Life cycle GHG emissions in the EU biofuels legislation

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Policy framework

Directive 2009/28/EC (RED)

10% target for RES in transport

Directive 2009/30/EC (FQD)

10% GHG reduction by fuel suppliers (6% through alternative fuels)

Sustainability Criteria and Life-cycle GHG emissions calculation identical in the two Directives

GHG Impact	❑ *Minimum 35% GHG Emissions saving (50% from 2017, 60% from 2018)*
Biodiversity	❑ *Not be made from raw materials obtained from biodiverse areas (including primary forests)*
Land use	❑ *Not be made from land with high carbon stock (i.e. wetlands, forested areas…)* ❑ *Not be grown on peatlands*
Good agricultural conditions	❑ *Requirement for good agricultural conditions and social sustainability*

LCA METHODOLOGY

GHG emissions saving calculated by:

1. Actual values → Methodology in Annex V - RED

Total emissions from the use of fuel:

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

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.

- if you can't (or don't want to) calculate actual emissions for your batch of biofuels
  - *(and are not in a recognised voluntary scheme)*
  - *(and you r LUC emissions are zero)*

2. Default values (if $e_l \leq 0$) → **Values listed in Annex V - RED**

- JRC calculates the "default values" of GHG emissions from different biofuels from different feedstocks

(Values now in Annex V from JEC – WTW input database)

Values in annex V will likely be updated soon

- JRC expert consultation on 22-23 November

EUROPEAN COMMISSION

Example of default values in Annex V - RED

Institute for Energy

Biofuel production pathway	Typical GHG emission saving	Default GHG emission saving
sugar beet ethanol	61 %	52 %
wheat ethanol (process fuel not specified)	32 %	16 %
wheat ethanol (lignite as process fuel in CHP plant)	32 %	16 %
wheat ethanol (straw as process fuel in CHP plant)	69%	69%
sugar cane ethanol	71%	71%
rape seed biodiesel	45%	38%
palm oil biodiesel (process not specified)	36%	19%
palm oil biodiesel (process with methane capture at oil mill)	62%	56%
waste wood ethanol	80%	74%

= Typical + 40% increase on the estimated processing emissions

3. Combination of 1 + 2 → *Disaggregated default values in Annex V*

- **Cherry-picking (1):** an “ad-hoc” combination of disaggregated default + actual values can give lower emissions:

Example:

If your emissions from cultivation are > default value,

- You can make an actual value for processing emissions (avoiding the 40% “safety-factor” increase)
- But take the default value for cultivation

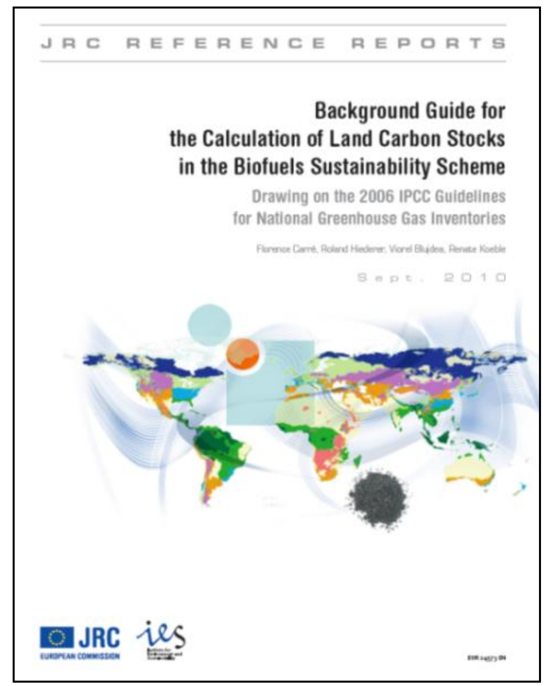
...to get lower possible emissions

Default values do not include:

- emissions for farm machinery manufacture
- energy for irrigation
- emissions from LUC

