying Uncertainties in N2O Emission Due to N Fertilizer Application in Cultivated Areas"[18] does compare uncertainties in calculations done using IPCC method and several models based on S&B dataset using different non-linear approximation curves. However, it remains unclear where GNOC stands among these different available tools, and why one or the other approximation curves has been chosen.

JRC: See answer to Q55).

Technical:

- The backbone of GNOC is non-linear N2O response to application of nitrogen.

Q57) At the same time the JRC seems to apply the same mineral fertilizer N application to all land across the EU, without differentiating application use at least at NUTS I level. Whether accurate or not, JRC had in its possession Nitrogen application data from Member States for each country and for each crop. For major EU feedstocks (rapeseed, wheat, sugar beet and maize) the (potential) difference in the results shall be demonstrated.

JRC: Mineral fertilizer N application to each crop is varying between the countries and also within the country depending on the yield of the crop and depending on the carbon content of the topsoil. This is described on page 58 of the report. An example map of the fertilizer input to rapeseed at the 5 minutes grid cell within a NUTS2 region in France is given on page 60 of the report (bottom left). N2O emission calculations were carried out at the 5 minutes grid cell level.

Policy Coherence:

- Reduction of N2O emissions can be achieved either through reduction in fertilizer use, or through change in type of fertilizer used (coated urea etc.), managing timing of

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[16] Stehfest, E. & Bouwman, L. (2006). N2O and NO emission from agricultural fields and soils under natural vegetation: summarizing available measurement data and modeling of global annual emissions. Nutrient Cycling in Agroecosystems, 74 (3), 207–228. doi:10.1007/s10705-006-9000-7.

[17] Smeets, E.M.W., Bouwman, L.F., Stehfest, E., Van Vuuren, D.P. & Posthuma, A. (2009). Contribution of N 2 O to the greenhouse gas balance of first-generation biofuels. Global Change Biology, 15 (1), 1–23. doi:10.1111/j.1365-2486.2008.01704.x

[18] "Quantifying Uncertainties in N2O Emission Due to N Fertilizer Application in Cultivated Areas" A. Philibert, C. Loyce, D. Makowski 2012 http://dx.doi.org/10.1371/journal.pone.0050950

nitrogen application and managing practices (till/no-till) etc., i.e. without actual reduction of nitrogen application, but through facilitation of nitrogen up take.

Q58) If GNOC had an evaluation of those factors, it could indeed be a useful tool to promote better farming practices, and for farmers to assess environmental impact. In its current form, it is unclear what positive agenda it carries.

JRC: The effect (magnitude, positive/negative) of the different management factors like management practices on N2O emission is still debated. There is not enough information to include this into a global assessment.

2.2 GNOC results and the JEC-WTW [Section 3.7]

Q59) **Table 49 Potential biofuel crops assignment to S&B vegetation classes**

- Unfortunately, the JRC avoids the question of the categorization of crops: Maize is still considered as "Other" instead of "Cereals". This choice leads to the assignment of Maize with Coconut, Oil Palm, Sugar Cane and others, which, does not make sense and adds an effect value of 0.442.

- One could also argue that the other categorization exception (Rapeseed as "Cereals") contributes to the overall inconsistency of the table.

JRC: See answer to Q2).

Q60) **Table 50: Changes in crop yield and mineral fertilizer input between 2000 and 2010/11 (i.e. average of 2010 and 2011)**

- Footnote 1 of the cited IFA Report is clear that, since EU stats are done for crop year, the data and fertilizer use are for that one crop year. We want to clarify if the yields used correspond to one year yields and harvested area data (which in FAOSTAT and EUROSTAT would be referred as 2011) or an average of 2010 and 2011.

JRC: Data on yields and mineral fertilizer input have been updated as anticipated at the experts and stakeholders workshops in September 2016. An average yield of 6 years is now considered for all crops from Faostat (from 2009 to 2014). New data for fertilizer inputs in Europe (for 2013/2014) received from Fertilizers Europe in August 2016 have been also used in the updated calculations.

Q61) **Figure 6 Weighted global average N2O soil emissions from biofuel feedstock cultivation.**

- In the figure description, the results are "weighted by feedstock quantities supplied to the EU market". However, for maize RED Annex V refers only to maize produced in the EU itself. Current practice of sustainability schemes as verified by EC, is that all maize imported into EU or any maize ethanol from non-EU produced maize cannot be based on default values, i.e. requires individual calculation.

Given the knowledge that there is substantial gap in carbon footprint of fertilizers used in the EU and abroad, we ask JRC to clarify this choice.

- From the technical point of view, the report doesn't contain an analysis of how stable trade patterns in grains or oilseeds are year on year. Such an analysis is required to establish relevant mix. However we note that trade patterns may be volatile, and so suggest to focus on assessing the carbon footprint of EU feedstock.

JRC: Typical and default values refer to feedstocks consumed in the EU. Trade patterns are therefore relevant in order to estimate how much feedstock is produced in EU or outside EU. However, it is true that for most of the cereals basically all production is in EU with the exception of maize. A small percentage of the EU consumed maize comes from Ukraine (on the basis of updated data from Eurostat) as also confirmed by stakeholders during the workshops.

Q62) **Nitrogen Application:**

As mentioned above, the Report assumes a static level of fertilizer use across the EU.

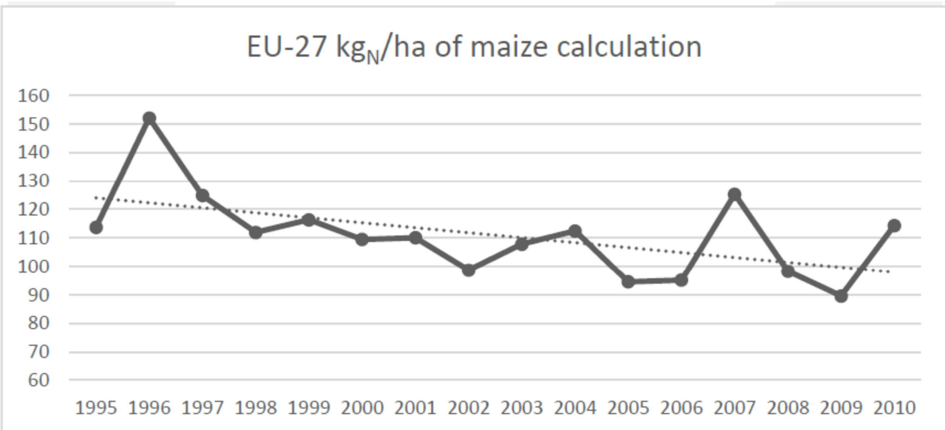
For example, IFA data for 2011 implies that the average artificial N application in the EU for maize is 147 kgN/ha. There are at least three data sources that show this number is extremely inflated.

- First, data collected by Member States in 2009 show that the weighted average from the Member States who reported nitrogen application explicitly is just 85 kgN/ha on 76% of EU-27 maize harvested area.

For EU average to be close to 147 kgN/ha application in the rest of the countries should have been 340 kgN/ha, which are beyond reasonable assumptions (Austria and France having highest yields apply 135 and 156 kgN/ha respectively).

- Second, the 2014 (and 2015) Fertiliser Europe Industry reports and FAOSTAT data for EU harvested area for various coarse grains suggest that the correct number shall be under 120 kgN/ha.

- Third, in a study by Iowa University[19] which aggregated various available sources and showed that over 15 years nitrogen application in EU maize averaged around 110 kgN/ha.



[19] ageconsearch.umn.edu/bitstream/140952/2/12-WP_535.pdf

JRC: Meissle et al. (2009)[20] collected information on maize production characteristics in 11 regions in Europe. The N input to maize he obtained by an inquiry among experts in the different regions is quite different from the data presented in the study of Iowa University, Fertilizer Europe and FAOSTAT. The N inputs to maize in the different regions range from 100kg N/ha in Southwest Germany to 350kg N/ha in the Ebro valley in Spain. For France, one of the main producers of grain maize he reports N input between 210 and 230 kg/ha in 3 different regions.

Q63) **2.3 Manure calculation [Section 3.8]**

This report propose to add a default amount/proportion of manure to all cultivation, whether it is the actual case or not. We consider the associated methodology lacks representativeness: the amount of mineral fertilizer applied is not reduced with respect to the added manure. In practice this should be the case.

Methodology:

- It is unclear if for purposes of modelling the manure application the EU was considered as one country or not.

- We understand that in its manure application ratio of 50% JRC relied on USDA 2009 survey of US farm practices. We shall remind the JRC that most of the biofuel feedstock in the EU is home-grown.

We shall note the following:

- Manure application on the fields and manure management in general is regulated in EU. Those regulations may differ from US regulations.

- We cannot understand how uneven (50% soil receives/50% does not receive) distribution of manure on fields points to the reasons.

If we to take example the following case[21] "In the Brittany region of France […] on average, 134 kg nitrogen is available per hectare from manure. In addition, 93 kg is purchased in the form of inorganic fertilizer, against a crop uptake of only 146 kg N/ha. This results in an excess of about 80 kg N/ha". In this case there could have been a logical conclusion, that 40% of manure is applicable to the crops. I.e. without the corresponding understanding of mineral fertilizer application, one cannot make conclusions of the of manure applicability to crop production. In other words, we believe that logical conclusion from USDA 2009 is incorrect.

We believe, that the study[22] "Study on variation of manure N efficiency throughout Europe" which discusses manure N-efficiency (i.e. potential for uptake of Nitrogen by crops) is more relevant to the topic.

[20] Meissle, M., Mouron, P., Musa, T., Bigler, F., Pons, X., Vasileiadis, V.P. et al. (2010). Pests, pesticide use and alternative options in European maize production: Current status and future prospects. Journal of Applied Entomology, 134 (5), 357–375. doi:10.1111/j.1439-0418.2009.01491.x.

[21] http://www.fao.org/ag/againfo/resources/documents/lxehtml/tech/ch3c.htm

[22] http://ec.europa.eu/environment/water/water-nitrates/pdf/Man_N_Eff_Final%20Report.pdf

- The study suggests that, on average, way less than 50% of Navailable/applied can be attributed to crops. One of the reasons being that manure is applied during the autumn due to regulations.

- It also suggests that N uptake efficiency is different in the regions, and since there is differentiation of crop production in EU countries, it would result in different weighted average attribution to crops, and as a result different N2O emissions.

Application of manure in proportion to nitrogen intensity of crops versus pro rata to arable area:

- Farmers do not grow one crop at time, since that is effectively restricted by EU regulations (limits the size of the field under monoculture plus crop rotation). Therefore, the farmer who has a field of low nitrogen intensive crop and a field of say corn would be faced with a choice where to apply fertilizer. If he can cover a field of low nitrogen demanding crop solely with manure and corn field solely with fertilizer, the farmer would have only one run of the fertilization equipment on the fields. However, if he decides to do it pro rata, then he might end up with two runs for each field doubling amount of diesel used. USDA 2009 suggests concentration of manure used for corn growing, which can be explained by corn-soybean rotation cycle prevailing in the US.

- Moreover, in the case of solid manure N up-take takes more than a year, and thus due to crop rotation it leads to N distribution based on area covered.

- Therefore, we suggest to return to planted (harvested) area attributional basis.

JRC: Our data on the use of synthetic nitrogen derives from sales data on actual N use, not on recommendations. Therefore our data on average use of synthetic nitrogen per crop already takes into account the reduction in synthetic nitrogen by farmers using manure.

Thank you for pointing us to the AEA survey on EU manure-N efficiency. It was indeed a useful tool for estimating the fraction of N in manure that is actually available for crop growth. As explained in our revised report, the data in the AEA survey indicate that a weighted average of 39% of manure-N is available in the first year, but that in addition crops benefit from at least 12% of the manure-N applied in previous years. This indicates that our estimate that 50% of N from manure is available probably an underestimate for EU. We note that the opinion expressed by national experts was that all manure N applied to crops should be attributed to crops.

The AEA report shows varying national estimates of the crop-availability of nitrogen from manure. Part of the variation is probably real, whereas part is due to unrepresentativeness of the national estimates, which may be based on measurements at few or even single sites. In any case, our EU-average value weights the different national estimates by the manure used in each country; therefore the average is appropriate for the calculation of the EU-average contribution of available N from manure.

We do not assume that each farmer distributes manure pro rata to each crop every year; we are talking about the average from calculating the total manure-N applied to a crop divided by the total production of that crop. In the few available datasets of manure application by crop, it is clear that more intensive crops on average receive more manure than those that need less nitrogen. ePURE choose the example of US corn and US soybean. According to the USDA manure report, US corn receives on average about 125lb/acre manure (compared to 156 kg/ha synthetic N), whereas US soybeans receive about 75 lb/acre (compared to 93 kg/ha synthetic N). So even in ePURE's chosen example, it is clear that it is more accurate to assume that average manure application is proportional to the synthetic N application, than to assume it is constant per hectare.

As mentioned above, some manure-N is indeed released in subsequent years, when the crop being grown could be different, due to crop rotation. However, as described in detail in the updated report, whilst 39% of the manure-nitrogen is released in the first year, only 2-3% is released in each subsequent year. Therefore the effect of crop rotations in evening out manure-N availability between crops is quite limited.

Q64) **2.4 Emissions from acidification and liming methodology [Section 3.10]**

We believe that the assumptions made by the JRC about the neutralization of the acid generated by N-fertilizer lack representativeness and consistency in a coherent modelling approach.

Methodology:

Following a recommendation from year 1935, JRC took an arbitrary decision on the value to be used to model the emissions from neutralization of fertilizer acidity:

"The Association of Official Analytical Chemists (AOAC) Method 936.01 recommended that farmers apply 1.8 kg CaCO3 per kg N (as urea or ammonium nitrate), to neutralize acidification caused by the fertilizer […] Since the AOAC recommendation was made in 1935, improved techniques may have increased the fraction of N taken up by crops, so that now perhaps less than 50 % of the nitrogen causes acidification. On the other hand, total use of nitrogen fertilizer has greatly increased in the same time, and this tends to reduce the nitrogen uptake efficiency. The emissions from neutralisation of fertilizer acidity lie at between about 25 % and 50 % of the stoichiometric value of 1.57 tonnes CO2/tonne N. We shall use a mean value of 37.5 %, which gives 0.59 tonnes CO2 per tonne N. "

Given the final impact of this "consideration" which is about 1 to 3% of the total cultivation emissions we consider this value and methodology as highly questionable.

JRC: The question only quotes the concluding lines of this section of the August 2016 JRC report, which preceded it with three pages of detailed analysis of the available literature, using three different approaches. For the first approach, JRC has traced the original source of the acidification figures that have become the standard numbers used by many current farm guidelines for calculating lime requirements.

However, as stakeholders referred us to Fertilizers Europe report "Energy efficiency and greenhouse gas emissions in European nitrogen fertilizer production and use", we now use these figures for the CO_2 arising from neutralization of acidity from fertilizers (see section 3.10 for more details).

3. Biofuels processes and input data [Section 6.]

Q65) Once again, we deplore the data set used by JRC to define the presented pathways. For Wheat, Maize and Sugar beet the sources match the one presented in 2013. As stated in the North Energy report, they lack representativeness, transparency and consistency.

JRC: The data and reporting have been updated and improved in the current version of the report. Various sources including data from industry (e.g. Ethanol Europe for maize) are used and reported in section 6.

Q66) **3.1 Maize Pathway [Section 6.2]**

Representativeness of the outlined process:

In April 2013 Ethanol Europe, an ePURE member, supplied data to JRC on the Pannonia plant showing that, utilizing a typical US ethanol plant technology at that time it largely outperformed the data used from Greet 2009.

Ethanol Europe also pointed to other sources of information on typical corn ethanol efficiencies, which were ignored. Grain ethanol production is dynamic industry, and efficiencies improve year on year.

Ethanol Europe also alerted the JRC to the fact that most corn ethanol facilities use corn oil extraction these days, and thus its presentation of pathway is not correct.

Ethanol Europe will be providing dynamics of efficiency gains over the period of time between 2012 and 2016 to EC/JRC directly, to show that data used is largely contradicts the reality and ignores "technological progress".

Pathway Data	Representativeness	Transparency	Consistency
Bioethanol Production			
Wheat Input/Bioethanol Output	**Unrepresentative data (nominal value for single UK plant in 2010)**	**Low (choice and combining of data unexplained)**	**Not based on EU-27 current range of plants**
Maize Input/Bioethanol Output	**Unrepresentative data (nominal value for US 2009)**	**Low (choice and combining of data unexplained)**	**Not based on EU-27 current range of plants**
Sugar Beet Input/Bioethanol Output	**Unrepresentative data (nominal values for DE 1997 and 1998)**	**Low (choice and combining of data unexplained)**	**Not based on EU-27 current range of plants**

Extract from the North Energy 2013 Report[8]

[8] Deliverable 1 - Critical Review of the JRC Proposal- North Energy 2014 http://epure.org/media/1426/20160916-north-energy-review-of-the-methodology-contained-in-annex-v-of-the-renewable-energy-directive-and-annex-iv-of-the-fuel-quality-directive-critical-review-of-the-jrc-proposal.pdf

JRC: Data sent by Ethanol Europe in September 2016 has been taken into account (see section 6.2). Table 110 'Data used to calculate the 'adopted value' from various sources' shows the sources used to calculate the 'adopted value' (for more details on the data included please check the table).

3.2 Straw Pathway [Section 6.20]

Q67) *Representativeness of the outlined process:*

Considering the array of technological set-up for cellulosic ethanol made from straw, we are doubtful about the representativeness of the outlined pathway:

- Different pathways may use different pretreatment technologies, may have different uses of biogas produced internally (used directly for CHP or upgraded and sold), may have different inputs of chemicals and other auxiliaries and may have on-site, off-site or integrated enzyme (cellulase) production.

- In that context, the study assumes integrated enzyme production, which is a deviation from current practice at existing large-scale cellulosic ethanol biorefineries.

JRC: In the EU, the cellulosic ethanol technology is not yet commercially widespread. The pathway has been updated on the basis of publically available data from Biochemtex in Italy and Clariant in Germany, the two main operating plants in EU. JRC had contacts with the two companies during the update of default values but the companies were reluctant to provide additional details on their processes and disclose information not publicly available. The JRC believes it has modelled the process well using the data which has been available to us to date.

Q68) *Comments on the used values*

The data for the straw process seems to come primarily from a study by a single consultant (Johnson, 2016) and data from the 2001-version of a book (Kaltschmitt and Hartmann, 2001). These data are combined with a few data points made publically available by Biochemtex in 2015[23].

Due to the heterogeneity of cellulosic ethanol technology, the combination of data sources raises questions about consistency.

- The straw use of 6 tdry straw/tethanol is too high and not in alignment with the stated reference (Biochemtex 2015). A more realistic range would be 4-5 tdry straw/tethanol (not taking into account integrated enzyme production).

- We want to clarify how the chemicals NaOH, H2SO4 are used in the described process. Their use seems too high but may be related to pretreatment. If so, this should be mentioned and explained

- Similarly, the use of ammonia seems high, which may have to do with the integrated enzyme-production. This should also be discussed.

JRC: JRC has updated the straw to ethanol yield on the basis of the information provided by Biochemtex during and after the workshop in September 2016 (see table 277 'Conversion of wheat straw to ethanol via hydrolysis and fermentation with biomass by-product used for process heat and electricity (which is also exported)'). However, no further information or details on the process were disclosed by the two operating European companies (Biochemtex and Clariant). Therefore, JRC is still using data from Johnson, 2016 which is a peer-reviewed paper and provides the most up to date figures available in literature on cellulosic ethanol production.

Conclusion

Q69) The JRC 2016 report lacks consistency and representativeness. As stated in the North Energy 2013 report:

"Overall assessment of the JRC proposal has led to the conclusion that its main purpose has been to collect new data rather than to assemble representative and coherent data

[23] https://ec.europa.eu/energy/en/events/renewable-carbon-sources-processing-fuels-and-chemicals-workshop - Presentation 2-4

for generating typical and default values. The need for coherent datasets, consisting of interdependent values that should not be collected from diverse and possibly unrelated sources and models, has been raised as a crucial issue in the preparation of truly representative data on which to based suitable typical and default values. However, it has been noted that, in many instances, information from different sources, which might or might not may or may not be compatible, has been mixed together to derive data in the JRC proposal. This does not conform with best practice in the application of LCA to GHG emissions calculations."

The final GHG emissions are heavily impacted by modelling decisions from JRC. For example, the soil N2O emissions modelling definitely lacks of scientific justification, hence its suitability remains unproven.

We want to clarify how the GNOC model, which is a hybrid model derived from IPPC Tier-1, stands among others models, and especially how it represents a more accurate and coherent approach to model N2O emissions.

We are concerned to see that the outlined pathways remain contradictory to reality, technological and scientific progress, as most of them are backed by old data sources.

New process added to ethanol pathways are unrepresentative of the current state of the industry: for example the drying process for maize or straw to ethanol.

Consequently, we consider that the presented JRC report is not fit for regulatory purpose.

JRC: See answer to Q47).

Questions received after the workshop (ePURE)

Q70) ***GNOC***

We understood that the European Commission intends to derive default values covering the whole world. However, the methodology applied is questionable. Cultivation emissions are based on averages, meaning that non-EU feedstock base biofuel would enter the system based on non-representative average cultivation emissions.

For example, major exporters of sugarcane ethanol to EU today are Guatemala, Pakistan and Peru. That ethanol enters the EU under the default values for sugarcane, which are derived exclusively from Brazilian sugarcane data (whether that data is adequate or not is a continuous point of discussion in itself). However, we see no reference to LCA work being done for the aforementioned jurisdictions.

JRC: See answer to Q61).

Q71) ***Data about the feedstock origin is available***

The European Commission would like to have information about the feedstock by country of origin of the biofuels. We note that all biofuels entering the EU fuel system are accompanied by sustainability certificates which indicate the country of origin of the feedstock used. That information is available to Member States. We understand that this information would be useful for policy makers for the development of policy proposals and economic and environmental impact assessments. We welcome the European Commission effort to collect such data.

