UPDATES IN EU LEGISLATION ON BIOFUELS

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BIOFUELS POLICY FRAMEWORK

- Directive 2009/28/EC (Renewable Energy Directive - RED)
- Directive 98/70/EC (Fuel Quality Directive - FQD)

Mandatory targets:

- 10 % share of renewable fuels in transport (RED)
- 10% GHG intensity reduction of transport fuels – 6% from biofuels/alternative fuels (FQD)

Sustainability criteria:

- Minimum 35% life-cycle GHG Emissions saving (50% from 2017, 60% from 2018)

GHG emission savings from biofuels / bioenergy

- Methodology to calculate **"DIRECT"** life cycle GHG emission savings is fixed by the RED;
- Calculation is straightforward...BUT
- Data collection for *typical systems* is challenging!

- Operators can calculate and declare their ***ACTUAL VALUES***
- ...or use ***DEFAULT VALUES*** listed in Annex V of the RED ***(only if Land Use change emissions = 0)***

- **Default values** are an option to facilitate economic operators
- Include a "safety" factor of 40% increase in emissions from processing
- ***"Disaggregated"*** default factors are also specified in annexes: a combination of default for some production steps + actual for others can be used.

Use of actual values is recommended

Big scope for reducing declared emissions, compared to default values:

- Declare only low-emission steps; use defaults for the high-emission ones

Processors can

- Avoid the 40% “conservatism factor” on process emissions, just by declaring
- Use renewable inputs (plant oils or biomass for heat, bio-ethanol/methanol)
- Choose most favourable plant split for by-product allocation
- Buy crops from regions with low soil emissions

Farmers can greatly reduce emissions by buying low-emission fertilizer using manure, etc.

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ANNEX V (default emissions) and input database entirely updated in 2013

Input data for biofuels are chosen by JRC

- On-line since 2005, with invitation to stakeholders to suggest corrections
- Database of INPUT DATA is continuously updated, and also used for JEC-WTW reports (which use different methodology, and takes a “snapshot” of the input database at different times)
- Updates come from
  - Improved data from JRC
  - Suggestions from stakeholders
- Many bilateral meetings and consultation
  - Expert meeting at JRC Nov. 2011
  - Stakeholder meeting in Brussels May 2013

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What's new in upcoming update

1) New pathways:

- **Ethanol:** barley, rye
  (combined pathways "ethanol from cereals" under discussion)

- **FAME:** coconut oil, Jatropha oil, waste cooking oil (less than 550 km and more than 500 km);
  - FAME from produced animal fats from rendering plant (in present annex waste veg oil and animal oil are together)

- **Hydrogenated vegetable oils (HVOs) and Pure plant oil (PPOs)** from <u>all the feedstocks</u> as FAME pathways (in present annex HVO is only from rapeseed, sunflower, palm oil, pure veg oil from rapeseed)

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- **Compressed biogas from silage maize**

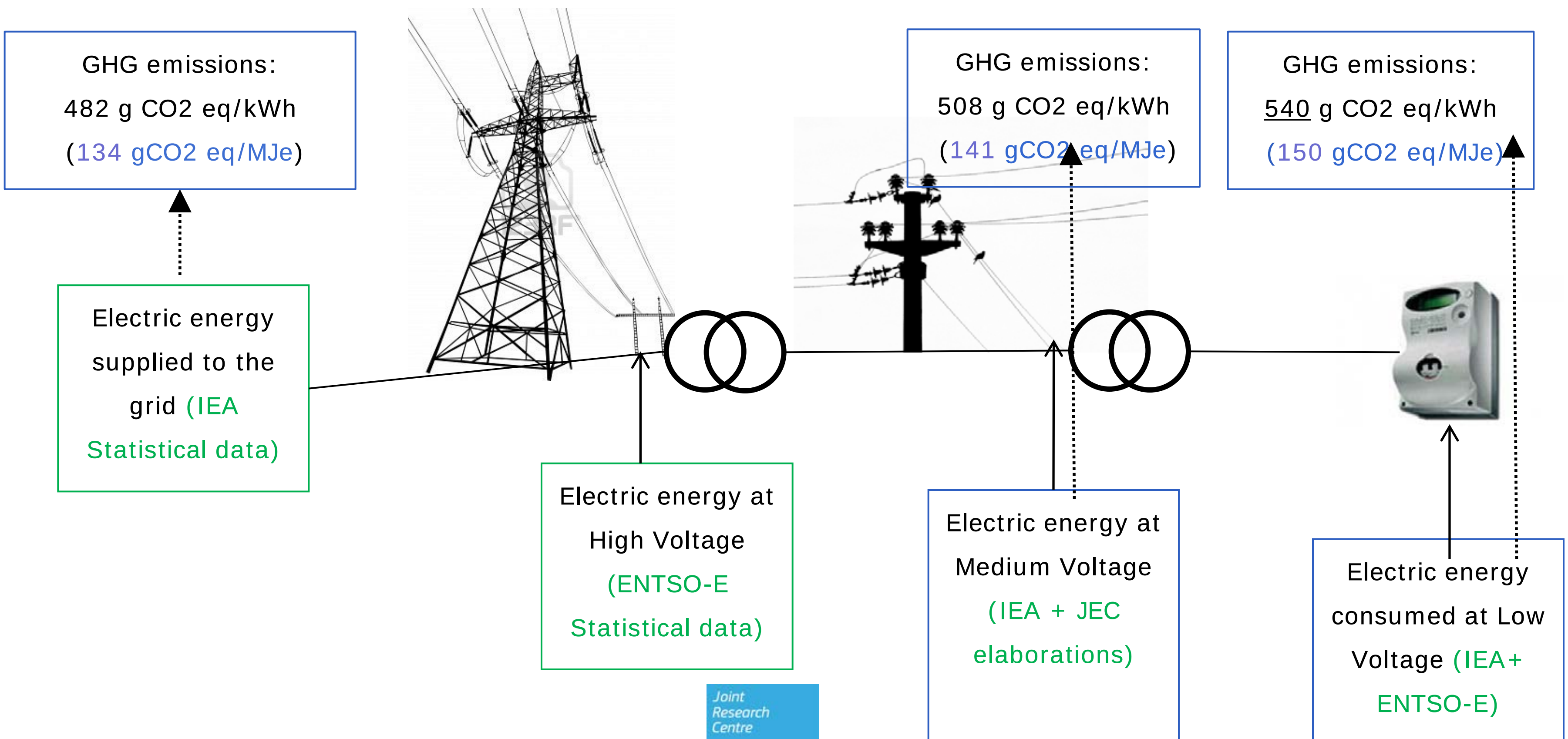
- **Biomethane pathways**: same feedstocks (maize, manure, biowaste), but new technologies added (open or closed digestate, in combination with various technologies to upgrade biogas to biomethane etc)