- **LUC emissions (e_l):**

Commission's decision on Guidelines for the calculation of land carbon stocks (2010/335/EU of 10/06/2010) based on JRC work:



- **N_2O emissions from cultivation:**

(Now default values in disaggregated e_{ec} factor)

JRC methodology: combined "Stehfest&Bouwman-statistical model" with IPCC Tier1 Approach

- Mineral fertilizer data based on IFA
- Input data from several global databases and is disaggregated on a ~9km grid
- Harmonized method for all feedstocks, global application is possible.
- Cover a wide range of potential biofuel feedstock defined by the EU Commission

Main uncertainties:

1. Allocation of emissions between fuel and co-products, **in proportion to their energy content (Lower Heating Value)**

Issues:

- *Most of the emissions from soy cultivation and crushing is attributed to the meal*
- ***Definition of LHV in the directive:***

There are 2 definitions for moist material:

1. Heat from burning the dry part of the material (not including the energy in steam in the exhaust)
2. Heat of the entire co-product stream, i.e. Like (1) but subtracting the energy to evaporate the water in the material

The Commission says in a 2010 Communication:

“for allocation you must use the second definition”

Consequences of allocation using the “wet” LHV definition

- In case of ethanol, the LHV depends on its dilution (while “dry” LHV is a fixed quantity per dry-matter mass of material)

- The Lower Heat Value of wet materials decreases. Therefore wet by-products (like undried DDGS) get less allocation than dry ones

JRC emissions calculation tool works internally with the first definition, and all “per MJ” results are “per MJ LHV of the dry matter “

Fortunately, for (dry) final fuels there is only one LHV

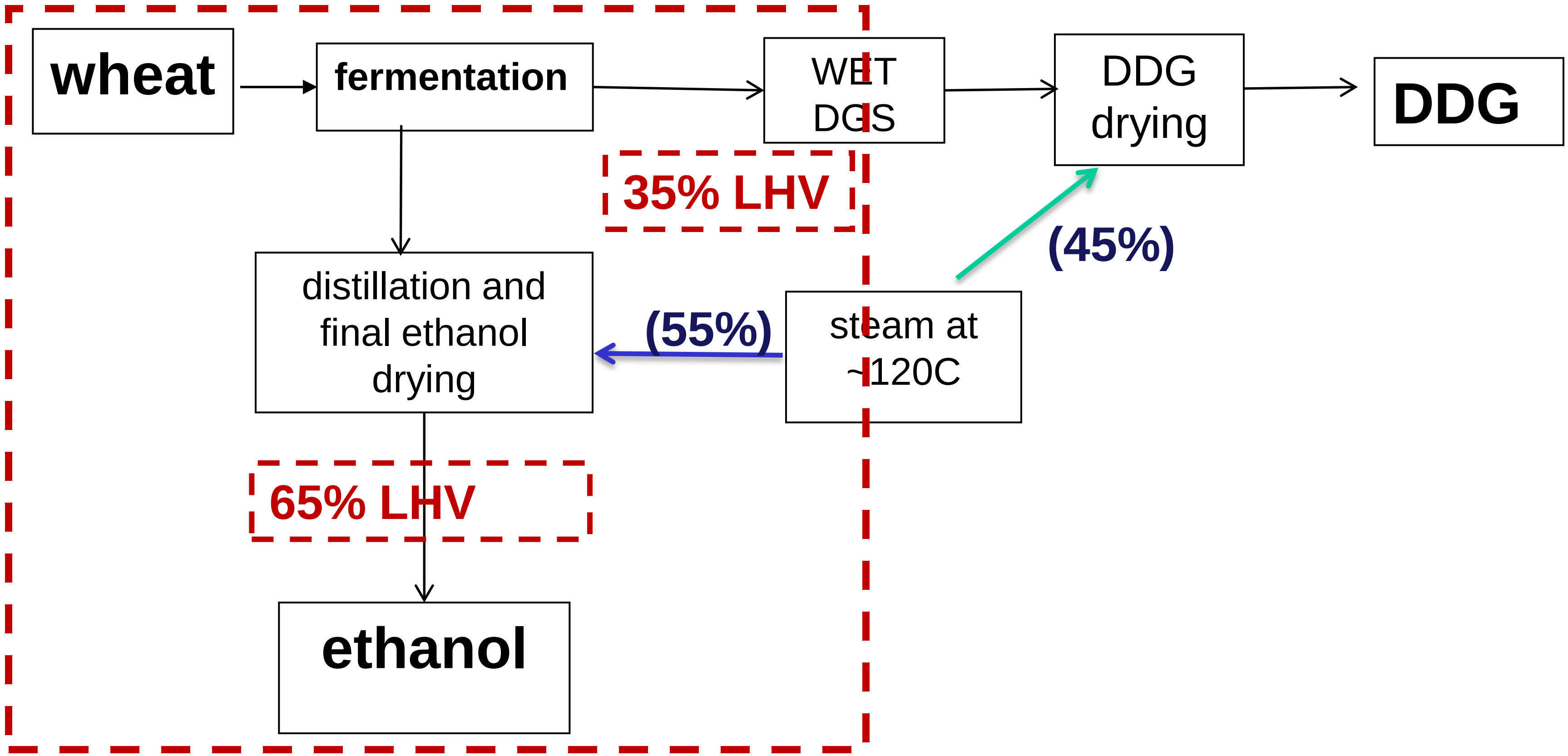
2. Definition of point of allocation:

“The allocation applies immediately after a co-product and biofuel/bioliquid/intermediate product are produced at a process step [...]”

- **Cherry-picking (2):** producers can split their process wherever suits them to give lowest apparent GHG emissions to the product

Example: conventional bioethanol plant producing roughly the same amount of ethanol and DDGS

Example: ethanol plant



Splitting here the process :

- Emissions from drying DDG “disappear” from the ethanol process
- Emissions of ethanol distillation+drying partly allocated to wet DDGS

WITHOUTH ANY REAL EMISSION SAVING!

Main uncertainties:

3. Definition of “waste/residues”:

“A processing residue is a substance that is not the end product(s) that a production process directly seeks to produce. It is not a primary aim of the production process and the process has not been deliberately modified to produce it.”

RESIDUE/WASTE

- No allocation
- Counts double

Valuable as biofuel!

BY-PRODUCT

(big) allocation by LHV

Cheap!

Some feedstocks defined as “waste” (e.g. animal fat) are instead used (e.g. in industrial steam boilers to heat the rendering plant).

But if now used for bioenergy (with “zero” emissions) they are often substituted with fuel oil!

Harmonisation

➢ **Need to define and harmonize "standard values", i.e. conversion factors from input data to GHG emissions**

1. **Significant variation possible in actual GHG values (RED 19.1.b) following RED Annex V.C**
   - Using same input values
   - Caused by variation in standard values (or "conversion factors" / "background processes") to convert kg, MJ or m^3 into $CO_{2,eq}$