JRC: Indeed it would be useful to have information on the country of origin of the feedstocks used specifically for biofuels. Unfortunately this data is not available to JRC at present, although it could be incorporated in a future update.

Q72) ***Comparison with DNDC/IPCC***

JRC/DG ENER Presentation:

The GNOC model was created to address the gaps from the IPCC and the DNDC models. The IPCC Tier1 model was presented as scientifically incomplete and the DNDC model as needing a vast amount of data and computational power: in fact, the DNDC model was completely discredited. When questioned on a potential comparison of the GNOC model with the DNDC model (as the only comparison in the report is with the IPCC Tier 1 model, to conveniently show lower results), the JRC answered that it was not needed.

Comments

The GNOC model presented as a 'Tier 2 model' includes regional parameters, but, is based on worldwide data, which does not account for local and regional disparities. This model should have been calibrated with data on its region of application, Europe. Considering that the DNDC model was used in previous material, ePURE views the comparison between the DNDC model and the GNOC model as critical.

JRC: See answers to Q55) and Q57).

Q73) ***Source data***

JRC/DG ENER Presentation:

One question raised by Vadim Zubarev (Ethanol Europe) was the fact that final dataset used for entry into GNOC and the outputs were not transparent, i.e. presented only in aggregated form. Another comment made, was that the database's size of a thousand global measurements might not be representative enough of the European crops and, that populating database with recent field data would improve quality of regressions. Robert Edwards (JRC) personal point of view was that the GNOC model should include more data, but that the JRC cannot get the funding to proceed.

Furthermore, when asked about the origin of the thousand measurements, and more specifically about the number of European measurements points, the JRC was not able to answer.

Finally, when asked about the calibration of this model, which should offer the ability to differentiate crops (in comparison with IPCC Tier 1), the JRC presented the GNOC model as a statistical regression from real world data, which intrinsically does not need calibration.

Comments

The lack of European data represents ePURE's major concern; assessment of the Stehfest-Bouwman (2006) database24 show that a majority of the data is coming from regions outside of Europe:

Crop	*Total (%$_{Total}$)*	*Europe (%$_{Total}$)*
Maize	*165 (8,7)*	*28 (1,5)*
Sugar Beet	*5 (0,3)*	*5 (0,3)*
Wheat	*106 (5,6)*	*67 (3,5)*
Sugar Cane	*30 (1,6)*	*0 (0,0)*

Table 1 Analysis of the Stehfest-Bouwman database

In the context of the previous trials conducted in UK (MIN-NO) and France (NO GAS project by Terres Inovia) which led to inferior N2O emissions, the JRC stated that these values are specific and 'local' in a way that they do not include extreme values. Nonetheless, these extreme values are heavily impacting the final N2O emissions, as they may be orders of magnitude higher than the majority of the other values of the sample. This observation leads to question the purpose of taking the average value instead of the median value of the N2O emissions sample.

JRC: JRC agrees that it would be desirable to update the experimental database of the Stehfest and Bouwman statistical-regression for estimating N2O emissions. Then the new regression could be incorporated in a future update of default values.

However this would not necessarily lead to a reduction in the N2O estimates: the results are not simply averaged, but regressed against the known variables affecting N2O emissions. Therefore, even if the average emissions from new measurements are lower than in the default calculations, this would not necessarily reduce the estimate average emissions if the new results were obtained in conditions where low N2O emissions would anyway be expected from the regression.

The factors that determine N2O emissions are physical soil conditions, weather and management, and none of these are specific geographical location of the field. In other words, a field the same soil characteristics, experiencing the same weather and planted with the same crop using the same inputs would give the same N2O emissions whether it was in EU or USA. So there is no reason to exclude data from outside EU. Differences in factors such as average rainfall or nitrogen use would be accounted for in the regression methodology.

In order to calculate the average emissions from biofuels, we need to know the average N2O emissions, and not the median N2O emissions which exclude high emissions from the fields and growing-seasons with particular weather and soil conditions, as these also contribute to the average emissions from growing a crop. It will be interesting to see the results of the NOGAS project for the harvest of 2016, where unusually wet conditions prevailed.

[24]http://www.pbl.nl/en/publications/2006/N2OAndNOEmissionFromAgriculturalFieldsAndSoilsUnderNaturalVegetation

Q74) ***Methodology***

JRC/DG ENER Presentation:

One question about the categorization of feedstocks in the GNOC model was only partially answered. The JRC does recognize the current classification as misleading, and will change the name of the 'Cereals category'. Additionally, the Maize which was categorized as 'Other' may be revised.

Comments:

We want to clarify the motivation behind the implementation of this model: considering that European renewable ethanol feedstock is grown in Europe, what is the point of implementing a global model with a limited and disperse database on European crops? For example, what are the scientific justifications to apply a global model on the sugar beets, with global data, considering that the sugar beet does not travel?

One natural evolution of the DNDC model should have been a Tier 2 Model, not a statistical model backed with mostly non-European data. Additionally, we would want the JRC to publish the error bars associated with the GNOC model (as it is a scientific obligation in every publication related to N2O emissions model).

We have every reason to believe that the data from the JRC 2016 report is not representative of reality and cannot, under any circumstances, be applied locally or be used for regulatory purposes.

The N2O modelling is heavily impacting final emissions, without any possibility to use actual values:

Crop	Yield (kg/ha) – CAPRI (average 2010-2011) – p.48	Input parameters ($g_{N2O}/MJ_{Feedstock}$)	N_2O emissions (kg/ha/y)	% of the cultivation emissions	$\Delta g_{CO2eq}/MJ_{Ethanol}$ JRC 2016 Report vs RED
Wheat	5550	0.044 – p.125	3.59	50%	5,95
Sugar Beet	80760	0.0121 – p.139	3.98	53%	0,17
Maize	7328	0.055 – p132	6	46%	12,80

Table 2 Impact of the N_2O input on the cultivation and final GHG emissions. Calculated from the JRC 2016 Report

ePURE welcomes the fact that the JRC/DG ENER will consider a split between N2O emissions and other emissions in the cultivation part of the defaults values.

JRC: Regarding the categorization of feedstocks (maize as "other crop" and rapeseed as "cereal") see also answer to Q2).

According the definition given in IPCC (2006) the GNOC approach is a mix of a TIER2 approach for direct soil N2O emissions (s. IPCC 2006 Volume 4 Chapter 11 p. 11.10) from N fertilizer application and a TIER1 approach for indirect emissions.

Regarding the discussion of the uncertainties, see answer to Q55).

Q75) ***N input***

JRC/DG ENER Presentation:

When asked about the aglime effect, and the assumption made to get to the value 37.5% of the stoichiometric value, the JRC could not remember what was the source used. The ethanol stakeholders then proceeded to provide the source indicated in the JRC 2016 report. The JRC said that this 'consideration' was not impacting the final GHG emissions of the biofuels.

Comment:

This answer is not true: this 'consideration', based on a 1935 source, is impacting the final GHG emissions of the biofuels by 1 to 3% without any compensating effects.

JRC: The August 2016 input data report included 3 pages of detailed literature analysis to support the 37.5% figure using three separate approaches: it would not be reasonable to expect a speaker to be able to recite this all from memory. Please refer to the answer to Q64).

Q76) ***Source data -Fertiliser Trade:***

The JRC complained that no data on sources of fertiliser trade are available and it had to rely on experts' opinion to understand the origin of fertilisers in Europe. The JRC also persistently made a point that Chinese fertilisers may enter the system, especially through palm oil cultivation in Indonesia and Malaysia. We found data sources which would have given JRC a better understanding of fertiliser trade flows:

- The map of worldwide fertiliser trade flows after registration is downloadable for free[25]. The map clearly demonstrates that most of Chinese fertilisers end up in India, and not in EU or SE Asia. It also indeed confirms that most of N fertiliser comes into EU from Russia (mainly ammonia) and Middle East/North Africa (mainly urea).

- The Indonesian Fertiliser Association publishes26 its statistics and shows that it is net exporter of fertiliser. The insight, though outdated, can be found here27.

We also draw European Commission's attention to the fact that ICIS28 advertises its price benchmark services based on marginal costs of production model. That implies that ICIS has production efficiencies data and configurations for major fertiliser producers in the World, which would allow to derive carbon footprint estimates of fertilisers.

JRC: Trade data for fertilizers is included in the JRC calculation and shown in the report circulated to stakeholders in August 2016 (version 1b). The trade patterns are shown in section 2.3 of the report, figure 1 'EU Nitrogen fertilizer production sources' and table 46 'Input data for fertilizer manufacturing emissions calculation'. Indeed, fertilizers imports to EU are from Russia and North Africa/ Middle East as you suggest. Statistics from the International Fertilizer Association (IFA) and Fertilizers Europe data are mainly used.

At the moment we are using emissions calculated for average EU-consumed fertilizers for all countries. It is a daunting task to estimate fertilizer production emissions for fertilizer

[25] http://www.icis.com/resources/fertilizers/trade-flow-map-2015/

[26] http://www.appi.or.id/?statistic.

[27] https://www3.epa.gov/ttnchie1/conference/ei13/ghg/munawar.pdf

[28] http://www.icis.com/fertilizers/

used all producing countries; to start it, we need a consistent and reliable source of data. We are aware that there is an IFA report comparing emissions from different countries, which could help, but this is unfortunately confidential.

Q77) ***Ukrainian Fertiliser Use***

The JRC indicated to not possess the fertiliser use data for Ukraine in relation to maize. Ukrainian agricultural statistics are available at the State Statistic Service of Ukraine web site[29].

Navigation through web site and main statistical reports are available in English, but some detailed statistics, like fertiliser use per crop is published only in Ukrainian. Please find below more details:

		2009	2010	2011	2012	2013	2014	2015
N	*thsd 100 kg*	*910.5*	*1392.5*	*1943.4*	*2511.1*	*3186.1*	*2997.1*	*2567.8*
P	*thsd 100 kg*	*159*	*251.4*	*358.8*	*480.5*	*599.5*	*552.8*	*432.4*
K	*thsd 100 kg*	*160.7*	*208.9*	*315.8*	*414.4*	*610.4*	*497.1*	*422.9*
Organic Fertiliser	*t gross*	*1769.5*	*1515.8*	*1828*	*2143*	*2575.3*	*2459.7*	*2287.3*
Area (ha)	*thsd ha*	*1514.1*	*2024.3*	*2813.3*	*3538.8*	*3787.3*	*3571.1*	*3049.6*
N	*kg/ha*	*60.1*	*68.8*	*69.1*	*71.0*	*84.1*	*83.9*	*84.2*
P	*kg/ha*	*10.5*	*12.4*	*12.8*	*13.6*	*15.8*	*15.5*	*14.2*
K	*kg/ha*	*10.6*	*10.3*	*11.2*	*11.7*	*16.1*	*13.9*	*13.9*
Organic	*t/ha*	*1.17*	*0.75*	*0.65*	*0.61*	*0.68*	*0.69*	*0.75*

Table 3 Ukraine - Fertiliser Use for Grain Maize cultivation. Organic fertiliser is measured in gross tons applied, while chemical fertiliser are in kg of nutrient.

It shall be noted that Ukrainian statistics differentiate two classes of harvested land (i) land of enterprises (both private and state) and (ii) land in hand of population. The fertiliser consumption data refers only to the land of enterprises, while overall grain production and yield calculations would include all harvested area similarly to what FAO reports. Therefore, one can assume that if a fertiliser was used for the full harvest area, it would be a conservative assumption.

Secondly, the JRC intends to use 6-year average yield data and 2013/14 fertiliser use data. While generally for EU that might be adequate, since fertiliser use is relatively static, that would not be the case for countries like Ukraine where fertiliser use grows along with the yield growth. We would suggest JRC to make similar sort analysis for Romania as well.

JRC: For Ukraine, JRC use data from the International Fertilizer Industry Association (IFA, 2013) to be consistent with the data used for other not-European crops imported to EU.

[29] http://www.ukrstat.gov.ua/

Q78) ***Ethanol Pathway***

JRC/DG ENER Presentation:

Julien Coignac (Cristal Union) raised that the conversation value of wheat into ethanol is not right (closest to 2.8 t wheat grain 13.5% H2O/t Ethanol than 3.333 t wheat grain 13.5% H2O/t Ethanol in reality). The JRC answered that the yield should not induce a change in the final GHG emissions.

Comment:

According to Julien Coignac (Cristal Union), the difference is approximately +2 g CO2eq/MJ Ethanol for 3.333 t wheat grain 13.5% H2O/t Ethanol from 2.8 t wheat grain 13.5% H2O/t Ethanol.

JRC: JRC has updated conversion data for the wheat to ethanol pathway combining information from various sources including ADEME as suggested by Cristal Union in the comments. Please see section 6.1, table 90 'Conversion of wheat grain to ethanol' and table 91 'Data used to calculate the 'adopted value' from various sources' for more detail on the input data and the sources considered.

Q79) ***Ethanol from straw***

JRC/DG ENER Presentation:

There are two different pathways representing the production of ethanol from straw:

1) From straw < 500 km

2) From straw > 500km

Assumptions:

• There are no upstream emissions from straw (except the baling process).

• This pathway is incomplete and not established.

There are 2 sources to describe this pathway:

1) The yield is coming from a Biochemtex presentation

2) Input data from a second recent study (containing a more optimistic yield not taken into account).

Comment:

According to Jesper Hedal Kløverpris (Novozymes), the final yield of 6 t straw dry/t ethanol is too high, which was confirmed by Paolo Torre (Biochemtex). In fact, the JRC uses important data points from the Biochemtex unit, which is smaller than industrial scale.

Pathways with and without on-site enzyme production shall be developed.

JRC: In the RED-recast proposal COM(2016)767, there is only one straw to ethanol pathway. This default value is calculated on the assumption that a fully commercial plant would need to:

- integrate enzyme production in the plant, as this would save 20% of costs [Johnson 2016].

- use the biomass by-product (mostly lignin) for process heat and electricity, avoiding the cost and emissions from fossil fuel.

The yield has been improved in line with the information provided by Biochemtex during and the workshop in September 2016 (see table 277 'Conversion of wheat straw to ethanol via hydrolysis and fermentation with biomass by-product used for process heat and electricity (which is also exported)'). We note that the general trend has been for yield estimates to get *less* favourable over time, as practical difficulties were recognized. A paper from UC Berkely (Klein-Marcuschamer et al., 2012[30]) reports that, using the state-of-the art in 2012, 6.45 dry tonnes of corn stover are needed to make 1 tonne of ethanol, and a reasonable future target would be 4.96 tonnes.

Although JRC has studied the carbon intensity of wheat straw in more detail, straw is on the list of residues and wastes, and therefore under RED-recast rules automatically is assigned zero emissions in the field.

Q80) ***Methodological gaps***

Drying process:

JRC/DG ENER Presentation:

The JRC explained that they were not considering that all EU crops were dried, but that the purpose of their work was to find an average drying emission for the EU crop, with a "zero" for crop that did not need drying.

From CAPRI data, the JRC found an average of the quantity of water that needed to be removed from EU crops. From this assumption, the JRC considered that EU wheat needed to be dried by 1.0% on average.

Following an 'experts' consultation', the JRC decided that the fuel associated with this process was coming from NG (50%) and LPG (50%).

Comments:

During the first meeting on 27 September 2016, the attendee from CAPRI was surprised to see their data used for regulatory purpose, as they were considered as not fit for this purpose and vastly extrapolated in the JRC 2016 report. ePURE invites the JRC to consult its first comments indicating that the drying process (as described in the JRC 2016 Report) is not representative of reality.

JRC: The average % of water removed from each crop for cereals has been updated in the current version of the report (see section 2.5.2). The figures used by the JRC from CAPRI were double-checked by the CAPRI expert (Markus Kempen) who participated at the expert workshop in Brussels in September 2016. He provided additional information to the JRC after the workshop and the figures have been updated accordingly. As a result of these changes, the average % of water removed from each crop is substantially

[30] Klein-Marcuschamer D, Oleskowicz-Popiel P, Simmons B and Blanch HW, The challenge of enzyme cost in the production of lignocellulosic biofuels. Biotechnol Bioeng 109(4):1083–1087 (2012).

reduced: the results are shown in table 49 'CAPRI drying data' of the report and linked to the respective pathway (wheat, maize, rye, barley, triticale) in section 6 of the report.

Q81) ***FFC***

JRC/DG ENER Presentation:

DG ENER stated that it wanted to update the FFC values, but that there were only two ways to update the FFC:

1) Revision of the Annex V.

2) Wait until Directive 2015/52 is transposed and that the reports from the Members States are published (in 2018).

Comments:

Trying to update default values without updating the FFC is non-sense. In the JRC 2016 report, the new emission factors are used to calculate GHG emissions of biofuels, but not their savings. Furthermore, Directive 2015/652 already provides an average GHG intensity of fuels (94.1), which could be used.

Once again, the JRC tries to introduce a patchwork of LCA and methodological approaches:

• Sourcing of petroleum products: Attributional LCA

• Refining: Consequential LCA.

Consequently, ePURE would welcome a simultaneous update of the FFC and the defaults values.

JRC: The fossil fuel comparator has been updated in the Commission proposal of Directive RED recast - COM(2016)767. The new fossil fuel comparator is 94 gCO2eq/MJ (Annex V part C, point 19).

Q82) ***Marginal approach***

JRC/DG ENER Presentation:

The JRC was asked about their change of methodology when considering the LCA approach. The JRC answered that they did not change the approach as they want to keep an attributional approach. Vadim Zubarev (Ethanol Europe) also commented that emission factors shall be used consistently across climate policy assessments. The most immediate example would be that if proposed factor were to be applied to assess E-mobility regulations, those would turn out climate harmful. Moreover, the value being based on a 50/50 split between natural gas and coal is not representative of the economic context, and may not be compatible in mid-term EU ETS policy approach advocated by EC.

The JRC/DG ENER answered that this approach and these values were in line with the 2014 approach, which used marginal values for input data.

Comments:

Once again, we ask the JRC to resolve this controversy. Similarly, to our first comments, this approach and methodology is not following any logic. Stating that this approach is similar to the one adopted in 2014 does not constitute a scientific nor a sufficient explanation. Even if we were to accept that marginal values were the right choices (which is not the case), the associated methodology does not make sense: when one is choosing marginal electricity, it cannot, in this economic context, be produced from coal and natural gas.

JRC: At the time of the stakeholder meeting, the Commission had not made a decision on the fossil fuel comparator and the emission factors. The recently published proposal for a recast of the RED - COM(2016)767 describes the methodology for the calculation of typical and default values in Annex V part C and defines the fossil fuel comparator.

For the fossil fuel inputs, the emissions factors are consistent with the GHG intensities reported in Directive 2015/652. They have been updated in the report accordingly (see section 2.1 of the report).

Q83) ***Bioelectricity***

JRC/DG ENER Presentation:

Jesper Hedal Kløverpris (Novozymes) asked about the JRC approach to bioelectricity co-produced with cellulosic ethanol. The JRC answered that the replacement approach (system expansion) could incentivize cellulosic ethanol producers to direct their efforts toward the production of electricity in order to drive down the carbon footprint of the ethanol and at the same time obtain feed-in tariffs for green electricity.

Comments:

First of all, this concern is not likely to materialize (as long as the ethanol only gets a GHG co-product credit for the net electricity produced). Keep in mind that higher electricity production will come at the expense of the ethanol yield. Secondly, the JRC has created a patchwork of different LCA approaches incl. attributional LCA; consequential LCA, and exceptions to both. Section C.16 (regarding excess electricity from co-generation) in Annex V of the RED is a horrifying example of a departure from any generally excepted LCA procedure. This must be remedied but the JRC did not answer how the credit for excess electricity form cellulosic ethanol production will be calculated. New pathways, such as the cellulosic ethanol, will be difficult to describe without a saner and more logical approach to electricity released to the grid. Besides, if the JRC has concerns over excess electricity being 'credited twice' (through a co-product credit to the ethanol and through feed-in tariffs) this should be solved by other means than obscuring the LCA of cellulosic ethanol. Additionally, the JRC tends to forget about energy efficiency: by only taking into account extreme case of 'perverse' approach, the JRC does not consider industrial reality. Some extreme situations avoided by the JRC with its current modelling are already industrial non sense that will not happen in reality.

JRC: As legislation offers far greater incentives to save GHG in the transport sector, it is important to split the GHG savings of a plant between savings in the electricity sector and savings in the transport sector. This requirement does not exist in most LCA studies.

The new recast of the RED, COM(2016)767[31], specifies a new methodology for allocating emissions between ethanol and exported electricity. It uses a form of allocation by exergy applied to the steam from the shared boiler(s). This achieves the same objective as the method in the existing RED-annex V, and gives fairly similar results. At the time of the stakeholder meeting, the Commission had not made a decision on which methodology to adopt, so we were unable to announce it.

UNICA (Brazilian Sugar Cane Industry Association)

Questions received before the workshop

The only comments we would like to make relate to electricity generated from sugarcane biomass and future developments in technology in the production process.

Q84) As we have already informed in the past, the electricity produced out of sugarcane biomass is not replacing traditional sources of electricity, but rather marginal sources. Sugarcane electricity accounts for less than 5% of Brazil's total electricity demand and is not generated all the yearlong. Sugarcane-derived electricity replaces thermoelectric generators using oil and gaz. The emission factors are regularly published by the Brazilian Ministry of Sciences and Technology at: http://www.mct.gov.br/index.php/content/view/354444.html#ancora. On top of that, although the JRC is taking it into consideration, we know that the RED methodology is not computing the extra electricity that is sold to the grid. We would like to reiterate that this electricity should be counted as it generates GHG emission reduction and it is a co-product of the sugarcane.