- **Lignocellulosic biofuels**: new upstream processes for Forest Harvest Residues collection, SRC now includes Eucalyptus and Poplar.

2) New EU27 Electric Energy mix

Increased compared to the former values bacause of:

- new geographic boundaries (EU27, not EU15)
- updated statistical data (IEA, 2009)
- more details in energy losses calculation (including sub-station and pump storage losses)



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3) Methodology for quantification of soil N_2O Emissions from Biofuel Feedstock Cultivation

Method now in RED:

- Based on a soil chemistry model (DNDC) and partly IPCC (non-European crops);
- Expert knowledge is needed to set-up and run the model;
- No guideline was given in the RED for reporting soil N_2O emissions

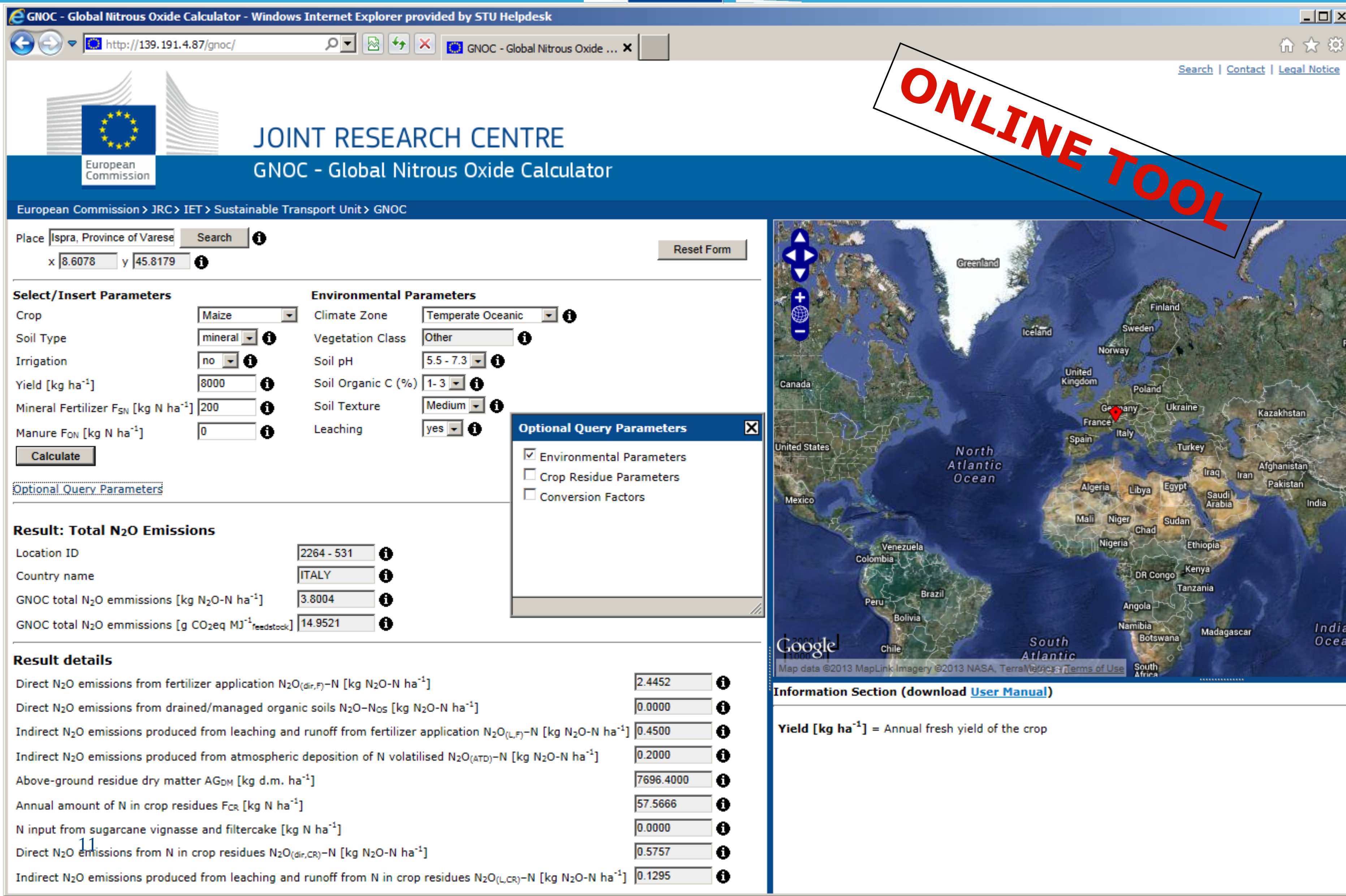
  - Declared cultivation emissions are meaningless unless local soil-properties are considered (at the least)
  - IPCC (tier 1) is popular in LCA, but is **very** rough, do not take into account different land cover, soil type, climatic conditions, management practices.