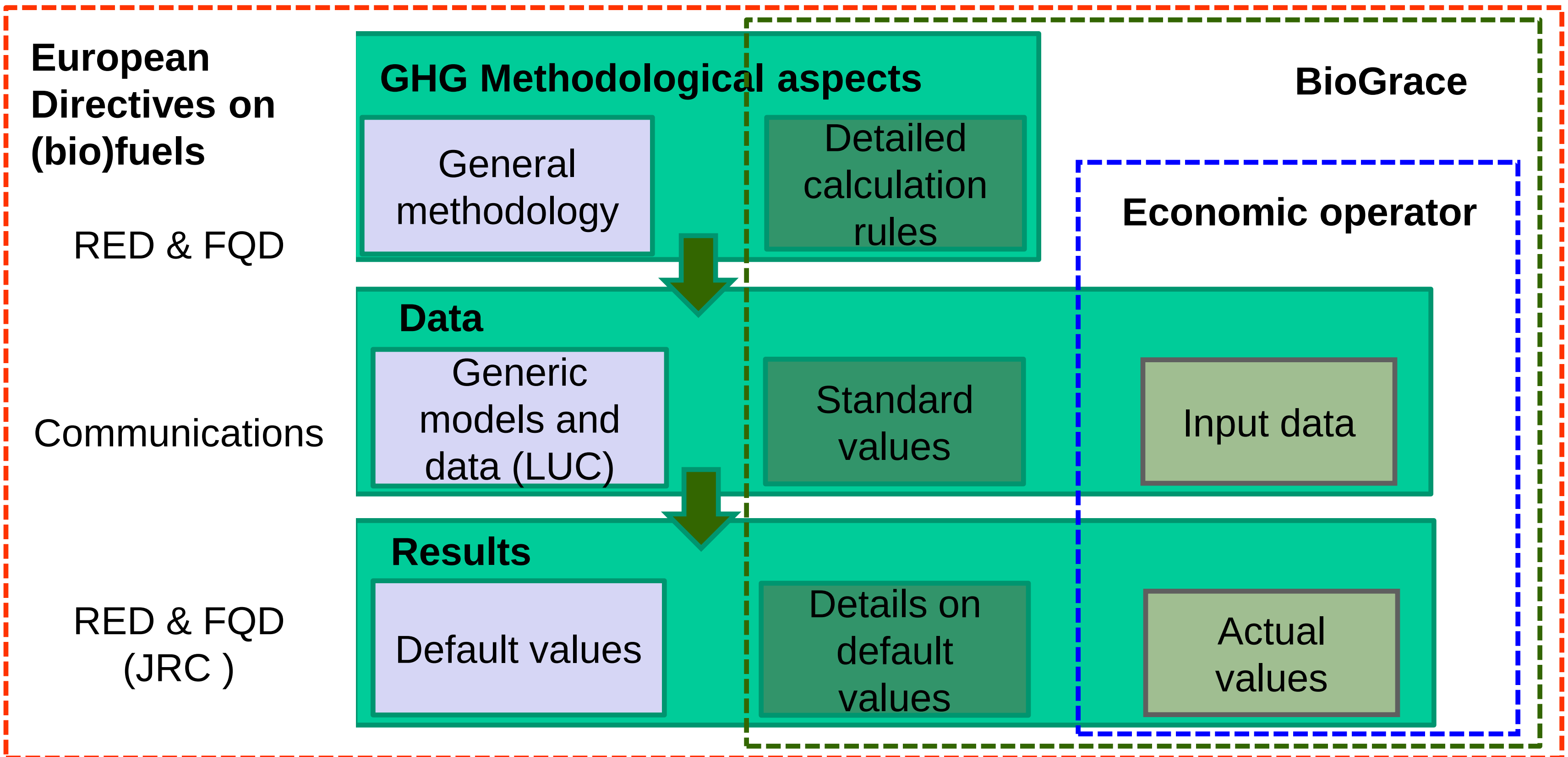
2. **This causes a problem using actual GHG values**
   - Auditors can not check if standard values are correct
   - Economic operators can choose most beneficial values to get better GHG performance of their biofuel without effectively improving the production chain!

BioGrace project

Harmonise calculations of biofuel GHG emission

- List of standard conversion values
- Software to allow stakeholders to perform calculations themselves