JRC: The procedure for dealing with electricity exports from biofuel processing has changed from that in RED 2009. However, both procedures separate GHG savings from biofuel from GHG savings from bioelectricity. In the new procedure, the emissions from a boiler producing steam for cogeneration are allocated between the products (in this case ethanol and electricity) according to the steam-exergy used in each process.

In the case of electricity exported from cogenerating sugar-cane-bioethanol mills, the boiler is fed with bagasse, and this appears on the list of bio-residues that are accorded zero carbon intensity at the point of production. Therefore the only GHG emissions considered from the boiler are the tiny amounts of N2O and CH4 released during combustion. These small emissions are allocated between the steam used for the ethanol production and that used for producing the exported part of the electricity.

As before, the RED does not attribute to biofuel the emissions savings in the bioelectricity sector.

Q85) I'd like also to flag important developments that will become mainstream in the medium run and that have the potential to become standard in the near future and contribute further to greenhouse gas mitigation. These technologies include higher ethanol yields in the fermentation process, vinasse concentration, biogas

[31] See also COM(2016) 767 final/2 of 23.02.2017 ANNEXES 1 – 12: Corrigendum of COM (2016)767.

production from vinasse and other residues (filter cake, bagasse and straw). These technologies are being tested by a number of sugarcane mills and, at the moment, there are no available emission mitigation data since the technology providers have not made public the results yet. However, it is expected that until the end of 2017 or earlier results will be widely known. In Brazil sugarcane mills are in the process of becoming effective biorefinaries where energy optimization and emission of regulated and greenhouse pollutants is a key feature of upmost importance.

JRC: We are happy to hear of the expected improvements. Please keep JRC informed of the results when they are known, and of the scale of adoption of the improved technologies. They can then be considered in future updates of the default emission figures.

Q86) Dear Robert and Luisa, I was reading the draft report again and I went through the questions and answers at the end of it. I saw a question that I made about the share of burnt cane that you consider in your calculation and wondered if you have changed this number in your new calculation. As you know, mechanization is progressing very rapidly in Brazil and the majority of the cane is not burnt in the fields anymore.

In the State of São Paulo, responsible for 60% of the cane production in Brazil, the share of the cane that is harvested mechanically and not burnt in the field amounts to 91% (see report from the Environment Department of the State of São Paulo: http://www.ambiente.sp.gov.br/etanolverde/files/2016/06/Etanol-Verde-Relatorio-Safra-15-16.pdf)

For the Center-South of Brazil which accounts for 90% of the cane production, this figure was 71.6% in 2011/12. You can find the data in the CONAB (Government body in charge of agricultural supply) report attached to this email, p 49.

We know that this number has now increased to 90%, but the 2011/12 data is the last official number that has been published.

If you have not up-dated this parameter in your calculation, I hope you will be able to use these numbers.

JRC: We have updated our calculations to consider only 10% trash is burnt. However, the effect on the default emissions is tiny because the CO_2 emissions from trash burning are biogenic and therefore not counted in the RED calculations. We only consider a small emission resulting from N_2O and CH_4 released in burning.

Questions received after the workshop (UNICA)

Q87) As requested during the workshop, please find a PPT presentation with the productivity of the sugarcane for the last 10 years. It is in slide 7 of the attached presentation. As you can see, 2011 was an exceptionally bad year because of extreme weather conditions, not typical at all. Since then, the productivity of the cane has been recovering but because this is a semi-perennial crop, the effects were still felt until last harvesting season. This is different from sugar beet that is replanted every year. But this year the cane has recovered to normal levels. On top of this, according to Mr. Macedo, mechanization brought some changes. The cane that is now brought to the mill has also some straw (previously the straw was fully burnt in the field) attached to it. Therefore, the cane is not the same that the one previously brought to the mill and this explains the loss in TRS. But this straw is then transformed into steam and electricity and emissions from this straw cannot be allocated to ethanol production.

As far as the areas under reform are concerned, they amount to 10 to 20%. But the reform areas remain without cane during 5 months only. The majority of the mills plant Crotalaria juncea as a way to regenerate soils and absorb nitrogen from the atmosphere. Some mills, in specific regions, plant peanuts during this short period. In any case, NO2 emissions resulting from this production cannot be attributed to sugarcane. The cane that is "reformed" is harvested 16 to 18 months later, together with the cane that could not be harvested because of weather conditions. Please find in attachment the data for planted versus harvested area.

JRC: For all crops, we have used the average crop yields for 2009-2014, which included the latest data available from FAO at the time. We understand your concern, but we cannot make exceptions to this rule, because it would be equivalent to predicting that there will be no future adverse climate events. We will update the yield data in future, and that would, for example bring also the most recent bad EU harvests into consideration.

Thank you for pointing out the increasing trash content of cane; we have taken it into account. The carbon emissions from the bagasse and trash boiler are not counted anyway, and the small GHG emissions caused by N2O and CH4 from the boiler are allocated between exported electricity and ethanol, as indicated in answer to Q84).

ABENGOA

I have noted some minor changes in the JRC's methodology towards the data collection and selection in the 2016 report compared to the 2013 report, but I do not see a significant change. So, as far as I can judge, Dr. Mortimer's critique of the methodology behind the 2013 ethanol pathway data remains up-to-date and valid.

Dr. Mortimer used the lens of 4 criteria to judge the data:

- Representativeness;
- Consistency;
- Transparency and
- Significance.

His executive summary makes the following eight comments that I quote:

Q88) **Incomplete – data and notes:** this version is incomplete, that it contains mistakes in references to sources of information as well as missing references, and that the notes provided on the data presented have inadequate details about information from original sources and how such information have been used and combined.

JRC: The current version of the report has been improved compared to the draft version the comments refer to. Additional information and sources provided by industry and stakeholders before and after the workshops held in Brussels in September 2016 have been taken into account. The reporting has been improved as well.

Q89) **Unrepresentative and incoherent data:** its main purpose has been to collect new data rather than the necessary task of assembling representative and coherent data for generating typical and default values. Instead, it would appear that information from diverse, possibly-unrelated and potentially-incompatible sources and models have been mixed together. Additionally, much of the information consists of nominal values selected from single sources or limited numbers of sources. This does not provide a sound basis for deriving truly representative data.

JRC: JRC had dedicated a long time searching a wide variety of sources for the relevant information used in the input data. It would be desirable to have all data for the EU average available for all processes from a single up-to-date source. Unfortunately, such a source does not exist. Official statistics and real-world data are used whenever these are available on the appropriate geographical level.

Q90) **Unrepresentative – narrow geography:** this critical review focuses on the current means of providing bioethanol, consisting of the production of bioethanol from wheat, maize, sugar beet and sugar cane. It is concluded that, instead of representing the EU-27 supply of bioethanol from these particular feedstocks, as might be expected, the data used for deriving typical and default values were based, specifically, on EU-27 wheat and maize cultivation, and Brazilian sugar cane cultivation. Additionally, data for the conversion of these feedstocks to bioethanol are based on an unrepresentative mix of information for the processing of wheat (from the UK, Canada and/or the USA, and Germany), maize (from the EU and USA), sugar beet (only from Germany) and sugar cane (only from Brazil).

JRC: Typical and default values refer to the average for the feedstocks consumed in the EU. JRC has used data from Eurostat to estimate the amount of feedstock which is produced in EU and the amount which is imported to the EU. For most of the cereals basically all production is in EU with the exception of maize. A small percentage of the EU consumed maize comes from Ukraine, as also confirmed by stakeholders during the workshops in September. Therefore, most of the data collected for the cultivation of cereals refer to the EU and some data are for Ukraine in the maize to ethanol pathway.

For cereal-ethanol processing, JRC has updated the figures with additional information provided by industry (Pannonia Ethanol plant for example), data from GREET for dry mill plants, data from ADEME and other relevant references (peer-review papers). For a complete description of the references used in the pathways, please see the updated version of chapter 6 of the report (from section 6.1 to 6.5).

For sugar beet, in section 6.6 of the revised report we have compared the existing input data with those from other EU sources: ADEME and Mortimer himself. The numbers were similar.

Sugarcane ethanol used in EU is almost entirely produced on Brazilian plantations; therefore, data from Brazil are used in this pathway.

Q91) **Incoherent cultivation data:** It would appear that coherent datasets, which include information that is interdependent, have not been used for cultivation data. It is suggested that, as a minimum, coherent datasets should have been formulated for crop yields, chemical nitrogen (N) fertiliser application rates and soil nitrous oxide (N_2O) emissions, with possible extension to include diesel oil consumption rates and, ideally, all other cultivation inputs and soil carbon dioxide (CO2) emissions.

JRC: Wherever possible JRC does use coherent datasets for cultivation data. Yields for almost all crops are from Faostat and Eurostat for common wheat (for the same time period 2009-2014); fertilizers (N, P205 and K2O) are from Fertilizers Europe for crops cultivated in the EU[32] and from the International Fertilizers Association for crops cultivated outside EU (latest available year for both datasets); diesel input and pesticides are from CAPRI: both datasets refer to EU27; seeding material are from Faostat. For soil emissions modelling and lime modelling please see answers to the questions below.

Q92) **soil emission modelling:** the JRC proposal relies quite significantly on modelling. This necessarily includes the modelling of soil N2O and CO2 emissions that are unlikely to be measured in the regulatory context. However, no evidence is presented that the soil N2O emissions model, incorporating the Global crop- and site-specific Nitrous Oxide emission Calculator (GNOC), and the Acidification and Liming model, which simulates soil CO2 emissions, have been validated with actual measurements from field trials. This raises doubts about whether these models, which are clearly sophisticated, are actually more accurate and reliable than existing procedures.

JRC: The Stehfest & Bouwman formula used to calculate the direct Fertilizer Induced N2O Emissions in GNOC is not a model, but a statistical fit to all available field measurements (at the time it was formulated). GNOC is just a tool for gathering the input data needed for applying the formula to given areas.

By contrast, the previous method *did* use a model (DNDC) whose results deviated from measurements, especially for soils with higher organic carbon levels. Furthermore, the definition of the emissions attributed to crops was not consistent either with IPCC recommendations or with attributional LCA.

Measurements for the in-direct emission paths (leaching and volatilization) are very scarce and we follow the method suggested by IPCC (2006).

The most common "existing procedure" in other studies is IPCC tier 1, and this gives results on an EU-average scale very similar to GNOC (the only difference is that GNOC gives slightly more differentiation between crops because it takes into account their geographical distribution).

Q93) **lime modelling:** Agricultural lime (CaCO3) application rates, also simulated by the Acidification and Liming model, have not been comprehensively verified with actual survey data. It is noted that, in the absence of coherent and comprehensive statistics on other cultivation inputs, information has been combined together from disparate sources for different periods of time, resulting in potential inconsistencies.

[32] The Fertilizers Europe data is consistent with the IFA data, but is disaggreagated to a wider range of crops, which is why we use it.

JRC: There is no single consistent source of data. JRC did the best it could with the data available; see the answer to Q64). Some lime data has been improved: see section 3.10 of the new report.

Q94) **N fertilizer modelling:** the JRC proposal uses an EU-27 supply model for deriving the GHG emissions factor for the provision of chemical N fertilisers. Instead of deriving relevant GHG emissions factors from the mix of different types of chemical N fertiliser that are actually used in cultivation, modelling addresses only a mix of ammonium nitrate and urea. Hence, the subsequent GHG emissions factor for chemical N fertilisers might not be entirely representative for the EU-27 and it has been incorrectly applied to cultivation outside the EU.

JRC: There is no data available to say which type of nitrogen fertilizer is applied to which crops. Therefore we are obliged to use the overall mix. Fortunately, with the improvement in the emissions performance of the nitric acid industry, the emissions for making nitrate fertilizers are now close to those of urea-type fertilizers, so there is little error in using the mixed value even outside EU. We agree that it would be more accurate to consider the differences in production emissions for fertilizer used and sourced outside EU. However, the input data is not available to JRC.

Q95) **individual plant data:** The JRC proposal adopts generic pathway data for bioethanol production based mainly on individual examples of installations. This means that subsequently-derived typical values for the GHG emissions of bioethanol production are likely to be illustrative rather than representative. Instead, pathway data should have been based on information which reflects the current or recent bioethanol industry, its plants and their actual performance.

JRC: We have updated the existing data on ethanol production with new data we have received from Pannonia ethanol in 2016, as well as adding a formal comparison with data from ADEME and other references. We had previously made such data comparisons, but since the deviation from the existing data was small, we had not complicated matters by incorporating all the known data. Unlike EBB, ePURE have not provided any industry-wide data surveys.

ADEME

Q96) P 121 Table 79 Cereal share of ethanol feedstock

The table is based on the situation between 2007 and 2009. Isn't it worthwhile to use more recent data? The Grain Report from USDA FAS "EU biofuels annual 2015" provides figures about used feedstock for ethanol production (except triticale) in UE between 2009 to 2012.

JRC: The cereal mix (excluding maize) has been updated. Data from ePURE, 2016, 'Annual statistics report 2016', combined with Ecofys, 2014 data have been used (see table 85 'Cereal share of ethanol feedstock in the EU' for more details).

Q97) P 138 Additional comments

I confirm that for sugar beet yields data have been considered on the period 2006-2007. Moreover an average value has been calculated on basis of weighted average of the two main supply administrative regions (Champagne Ardennes and Picardie).

JRC: Thank you for the confirmation.

Q98) P 161 Table 128 Triticale cultivation

In this table for K2O and P2O5 fertilizer, pesticides, data correspond to average of data for feed wheat and rye. Like data for N fertilizer, they are similar of slightly higher than those for wheat in table 80. But is triticale not supposed to need less fertilizer or pesticides than wheat?

JRC: Fertilizers input for triticale are not available in the tables provided by Fertilizers Europe. We have assumed that the amount of fertilizers correspond to the average of inputs used for feed wheat and rye. Therefore on a per-hectare basis, triticale uses less fertilizer than wheat. However, since rye and triticale have lower average yields than wheat, the amount of K2O and P2O5 per tonne of crop is slightly higher for rye and triticale than for wheat. Therefore, slightly higher inputs are found for triticale in kg of input *per MJ* of crop (see table 124 'Triticale cultivation' of the report). However, the differences between emissions-per-MJ of cereals (except maize) result to be so small that we anyway use the weighted average.

Q99) P 178 Table 154

Sources: Do you take data from ADEME 2002 or ADEME 2010?

JRC: Data from ADEME 2010 has been considered.

Q100)P 201 § 6.11 Palm oil to biodiesel

Why calculations were not based on national data from Indonesia and Malaysia for cultivation and oil extraction as for soybean biodiesel?

JRC: Yes, indeed they are. Data on cultivation and oil extraction come mainly from the Malaysian Palm Oil Board (MPOB) (Choo et al., 2011). See section 6.11 of the report.

Q101)P 209 § 6.12 Jatropha to biodiesel

Previously in the document it was explained that the pathway "camelina to biodiesel" was not added because there is no real production of camelina. But in the present case is there really significant and continuous production of jatropha and conversion in biodiesel? No cultivation area is cited in the document and according to dates of sources data probably correspond to pilot production. Is this pathway included more in the same mind than lignocellulosic biofuels pathways than conventional biofuel pathways?

JRC: Jatropha is not included in the list of default values published in the Commission proposal COM(2016)767 - RED recast and in the updated version of the report.

Q102)P 211 Table 211

Why N2O calculation was not possible with GNOC and needed a dedicated one?

JRC: Jatropha was not on the crop-list of the Stehfest and Bouwman statistical fit to N2O measurements, used in GNOC.

Q103)P 216 § 6.13 Waste cooking oil

What is "pure plant oil from waste cooking oil"? waste cooking oil after purification operations?

JRC: Yes.

Concerning data for Transesterification of UCO, in ADEME 2010, we have considered data from a specific process used in the only existing plant in France with some differences compared to BDI that doesn't enable comparison with data in table 221.

JRC: JRC is aware different transesterification processes exist in the EU, however BDI technology was chosen as it is a prevalent technology in EU biofuels manufacture that is can be applied directly to UCOME processing without extra pre-processing.

Q104) P 218 § 6.14 Animal fat

Table 223 How is calculated the fraction of rendering process considered to be adding positive value?

The proposition to attribute a part of rendering process impacts to the products of rendering is in line with recommendations concerning allocation choices. But the level of the fraction seems us too high. If considering an economic allocation between meat and products of rendering, it would more lead to a fraction around 5% than 37%.

JRC: There appears to be a mis-understanding by the stakeholder. JRC do not consider allocation between *meat* and products of rendering. No emissions are attached to the abbatoire waste, which is the input to the rendering process. Meat is not a product of rendering, which produces only tallow and "meat-and-bone-meal" (= *farine de viande osseuse")*. Tallow only recieves 17% of the rendering emissions, as explained in section 6.14.

Q105)P 222 § 6.22 HVO

Are there no more recent data coming from Neste plants in Singapour and Rotterdam? Or no significantly different from those quoted here?

JRC: JRC indeed had incorporated updated information from industry which had not been reflected in the references; this has been corrected.

Table 229: in the title tallow oil is cited (except palm and tallow oil). But tallow oil is not a vegetable oil. Is there not a mistake or an eventual confusion with tall oil that is also not a vegetable oil?

JRC: Correct; the term has been simplified to just 'tallow'.

Q106)P223

Table 231 same question than previously, vegetable oil is indicated in the 3rd line of the table. Is the considered substance effectively tallow or tall oil?

JRC: Correct; the term 'vegetable oil' is now replaced with 'tallow'.

Q107)P 230 § 6.17 Wood to liquid hydrocarbons

The demo unit in France connected to BioTfueL project is already not in running phase. So we have no more recent data to provide from this example.

JRC: Thank you for the information.

Q108)P251

Improved N2O calculation from GNOC. "Only the land use data is still for year 2000 because no more recent data is available". But the Corine land cover inventory has been updated in 2006 and 2012. Why these updates haven't been taken account for? No major changes inducing enough significant evolutions in calculation?

JRC: For the N2O calculations based on the GNOC approach we need the information about distribution and yield of the single crops. CORINE covers only Europe and provides only general land use classes as e.g. "arable land" (with a few exceptions e.g. rice and citrus fruits). To our knowledge there is currently no data set available providing the information at the required detail and spatial coverage for a more recent year than 2000.

NESTE

Q109) **HVO should have pathways and default values for all the same raw materials as conventional biodiesel (FAME)**

It is not clearly stated in the draft document which pathways will be considered for HVO. To ensure technology neutrality, HVO should have default values for the same feedstocks and pathways as conventional biodiesel or FAME. These include, but are not limited to:

- Animal fat (Cat I, II & III) / Tallow oil to HVO

- Waste oil (including used cooking oil) to HVO

- Rapeseed oil to HVO

- Sunflower oil to HVO

- Soya oil to HVO:

- Palm oil to HVO:

- without methane capture

- with methane capture

- Jatropha oil to HVO

Member states often use Annex V as a basis for national legislation in transposing the RED and its provisions into the national law. In some member states market acceptance of biofuels is dependent on existence of an Annex V pathway. Pathways and default values are needed to gain fair and equal treatment from member state authorities, enabling creation of a single European biofuels market.

JRC: Done except for jatropha (please see RED recast, Commission legislative proposal COM (2016)767). At the stakeholders meeting industry indicated that jatropha biodiesel production remains negligible.

Q110) **Use of marginal electricity mix**

Whatever approach is chosen for accounting the GHG impact of grid electricity as process electricity. The same rule should apply for grid electricity used in electric vehicles. This refers to the introduction of marginal electricity mix consisting of only fossil sources.

This relates to technology neutrality of different biofuel options. Grid electricity as a power source in a biofuel process has to be treated similarly to grid electricity used to power electric vehicles.

JRC: GHG emissions of the (actual) average EU electricity mix from JEC-WTWv4a are used in the new calculations (see section 2.1 of the report).

For reporting under the FQD (2015/652), national average emissions for electricity should be used.

Q111) **Factor from typical to default**

Previously the factor to convert typical process inputs to default inputs has been 1,4. This is rather high considering the state of biofuel technologies included in the default pathways. JRC could consider using a lower value to convert typical values into defaults.

JRC: In calculating default emissions from typical emissions, no conservatism factor is applied to emissions from cultivation, transport or distribution stages of biofuel production: the entire range of emissions performance is supposed to be accounted in the 1.4 factor on emissions from processing alone. Thus the factor is not supposed to cover only the range of production emissions.

Q112) **Broader diversity of renewable feedstocks would contribute to reaching EU renewable energy targets**

Additional feedstock pathways to be considered for both biodiesel and HVO:

- Palm oil with methane avoidance (organic matter removed from the waste water stream, before decomposition)

- Spent bleaching earth oil

- Camelina oil

JRC: Please supply data if this is a prevalent process. There is already a pathway for palm oil biodiesel production with methane capture.

For spent bleaching earth (SBE) oil, the JRC can create a pathway in future. We consider it likely a low-volume source compared to other pathways, but welcome figures on volumes being recycled and the total resource size.

Industry confirmed to the JRC at the stakeholders workshop in Brussels (September 2016) that there was no need for camelina oil pathways, as production had not developed as foreseen.

EOA (European Oilseed Alliance)

Q113)**1 ° the calculation of N2O emissions:**

It is fine to use the method of S & B, 2006.

However, in the JRC method: the method S & B, 2006 is used for calculating emissions related to mineral and organic fertilizers; for emissions related to the residues, a fraction is added, calculated with the IPCC 2006 method.

Measurement data used by S & B, 2006 to build their equation necessarily covered the period of cultivation but also for some data the period before / after cultivation: some of these measures so also include a part of emissions from the residues, which has therefore been already taken into account in the development of the equation. Therefore re - add emissions related to the residue is a bit questionable.