    And it is **not intended for use at sub-national level**

NEW JRC Global Nitrous Oxide Calculator (GNOC) (see Robert Edwards talk tomorrow)

Combined "Stehfest&Bouwman- statistical model" with IPCC Tier1 Approach

- JRC's GNOC on-line tool will allow a local N_2O emissions estimates based on soil properties and other variables (fertilizer, manure, crop, climate...) anywhere in the world
- The new default values average the results of the GNOC calculator applied to all places where a crop is grown in each country (or in EU) (M3 database of world crop distribution).
- Then a weighted average is made, of emissions per tonne of crop for countries *supplying EU market* (FAO trade matrix)


GNOC - Global Nitrous Oxide Calculator - Windows Internet Explorer provided by STU Helpdesk
http://139.191.4.87/gnoc/
GNOC - Global Nitrous Oxide ...
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JOINT RESEARCH CENTRE
GNOC - Global Nitrous Oxide Calculator
European Commission > JRC > IET > Sustainable Transport Unit > GNOC
Place Ispra, Province of Varese Search
x 8.6078 y 45.8179
Reset Form
Select/Insert Parameters
Crop Maize
Soil Type mineral
Irrigation no
Yield [kg ha-1] 8000
Mineral Fertilizer FSN [kg N ha-1] 200
Manure FON [kg N ha-1] 0
Calculate
Optional Query Parameters
Environmental Parameters
Climate Zone Temperate Oceanic
Vegetation Class Other
Soil pH 5.5 - 7.3
Soil Organic C (%) 1 - 3
Soil Texture Medium
Leaching yes
Optional Query Parameters
Environmental Parameters
Crop Residue Parameters
Conversion Factors
Result: Total N2O Emissions
Location ID 2264 - 531
Country name ITALY
GNOC total N2O emmissions [kg N2O-N ha-1] 3.8004
GNOC total N2O emmissions [g CO2eq MJ-1 feedstock] 14.9521
Result details
Direct N2O emissions from fertilizer application N2O(dir,F)–N [kg N2O-N ha-1] 2.4452
Direct N2O emissions from drained/managed organic soils N2O–NOS [kg N2O-N ha-1] 0.0000
Indirect N2O emissions produced from leaching and runoff from fertilizer application N2O(L,F)–N [kg N2O-N ha-1] 0.4500
Indirect N2O emissions produced from atmospheric deposition of N volatilised N2O(ATD)–N [kg N2O-N ha-1] 0.2000
Above-ground residue dry matter AGDM [kg d.m. ha-1] 7696.4000
Annual amount of N in crop residues FCR [kg N ha-1] 57.5666
N input from sugarcane vignasse and filtercake [kg N ha-1] 0.0000
Direct N2O emissions from N in crop residues N2O(dir,CR)–N [kg N2O-N ha-1] 0.5757
Indirect N2O emissions produced from leaching and runoff from N in crop residues N2O(L,CR)–N [kg N2O-N ha-1] 0.1295
Greenland
Iceland
Finland
Sweden
Norway
United Kingdom
Poland
Canada
Germany
France
Ukraine
Kazakhstan
Italy
Spain
Turkey
United States
North Atlantic Ocean
Iraq
Iran
Afghanistan
Pakistan
Algeria
Libya
Egypt
Saudi Arabia
India
Mexico
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Venezuela
Colombia
Kenya
DR Congo
Tanzania
Brazil
Peru
Angola
Bolivia
Namibia
Botswana
Madagascar
Chile
South Atlantic
South Africa
Indian Ocean
Google
Map data ©2013 MapLink Imagery ©2013 NASA, TerraMetrics Terms of Use
Information Section (download User Manual)
Yield [kg ha-1] = Annual fresh yield of the crop