JRC: We are not using the S&B method to calculate N2O emissions directly but to derive the Fertilizer Induced Emissions (FIE) which is the emissions from the fertilized field minus the emissions from the unfertilized field divided by the N input (mineral fertilizer and manure N). As ecosystems without anthropogenic management show very low or close to zero emissions, the emissions from the "unfertilized plot" are mainly the result of the management history. The management history includes crop residue incorporation. As we subtract this effect when deriving the FIE we need to account for the incorporation of crop residues separately. This approach is the same as applied in IPCC (2006) for the TIER1 N2O emissions. More background information can be found in the IPCC guidelines and the publications of Stehfest and Bouwman.

Q114)**2 ° Emissions related to residues**

The IPCC method has been applied with a 1% emission factor. It seems that the figures of 0% for wood residue and 0.06% (I think) for "green" waste would be more appropriate (cf "Project Report No. 548 Minimising nitrous oxide intensities of arable crop products (MIN-NO)").

JRC: The MIN-NO report you refer to considers the suitability of IPCC guidelines for predicting measured N2O emissions from crop residues over the 12 months following incorporation. It states that in the short term (i.e. in its tests up to ~12 months), the IPCC emission factor of 0.01 for N2O-N/(N in residues) is satisfactory for predicting N2O releases from residues containing 2%N or more. However, for residues containing less than 2% N, N2O emissions it describes emissions as "small and long term", and suggests they should be incorporated in an additional "background" emission of N2O from accumulated residues. (This "background" emission should not be confused with the "natural background emissions" from undisturbed natural land, which are much lower.)

The scope of the IPCC guidelines is to estimate total anthropological N2O emissions from cropland. By contrast, the MIN-NO report seeks to explain the release on N2O relate emissions in one 12-month period to residue incorporated crop residue incorporation to N2O emissions measured over the next 12 months in three UK locations. Thus IPCC and MIN-NO consider different time-frames.

The reason that residues with less than 2% N release no significant N2O in the following 12 months is the well-known fact that soil organic matter tends to a constant ratio of C/N of 25 to 30 [e.g. G. H. Dar

Soil Microbiology and Biochemistry, New India Publishing, Aug 1, 2009, or Google "C/N ratio"]. As all crop residues contain about 42% dry-matter carbon (confirmed by the MIN-NO results) that is equivalent to about 1.5% N.

- If residues contain more than ~1.5% carbon, the excess N is released rather fast, largely in the first 12 months, producing N2O in the process. This release is measured in the MIN-NO experiments.

- If residues contain less than ~1.5% nitrogen, they will at first sequester available nitrogen from the soil to attain the equilibrium C/N ratio. That causes an initial reduction in N2O emissions (if farmers do not counter the N sequestration by applying more fertilizer). The nitrogen taken up, together with the initial nitrogen content of the residues, is released more slowly as the residues decompose. Accumulated over the first year or so, the uptake and release of nitrogen by residues may approximately balance out, so it is not surprising that MIN-NO found no significant effect on N2O emissions in the first year. However, after the first year there is no compensating uptake of nitrogen so the residues must produce a net emission on N2O as they decompose. In the end all the residues will decompose and release all the nitrogen, even if the decomposition may continue (at a diminishing rate) for twenty years or more.

- As crop soils contain accumulated rotting residues from many previous planting seasons, there is an emission of N2O even if no additional nitrogen is applied in that season: this is what MIN-NO report refers to as "background emissions". The contribution of a given year's residues is only a small part of the total "background emissions", so it is impossible to distinguish, given the large variability in emissions caused by weather and other factors. Nevertheless, the total cumulative contribution to N2O emissions of the residue applied in a given year is given by its nitrogen content. Thus we think it is justified to follow IPCC guidelines in considering all the nitrogen content of all retained crop residues, even if they are below 2%.

- IPCC are also justified in this method in estimating the anthropogenic N2O emissions from a country's entire cropland: assuming the area fractions of crops is stable, the "background emissions" reflect the sum of the emissions from residues incorporated in previous years. And, if management practices are stable, that is the same as the sum of future N2O emissions caused by incorporation of residues in the year in question.

In summary, MIN-NO only discusses N2O emissions caused by residue incorporation in the first 12 months, and that misses the cumulative contribution to emissions in future years, which is typically greater. MIN-NO finds that for residues with 2% nitrogen, the IPCC emission factor of 0.01 satisfactorily fits the results. As half that nitrogen would not be expected to create any emissions in the first 12 months, it implies that the IPCC factor is underestimating (by a factor 2) the emissions from the other half of the nitrogen.

Q115) **3 ° The emissions calculation method related to the nitrogen fertilizers "supply chain»** is not detailed: where do come from the figure presented in page 39?

JRC: There is a section in the report called 'N fertilizer manufacturing emissions calculation' dedicated to describe and show data on N fertilizer production (see section 2.3 of the report).

Q116) **4 ° GHG emissions related to the production of fertilizers:**

There is no separation between ammonium nitrate, urea, and solution N. It is mentioned that an average value between those of ammonium nitrate and urea has been taken. The data from the UNIFA (french fertilizer industry) show that for FOB plant, the value of GHG emitted by the fertilizer production chain is substantially the same (ammonitrate: 3.52 kg CO2e / kg N against 3.57 for urea and N solution) but seems to be much lower that the value proposed by the report = 3.977.

JRC: We have updated the input data in our calculation and the new result is 3.774 kgCO_2eq/kgN (see section 2.3 of the report). The main difference with the UNIFA/Fertilizers Europe figure is that our figure is for fertilizer *consumed* in EU, whereas theirs is for fertilizer *manufactured* in EU. Thus our number includes emissions from imported fertilizer, which increase the average slightly. (There is also a small difference due to different upstream emissions assumed for NG etc).

Q117) **5 ° Figures on diesel + pesticide use for cultivation of rape:**

References may be found through the projects AgriBalyse and Ecoalim for France.

JRC: Thank you for the references; however for diesel and pesticides, we use data from the CAPRI model which refer to EU27 averages and not one specific European country.

Q118) **6 ° % N of residues:**

For rapeseed, the values of JRC are substantially higher than our French references for above-ground residues (0.0068 instead of 0.01) and below-ground residues (0.084 instead of 0.01); for Sunflower the difference is not so important.

For soybeans, there is a feeling that air and underground residues values are too high: in the document, it is precised that the N content of aboveground residues would be of 6.5%! Our references in France show that it would be of 1.1%. Moreover, the data used for calculate the ratio NBG come from experiments made in Brazil, Argentina, the USA, Canada and China: the crop production conditions are very different from those in Europe, and particularly in France. The yield data reference of 26 q/ha seem to be too low (French mean of soybean yield: 32 q/ha).

JRC: For the default values we relied mainly on global residue data given in IPCC (2006) We are aware that there might be better information available, but a detailed literature study regarding the residue parameters (above and belowground residue biomass and N content) was not possible for all feedstock in the frame of this project.

The N content for above-ground soybean crop residues assumed in our calculations are 0.8% and 8.7% for below-ground residues. The reason the below-ground residues value seems high, is that it has been adjusted so that the method give N2O emissions consistent with measurements. As explained in the report, the IPCC residues method misses N2O emissions arising from nitrogen that is deposited in the soil by rhizodeposition, and IPCC probably under-estimated the total mass of below-ground residues of soybean. Unfortunately, we did not have enough data to separate these effects, simply combining all these effects into an "effective" N content of below-ground residues that gives the correct emissions when applied to the IPCC formula.

The updated soybean yield (2014) for France which we consider in our calculations is 2900 kg/ha (this is consistent with the figure given by EUROSTAT for France for 2014).

Q119) **7 ° Classification of the sunflower in the 'other' class for the calculation of direct Emissions: unfortunately, we have only two French data on sunflower.**

They give no significant difference in N2O flows between the crops compared in our fields (comparison betwenn wheat, sunflower and rape) but the first year sunflower was over the others, but it was the reverse in the second year.

JRC: This gives some confidence in our re-classification of rape from the Stehfest & Bouwman "other" to the "cereals" group. On the other hand the observations in the sunflower measurements confirm that there are large annual fluctuations in soil N2O emissions due to variations in meteorological and management conditions.

Q120) **8° Reference on yields:**

They are too low for rapeseed, sunflower and soybean with regards to France figures.

Rapeseed = 3243 kg instead of 2877, sunflower = 2410 instead of 1897, and soy = 3120 instead of RFC 2822 (figures from Ecoalim project).

JRC: For all crops, JRC has used the average crop yields for 2009-2014, which included the latest data available from Faostat at the time. Yields and inputs refer to the average EU.

RVO (Netherlands Enterprise Agency)

Questions:

Q121) **Timeline for final report and for decision on the fossil fuel comparator?**

The emission factors of all fossil fuel inputs (coal, natural gas), of electricity and of fertilisers (paragraphs 2.1 - 2.4 in the report) depend on a decision on the fossil fuel comparator! Can you give a timeline for when this decision is to be taken? Can you give an indication for when a final version of this report is expected?

JRC: This is the final version of the report which contains the input data used to calculate the typical and default emissions listed in Annex V of the Commission proposal COM (2016)767 (RED recast).

Q122) **Emission factors for the supply of main products**

The emission factors for the supply of some main products are very different as compared to the 2009 numbers. For instance:

a. HCl was 750,9 g CO2,eq/kg and is now 375,5 g CO2,eq/kg

b. Sodium hydroxide (NaOH) was 469,3 and now becomes 764,5 g CO2,eq/kg

Can you give an explanation for these large differences?

JRC: All emissions factors have been updated in the current version of the report (see section 2.2).

Q123) **Power-to-liquids**

Will there be default values for "Power-to-liquid" fuels? If so, will data be included in this report or will data be described elsewhere?

JRC: 'Power-to-liquid' fuels are not part of the report and they are not in the list of pathways with typical and default values in Annex V of COM(2016)767. However, 'renewable liquid and gaseous transport fuels of non-biological origin' is one of the renewable fuels that can contribute toward the reaching the incorporation oblgation for fuel suppliers under proposed Art 25(1) of the new legislative proposal. The proposed 25(6) of the legislative also foresees to empower the Commission to adopt delegated acts 'to specify the methodology for assessing greenhouse gas emission savings from renewable liquid and gaseous transport fuels of non-biological origin and waste-based fossil fuels and to determine minimum greenhouse gas emission savings required for these fuels' (Art 25(6)).

Major points of attention

Q124) **CHP's and excess electricity**

It would be logical to amend the methodology for making calculations on CHP's with excess electricity. This was already discussed at previous workshops (see JRC response on top of page 269). The following considerations are important for this discussion:

a. It would be logical to harmonise the methodology for biofuels/bioliquids and for solid & gaseous biomass used for production of electricity, heat and/or cooling.

b. For "solid biomass" calculations the credit does not work as both heat and electricity are products. As a consequence, exergy is used to divide emissions between heat and electricity in recent JRC calculations for "solid biomass" calculations, which were published in JRC Report EUR 26696 (July 2014), updated by JRC report EUR 27215 EN (2015).

Therefore, the preferred way forward would be to also use the exergy-based calculations for biofuel/bioliquid pathways which include a CHP with excess electricity. Depending on what is decided on this issue, the following lines in the report should be modified: - p.95 neat bottom: "Replaces electricity from a lignite-fuelled ST" - p.96 "This replaces electricity from a straw-fuelled ST process."

JRC: Annex V (part C) of the Commission proposal COM(2016)767 (RED recast) contains provisions on CHP's with excess electricity which are consistent with Annex VI of the same Communication for the solid and biomass fuels.

Q125) **Average cereal pathway**

Page 120: An average cereal pathway has been calculated ……… To our opinion, no default value for an average cereal pathway should be included in RED Annex V or any future document with GHG default values, as this will cause that economic operators will use a different value as compared to the their actual (barley, wheat, maize, triticale, rye) pathway. As a better GHG emission saving in some member states (currently in particular in Germany) leads to a higher biofuel price, a decision to include an average cereal pathway has financial consequences for economic operators whereas there is no objective measure for creating an average pathway for cereals and – for instance - not creating an average pathway for EU-produced oilcrops (rapeseed and sunflower)….

JRC: In Annex V of the legislative proposal COM(2016)767-RED recast, typical and default values for 'maize to ethanol' pathway and 'cereal except maize' pathway have been included. That reflects the close similarity of the emissions per tonne of different non-maize cereals. This simplification was welcomed by stakeholders at the 2013 workshop.

Q126) **Units of cultivation data**

The cultivation data (tables 80, 93, 101 etc.) are expressed in kg or MJ input per MJ of crop. This is not a common unit for farmers and others that work with data on crop cultivation. Please express these data (also) in kg or MJ input per ton of crop, or in kg or MJ input per hectare per year (as was done in the Excel file that was released in 2008).

JRC: The tables in the report show the data needed to make the conversions (e.g. the LHV of the feedstock). The excel file with all input data and calculations will also be made available to stakeholders in order to be able to replicate the calculations and get the information in the desired unit of measure.

Q127) **Moisture content of wheat should be consistent throughout the pathway**

On page 126, table 84, a wheat moisture content of 13,5% is reported. This is not consistent with the moisture content of 13,5% of the cultivated wheat and the 1,02% of moisture removed in the dying step. Please produce a consistent pathway by using 12,48% moisture after drying, by::

a. changing the comment in the second row of table 84 to "3294,2 twheat grain @ 12,48% H2O/tethanol"

b. changing the first comment under this table into "0.37841 kg DDGS (at 10% water) / kg wheat (at 12,48% water) , which corresponds to 0.374 kg DDGS (at 10% water) / kg wheat (at 13.5% water) (Ref. 4)."; and

c. changing the second comment under this table into "0.303538 kg ethanol / kg wheat (at 12.48% water), which corresponds to 0.300 kg ethanol / kg wheat (at 13.5% water) (Ref. 4)."

Same for maize, barley, rye, triticale and also for sugar beet (both 76,5 and 75% moisture content in one pathway, without drying). Moreover, in table 81, please add the water content of the wheat, so - Wheat (13,5% moisture) Input ** ** - Wheat (12,48% moisture) Output ** ** Same for table 94 (drying of Maize), table 106 (Barley), table 124 (Rye), table 129 (Triticale), table 134 (Rapeseed), table 155 (Sunflower), give water content of dried soybeans as comment under table 168, table 180 (Soy Brazil), table 187 (Soy Argentina), table 191 (Soy US)

JRC: This is a misunderstanding: in order to clarify the issue, we added some explanation in the report (for all pathways) after the table showing the cultivation data input. Basically, for wheat for example, the raw input data in the table are either provided 'per tonne of moist crop' or converted from 'per-ha' using yields in tonnes of moist crop per ha. Here, the moist yields (from FAO) are for the *traded moisture content* of wheat. This varies slightly by country, but on average is about 13.5% in EU. However, the freshly-harvested crop has a higher average moisture content; consistent with the CAPRI estimates of the amount of water removed, the average initial moisture content must be 13.5% + 0.2%= 13.7%. See also answer to Q16) for sugarbeet.

Q128) **Wet / dry LHV's**

Page 205: The heading of the column most to the right in table 199 is "LHV of dry part per wet kg" which is quite cryptic. It probably refers to the fact that in another column of the same table the wet LHV is calculated in another way (including the heat of evaporation of water). Can JRC include in this report a half- or one-page paragraph in which the difference between the two LHV calculations is explained, including a rationale for why – when converting mass to energy content and vice versa – the dry LHV is multiplied with the mass of the dry biomass fraction instead of multiplying the wet LHV with the mass of wet biomass? In the BioGrace-II methodological background document this difference has been explained, feel free to copy/paste from this explanation (added in the annex to this document for your convenience).

JRC: Thank you for the suggestion. Additional explanation on the LHV definitions has been added at the start of section 6 of the report (page 123 'Lower heating value (LHV) definitions') from the Biograce II background document. A reference to the definitions is then consistently made in Chapter 6 for each pathway.

More detailed comments

Q129) **Truck transport**

There is an inconsistency between the comment on page 98 (for a 40 ton truck) "The return voyage (empty) is taken into account in this value" (which would result in a larger value as expressed in [MJ/ton km] and the comment on page 101 "Distance is multiplied by 2 because of the return voyage (empty)" which would result in a larger value as expressed in [ton km / MJ] when using the exact amounts of km transported. To our understanding the second comment is wrong; the one-way transport distance is used, and the return trip is included in the transport-type dependent value expressed in [MJ/ton km].

JRC: Correct; however, the final report and the list of default values doe not include jatropha.

Q130) **Transport through pipeline**

Page 174/175 (FAME) and page 223/234 (HVO): Although some of the FAME and HVO is transported through pipeline, no emissions are calculated for this transport. Wouldn't it be possible to (a) get a number for the length of a typical pipeline and (b) obtain energy requirements (input of electricity, fuel oil) per distance and ton of material transported by pipeline, so that pipeline transport can be added to a new paragraph 5.5?

JRC: Emissions are calculated and included for transport by pipeline, it was a typing-error in the report. Although the original data was supplied without distance JRC assumes it is approximately 5km.

Q131)**Soybean and soy oil transport**

On page 184 it is assumed that FAME from soybean is transported to Europe and that for the GHG calculation it wouldn't matter if soy oil was transported to Europe and (refining and) esterification took place in Europe. However, from table 165 it can be concluded that the actual amount of EU soy biodiesel production (0,623 Mton) is larger than the amount of soy oil that is imported into Europe (0,38 Mton) and that the largest share (around 82%: 100%*1,71/2,09) of soy oil available in Europe is imported as soybean instead of soy oil. The EU production is about 40% of the oversees production (table 166). This will have an effect on the GHG results for FAME from soybean if the alternative pathway (import of soybeans, all processing in Europe) has a significant other GHG footprint than when oil or FAME Is transported oversees. Has JRC calculated this "soybean transport" pathway? If so: does it lead to different or to similar results?

JRC: The assumption on soybean transport has been changed in the new version of the database and report. We consider now that soybean is transported to the EU in solid form and not in liquid form, on the basis of updated data from Eurostat on trade patterns for the 2011-2014 time period. Please see section 6.10 and table 177 of the report for updated data.

Q132)**HVO production also overseas**

Paragraph 6.15 (page 222): This paragraph is on HVO production in Europe. However, there is significant HVO production overseas (eg Singapore). It would be valuable to add a short comment at the top of page 222 on the expected GHG intensity of the alternative pathways. As energy densities and transport modes of HVO and vegetable oils are similar and as energy requirements might not or hardly depend on the location of the plant – the GHG intensity might be rather independent of the location of the HVO production plant.

JRC: JRC includes imports of raw materials in the avaerge emissions calculations, and as you point out, whether it is the raw materials or finished product that is imported is not expected to change the overall GHG emissions much.

Q133)**Some details**

a. P.48: the heading of the last column should probably be "Kg pesticide/ton of moist crop" instead of "Kg pesticide/kg of moist crop"

JRC: Corrected. Thank you for pointing it out.

b. P.122: Do the colours of the boxes (green, blue, black) have any meaning?

JRC: No, they don't.

c. p.122 (near bottom): Remove the sentence "straw allocation has been removed." as straw allocation was also not included in the 2008/2009 calculations.

JRC: Deleted.

d. P.133,comments below table 97: Data on maize ethanol are incomplete. A calculation can only be made if the moisture content of both corn (after drying) and DDGS are known.

JRC: The reporting for cereals pathways has been improved in the current version of the report.

e. P.149, comments below table 104: Include the moisture content of the sugar beet pulp.

JRC: It is now included.

Thünen Institute

General remarks

Experience with current balancing methodology of the EU-RED, in particular with NUTS2 values reported by member countries, which are used as default values by the industry, highlights the need for a more standardized methodology, which ensures that reported values are comparable. Furthermore, technological and scientific advancements make an update of default values desirable.

Comments regarding Chapter 2: General input data for pathways

Q134)Content table: the numeration 2.3 is missing

JRC: Corrected.

Q135) Some figures in chapter 2.2 are outdated, e.g. in Table 8 and Table 9. The provided reference (Kaltschmitt and Reinhardt, 1997) is almost 20 years old and technological progress has been made since then. The JRC should consider replacing the figures by those from ifs Proceedings No: 639 and/or 751.

- Brentrup, F. P. (2008). GHG emissions and energy efficiency in European nitrogen fertiliser production and use. Proceedings No: 639 of The International Fertiliser Society.

- Christensen, B. L., S.; Brentrup, F.; Pallière; Hoxha, A. (2014). Assessing the carbon footprint of fertilisers at production and full life cycle. Proceedings No: 751 of The International Fertiliser Society.

JRC: Figures in table 8 'Supply of P_2O_5 fertilizer' and table 9 'Supply of K_2O fertilizer' of the report have been updated using data from Fertilizers Europe (reference below). Please see the updated tables in the report.

Ref: Fertilizers Europe, 2014, 'Carbon Footprint reference values. Energy efficiency and greenhouse gas emissions in European mineral fertilizer production and use', 26 March 2014, available at: http://fertilizerseurope.com/index.php?eID=tx_nawsecuredl&u=0&g=0&t=1481193783&hash=222ec55aaf0e810f1cd3a33387df531fec4acd5c&file=fileadmin/user_upload/publications/agriculture_publications/carbon_footprint_web_V4.pdf

Q136) Page 27 and 29: Chlorine (Table 16) and NaOH (Table 20) are produced in the same process, therefore the same reference year should be used, e.g. either …-DE-2000 (table 20) or …-DE-2010 (table 16).

JRC: Yes, we agree. 2010 data are now considered in both processes (see updated tables 16 'Supply of chlorine via membrane technology' and table 20 'Supply of NaOH' in the report).

Q137) Page 44: Why are urea and ammonium sulphate aggregated? They do not provide the same function, i.e. (NH4)2SO4 adds not only N but also S.

JRC: We have not considered emissions from sulphur fertilizers, only nitrogen fertilizers. Far more nitrogen fertilizers are used, and N fertilizer also has higher GHG emissions per kg than sulphate (we can see this from the relatively low emissions for sulphuric acid production), so the emissions from sulphur fertilizer are small by comparison. Furthermore, there is no consistent source of data on use of sulphur fertilizer per crop.

The data on N fertilizer use per crop contain no breakdown on the mix of N-containing fertilizers used by particular crops. Therefore we have to consider the overall EU mix of N fertilizer types.

The emissions for producing urea are dominated by those of ammonia production (whereas nitrate fertilizers also have emissions from nitric acid plants). As ammonium sulphate is made by reacting ammonia with sulphuric acid, the nitrogen in ammonium sulphate will have similar production emissions to urea, per kg of N.

Comments regarding Chapter 3: Soil emissions from biofuel crop cultivation

The JRC proposes a modification of the model by Stehfest and Bouwman (2006) in conjunction with IPCC methodology for emissions from organic soils and indirect field emissions (Global Nitrous Oxide Calculator; GNOC). In general, this can be expected to give more reliable estimates than a process model such as the DNDC model, since these process models are known to have problems without extensive calibration for specific sites.

Q138) Will other methods still be allowed by the EU-RED? If yes, the JRC should investigate the impact of different models on default values.

JRC: Methodology requirements for calculation of GHG emissions of biofuels and bioliquids are laid down in Annex V of the Commssion's proposal for the recast of the RED - COM(2016)767[33]. Importance of implementation of the GHG emission calculation methodology in a more harmonized way was also mentioned by experts before and during the workshop in September 2016. In order to ensure uniform application of Annexes V and VI, the Commission has proposed also adoption of implementing acts setting out detailed technical specifications also for calculation of annual cultivation emissions.

[33] See also COM(2016) 767 final/2 of 23.02.2017 ANNEXES 1 – 12: Corrigendum of COM (2016)767.

Q139)There are consequences of using a non-linear model with aggregated input data. We are not sure the JRC is aware of these; at least, they are not explained in the report.

If a linear model is used the following relationship holds:

$(xi)=(x\bar{i})$, where f is the linear model, xi the input data and ¯ denotes arithmetic mean values. I.e., if you want to calculate the mean emission, you can simply use the mean input for the model. This is not the case for a non-linear model, e.g., for the mean of two input values:

$\exp(\beta 0+12(x1+x2)\cdot \beta 1)=\exp(\beta 0)\cdot\exp(x1+x2)\beta 12=\exp(\beta 0)\cdot\exp(x1+x2)\beta 12$
$=\exp(\beta 0)\cdot(\exp(\mathrm{x}1)\cdot \exp(x2))\beta 12$

$\neq 12(\exp(\beta 0+x1\cdot \beta 1)+\exp(\beta 0+x2\cdot \beta 1))= \exp(\beta 0)2(\exp(x1)\beta 1+\exp(x2)\beta 1)$

In fact, what is derived from the model if the arithmetic mean of input data is used is more similar to the geometric mean than to the arithmetic mean of N2O emissions. The Stehfest and Bouwman (2006) model was calibrated on annual data from single fields. Since using the GNOC for each field and for each year in Europe is not feasible, aggregated input data has to be used. The JRC therefore must specify a specific fixed aggregation level for input data in space and in time, if the GNOC is to be used to estimate N2O field emissions. For example, the GNOC could be used with mean fertilization level of a NUTS3 region based on one specific cultivation year. And the arithmetic mean of the NUTS3 regions would give the flux for the respective NUTS2 region. If the aggregation level for input data is not fixed, results are not comparable. It should also be noted that the result will not give the arithmetic mean of N2O fluxes in a NUTS2 region or member state or Europe.

JRC: We agree with this. Minimum and maximum range of spatial and temporal resolution of the input data should be a part of the method to be applied for the NUTS2 reporting. This is required also for the comparability of the country reports. For the application at global level all calculations were done at 5 minutes grid level. All other spatial aggregations were calculated as production weighted means of the 5 minutes grid level results.

Q140) The GNOC model predicts higher emissions from soils with coarse texture than from soils with medium texture. This does not agree with the current understanding of N2O producing processes (primarily denitrification and nitrifier denitrification). Sandy soils usually exhibit the lowest N2O emissions if all other conditions are equal. We therefore suspect that this is a model artifact. This brings into question whether the model should actually stratify by soil texture, i.e., how well this effect can be separated from other effects.

JRC: An update and re-evaluation of the statistical model would be desirable. Especially including the collection of field measurement data which became available meantime. However, this is not possible in a short term. It requires the launch of a dedicated research project.

Regarding the soil texture: the Stehfest and Bouwman method distinguishes 3 texture classes "coarse, medium and fine". The effect values for the 3 texture classes are 0, -0.1528 and 0.4312 respectively. Thus, the **highest** emissions are attributed to soils with **fine** soil texture. More precisely, the emissions from fine textured soils applying the effect values are ~50% higher than from coarse textured soils (keeping all the other parameters the same). This agrees with the findings that sandy soils exhibit lower N2O emissions than fine textured soils if all other conditions are equal. The difference between medium and coarse textured soils (which can be probably questioned) applying the effect values is much smaller (N2O emissions from medium textured soils are ~14% lower compared to the emissions from coarse textured soils).

Q141) The JRC reassigns oilseed rape from the "Other" to the "Cereals" class. Although this might be more justified than the original classification we would like to point out that Walter et al. (2015, DOI: 10.1111/gcbb.12223) reported that direct N2O emissions from winter oilseed rape were significantly higher (by 22 %) than emissions from winter cereals.

JRC: The meta analysis of Walter et al. based on data from 13 central European sites showed that the assignment of rapeseed to the crop class "other" in the Stehfest and Bouwman method would overestimate the emissions from rapeseed considerably. The assignment to the crop class "cereals" seems to lead to an underestimation, but the results are much closer to the observed emissions in the meta-analysis than applying the crop class "other". As pointed out a re-evaluation of the S&B formula including measurement data which meantime became available worldwide would be desirable. This re-evaluation could cover also the classification of the crop classes. However, the re-evaluation should be done at global context, covering different environmental conditions and management systems. See also answer to Q2).

Q142) The GNOC model subtracts the model intercept at zero fertilization. It should be noted that this intercept is just a model property and in no way related to N2O emissions from an assumed natural state of the respective region. In fact, it should be considered to not subtract this intercept because N2O emissions from (European) ecosystems without anthropogenic influence (which do not exist anymore) were very nitrogen limited and N2O emissions from these should be negligible. Arguably, all N2O emissions from agricultural fields are anthropogenic.

JRC: We are not accounting for "background emissions". The method and concept is described in detail in the report (see e.g figure 2 page 51). We assess the so-called "Fertilizer Induced Emissions - FIE" (emissions from the fertilized plot minus emissions from the unfertilized plot divided by the mineral fertilizer and manure N input) at a 5 minutes grid globally. Relating the FIE to the fertilizer input allows to derive disaggregated emissions factors (only direct emissions from mineral fertilizer and manure N input) depending on crop type, management and environmental conditions. We apply these disaggregated emission factors instead of the global factor for direct emissions from mineral fertilizer and manure N application (EF1) of 1% given in the IPCC (2006) guidelines for the TIER 1 approach. The IPCC TIER1 EF1 in fact is also based on the FIE approach, however the EF1 represents the global average over all crops and environmental conditions.

As you point out ecosystems "without" anthropogenic impact/management show very low or close to zero emissions. The emissions from the "unfertilized plot" are mainly the result of the management history. The management history includes crop residue incorporation. As we subtract this effect when deriving the FIE we need to account for the incorporation of crop residues separately. We also account for the indirect emissions (leaching, volatilization) from all N inputs following IPCC. This approach is the same as applied in IPCC (2006) for the TIER1 N2O emissions. More background information can be found in the IPCC guidelines and the publications of Stehfest and Bouwman.

Q143) The JRC calculates manure input by distributing manure N homogenously over all arable land in a country. This approach does not reflect reality. In Germany, animal husbandry is concentrated in specific regions (mainly in the north-west) and manure is not transported over long distances. Thus, use of manure as fertilizer is concentrated in the same regions. Since a non-linear model is used for the calculation of N2O emissions, the JRC approach underestimates emissions.

JRC: Crop specific mineral fertilizer input information is available only at country level (for Europe and the rest of the World). Manure N in GNOC is based on animal types, numbers and excretion rates at a 10 km by 10 km grid level. We agree that in regions where animal husbandry is concentrated and where manure N is available, the N input of mineral fertilizer will be reduced. However there is not sufficient information that allows mapping this effect on country or global level. We distributed mineral N input to the crops in a 5 minutes grid cell taking into account crop specific N inputs, crop yield and soil organic carbon content but independently from the amount of manure available in this grid cell, in a second step we distributed the manure available in a country (with some weighting as described in section 3.8 of the report) over the agricultural area in the 5 minutes grid cells. Thus in regions with animal husbandry we might overestimate the share of mineral fertilizer N input but underestimate the share of manure N input at the same time. The opposite holds for regions where only small amounts of manure are produced. In the GNOC calculations according IPCC (TIER1) the difference between mineral fertilizer and manure is taken into account only for the fraction volatilized which is 10% of the N input in the case of mineral fertilizer and 20% in the case of manure N input. For all the other pathways (direct emissions and indirect emissions from leaching) the mineral fertilizer N and manure are treated the same emissionwise.

Q144)Table 47: residues from palm oil and coconut plantations are not considered, although data for oil palms is available in peer-reviewed journals, see:

- Stichnothe, H., F. Schuchardt and S. Rahutomo (2014). "European renewable energy directive: Critical analysis of important default values and methods for calculating greenhouse gas (GHG) emissions of palm oil biodiesel." The International Journal of Life Cycle Assessment: 1-11.

The importance of N from residues for N2O-emissions of oil palm plantations is described at page 62, but they are not shown in Table 47 and not taken into account for oil palm cultivation (page 202), although it is stated at page 50 that missing parameters for crop residues of oil palms and coconut were taken from literature.

Why are residues from oil palms not considered while residues from agricultural crops are?

JRC: As given in the report (section 3.3, table 52 'Crop specific parameters to calculate N input from crop residues') the amount of crop residues considered for oil palm is 159 kg

N/ha yr (value based on Schmidt (2007)[34]) and for coconut 44 kg N/ha yr (value based on Magat (2002)[35], Mantiquilla et al. (1994)[36], Koopmans and Koppejan (1998)[37], Bethke (2008)[38]). The crop residue N input for oil palm and coconut refers to the annual average over the lifetime of the plantations. These values are taken into account as N input from crop residues when calculating N2O emissions from oilpalm and coconut cultivation. Crop residues are a major N source in palm oil plantations. The contribution of crop residue N to the total emission from oil palm cultivation is ~40% (see Figure 7 in section 3.7).

Q145) Fig 4 is not plausible. Figures estimated at the NUTS2 level are higher than those estimated at the country level. This might be the issue of using input data with different aggregation levels as explained above. Furthermore, it is suspicious that fertilizer inputs per yield are relatively low in northern Germany in comparison to extremely high inputs in the adjacent NUTS2 region in Poland. Astonishingly, considering the very different N inputs, similar GHG emissions were calculated for these regions. We were unable to reproduce the numbers shown in this figure.

JRC: The emission calculations are done at the 5 minutes grid level globally. This is illustrated for a NUTS2 region in France by the maps at the bottom of the Figure 4. NUTS2 and country level emissions are aggregates of the emissions at grid level. The average emissions at NUTS2 and country level are calculated as production weighted average of the emissions calculated at 5 minutes resolution.

The following statement is difficult to understand "Fig 4 is not plausible. Figures estimated at the NUTS2 level are higher than those estimated at the country level". The emissions are driven by the environmental and management factors which vary in the regions.

Fertilizer input in the map is given as **N input per kg rapeseed harvested for the year 2000**. Actually the **fertilizer input per ha** was lower in Northern-western Poland (~160 kg/ha mineral N) than in e.g. Mecklenburg-Vorpommern (~200kg/ha mineral N) but the rapeseed yield at the time was much lower in Northern Poland (~2000 kg/ha)

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34 Schmidt, J. H., 2007, Life cycle assessment of rapeseed oil and palm oil. Part 3: Life cycle inventory of rapeseed oil and palm oil, Aalborg University. Retrieved from http://vbn.aau.dk/files/10388016/inventory_report.

35 Magat, S.S., 2002, Coconut (Cocos nucifera L.). Agricultural Research and Development Branch, Philippine Coconut Authority. Retrieved from http://www.fertilizer.org/ifa/content/download/8951/133688/version/1/file/coconut.pdf

36 Mantiquilla, J.A., Canja, L.H., Margate, R.Z., Magat, S.S., 1994, The Use of Organic Fertilizer in Coconut (A Research Note). Philippine Journal of Coconut Studies. Retrieved from www.pcrdf.org/artimages%5Carticle - fertilizer.doc

37 Koopmans, A., & Koppejan, J., 1998, Regional Wood Energy Development in Asia: Agricultural and Forest Residues - Generation Utilization and Availability; presented at the Regional Consultation on Modern Applications of Biomass Energy, 6-10 January 1997, Kuala Lumpur, Malaysia. Retrieved from http://wgbis.ces.iisc.ernet.in/energy/HC270799/RWEDP/acrobat/p_residues.pdf

38 Bethke, C.L., 2008, Nutritional Properties of AGROCOIR; prepared for AgroCoco, El Majo, LLC. Horticultural Soils and Nutrition Consulting, Michigan, USA. Retrieved from http://www.agrococo.com/Bethke/NUTRIENT_ANALYSIS_OF_AGROCOIR.pdf

than in Northern Germany (~3500 kg/ha). For the update of the rapeseed default values we continuously update yield and fertilizer input to the latest data available.

Clarification in detail can be provided, if your re-calculations of the emissions and the underlying assumptions for Northern Germany and Northern Poland are shown to us? The N2O emissions based on GNOC are the result of **not only of management but also of environmental conditions**. From the map showing the final emissions it is not possible to deduce which was the main factor influencing the final results. One of the reasons for the emissions being similar in both regions despite the fact that N input is different relates to the higher share of organic soils in Northern Germany compared to Northern Poland.

Q146) Fig. 7: According to the figure 0.4 % of maize is grown on organic soils whereas 1.2 % of rapeseed is grown on organic soils. At least in Germany, rapeseed cultivation on organic soils is very uncommon. In contrast, maize cultivation on organic soils is much more common. Thus, this doesn't seem plausible.

JRC: We agree that grassland and green fodder crops (e.g. green maize) are more likely to be found on organic soils than grain maize and rapeseed. For our calculations we derived the distribution of organic soils from the Harmonized Word Soil Database (s. report) on a 5 minutes grid. We overlaid the distribution of organic soils with the distribution of agricultural crops available at a 5 minutes grids (Monfreda et al. (2008)). However, taking into account the fact that other land uses (forest, grassland) are more likely to be found on organic soils than arable crops we allocated arable land on organic soils only if the area of arable land was larger than the area of the non-organic soils. This lead to the (low) values of 0.4% of grain maize and 1.2% of rapeseed on organic soils in Germany.

Q147) The JRC considers only 50 % of manure when calculating N2O emissions.

This is explained in Section 3.8: "Therefore we consider that half the manure is not needed by the crop, and is applied for the purpose of getting rid of excess manure." This is not correct. Manure contains about 50 % N as NH4+, which is short-term available to plants, and about 50 % N as organic N, which is only long-term available to plants (i.e., after mineralization). Thus, to meet short-term plant demands, farmers have to apply roughly double the amount of manure N in comparison to mineral fertilizers. We refer the JRC to the concept of "mineral fertilizer equivalents"[39]. Furthermore, manure "disposal" beyond the demands of the plants is not allowed by the German fertilizer ordinance; moreover this assumption is in opposition to the aims of the European Nitrate Directive and the Water Framework Directive. If only 50 % of manure N is considered for the GHG balance, this might create an incentive for biomass growers to apply more N than needed.

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[39] Gutser, R., Ebertseder, T., Weber, A., Schraml, M., Schmidhalter, U., 2005. Short-term and residual availability of nitrogen after long-term application of organic fertilizers on arable land. Journal of Plant Nutrition and Soil Science 168, 439-446.

Delin, S., Stenberg, B., Nyberg, A., Brohede, L., 2012. Potential methods for estimating nitrogen fertilizer value of organic residues. Soil Use Manage. 28, 283-291.

We noticed that in the GNOC manual published on the JRC webpage this has been changed between versions 1.2.3 and 1.2.4 and 100 % of manure is accounted for now. A different argument is hinted at in the GNOC manual (difficulties in estimating manure input). The current online tool version is thus in contradiction to chapter 3.8 of the JRC report, which is particularly confusing for users of the GNOC-online tool, if they want to estimate the emissions on their premises. Considering organic-N of crop residues but not of manure and digestate is inconsistent. For consistency reasons alone the JRC should consider all organic-N (in residues and manure or digestate) as the IPCC methodology does.

JRC: The purpose of the GNOC online tool is different from using GNOC as a tool in calculating average N2O crop emissions for default values. The GNOC online tool calculates the total N2O emissions from a field, and is not concerned about whether this should be attributed to crops or livestock. By contrast, the default values calculation considers only the part of the nitrogen emissions that can be attributed to crop growth.

If GNOC is used to calculate total emissions from the field, for IPCC reporting for other legislation, users should consider all the N in the manure applied. Only for application to calculating the emissions attributable to a crop, as in the case of biofuels, should half the manure-nitrogen be considered, (and the rest attributed to emissions from livestock management, according to this rule).

In our revised report, we have considered the literature on the availability of nitrogen from manure, making use of a survey of European literature made for the Commission. This confirms our decision to consider half the nitrogen to be available for crop growth, meaning that emissions from the other half of the manure-nitrogen should be attributed to livestock production. The survey we used includes the first reference you cite, and that proposes that the long-term availability is between 40 and 70% of the nitrogen in the applied manure. Thus our 50% assumption is in the range. (Your second reference only measured nitrogen availability for 4 weeks in a laboratory).

Q148) Page 58: The calculation of N-leaching in GNOC is based on a binary-approach. Either 30% of the total N-input including residues is considered to be leached or 0%, if "the area where leaching/run-off occurs as areas where Σ(rain in rainy season) - Σ (PE - potential evaporation - in same period) > soil water holding capacity, or where irrigation (except drip irrigation) is employed." N-leaching has a substantial effect on the GHG-calculation and consequently the GHG-savings, e.g. if rapeseed N-input is 137.4 kg N/ha and dry yield is 2.9t rapeseed/ha, then the total amount of N from leaching is either 0 or 62 kg N/ha. Given that 1% is emitted as N2O, which has a GWP of 296 than the contribution of N2O field emissions from leaching is either 0 kg CO2eq/ ha or 288 kg CO2eq/ha, for comparison the N-input of fertilizer causes 639 kg CO2eq/ha field emissions.

JRC: The calculations of N-leaching is following the TIER1 approach in IPCC(2006).

Q149) Section 9 gives a rather detailed argument for adjusting the IPCC approach regarding leguminous crops, in particular soybeans. The basis is a paper "Chudziak & Bauen, 2013" which is listed as submitted to the journal Agriculture, Ecosystems and Environment. We could not find this manuscript in the journal's archive or in the Web of Science database. Apparently, the manuscript was rejected. The JRC should not deviate from the IPCC method without a peer-reviewed scientific publication as the basis.

JRC: The article was not rejected; it was just that the principal author never found time to finish the paper. Please note that we dedicated a whole chapter on this issue. The findings of "Chudziak & Bauen, 2013" are underpinned by findings in other studies as well. We also checked the calculated N2O emissions in soybean cultivations with different N contents in below-ground biomass for soybean (Figure 9) against measurements. The comparison showed that applying the GNOC method with the default IPCC (2006) values for N contents in biomass would clearly underestimate the emissions observed in the field (dashed red line in figure 9). Except for the 2 Chinese sites (blue points) all measurements in fig. 9 refer to unfertilized soybean cultivations. If we apply the GNOC method assuming no fertilizer input and the revised N content in below-ground biomass we obtain the emissions given by the brown dashed line – the results are in good accordance with the field measurements.

Q150) The current methodology does not account for crop rotations. For example, a typical crop rotation in Germany is cereal – rapeseed – cereal. After rapeseed, cereal crops need to be fertilized less and higher yields of better quality are achieved[40]. Rapeseed also interrupts the propagation of wheat pathogens[41] thereby helping to maintain wheat yields and reducing application of pesticides. The JRC should investigate if and how such indirect effects could be included in the GHG balance.

JRC: Unfortunately crop rotation information is scarce. For our calculations the crop rotation information would be needed for all crops in all regions in and outside Europe.

[40] Christen, O., K. Sieling and H. Hanus (1992). "The effect of different preceding crops on the development, growth and yield of winter wheat." European Journal of Agronomy 1(1): 21-28.

Sieling, K., C. Stahl, C. Winkelmann and O. Christen (2005). "Growth and yield of winter wheat in the first 3 years of a monoculture under varying N fertilization in NW Germany." European Journal of Agronomy 22(1): 71-84.

[41] Majchrzak, B., Kurowski, T.P., Wachowska, U., Jazwinska, E., 2010. Changes in soil microbial communities as a result of growing Brassicaceae crops. Acta Agrobotanica 63, 161-169.

Ethanol Europe

Maize pathway

Q151) **Feedstock Mix**

Current RED provides default value for ethanol produced from EU grown maize, where EU is considered to be EU-25. At least this interpretation was taken up and implemented by major sustainability schemes. E.g. if maize is coming from Ukraine into the EU ethanol facility it has to have individual GHG calculations, and this is already established practice. It appears that the report proposes to include imported maize into the average calculation:

- Please clarify why such choice has been made
- What is considered to be maize country mix
- Please show data sources for yields, fertliser use, manure application, drying for EU and for those countries separately
- How those countries of origin are relevant to EU ethanol production?

JRC: Data for the EU consumed feedstocks are considered. Most of the maize is produced in EU and only a small percentage imported from Ukraine. European data and data for Ukraine used in the calculations are shown in the report (see section 6.2).