SBET: SUGAR BEET to EtOH

Sugar beet cultivation

	I/O	Unit	Amount	Source	Comment
Diesel	Input	$MJ/MJ_{sugar\ beet}$	0.01485	1, 4, 5, 6	16.3 MJ/(kg dry sugar beet)
N fertilizer	Input	$kg/MJ_{sugar\ beet}$	0.000324	2	1.32 kg N/t
Ca fertilizer as CaCO3	Input	$kg/MJ_{sugar\ beet}$	0.001085	7	
K_2O fertilizer	Input	$kg/MJ_{sugar\ beet}$	0.00048	3	134.9 kg K_2O/(ha*yr)
P_2O_5 fertilizer	Input	$kg/MJ_{sugar\ beet}$	0.00021	3	59.7 kg P_2O_5/(ha*yr)
Pesticides	Input	$kg/MJ_{sugar\ beet}$	0.0000774	1, 4, 5, 6	18.0 kg/(ha*yr)
Seeding material	Input	$kg/MJ_{sugar\ beet}$	0.0000214	1	6.0 kg/(ha*yr) [1]
Sugar beet	Output	MJ	1.0000		68860 kg beet @ 75% H2O [4]
Field N_2O emissions	-	$g/MJ_{sugar\ beet}$	0.0160	2	
CO_2 from neutralization & other soil acidity		$g/MJ_{sugar\ beet}$	0.3084	7	

Source:

Dreier, T.; Geiger, B.; Lehrstuhl für Energiewirtschaft und Kraftwerkstechnik, TU München (IfE); Saller, A., Forschungsstelle für Energiewirtschaft (FfE): Ganzheitliche Prozeßkettenanalyse für die Erzeugung und Anwendung von biogenen Kraftstoffen; Studie im Auftrag der Daimler Benz AG, Stuttgart und des Bayerischen Zentrums für Angewandte Energieforschung e.V. (ZAE); Mai 1998

Edwards, R.; Koeble, R.; Joint Research Centre (JRC): Results from JRC-IES Global Nitrous Oxide Calculator (GNOC): weighted; EU average of countries supplying energy crops used in EU; 15 July 2012

European Fertiliser Manufacturer Association (EFMA), 2008

CAPRI database, Energy use data extracted by Markus Kempen of Bonn University, March 2012, converted to JEC format using information in refs 5 and 6.

Kraenzlein, T. Energy Use in Agriculture. Chapter 7.5 in CAPRI model documentation 2011: Editors: W. Britz, P. Witzke. Available at: http://www.capri-model.org/docs/capri_documentation_2011.pdf.

Kempen, M. and Kraenzlein T. (2008) Energy Use in Agriculture: A modeling approach to evaluate Energy Reduction Policies. Paper prepared for presentation at the 107th EAAE Seminar "Modelling of Agricultural and Rural Development Policies". Sevilla, Spain, January 29th, February 1st, 2008.

Edwards, R., Joint Research Centre (JRC): Acidification and liming; 15 July 2012

Handling and storage of sugar beet

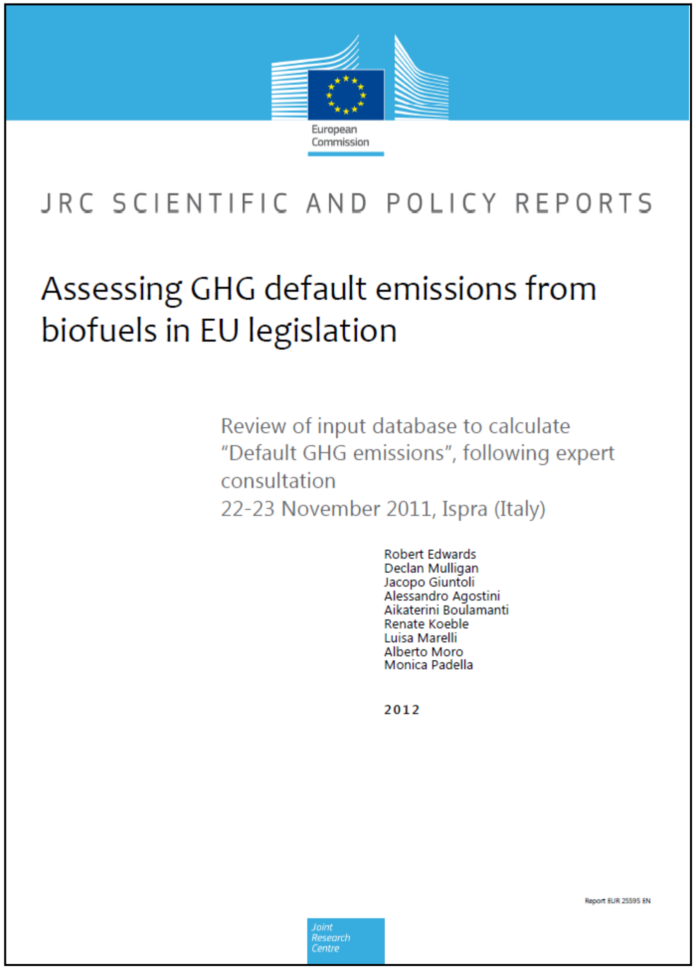
	I/O	Unit	Amount	Comment
Sugar beet	Input	$MJ/MJ_{sugar\ beet}$	1.0000	
Electricity	Input	$MJ/MJ_{sugar\ beet}$	0.00141	same as for wheat on a per wet-kg basis
Sugar beet	Output	MJ	1.0000	