Q152) **N-fertiliser emission factor**

Based on Fertliser Europe data the share of imported fertilisers declined in 2015 comparing to previous years. In low energy price environment such trend appears to be logical and may continue.

JRC: Indeed, we found the presentation on the Fertilizers Europe website, which indicates that the overall fraction of N fertilizers declined slightly in 2015 compared with the data they provided us (from 2012). However, the data is not disaggregated into urea-type and nitrate-type fertilizers, so we cannot make use of it without further information. The split is important, because most of the imported fertilizer in 2012 was urea-type, and the imported urea fertilizer actually has a lower emissions than the urea-type fertilizer made in EU (according to the assumptions explained in the report), so if it was mostly urea imports that decreased, this would lead to higher average EU fertilizer emissions. If more complete realibale data becomes available, we can use it for the future updates of Annex V.

Q153) **Choice of power source**

Approximately 2.1 billion litres of ethanol in the EU is produced from maize. Given current trade patterns de minimus amount of maize ethanol is being imported from the US (or any other country). Most, if not all, maize ethanol production capacity in Europe use gas fired dryers or dryers utilizing gas turbine exhaust (we are confident for at least 1.8 billion litres of capacity), but not steam dryers as anticipated in the conversion step 5. In the US plant utilising steam dryers do exist, but mostly in cases when plants were co-located with coal fired heat and power facilities or in rear cases when intention was to build one nearby. Typical plant in the US would use gas fired dryers as well and energy consumption is typically measured as amount of gas to be consumed.

In case of biomass powered CHP either correction needs to be done for less efficient steam dryers or biogas pathway has to be added.

JRC: For maize to ethanol, COM(2016)767 (RED recast) allows for different sub-pathways with different fuels used for steam production. Economic operators can select the pathway closest to their conversion process.

Q154)**Nitrogen Source**

it shall be noted that European facilities typically do not use ammonia, and would use urea as source of nitrogen.

JRC: This is a misunderstanding. We know that ammonia is hardly used directly as a fertilizer in EU. But EU imports part of the ammonia that is converted to urea and nitrate-type fertilizers and this is taken into account in our calculations, as indicated in the flow diagram.

Actual performance of ethanol facilities

Q155)*Energy*

Back in 2013 we provided JRC with Pannonia Ethanol's data which at that stage was already largely different from data contained in GREET 2009 used in the report and pointed to other sources.

Since then GREET was also updated several times see https://greet.es.anl.gov/files/update-corn-ethanol- 2014[42]. Current version uses 24,000 btu/gal of natural gas and 0.75 kwh/gal electricity, i.e. 30% less than in JRC report.

Over the past few years Pannonia has improved its carbon footprint as well. Below is Pannonia's data using European metrics:

		2012	2013	2014	2015	H1 2016
Ethanol Yield	l/ton	418	421	429	427	424
Nat Gas Yield	GJ LHV/cbm	7.2	7.0	6.5	6.2	5.7
Electricity Yield	kwh/cbm	162	161	170	185	176
DDGS Yield (moist)	kg/ton	300	299	279	276	280
Corn Oil	kg/ton			6.3	8.5	8

In the last 3 months gas consumption got to 5.55 GJ/cbm, and we expect it to go further down in 2017 to 5.2-5.4 GJ/cbm following commissioning of further energy optimisation equipment later this year. Gas consumption includes drying of DDGS and generating steam. Electricity includes all utilities, i.e. including pumping well water and water cooling. That on both electricity and gas usage is 40% below what current JRC report is using as a "typical" energy consumption.

[42] When adjusting the data to European case, corrections need to be made in so far that gas consumption data is usually presented at HHV (and it is gas consumption, not steam), but in this particular case Argonne Labs may have made adjustments.

And we still see ways and technologies to optimize energy footprint further, mainly through various technologies of mechanical separation of the water, versus evaporation.

JRC: Thank you for providing this information. Pannonia Ethanol's 2015 figures is one of the sources used to update conversion inputs for the maize to ethanol pathway. Please see section 6.2 and, in particular, table 109 'Conversion of maize to ethanol in EU' and table 110 'Data used to calculate the 'adopted value' from various sources' for the updated values and references.

Q156) *Conversion Yields and technology evolution.*

Ethanol conversion yields and products produced are not that important in the context of RED methodology, since allocation is done on energy basis. However, in the methodology used in JEC that plays a larger role.

While current ethanol world still have mid-protein DDGS as major co-product, that unlikely be the case in 2020 and that definitely won't be the case by 2030.

Already number of facilities convert corn fibre into cellulosic ethanol in US following EPA approval of the pathway (Quad County, Pacific Ethanol) or uses small volume of cellulases to liberate the corn oil, so corn oil yield are reaching 25 kg/ton vs Pannonia Ethanol's 8 kg/ton (we have to admit to be laggards in that part).

On the other hand, technologies addressed at either post fermentation fractionation or maize front-end fraction, similar to the one used in Biowanze wheat facility JRC visited in 2013, are advancing. In the substantial part of wheat ethanol production is taken place in facilities with deep grain fractionation.

Thus from the policy perspective taking current state of the industry vs the one it was 5 years ago for deriving the default values is coherent, but using even current state of industry for impact assessment of 2030 policy (especially when compared to technological pathways not existent at scale) when actual developments are known is counterintuitive.

JRC: The recently published proposal for a recast of the Renewable Energy Directive COM(2016)767 (RED-recast), contains the provision that allows an update of Annex V in order to incorporate any developments and progress that may occur in biofuel pathways in the future.

Q157) **Manure Application**

In addition comments provided by ePure, EC and JRC could review discussion on manure application emissions done by Argonne Lab in latest GREET update https://greet.es.anl.gov/publication-cclub-land-management, where manure application was included into LCA. This is not to suggest that this could be applicable to Europe, however it clearly shows that the route taken by JRC in the current report is overly simplistic.

JRC: The GREET method in your reference attributes 100% of the emissions from manure-nitrogen to crops, not 50% as we do (with the rest attributed to livestock farming). It uses the IPCC tier1 default method, which is less differentiated by crop than our calculation (although both methods give similar overall country-average results for the same N inputs). GREET also takes into account emissions from transport and spreading of manure, which are neglected in our method, but they have a small impact on the overall emissions.

Q158) **Drying of grains**

Following shall be further considered, that part of grains are consumed on farm, with different technics of storage.

JRC: We rely on CAPRI to model the representative drying and storage emissions for EU crops. If CAPRI takes into account that some grains are consumed on the farm without being dried, it would mean they underestimate the drying emissions for the pathway providing crops for biofuels. However, we suppose that this only accounts for a small part of grain production.

The CAPRI expert Marcus Kempen, who was present at the workshop, agreed to re-examine the data on drying, and has revised downwards the CAPRI estimates of the degree of drying of crops.

Q159) **Enzymes**

As a practical matter in Europe mainly DuPont and Novazymes are providing enzymes for biofuel production. They would also cover 70% of US marker. It is suggested to approach those companies to provide data on carbon footprint of glucoamylase, alphamylase and cellulases (for cellulosic pathways and in case of future use in grain ethanol facilities).

They would also have "recommended" and typical application rates.

JRC: Indeed, emission factors of gluco-amylase and alpha-amylase are taken from a scientific publication (MacLean and Spatari, 2009) which is based on Novozymes figures. MacLean and Spatari use as reference the same publication (Nielsen et al., 2007) that Novozymes sent to JRC after the workshop in September 2016 (see table 26 'Supply of alpha-amylase enzymes' and table 27 'Supply of gluco-amylase enzymes' of the report).

Other Pathways.

Q160) **Cellulosic ethanol**

• Why straw pellets and not straw bales, which is more wide spread form?

• It is suggested to study GREET 2015 corn - corn stover pathway and analyse possibility to develop wheat – wheat straw assessment.

• Pathway assumes that lignin is burned in onsite biomass power plant:

o There are commercial scale facility(s) build in the world with natural gas fired energy centre and no electricity production, with drying lignin for delivery to coal fired plants

o Export electricity to the grid creates a carbon credit which gets accounted in transport sector under FQD, in transport emission statistics and policy compliance. The same electricity (likely) gets feed-in tariff support in the EU and is accounted towards meeting RED renewables targets. Hence double counted

JRC: The straw-ethanol pathway assumes straw bales are used: the data from the straw-pellets pathway is shared only up to the pelleting process.

Although JRC has studied the carbon intensity of wheat straw in more detail, straw is on the list of residues and wastes, and therefore under RED rules automatically is assigned zero emissions in the field.

Indeed the default calculation assumes that the process heat comes from burning the unfermentable biomass from the straw (mostly lignin). If the process is heated with natural gas and the lignin exported, the calculation would be different: on the one hand the carbon footprint of the NG would need to be considered, but on the other hand, there would be an allocation to the lignin by-product on the basis of LHV. Numerically, the result might not be much different, but, if empowered to do so, the Commission could add a second default value to deal with this case.

The method defined in RED does not account for exported electricity by means of carbon credits, but with an allocation method that avoids any danger of double-counting. The method also avoids transfer of carbon savings from electricity sector to transport sector, where they are more valuable.

CRISTAL UNION

N2O emissions methodology:

Q161) Comparison of GNOC with models previously used to estimate N2O emissions:

- What are the disadvantages of the DNDC model? On which topics the GNOC model enables progress?
- What are the arguments that led to the change from DNDC and IPCC tier 1 to GNOC model?
- Is there a reduction of uncertainty when estimating N2O emission with the GNOC model instead of IPCC tier 1 and DNDC?

JRC: Please see answers to Q55) and one of the questions received in 2013 (Q6, reported in Appendix 3 of JRC report, version 1a[43]) and copied here.

> ***Q6:*** *N2O methodology developed by the JRC has been largely explained in the report and during the workshop during which scientific progresse vs existing methods (e.g. IPCC) was lso explained in more detail.*
>
> *The revision of the existing methodology is proposed by the JRC in close discussion with the Commission for the following reasons:*
>
> *The current default values for cultivation of biofuel feedstock in the RED Annex V are based on 2 different methods.*
>
> *a. default soil N_2O emissions from potential biofuel crops grown in Europe (**wheat, rapeseed, sugar beet, sunflower**) result from the application of the soil chemistry model DNDC for **EU15**.*
>
> *b. default soil N_2O emissions from imported biofuel crops (**maize, soybean, sugar cane, oil palm**) were calculated according the **IPCC (2006) TIER1** approach as*

[43] Edwards, R., O'Connell., A., Padella M., Mulligan D., Giuntoli, J., Agostini A., Koeble R., Moro, A., Marelli L., 2016. 'Definition of input data to assess GHG default emissions from biofuels in EU leglisaltion, version 1a, December 2015'. JRC Sciency for policy report, EUR 26853 EN.

at a current stage the global application of DNDC is still a challenge because not enough data is available.

Thus, the current default values for feedstock mentioned under a. do not account for possible differences in cultivation emissions in locations outside EU15 (e.g. Eastern Europe, US) and default values for feedstock listed under b. are based on a different methodological approach.

A further aspect for looking for an alternative methodology has been the fact that the DNDC model requires specific expertise of the user and it needs to be fed with detailed data (parameterization, daily meteorological parameters e.g.). This led to the situation that EU countries to fulfil their reporting obligations about average biofuel cultivation emissions on NUTS2 level (Article 19.2 of the RED) mainly based their calculation on the IPCC (2006) TIER1 approach. This resulted in methodological inconsistencies between the default values and the average soil emissions calculated on NUTS2 level. Biofuel producers wishing to provide their own emission data will face the same problem. In fact, tools (as e.g. version 4b BIOGRACE) providing assistance in calculating cultivation emissions also had to rely on IPCC(2006) TIER1 for the estimation of N_2O emissions from cultivated soils.

We defined the minimum requirements of a methodological approach suitable for an update of the default values in the RED as:

- *applicability at least to all major 1st generation biofuel crops covered by the RED*
- *applicability in all regions where biofuel feedstock can possibly be cultivated*
- *the impact of different environmental conditions on N_2O fluxes has to be taken into account (requested in RED Article 19.2)*
- *consistency with other greenhouse gas emission reporting obligations (e.g. Kyoto, UNFCCC)*
- *published and peer reviewed*
- *applicable by non-experts and/or possibility to provide assistance via spreadsheet or web-tools.*

The new methodology described in the report complies with all the requirements we identified.

Q162) Database and model configuration:

- Is it forecasted to integrate in the N2O measure database of GNOC model new data from France (NO Gas project) and UK? Does this imply a modification of the equation parameter? Is it forecasted to re-examine regularly the equation parameters according to new available data?
- What means the Y-Intercept of the GNOC model? In terms of agronomy? Does it represent the background natural N2O emissions?
- We understand that the JRC relied on an important database of more than one thousand N20 measures spread worldwide to configure and calibrate the N2O GNOC model, according to several parameters (pH, climate, etc.). However, we also conclude that defining a sole model according to the worldwide data tends to smooth results and may not account for local disparities as well as specific models for each homogeneous region of the world configured with local data would do, as it has been done with the NO GAS project in France for example. Does the JRC agree with this argument?

JRC: Integrating new measurements requires the re-calibration of the Stehfest and Bouwman method: see answer to Q73).

As N2O emissions are highly variable the measurements need to cover as far as possible the range of environmental and management conditions that may influence the emission level of a certain crop. Thus, it has to be evaluated if a measurement data set available at country level fulfils these requirements.
For the discussion of the Y-intercept please see answer to Q142).

Q163) Background emissions:
Soils emit some N2O even if they are not farmed: so-called background emissions, which can be quite significant. Would it be consistent to estimate these background emissions which would otherwise have occurred and deduce them from the N2O emission estimation from energy crops calculated thanks to the GNOC model?
JRC: See answers to Q142).

Q164) Indirect emissions:
A global map delineating areas where leaching/run-off occurs was compiled based on climate and soil information, as described in Hiederer et al. (2010). Can we access this map?
JRC: The map and additional explanation is available in the annex.

Q165) *Emission factors:*

Regarding energy emission factors, some are calculated through a complete marginal approach, e.g. electricity, while other do not benefit from the same methodology, e.g. fossil fuels (oil, gasoline). What are the reasons of these methodological choices?
JRC: The emission factors of fossil fuel inputs have been updated in this version of the report (see section 2.1) and made consistent with the GHG intensities reported in Directive 2015/652.

Q166) *Sugar beet to Ethanol pathway*

We identified some "inconsistencies" in the Sugar Beet Ethanol pathway detailed by the JRC and here are some explanations:

	JRC		**Comments**	**Data proposed by Cristal Union**	
	Quantities	**Unit**		**Quantities**	**Unit**
Cultivation of sugar beet					
Pesticides	0,0000548	kg/MJ_Beet	French Technical Institute of Sugar beet indicates that less than 4 kg/ha of pesticides are used. Agribalyse project (Ademe) calculated a total of 3,88 kg/ha of pesticides as a French average mean.	3,8 to 4	kg/ha
	15,4	kg/ha			
Seeding material	0,00001	kg/MJ_Beet	French Technical Institute of Sugar beet indicates that less than 1,3 kg/ha of seeds is used. Agribalyse project (Ademe) calculated a total of 1,2 kg/ha of seeds as a French average mean.	1,2 to 1,3	kg/ha
	3,1	kg/ha			
Transportation of sugar beet					
40 t truck over a distance of 30	0,0074	tkm/MJ_Beet	Transport distance is on average 30km. However, more than 60% of returns are	0,005	tkm/MJ_Beet

km			used to deliver slops or other by-products used as field fertilizer.		
Transport to blending depot					
40 t truck over a distance of 305 km	0,012	t.km/MJ EtOH	The product is transported either by truck (70%) **<u>or</u>** by train (30%).	0,012	t.km/MJ EtOH
Maritime transport over a distance of 1 118 km	0,042	t.km/MJ EtOH		0	t.km/MJ EtOH
Inland ship over a distance of 153 km	0,006	t.km/MJ EtOH		0	t.km/MJ EtOH
Train over a distance of 381 km	0,010	t.km/MJ EtOH		0,010	t.km/MJ EtOH

JRC: Thank you for providing the information for France. However, our calculations are intended to represent average emissions within the EU. Therefore, the data we use for pesticides are from CAPRI and refer to EU27; seeding material is from a paper presenting data for EU and refers to pelleted seed.

Transport of slops is not included in JRC figures.

Transport of ethanol is considered to be the same for all ethanol pathways for consistency.

See also answer to one of the questions received in 2013 (Q135, Appendix 3 of JRC report, version 1a[44]) and copied here.

> ***Q135:*** *The quantity of seeding material has been updated in the new version of the report using recent data. The new sugar beet seed figure (3.6 kg/ha) refers to pelleted seed. The new references are:*
>
> *Rudelsheim, P. L. J and Smets, G. Baseline information on agricultural practices in the EU Sugar beet (Beta vulgaris L.). Perseus BVBA. May, 2012; and British Beet Research Organisation. Crop establishment and drilling bulletin, Spring 2011. www.uksugarbeet.co.uk.*
>
> *CGB clarified their 1.28 kg/ha of seed refers to un-pelleted seed. However the vast majority of sugar beet seed sown in the EU is pelleted. JRC were in contact with seed providers (Germains, UK).*

Q167) <u>*Wheat to Ethanol pathway*</u>

We identified some "inconsistencies" in the Wheat Ethanol pathway detailed by the JRC and here are some explanations:

	JRC	Comments	Data proposed by Cristal

[44] Edwards, R., O'Connell., A., Padella M., Mulligan D., Giuntoli, J., Agostini A., Koeble R., Moro, A., Marelli L., 2016. 'Definition of input data to assess GHG default emissions from biofuels in EU leglisaltion, version 1a, December 2015'. JRC Sciency for policy report, EUR 26853 EN.

				Union	
	Quantities	Unit		Quantities	Unit
Cultivation of Wheat					
Diesel	0,04014	MJ/MJ_Wheat	Agribalyse project (Ademe) calculated a total of 78 liter/ha of diesel as French average mean.	78	liter/Ha
	100,3	liter/Ha			
K2O fertilizer	0,00021	kg/MJ_Wheat	Agribalyse project (Ademe) calculated a total of 9,7 kg/ha of K20 of pesticides as a French average mean.	9,7	Kg/Ha
	16,1	Kg/Ha			
Pesticides	0,00007	kg/MJ_Beet	Agribalyse project (Ademe) calculated a total of 2,1 kg/ha of pesticides as a French average mean.	2,1	kg/ha
	5,4	kg/ha			
Drying, Handling and storage					
Electricity (Process for drying)	0,000251	MJ/MJ_Wheat	Wheat drying is done in the fields by leaving moisture decline naturally.	0	MJ/MJ_Wheat
Light heating oil	0,0015	MJ/MJ_Wheat		0	MJ/MJ_Wheat
Natural gas	0,0015	MJ/MJ_Wheat		0	MJ/MJ_Wheat
Electricity (Handling and storage)	0,00039	MJ/MJ_Wheat		0	MJ/MJ_Wheat
Conversion Wheat to Ethanol					
Yield	3,333	t wheat/t EtOH	According to ADEME study on biofuel emissions carried out in 2010 (French average data), yield is about 2,8830 t wheat/t EtOH	2,8830	t wheat/t EtOH
Electricity	0,0541	MJ/MJ_EtOH	According to ADEME study on biofuel emissions carried out in 2010 (French average data), electricity and steam consumption are much lower than those indicated by JRC: 0,022 MJ of electricity consumed and 0,294 MJ of steam consumed per MJ of EtOH .	0,022	MJ/MJ_EtOH
Steam	0,3637	MJ/MJ_EtOH		0,294	MJ/MJ_EtOH
Transport to blending depot					
40 t truck over a distance of 305 km	0,012	t.km/MJ EtOH	The product is transported either by truck (70%) **or** by train (30%).	0,012	t.km/MJ EtOH
Maritime transport over a distance of 1 118 km	0,042	t.km/MJ EtOH		0	t.km/MJ EtOH
Inland ship over a distance of 153 km	0,006	t.km/MJ EtOH		0	t.km/MJ EtOH
Train over a distance of 381 km	0,010	t.km/MJ EtOH		0,010	t.km/MJ EtOH

JRC: Thank you for providing the information for France. However, JRC data on diesel and pesticides come from the CAPRI model and refer to EU27; K2O data has been updated in this version of the report with new data from Fertilizers Europe provided to JRC in August 2016 (see table 86 'Cultivation of wheat' for the updated figures). The same sources are used for all feedstocks included in the report for consistency.

For drying, data has been updated in the current version of the report (see section 2.5.2). The figures used by the JRC from CAPRI were double-checked by the CAPRI expert (Markus Kempen) who participated at the expert workshop in Brussels in September and provided additional information to the JRC after the workshop. The figures are now lower than before.

DBFZ (Deutsches Biomasseforschungszentrum gemeinnützige GmbH)

Questions received before the workshop

Introduction

EU RED Annex V defines typical and default values for the reduction of greenhouse gas emissions of selected biofuel pathways. Article 19 (7) of that Directive, allows for an adjustment and updating of Annex V regarding the input data, the addition of new feedstock and technologies, an adaptation of the basic methodology for GHG accounting. JRC has recently published a draft report to update the default values of EU RED Annex V. This document includes a number of comments from different DBFZ researchers regarding the specific assumptions, mass and energy balances and references for selected biofuel pathways decribed in the JRC report.

General comments:

Q168) While data for biomass cultivation seems to be intendet to reflect a European average, the input data for the conversion processes seems to be often oversimplified without referring to specific technologies or processes. This in turn makes it difficult to compare these data to data from actual production sites or biofuel production plants.

JRC: The majority of processing data has been supplied directly to the JRC from industry; either from industry associations, or from large industrial manufacturers of the biofuel in question. In the case of biodiesel, the EBB has estimated for JRC the average processing and transport data for all their members. JRC acknowledges there can be different approaches to processing the same raw materials. However our calculations are intended to represent average processing emissions within the EU. Nonetheless, if experts feel they have processing data which results in markedly different emissions to that considered currently, the JRC would welcome such data. We do wish to remind experts that our calculations must represent an EU average, and not only a single processing facility.