Source:

Kaltschmitt, M.; Reinhardt, G., A.: Nachwachsende Energieträger: Grundlagen, Verfahren, ökologische Bilanzierung; Vieweg 1997; ISBN 3-528-06778-0

Transport of sugar beet via 40 t truck over a distance of 30 km (one way)

	I/O	Unit	Amount
Distance	Input	$tkm/MJ_{sugar\ beet}$	0.0074
Sugar beet	Input	$MJ/MJ_{sugar\ beet}$	1.0000
Sugar beet	Output	MJ	1.0000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JRC SCIENTIFIC AND POLICY REPORTS

Assessing GHG default emissions from biofuels in EU legislation

Review of input database to calculate "Default GHG emissions", following expert consultation
22-23 November 2011, Ispra (Italy)

Robert Edwards
Declan Mulligan
Jacopo Giuntoli
Alessandro Agostini
Aikaterini Boulamanti
Renate Koeble
Luisa Marelli
Alberto Moro
Monica Padella

2012

Report EUR 25595 EN

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4) Accounting for co-products and cogeneration

- GHG emission allocated to biofuels and co-products by energy content (LHV) – no changes proposed

- Allocation for bioliquids used to produce heat and electricity. The new method accounts for:
  - Reduced emissions in CHP
  - Higher emissions to heat at higher T: emissions divided between electricity and useful heat based on T_{heat} (allocation by exergy)

$$EC_h = \frac{E}{\eta_h}\left(\frac{C_h \cdot \eta_h}{C_{el} \cdot \eta_{el} + C_h \cdot \eta_h}\right)$$

$C_{h,el}$ = Exergy in the useful heat/electricity (Carnot efficiency)

$\eta_{h,el}$ = heat/electrical efficiency

On-going discussions on definition of T threshold for Carnot efficiency (100 or 150°C? Or no threshold?)

Open issues:

- Up-date of FFC (now 83.8 gCO_2/MJ)
  - New value will be higher (better data on flaring emissions)
  - Marginal or average emissions at refinery ?
  - Separate values for diesel and gasoline?
- Manure to Biogas: attribute methane credits from avoided manure-storage emissions?
- Co-digestion: shall the mass balance be suspended to allow GHG savings calculation for co-digestion of multiple substrates? (e.g. maize+Manure)

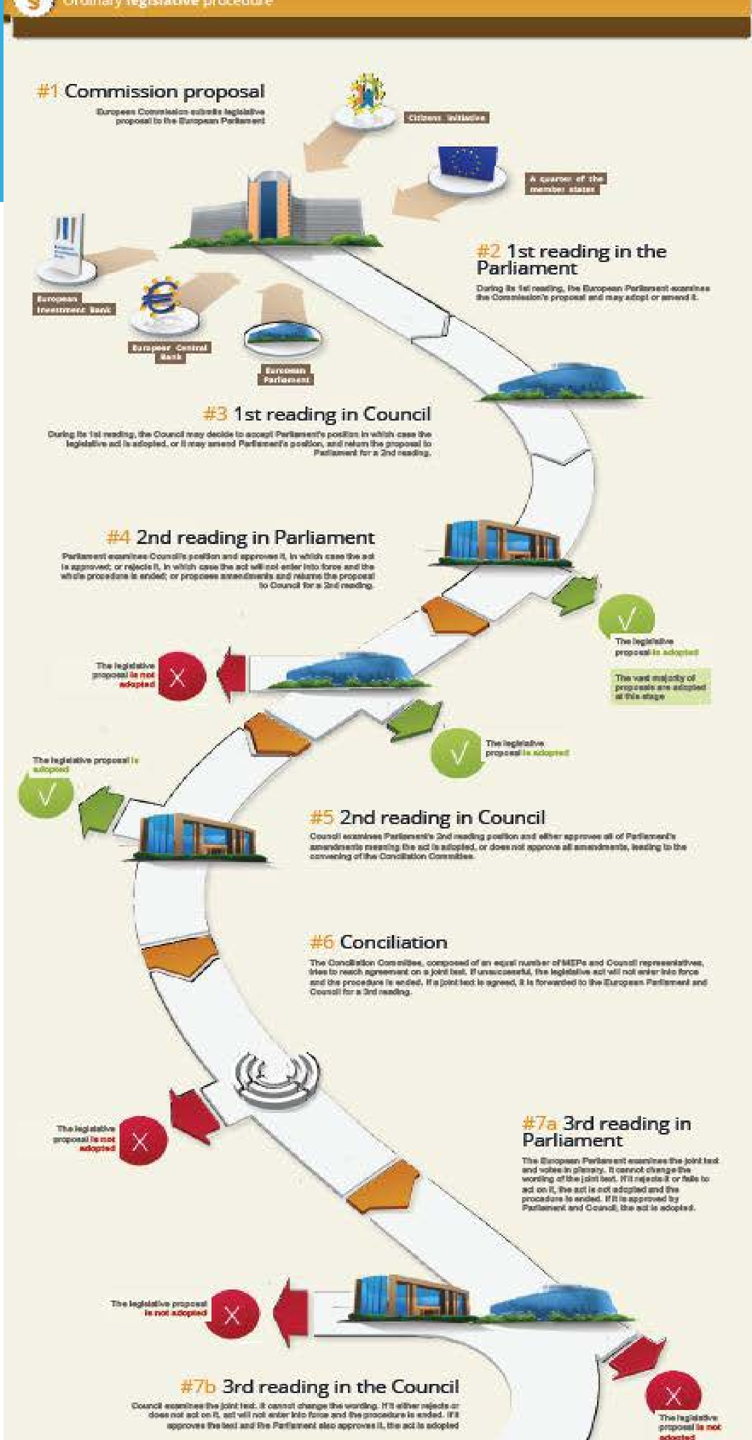
"ILUC" in EU legislation

1) EU Commission's proposal COM(2012)595 (Oct. 2012)

2) EP amendments (September 2013)

Overall objectives:

1) Reduce the use of land-based biofuels
2) Take ILUC emissions into account in GHG savings calculations
3) Encourage development of advanced biofuels
4) Protect existing investments



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In details:

- Limitation of food/energy crops-based biofuels towards the target to **6%** by 2020
- Sub-targets for advanced biofuels: 0.5% share by 2016, 2.5% by 2020 (+ 1.5% for electricity generated by those means).
  - Used cooking oil and animal fats are excluded from these targets, but will count double towards RED/FQD targets.
  - Most advanced biofuels: multiplication factor of 4 (and included in 2.5% sub- target).
- 60% GHG emissions savings for installations starting operations after 2014
- ILUC emissions introduced in FQD, counted towards 6% target, but not in sustainability criteria
- ILUC emission values to be introduced in life cycle GHG emissions calculations scheme in 2021.

- Proposed ILUC emissions (from IFPRI-MIRAGE model):
  - Cereals: 12 gCO_2/MJ
  - Sugars: 13 gCO_2/MJ
  - Oil crops: 55 gCO_2/MJ
- ILUC values to be reviewed by 2016 (including energy crops, SRC/SRF etc.)
- EC to Report on economic/environmental (GHG, biodiversity, water, soil fertility) impacts of the use of waste, residues and co-products by 2015
- EC to report on the effects of these measures by 2017

N.B. New amendments from 1st reading in the Council (October 2013)

SUPPORTING SLIDES

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Methodology to calculate GHG savings is set by the Directives (RED-Annex V, FQD-Annex IV)

$$E_b = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee},$$

GHG SAVING = $(E_f - E_b)/E_f$ (min. 35%)

Where E_f = emissions from the fuel comparator

E = total emissions from the use of the fuel;

e_{ec} =emissions from cultivation of raw materials;

e_l =annualised emissions from carbon stock changes caused by land-use change;

e_p =emissions from processing;

e_{td} =emissions from transport and distribution;

eu = emissions from the fuel in use;

e_{sca} = emission saving from soil C accumulation via improved agricultural management;

e_{ccs} = emission saving from carbon capture and geological storage;

e_{ccr} = emission saving from carbon capture and replacement;

e_{ee} = emission saving from excess electricity from cogeneration.

ILUC emissions are not included

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If technology progresses, why do some emissions go up?

▼ Technical improvements **reduce** emissions:

e.g. reduced emissions from N fertilizer factories

▲▼ Data corrections or new methodology, can go up or down

e.g. farm N_2O emissions,

e.g. correction of esterification data

▲ **More detailed analysis tends to reveal more emissions**.

This **increases** both fossil- and bio-fuel emissions

e.g. emissions from neutralization of fertilizer-induced acidity

e.g. EU electricity emissions

e.g. Flaring emissions in crude oil

Example: Combined cereals cultivation pathways

The Commission proposes a combined cereals-ethanol cultivation default value because...