Q169) The presentation and structure of the data presented is often hard to follow. Even though we understand that 1 MJ of biofuel is used as a functional unit, this unit is very unusal outside the "RED GHG calculation context". In some tables, additional units (e.g. kg input per ha or t output) are given. These units really helpd to understand and review the data. We recommend to present all input data per MJ biofuel and per t of process output. Furthermore, by-products of the conversion processes are always defined as output in the mass and energy balance tables.

JRC: The reporting has been improved in the current version of the report.

Q170) Some of the references used (see comments below) could be updated.

JRC: Thank you for providing new references, see details below.

Q171) Biomethane has become an important energy carrier and a promising option for the transportation sector. The existing default values for biomethane are not sufficient since they do not reflect typical constellations of substrate mixes used and biomethane facilities. In fact, the absence of sufficient default values has become an significant barrier for the utilization of biomethane in the transportation sector.

JRC: Biomethane is included in the JRC report on solid and gaseous biomass (Giuntoli J, Agostini A, Edwards R, Marelli L, Solid and gaseous bioenergy pathways: input values and GHG emissions, 2017, EUR27215EN, 10.2790/27486.

The following sections include a number of (often minor) specific comments regarding some of the input data for biofuel conversion processes presented in the report.

Bioethanol

Q172) General comment: An anaerobic digestion of co-product streams is considered in the sugar-beet-to ethanol pathway. Why is there no such option for the starch based ethanol pathways?

JRC: The starch-based processes make a single by-product from fermentation called Distillers Dried Grains with Solubles. The solubles come from evaporating the liquid residue as the distillers grains are dried. By contrast, in sugar beet processing, the main by-product, sugarbeet pulp, is sieved out before fermentation, so distillation leaves only a dilute liquid, slop that is not worth evaporating, and from which energy can only be economically recovered by anaerobic digestion.

Wheat to ethanol

Q173) Sources

The selection of sources is not representative and seems to be incomplete. MacLean and Spatari (2009) emphasize, for example, only the utilization of maize ("corn"), the processing of wheat is not reflected in this publication. Due to the different composition of both raw materials, a simple transfer of the amount of enzymes or the amount of required additives for the conversion of wheat to bioethanol is not appropriate. Furthermore, information sourced from personal communications are hard to verify. We suggest to focus on published and robust data.

Useful sources for Wheat to ethanol conversion:

- Mortimor, Elsayed, Horne (2004) Energy and greenhouse gas emissions for bioethanol production from wheat grain and sugar beet. Final report for British Sugar plc, Report No. 23/1

- Bentsen, Felby, Thorsen (2009) Energy, feed and land use balaces of refining winter wheat to ethanol. Wiley. Biofuels, Bioproducts & Biorefining

- Murphy, Power (2008) How can we improve the energy balance of ethanol production from wheat. Fuel 87: 1799-1806

- Stölken (2009) Bewertung der Getreide Roggen, Weizen und Triticale aus MV für den Einsatz in der Bioethanolerzeugung. Forschungsbericht. Landesforschungsanstalt für Landwirtschaft und Fischerei Mecklenburg-Vorpommern Institut für Acker und Pflanzenbau

Input data conversion

Taking only reference to the use of calcium oxide is not completely comprehensible. Also, an indication of the use of acids such as sulfuric acid or phosphoric acid for regulating the pH should be given.

JRC: Thank you for proving new references. JRC looked at all of them and two of them (Power et al., 2008 and Stölken, 2009) have been used in the updated version of the report. MacLean and Spatari is not used any more as main source for the amount of enzymes in the wheat pathway.

Conversion inputs have been updated in the report and sulphuric acid has been added as an input. Please see tables 90 'Conversion of wheat grain to ethanol' and table 91 'Data used to calculate the 'adopted value' from various sources' in section 6.1 for the new 'adopted values' and their sources.

Barley to ethanol

Q174) Sources

The selection of sources is not representative and seems to be incomplete. MacLean and Spatari (2009) emphasize, for example, only the utilization of maize ("corn"), the processing of barley is not reflected in this publication. Due to the different composition of both raw materials, a simple transfer of the amount of enzymes or the amount of required additives for the conversion of barley to bioethanol is not appropriate. Furthermore, information sourced from personal communications are hard to verify. We suggest to focus on published and robust data.

Input data conversion

Taking only reference to the use of calcium oxide is not completely comprehensible. Also, an indication of the use of acids such as sulfuric acid or phosphoric acid for regulating the pH should be given.

JRC: The same input data used for wheat ethanol are used for barley conversion. See above answer to the same question.

Rye to ethanol

Q175) Sources

The selection of sources is not representative and seems to be incomplete. MacLean and Spatari (2009) emphasize, for example, only the utilization of maize ("corn"), the processing of barley is not reflected in this publication. Due to the different composition of both raw materials, a simple transfer of the amount of enzymes or the amount of required additives for the conversion of barley to bioethanol is not appropriate. Furthermore, information sourced from personal communications are hard to verify. We suggest to focus on published and robust data.

Input data conversion

Regarding the assumption on the starch content of rye

The description of the table for the conversion process of rye to ethanol includes a comment describing that the reference values for rye are synonymous to wheat, as both raw materials have the same starch content. In fact, wheat has a fermentable starch content from 58.0 to 64.5% dry matter (average 60.3% dry matter) and an ethanol yield of around 43.3 l raw ethanol / 100 kg dry matter, rye has a fermentable starch content from 54.4 to 62.6% dry matter (average 58.2% dry matter) and an ethanol yield of around 41.7 l raw alcohol / 100 kg dry matter. Assuming equality for the starch content of both feedstocks is therefore debatable.

Taking only reference to the use of calcium oxide is not completely comprehensible. Also, an indication of the use of acids such as sulfuric acid or phosphoric acid for regulating the pH should be given.

JRC: The same input data used for wheat ethanol are used for rye conversion. See above answer to the same question.

Triticale to ethanol

Q176) Sources

The selection of sources is not representative and seems to be incomplete. MacLean and Spatari (2009) emphasize, for example, only the utilization of maize ("corn"), the processing of triticale is not reflected in this publication. Due to the different composition of both raw materials, a simple transfer of the amount of enzymes or the amount of required additives for the conversion of triticale to bioethanol is not appropriate. Furthermore, information sourced from personal communications are hard to verify. We suggest to focus on published and robust data.

Input data conversion

Regarding the comment p. 164 table 132

The commentary noted that reference values for triticale are synonymous of wheat, as both raw materials should have the same starch content. Again, that’s a debatable simplification.

Taking only reference to the use of calcium oxide is not completely comprehensible. Also, an indication of the use of acids such as sulfuric acid or phosphoric acid for regulating the pH should be given.

JRC: The same input data used for wheat ethanol are used for rye conversion. See above answer to the same question.

Sugar beet to ethanol

Q177) Sources

Useful sources to be considered:

- Mortimor, Elsayed, Horne (2004) Energy and greenhouse gas emissions for bioethanol production from wheat grain and sugar beet. Final report for British Sugar plc, Report No. 23/1

JRC: Thank you for providing this reference. A text box in the sugar beet pathway has been added to compare JRC data with data from Mortimer et al. Please see section 6.6, page 178.

Biodiesel

Q178) General comment: For conversion of sunflower, soy oil, pal oil and jatropha the same input data has been used as the for rapeseed esterification. The material- and energy flows are identically for esterification of different oils. It is assumed that this is variing in practice, due to different fatty acid composition of raw materials

JRC: The information given to JRC from the European Biodiesel Board indicated that the variation in process parameters between new EU vegetable oils was not sufficiently significant to warrant different transesterification data sets. However, for the palm oil to biodiesel pathway, the amount of sodium methylate used in transesterification has been updated on the basis of ADEME, 2010 data (see section 6.11 for details).

HVO

Q179) General comments:

The term „BtL-like fuel" is broad and does not explain which specific fuel fraction is addressed. Since the data used are based on the NExBTL process, the described fuel is probably diesel. The report states that „The resultant NExBTL product can either be used as a pure diesel fuel or mixed with diesel to be used as a fuel component." It is hard to understand and interprete the input table without a clear understanding to which fuel fraction they are reffering to.

We recommend to clearly explain which fuel fraction is addressed here. For example, the process would produce a greater fraction of napthta if adjusted to kerosene production. Would in this case, the Naphta fraction be part of the „BtL-like fuel"? Furthermore, the specific adjustment of the process (with focus on one specific fuel fraction) will have a significant impact on the mass balance (e.g. the input of vegetable oil). Literature shows input values of vegetable oil for Diesel & Naphta production between 1,06-1,30 MJ/MJBTL. We suggest to consider changing the title of the section to „HVO-Diesel".

JRC: JRC agrees Btl (biomass to liquid) is a broad term. It has therefore been changed to 'Diesel-like' fuel.

Q180) Sources

We suggest considering the following literature & sources for mass and energy balances:

- DBFZ (2014): Abschlussbericht. Projekt BurnFAIR. DBFZ Deutsches Biomasseforschungszentrum gGmbH.

- Pearlson, M.; Wollersheim, C.; Hileman, J. (2013): A techno-economic review of hydroprocessed renewable esters and fatty acids for jet fuel production. In: Biofuels, Bioproducts and Biorefining. Bd. 7 (Nr. 1). S. 89–96.

- Murata, Kazuhisa, et al. "Hydrocracking of algae oil into aviation fuel-range hydrocarbons using a Pt–Re catalyst." Energy & Fuels 28.11 (2014): 6999-7006. (Algenöl)

- Conkle, H. N., et al. "Production of Unblended,"Drop-in," Renewable Jet Fuel." (2013).

- Nikander, Sami. Greenhouse gas and energy intensity of product chain: case transport biofuel. Diss. Helsinki University of Technology, 2008.

JRC: Thank you for this useful information. However, it did not add to the information we already have (from Neste). The first and last references also quote Neste data, and the others are about jet fuels, not road fuel.

Lignocellulosic based synthetic fuels

Black liquor

Q181) Sources

Additional sources to be considered:

• Consonni, S., Katofsky, R. E. and Larson, E. D.: A gasification-based biorefinery for the pulp and paper industry, Chemical Engineering Research and Design 87 (2009), 1293-1317, DOI: 10.1016/j.cherd.2009.07.017

• Jafri, Y., Furusjö, E., Kirtania, K. and Gebart, R.: Performance of a pilot-scale entrained-flow black liquor gasifier, Energy & Fuels 30 (2016), 3175-3185, DOI: 10.1021/acs.energyfuels.6b00349

• Wiinikka, H., Johansson, A.-C., Wennebro, J., Carlsson, P. and Öhrman, O. G. W.: Evaluation of black liquor gasification intended for synthetic fuel or power production, Fuel Processing Technology 139 (2015), 216-225, DOI: 10.1016/j.fuproc.2015.06.050

• Kwon, H. S., Moon, J. H., Lee, U. D., Yoon, J. J., Walsum, G. P., Um, B. H.: Fractionation and gasification of black liquor derived from kraft pulping, Journal of Industrial and Engineering Chemistry 34 (2016), 122-129, DOI: 10.1016/j.jiec.2015.10.044

• Freitas Ferreira, E. T. and Perrella Balestieri, J. A.: Black liquor gasification combined cycle with CO2 capture – Technical and economic analysis, Applied Thermal Engineering 75 (2015), 371-383, DOI: 10.1016/j.applthermaleng.2014.09.026

JRC: Thank you for the useful information, which we have examined.

[Wiinikka 2015] gives the results of trials using the "DP1" prototype black liquor gasifier from Chemrec. The results show that more methane is produced than predicted by thermodynamics. As fuels are made from the CO and h2 components of the syngas, production of methane reducesthe fuel yield; however the untransormed methane would contribute to the production of electricity and process heat. Therefore, although less fuel is produced, less forest residue is needed to balance the heat and electricity needs of the pulp mill. So we do not think it would significantly affect the calculation of the GHG savings (to get a precise answer one would need to re-run the process-modelling program).

[Jafri 2016] report results on more testing the same gasifier using different process conditions and BL composition. This reduces the methane production, but does not alter the considerations above.

[Consonni 2009] is a computer simulation of a more sophisticated embodiment of the black liquor gasification concept, in which also the hog boiler is replaced by a fluidized-bed gasifier. However, this introduces a second technological hurdle, so would seem to be further from realization that the simpler application we have examined.

[Freitas Ferreira 2015] is a modeling exercise for different configurations of black liquor gasification for electricity production, has no new data and is not relevant to fuels production.

[Kwon 2016] proposes a true biorefinery that first hydrolyses the black liquor in a reactor, then separates valuable chemicals, and then gasifies the purified lignin that is left, for electricity production. It does not involve production of fuels.

In conclusion, we did not find anything in the new literature that would significantly change our calculation.

Q182) Input data conversion

Table 242: Roundwood is given in dry tonnes per ADt pulp or in GJ per ADt pulp? Unit GJ/air dried tonnes pulp in the heading of column 2 misleading.

Table 243: It is not clear how high the output (pulp and methanol) is relative to the input. 0.9 Dt pulp and 0.59 Dt methanol per ADt pulp are produced? Is meant that 2,05 t roundwood are converted into 1 t AD pulp and 0,59 t methanol? I needed some time to figure this out. Pulp unit in ADt/day is misleading. The same comments concern tables 244 – 247.

JRC: JRC agrees that the reporting was not clear. It has been improved in this version of the report (see section 6.16 and table 252 'Black liquor gasification to methanol').

Wood to liquid hydrocarbons

Q183) Sources

Additional sources to be considered:

• Hamelinck, C. N. and Faaij, A. P. C.: Outlook for advanced biofuels, Energy Policy 34 (2006), 3268-3283, DOI: 10.1016/j.enpol.2005.06.012

• Kim, K., Kim, Y., Yang, C., et al.: Long-term operation of biomass-to-liquid systems coupled to gasification and Fischer–Tropsch processes for biofuel production, Bioresource Technology 127 (2013), 391-399, DOI: 10.1016/j.biortech.2012.09.126

Wood to methanol

Sources

Additional sources to be considered:

• Tunå, P. and Hulteberg, C.: Woody biomass-based transportation fuels – A comparative techno-economic study, Fuel 117 (2014), 1020-1026, DOI: 10.1016/j.fuel.2013.10.019

• Phillips, S. D., Tarud, J. K., Biddy, M. J. and Dutta, A.: Gasoline from woody biomass via thermochemical gasification, methanol synthesis, and methanol-to-gasoline technologies: A technoeconomic analysis, Industrial & Engineering Chemistry Research 50 (2011), 11734-11745, DOI: 10.1021/ie2010675

Wood to DME

Sources

Additional sources to be considered:

- Tunå, P. and Hulteberg, C.: Woody biomass-based transportation fuels – A comparative technoeconomic study, Fuel 117 (2014), 1020-1026, DOI: 10.1016/j.fuel.2013.10.019

- Haro, P., Trippe, F., Stahl, R. and Henrich, E.: Bio-syngas to gasoline and olefins via DME – A comprehensive techno-economic assessment, Applied Energy 108, 54-65, DOI: 10.1016/j.apenergy.2013.03.015

- Haro, P., Ollero, P., Villanueva Perales, A. L. and Gómez-Barea, A.: Thermochemical biorefinery based on dimethyl ether as intermediate: Technoeconomic assessment, Applied Energy 102 (2013), 950-961, DOI: 10.1016/j.apenergy.2012.09.051

- Clausen, L. R., Elmegaard, B. and Houbak, N.: Technoeconomic analysis of a low CO2 emission dimethyl ether (DME) plant based on gasification of torrefied biomass, Energy 35 (2010), 4831-4842, DOI: 10.1016/j.energy.2010.09.004

JRC: Thank you for your inputs and for the additional references.

In updating the values for advanced biofuel processes we have first looked at the market penetration and diffusion of these technologies. Both ligno-cellulosic ethanol and thermochemical processes are not yet commercially widespread. However, for the first category a few examples are available in EU and MS and some operational data have been published in the years. For this reason the pathway Straw-EtOH has been updated based on publically available data from the experience gathered by Biochemtex and Clariant.

Thermochemical processes (namely BtL processes) are not commercially available and even investments in demo plants have been scaled down in recent years. Therefore, in terms of datasets, we are limited to processes modelled "on paper" in ideal and optimized conditions. Furthermore, the designs for BtL plants proposed so far, all are close to real self-sustaining bio-refineries that produce a multitude of fuels (e.g. FT-Gasoline, FT-Diesel and FT-Naphta) in conjunction with additional production of electricity to the grid. The inputs to the (design) processes are mainly material-based, such as catalysts, which are not consumables in the strict sense and which are traditionally not included in Well-to-wheels calculations and wouldn't be included in the RED methodology. Thus, the only parameters that characterize BtL plants in a RED perspective, are the efficiency of conversion (i.e. how much biomass input for unit of product) and the final suite of co-products (given the established allocation rules). For this reason, we decided not to update the values for BtL and DME plants compared to the last version of the database: i) these values are already based on optimized design; ii) even a slight change of the efficiency would have a limited effect on the overall GHG emissions; iii) any other dataset chosen would still be affected by limited link to the real world since "real-world" data do not exist.

Questions received after the workhop (DBFZ)

Besides the points we have discussed today there is one additional point I wanted to mention. However, since time was running I wasnt able to raise them.

Q184) Biomethane: For some reason, appropriate default values for biomethane are missing in your report. The current default values for biomethane (i am aware of the silage maize pathway in the report on biomass for heat and power) do only reflect a small part of the biomethane installations. Typicall installations use mixtures of different substrates. Because of missing default values, the effort of calculating actual values is significant for operators of larger biomethane plants (who can have easily up to 30 or more suppliers of feedstock). In fact, we often here from operators, that missing default values are a barrier which hinderst hem to sell their product to the „fuel/quota" market.

JRC: Biomethane is included in the JRC report on solid and gaseous biomass (Giuntoli J, Agostini A, Edwards R, Marelli L, Solid and gaseous bioenergy pathways: input values and GHG emissions, 2017, EUR27215EN, 10.2790/27486).

Q185) For further data on straw mobilisation and the BtL process i do suggest to look at the following references:

http://www.sciencedirect.com/science/article/pii/S0306261913005825

https://www.dbfz.de/fileadmin/user_upload/Referenzen/schriftenreihen/DBFZ_Report_13.pdf

https://www.dbfz.de/fileadmin/user_upload/DBFZ_Reports/DBFZ_Report_9.pdf

JRC: Thank you for your inputs and for the additional references. Please see answers to Q183).

ISCC (International Sustainability & Carbon Certification)

Two comments on your GNOC tool.

Q186) For the application in actual calculations it would be more helpful to provide the results of soil N2O emissions in g CO2eq per kg crop instead in g CO2eq per MJ crop, as it need to be added to the rest of the cultivation emissions and total cultivation emissions must be provide in the unit per kg crop.

JRC: A note has been added in table 56, section 3.7 of the report explaining how to calculate the N_2O emissions expressed in gCO_2eq per kg of dry crop from g CO2eq per MJ of crop using the Lower Heating Values (LHV) shown in chapter 6 of the report.

Q187) Furthermore, it would be good to not only ask for manure Fon but for organic fertilizers, as there are also other organic fertilizers like biogas digestif or EFBs in oil palm plantations which you would need to be included here.

JRC: The contribution of nitrogen from empty fruit bunches (EFB) in oil-palm plantations are considered in the same way that we consider nitrogen from other crop residues.

N from biogas digestate is taken into account as part of N from manure. This is now explained in the text of the report (see section 3.5 and section 3.8 of the report).

E4tech

Q188) It was mentioned that the changes proposed by the JRC in their 2016 document won't be able to be implemented until at least the 2020 update to the RED legislation. Did I understand this correctly and could you clarify why this is please?

JRC: Since the revision of the Renewable Energy Directive in 2015 by the Directive (EU) 2015/1513, the Commission is allowed to add, but not to remove or amend default values in Annex V. On 30 November 2016, the EC published the 'Proposal of a Directive on the Promotion of the Use of Energy from Renewable Sources' (COM (2016)767, RED recast) which contains the updated GHG emissions typical and default values based on the JRC calculations for the post-2020 framework. The proposal is currently under consideration by both the European Parliament and the Council following the ordinary legislative procedure.

Q189) When we were discussing the 2G biofuel pathways, reference was made several times to a relevant Staff Working Document, which I assume is this document? And I assume then that the data under discussion was the data contained in this document?

JRC: The Staff Working Document mentioned during the workshops is the SWD(2014)259 on 'State of play on the sustainability of solid and gaseous biomass used for electricity, heating and cooling in the EU' published in July 2014 and available at: http://ec.europa.eu/energy/sites/ener/files/2014_biomass_state_of_play_.pdf.

The SWD updates the values and the methodology defined in COM(2010)11 to account for the technical and market developments in the bioenergy sector. The JRC report 2015 (EN 27215) describes the assumptions made by the JRC when compiling the updated data set used to calculate default and typical GHG emissions for the different solid and gaseous bioenergy pathways, and results applying the methodology set in COM(2010)11 and SWD(2014)259.

Q190) Finally, I made a comment about the efficiency of the CHP having changed. In table 58 of the report that you sent around, the efficiency of NG CHP is 1/2.3867 = 42% thermal efficiency and 1/(2.3867/0.79)= 33% electrical efficiency . However in the current biograce sheet V4d (in the wheat ethanol NG-CHP chain for example) the efficiency of the CHP is 1/1.866 = 54% thermal efficiency and 1/(1.866/0.662) =35% electrical efficiency .