- differences between cereals turn out to be small
- it allows use of minor cereals which lack input data
- avoids telling producers in other countries their emissions.
- so cereals-ethanol from >500km adds only shipping emissions.

(remember producers also use the cereals-cultivation-default as part of an emissions declaration)

The mix of cereals was taken from DG-ENER “biofuels baseline 2008”

Combined soybean oil production pathways

- Start with national input data from the main exporters of soy beans, oil and biodiesel: cultivation, processing, transport and shipping to EU
- But combine into weighted average of all soybean production going to EU

  …using FAO trade matrix for sources of EU supply
- Based on real data, but without discriminating between producer countries

CULTIVATION INPUTS

nitrogen inputs

nitrogen production

agricultural lime

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FARM INPUTS

CAPRI (Univ. of Bonn) is a GIS model of EU agriculture used for evaluating the effect of policy changes on emissions (amongst other things).

We have adopted EU-average CAPRI farm inputs: diesel, pesticides etc..

(national expert suggestion at last consultation meeting)

But we use fertilizer data per tonne of crop from International Fertilizer Association/FAO, because we can use it also for non-EU crops.

Other farm inputs for non-EU crops from peer-review papers, national reports and stakeholders.

Weighting of N fertilizer input and farm-N2O per crop in cultivation defaults

Principle:
defaults are for weighted average of EU *consumption*

Crops (practically) all produced in EU
- **feed-wheat, barley, rye**
- **rapeseed, sunflower**
- **sugar beet**

Produced partly in EU:
- **Maize**

Practically all imported:
- **soy**
- **palm**
- **coconut**
- **sugar cane**

N fertilizer input data from Fertilizers Europe 2010/2011

FAO or Eurostat yields for 2010-11

N fertilizer input data from International Fertilizer Association,

FAO yields for 2010-2011

Countries weighted by export to EU (FAO trade matrix) (..and EU production)

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FERTILIZER PRODUCTION EMISSIONS

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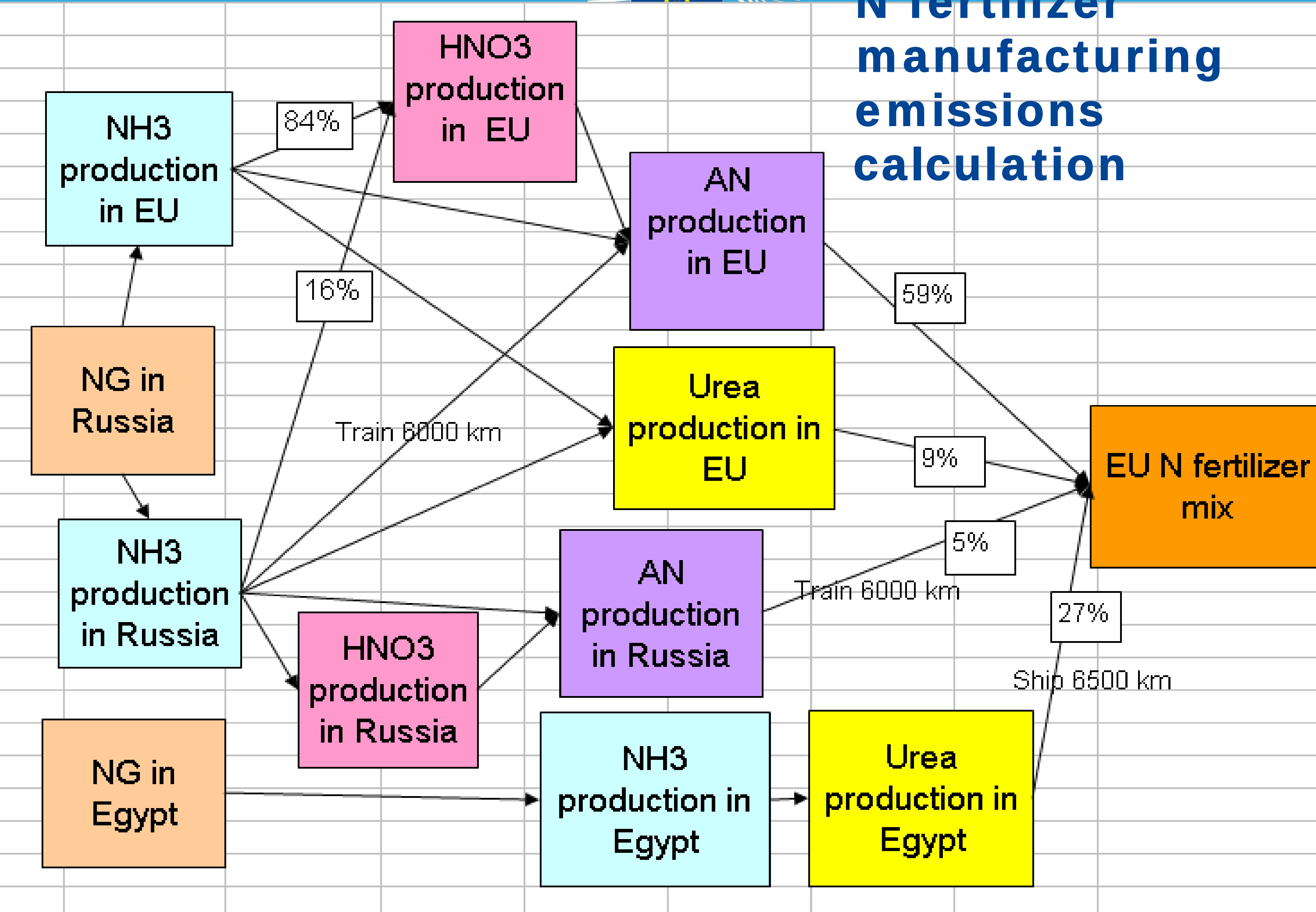
FERTILIZER MANUFACTURING EMISSIONS DERIVED FROM ETS

- EU fertilizer manufacturers must reach ETS targets in 2020
- They declared their emissions in 2007
- We interpolate a 2013 value between these
- Then we add extra emissions from imported fertilizer
- The intention is that producers can significantly improve declared GHG savings by using fertilizer from factories who declare emissions

N fertilizer manufacturing emissions calculation



FERTILIZER PRODUCTION EMISSIONS based on Fertilizers Europe submission to ETS + import emiss

2007 declared EU	**N-fert. mix used in EU**
CO_2	3234
CH_4	8.0
N_2O	9.74
CO_2 equiv	**6336**
2013 interpolation	
CO_2	3204
CH_4	7.93
N_2O	7.315
CO_2 equiv	**5315**
2020	**gCO_2e/kgN**
CO_2	3138
CH_4	7.8
N_2O	1.86
CO_2 equiv	**3887**

annex V defaults (2008) used ~6300gCO_2/kgN

average for all N fertilizer USED in EU, including imports.

+ 590gCO_2/kgN for CO_2 from N acidification in the soil

EU target 2020 under ETS

Nitrogen fertilizer production emissions assumptions:

- Average for all N fertilizer *consumed* in EU, including imports.
- Data principally from Fertilizers Europe submission to ETS. That includes data from an IFA world survey of fertilizer plant emissions.
- 2013 data by interpolation between 2007 emissions and 2020 benchmark
- only one N fertilizer value:
  mix for urea and AN; mix of EU production and imports
  - little data on which N fertilizer used where and for which crop
  - (urea and AN emissions are approaching each other)
- our annex V value [Kaltschmitt 2001] was about right in 2005-7
- Figures from Ecoinvent are higher. Some other sources ignored upstream emissions for NG, and are for selected factories.
- big scope for producers to reduce emissions by choosing a good fertilizer factory!

Issues with N fertilizer production emissions

1. Imported urea is assumed to come from Middle East (no breakdow
of exporters to EU is available).
…and emissions in Middle East plant are assumed the same as an E
urea plant
…but China is largest world exporter (with very high emissions from coal)

2. We assumed that foreign producers' emissions fall proportionally to EU ones, although they are not in ETS

3. How much have EU fertilizer emissions *actually* fallen since 2007?

4. The same EU N fertilizer production emissions are assume
for foreign crops, although probably too low.

UPDATE OF AGRICULTURAL LIMING EMISSIONS

- In annex V, we only included lime production emissions, We assumed aglime was
  20% CaO + 80% $CaCO_3$
- Now we assume it's crushed limestone (CaCO3) – lower production emissions
- Now we added to nitrogen fertilizer production emissions, the CO_2 released when acidification from N fertilizer is neutralized in the soil/rivers/sea
- Now we also estimated the CO_2 released when aglime is used to improve naturally acid soils for agriculture
- Calculation checked by independent academic, famous in the field. Only about 1/3 of IPCC aglime emissions
- kg/ha aglime worked out from soil pH in GNOC, normalized to total aglime use per country from EDGAR

estimation of TRACTOR-DIESEL (and pesticides) use per tonne of crop

Crops (practically) all produced in EU
- **feed-wheat, barley, rye,**
- **rapeseed, sunflower**
- **sugar beet**

Produced partly in EU:
- **Maize**

EUROSTAT 2008 data disaggregated by CAPRI per ha of each crop
÷
FAO (or Eurostat) yields for 2010-11

Practically all imported:
- **soy**
- **palm**
- **coconut**
- **sugar cane**

data per ha mostly from recent national sources
÷
FAO yields

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SHIPPING EMISSIONS

- Now we use data on ship fuel consumption from International Maritime Organization

Buhaug, Ø.,et al. “Second IMO GHG Study 2009", International Maritime Organization (IMO), London, UK, April 2009

- In annex V we assumed all return trips were empty (under ballast)

- Now we obtained expert opinion, for different cargoes/routes, on:
    - the % loading on the return trip
    - the average size of the ships