JRC: Yes, the NG CHP input data have been changed compared to the inputs used in the RED calculations (and biograce) following the outcomes of the expert consultation meeting held in Ispra in 2011. The experts considered the CHP data used in Annex V calculations to be too optimistic, so they were replaced by the current data, which are slightly more conservative. However, the main reason that CHP emissions have changed is the change in methodology for accounting for electricity exports, from a 'credits' system to one based on allocation of steam by exergy, as specified in Annex V part C of the proposed Directive COM(2016)767.

UPM

Q191) However, after the event we heard a comment that there was a question raised about why HVO from tall oil was removed in the report and that JRC is encouraging UPM to submit data in order to add this pathway. Could you give background information for this issue and elaborate where did this question rise? Although I was in the workshop I did not hear any discussion related to tall oil nor UPM. Could you also indicate from JRC`s point of view the importance of adding this pathway to existing ones?

JRC: Tall oil is not included as a pathway in the report and it does not appear in the list of biofuel production pathways presented in Annex V of the Commission proposal COM(2016)767 (RED-recast).

CGB (Confédération Générale des planteurs de Betteraves)

Q192)**Proposal to split the cultivation step into two separate parts (even if not in the JRC scope)**

Considering on one hand the weight of N2O emissions in the global GHG biofuels balance (particularly in the cultivation step) and on the other hand its variability (depending on the model/data used), we suggest to split the cultivation step into two bricks: N2O emissions and cultivation step (excluding N2O emissions step).

It would allow more flexibility to economic operators. They would be able to use specific data for N2O emissions (using GNOC, NUTS2 values, actual values, etc. all the possible ways to do it being to be defined) while going on using default values for the cultivation itself. Actually, not using default value for N2O emission would oblige economic operators to collect also actual values for the whole cultivation step, which would be an overwhelming administrative burden if to be done for every cultivated field!

As the N2O emissions have their own rationale, it seems feasible to isolate them in a dedicated subset of cultivation step.

JRC: The request has been accepted by the Commission and separate values for N2O have been included in COM(2016)767.

Q193)**N2O emissions**

CGB is not fully convinced that GNOC methodology is more accurate than DNDC, regarding the lack of current representativeness of data about sugarbeet.

This argues for an open approach of the N2O emissions estimations, as it is already the case in the existing rules.

JRC: For calculating default values, it is necessary to have a method that can be applied consistently to all biofuel crops anywhere in the world. This is impossible using DNDC as it requires input data that is not available globally. We cannot apply different methods to different crops.

Q194)**Sugar cane cultivation**

It is essential to us to have a fair and complete approach on the calculation of GHG emissions for all the feedstocks used to produce biofuels.

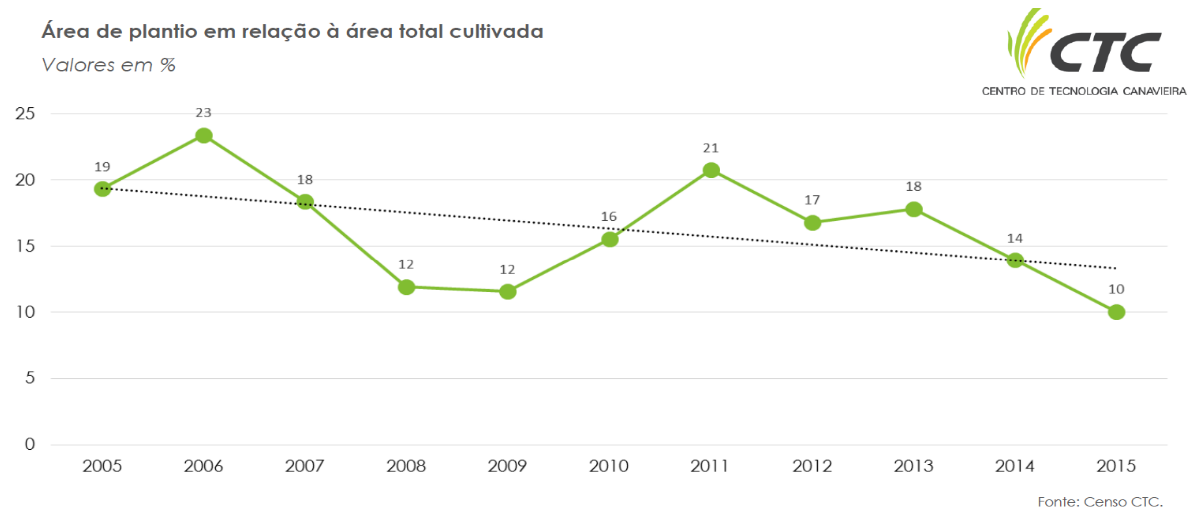
Regarding the sugarcane, a crop that has got many advantages, the dataset used by JRC should stick to reality.

Cultivation data: necessity of taking into account the whole cultivated area of sugarcane

Sugarcane is a perennial crop. Nevertheless, as the yield decreases cut after cut (i.e. year after year), the plantation is generally renewed after 5-6 cuts, i.e. 7-8 years. Therefore, every year, between 10 and 15% of the total cultivated area is not harvested as this area is dedicated to the replantation.

This is why in 14/15, 9,69 Mha of sugarcane were harvested in Brazil while 10,8 Mha were cultivated with sugarcane.

The following graph issued by the Centro de Technologia Canavieira (CTC) - alias Sugarcane Technological Centre - relates the evolution of sugarcane replantation rate over the recent years, showing an average of 15% since 2011:



Available data in the literature regarding sugarcane cultivation (quantity of inputs, yields, etc.) is only based on harvested area and not on the whole area dedicated to sugarcane in Brazil. It would be more relevant to also consider the average 15% of replanted areas, as they also receive fertilizers and chemicals. In addition, the considered areas (more than 1 million hectares) probably also emit N2O.

Yet, it seems that the replanted area is currently forgotten in the JRC dataset, for no understandable reason, leading to focus only on harvested area and finally to underestimate the global GHG emissions of the sugarcane ethanol. In our opinion, **this should be corrected, for instance by recalculating the sugarcane yield on the basis of the cultivated area rather than on the basis of the harvested area, as suggested in CGB/CIBE comments, made in 2013.**

JRC: We already take into account that one year in 6 (16.7% of the time) the crop is not harvested. It was not explained in the report, but the explanation has been added in the new version of the report (see comments in table 134 'Sugar cane cultivation' of the report).

Q195)<u>Conversion into ethanol</u>

The conversion yield of sugar crops to ethanol is directly linked to their sugar content. For this reason, it is not sufficient to consider the rate of dry matter for these crops and to neglect the actual sugar content.

For the sugarcane, the content of sugar is expressed through the Total Recoverable Sugar (TRS) or ATR in Portuguese. The TRS includes all the amount of sugar contained in the sugarcane and transformable into sugar or ethanol (hydrous and anhydrous).

It can be express per tonne of cane or per global quantity (tonne/ha or tonne/crop at an aggregated level). That is what usually done by UNICA per crop, as shown in the Slide N° 15 of the enclosed presentation (balances for 12/13 and 13/14 crops).

Moreover, the sugarcane is paid to producers on the basis of the actual valorization of the products made from it, and to do so, the Brazilian sector usually uses official conversion rates to calculate the price of sugar cane, these rates are regularly updated and appear in the Consecana Handbook. For the campaign 14/15, these rates were:

- 1 kg of raw sugar requires 1,0453 kg of TRS
- 1 litre of anhydrous ethanol requires 1,7492 kg of TRS
- 1 litre of hydrous ethanol requires 1,6961 kg of ATR

When used to check the breakdown of actual crops 12/13 and 13/14 into sugar and the two grades of ethanol for the whole Centre South of Brazil (Unica data above mentioned), these figures fully match with UNICA global data with an error margin below 0,3% (Cf the excel file enclosed).

It clearly shows that these conversion rates are relevant and representative of the Brazilian sector at a very large scale.

Therefore, coming back to JRC work (p 149 & 152 of the draft report), the conversion factor of 86,3 l ethanol/t sugar cane (Macedo, 2008) seems overestimated, as previously mentioned by CGB and CIBE in 2013.

When applied to the reference sugar content of the cane used in JRC dataset (142,2 kg sugar/t cane), the ORPLANA conversion rate into ethanol is no more than : 142,2/1,7492 = 81,29 l ethanol /t sugar cane, i.e. 5,8% lower.

On the basis of ORPLANA conversion rates applied to the actual balance of sugarcane/sugar/ethanol for the Centre South region in recent years, Macedo's conversion rate appears to be a slightly overestimated. This can be explained by the fact that Macedo's work was based on a sample of 44 mills only, probably not fully representative of the Centre South sugarcane sector.

JRC: Thank you for informing us on the TRS issue. We have raised down the yield of the process using the average TRS reported for 2012-2016 giving a yield of 81.3 litres of ethanol/tonne of sugarcane (see table 143 'Conversion of sugar cane to ethanol' of the report).

MPOB (Malaysian Palm Oil Board)

Pathway

Q196) The conversion of palm oil to biodiesel is a transesterification process and not esterification. JRC responded in Q65 that the name has been changed but it was noted that Step 7: Esterification was used in this Policy Report and there were two Step 7. Please refer to page 207.

JRC: You are right, thank you for pointing out the two reporting mistakes. The name has been changed in the report and the number of the 'step' updated.

Q197) Two pathways, i.e. palm oil biodiesel (process not specified) and palm oil biodiesel (process with methane capture at oil mill) have been made available for producers of palm oil biodiesel. MPOB would like to propose to include two additional pathways, i.e. palm oil biodiesel (oil palm cultivated on soils not specified) and palm oil biodiesel (oil palm cultivated on 100% mineral soils). MPOB is of the view that this proposal is reasonable taking into consideration the 16% peat/organic soils is too high and will unfairly penalise those who obtain their feedstock from 100% mineral soils.

JRC: RED does not discriminate between crops gown on different soil types; it consistently takes an average for the eligible crops. Economic operators have the option to declare actual cultivation emissions; for this, the GNOC tool allows convenient calculation of N2O emissions from plantations whether on peat or mineral soils.

Uses of Empty Fruit Bunches (EFB)

Q198) Currently, the EFB has many uses in addition to being used as mulch in the oil palm plantation. These include its use as raw material for production of biocompost fertiliser, source of renewable energy, viz as fuel for powerplants and production of pellets as solid fuel. The long fibres are also used as fillers for mattresses and other applications.

MPOB currently is not able to provide the national data on EFB usage because the usage rate is very dynamic and depends on the economic value and market demand. MPOB would like to emphasise that EFB is fully utilised in Malaysia in various forms.

JRC: Thank you for the information. Once a more accurate data becomes available, JRC will consider including them for a future update.

Palm Oil Mill

Q199) Biogas **Capture Infrastructures**

The number of palm oil mills in Malaysia with biogas capture facilities (as of 18 October 2016) is as follows:

Status	Number of Mills with Biogas Capture
Plant in Operation	90
Under Construction	6
Under Planning	145

Under the National Key Economic Area (NKEA), all palm oil mills in Malaysia are expected to install the biogas capture/methane avoidance facilities by 2020.

JRC: Thank you for the providing this information. A separate default value for FAME from palm oil with methane capture was already included in the report (see section 6.11).

Refining of Palm Oil

Q200)The physical refining data is available in the reference Choo et al. (2011) in responding to Q81.

JRC: Physical refining data are included in the updated version of the calculation and report (see table 222). This process is assumed to apply to 30% of the palm oil imported to EU which is the percentage of refined palm oil coming from Malaysia and Indonesia according to available data (FEDIOL).

Annex

Leaching/Runoff

IPCC (2006) defines the area where leaching/runoff occurs as areas where Σ(rain in rainy season) - Σ (PE - potential evaporation - in same period) > soil water holding capacity, or where irrigation (except drip irrigation) is employed. The rainy season(s) can be taken as the period(s) when rainfall > 0.5 * Pan Evaporation.

Calculation of areas where leaching/runoff occurs for a 5minutes by 5minutes grid globally are based on:

- long-term average of monthly rainfall (Hijmans, 2005),
- long-term average of monthly potential evapo-transpiration (PET) of the reference land use "grassland" (Hiederer, 2009/10 based on data from Hijmans, 2005)[45]
- soil water holding capacity data[46] on a 5 minutes by 5 minutes grid is provided along with the ISRIC-WISE soil properties data set (Batjes, 2006).

Input data and results are shown in **Error! Reference source not found.Error! Reference source not found.**. The top figure gives the amount of precipitation during the rainy season, the central map shows the soil water holding capacity (Batjes, 2006) and the bottom map depicts the excess of soil water holding capacity in the rainy season. All the areas > 0 mm in the bottom map are subject to leaching or run-off according the IPCC (2006) definition.

Within this study the second condition "where irrigation (except drip irrigation) is employed" has not been taken into account. To the knowledge of the authors there is only one source that gives information about irrigated areas with the required spatial resolution on a global scale. Siebert et al. (2007) produced a digital map showing the area equipped for irrigation for a global grid of 5 min. resolution. However, the type of irrigation can not be distinguished, thus it is not possible to exclude drip irrigation from the total irrigated area. It may be further assumed that irrigation in a region is usually not employed to all crops but predominantly to the crops most sensitive to drought and/or to the economically most valuable ones. Reliable estimates would require a more detailed analysis region by region.

45 A detailed description and discussion of PET, PE and Pan Evaporation is available from FAO (http://www.fao.org/docrep/x0490e/x0490e04.htm).). PET is used as an approximation of PE and Pan evaporation required according to IPCC (2006)

[46] Available water storage capacity (AWC; from -33 to -1500 kPa; cm m^{-1})

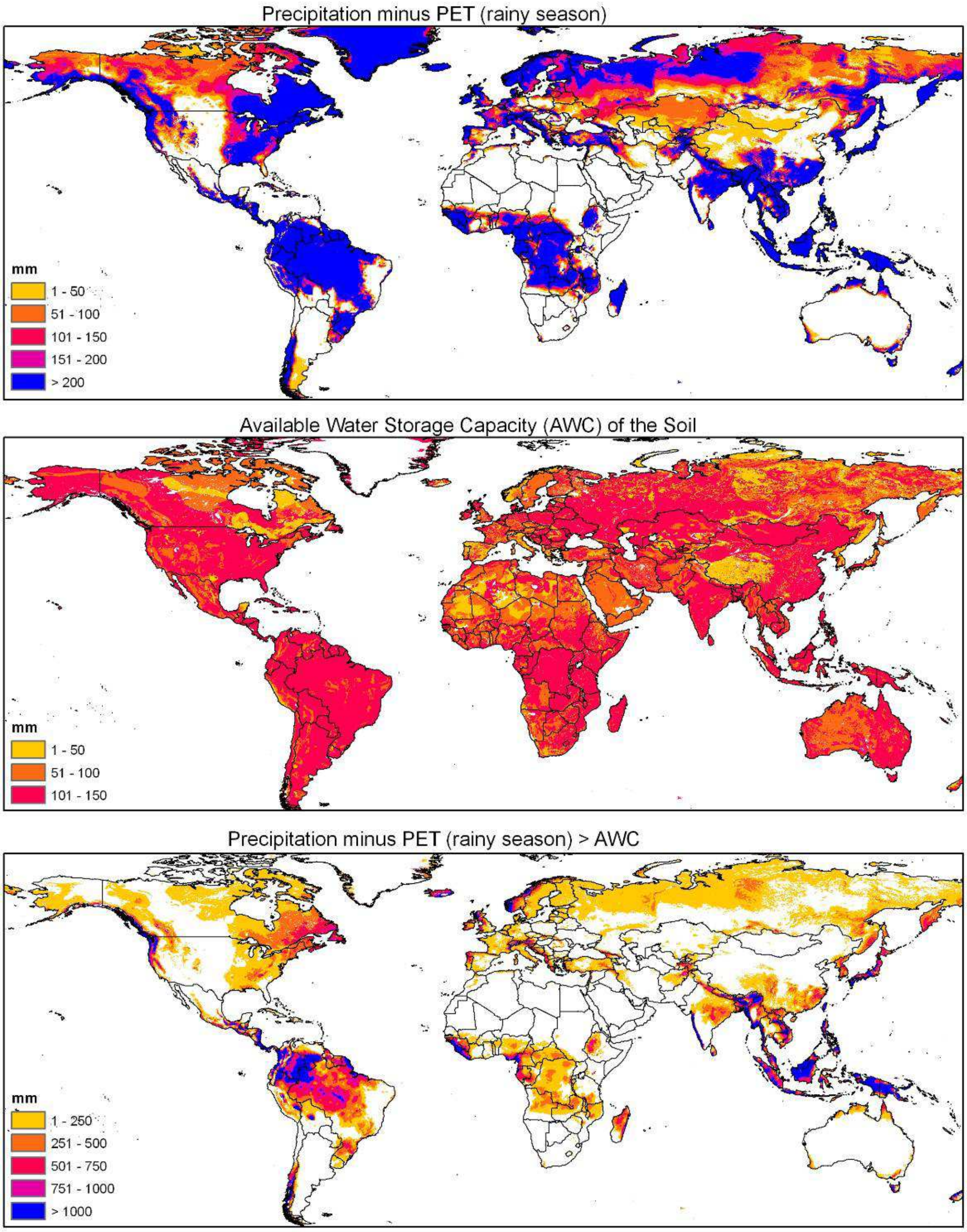


Figure 1: Input data and result of the delineation of areas where water holding capacity is exceeded and leaching/runoff occurs (bottom map). Description and data sources see text.

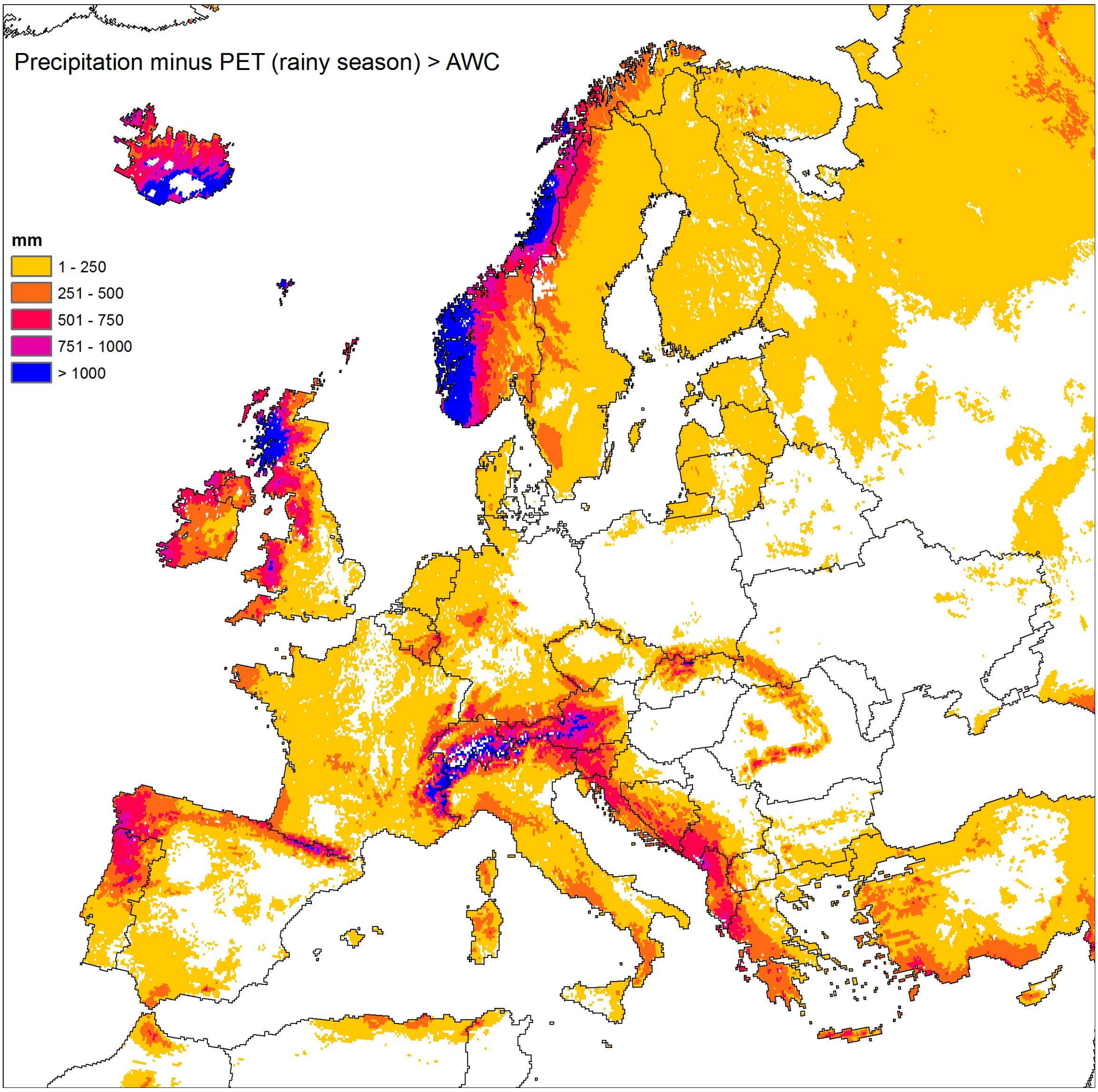


Figure 2: Delineation of areas where water holding capacity is exceeded and leaching/runoff occurs in Europe (corresponds to bottom map in Figure 1).

References

Batjes, N. (2006): ISRIC-WISE derived soil properties on a 5 by 5 arc-minutes global grid (version 1.0). ISRIC World Soil Information Report 2006/02.

Hiederer, R. (2009/2010), Joint Research Centre, Institute for Environment and Sustainability, Land management and Natural Hazards Unit, pers. communication.

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Siebert, S.; Döll, P.; Feick, S.; Hoogeveen, J. and Frenken, K. (2007) Global Map of Irrigation Areas version 4.0.1. Johann Wolfgang Goethe University, Frankfurt am Main, Germany / Food and Agriculture Organization of the United Nations, Rome, Italy".

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