http://www.biograce.net/



List of standard values from Biograce

1 GHG emission coefficients

N-fertiliser	5880,6	g $CO_{2,eq}$/kg N
P_2O_5-fertiliser	1010,7	g $CO_{2,eq}$/kg P_2O_5
K_2O-fertiliser	576,1	g $CO_{2,eq}$/kg K_2O
CaO-fertiliser	129,5	g $CO_{2,eq}$/kg CaO
Pesticides	10971,3	g $CO_{2,eq}$/kg
Seeds- rapeseed	729,9	g $CO_{2,eq}$/kg
Seeds- sugarbeet	3540,3	g $CO_{2,eq}$/kg
Seeds- sugarcane	1,6	g $CO_{2,eq}$/kg
Seeds- sunflower	729,9	g $CO_{2,eq}$/kg
Seeds- wheat	275,9	g $CO_{2,eq}$/kg
Natural gas (4000 km, Russian NG quality)	66,20	g $CO_{2,eq}$/MJ
Natural gas (4000 km, EU Mix quality)	67,59	g $CO_{2,eq}$/MJ
Diesel	87,64	g $CO_{2,eq}$/MJ
HFO for marine transport	87,20	g $CO_{2,eq}$/MJ
Methanol	99,57	g $CO_{2,eq}$/MJ
Hard coal	111,28	g $CO_{2,eq}$/MJ
Lignite	116,98	g $CO_{2,eq}$/MJ
Electricity EU mix MV	127,65	g $CO_{2,eq}$/MJ
Electricity EU mix LV	129,19	g $CO_{2,eq}$/MJ
Electricity (NG CCGT)	124,42	g $CO_{2,eq}$/MJ
Electricity (Lignite ST)	287,67	g $CO_{2,eq}$/MJ
Electricity (Straw CHP)	5,71	g $CO_{2,eq}$/MJ
CH_4 and N_2O emissions, steam from NG boiler	0,39	g $CO_{2,eq}$/MJ
CH_4 and N_2O emissions, steam from Lignite CHP	3,79	g $CO_{2,eq}$/MJ
n-Hexane	80,50	g $CO_{2,eq}$/**MJ**
Phosphoric acid (H_3PO_4)	3011,7	g $CO_{2,eq}$/kg
Fuller's earth	199,7	g $CO_{2,eq}$/kg
Hydrochloric acid (HCl)	750,9	g $CO_{2,eq}$/kg
Sodium carbonate (Na_2CO_3)	1190,2	g $CO_{2,eq}$/kg
Sodium hydroxide (NaOH)	469,3	g $CO_{2,eq}$/kg
Hydrogen (for HVO)	87,32	g $CO_{2,eq}$/**MJ**
Pure CaO for processes	1030,2	g $CO_{2,eq}$/kg
Sulphuric acid (H_2SO_4)	207,7	g $CO_{2,eq}$/kg
Ammonia	2660,8	g $CO_{2,eq}$/kg
Cycle-hexane	723,0	g $CO_{2,eq}$/kg
Lubricants	947,0	g $CO_{2,eq}$/kg

1 Lower heating values (LHV's)

Diesel	43,1	MJ/kg (0% water)
Gasoline	43,2	MJ/kg (0% water)
HFO for marine transport	40,5	MJ/kg (0% water)
Ethanol	26,81	MJ/kg (0% water)
Methanol	19,9	MJ/kg (0% water)
FAME	37,2	MJ/kg (0% water)
Syn diesel (BtL)	44,0	MJ/kg (0% water)
HVO	44,0	MJ/kg (0% water)
PVO	36,0	MJ/kg (0% water)
n-Hexane	45,1	MJ/kg (0% water)
Hard coal	26,5	MJ/kg (0% water)
Lignite	9,2	MJ/kg (0% water)
Corn	18,5	MJ/kg (0% water)
FFB	24,0	MJ/kg (0% water)
Rapeseed	26,4	MJ/kg (0% water)
Soybeans	23,5	MJ/kg (0% water)
Sugar beet	16,3	MJ/kg (0% water)
Sugar cane	19,6	MJ/kg (0% water)
Sunflowerseed	26,4	MJ/kg (0% water)
Wheat	17,0	MJ/kg (0% water)
Animal fat	37,1	MJ/kg (0% water)
BioOil (byproduct FAME from waste oil)	21,8	MJ/kg (0% water)
Crude vegetable oil	36,0	MJ/kg (0% water)
DDGS (10 wt% moisture)	16,0	MJ/kg (10% water)
Glycerol	16,0	MJ/kg (0% water)
Palm kernel meal	17,0	MJ/kg (0% water)
Palm oil	37,0	MJ/kg (0% water)
Rapeseed meal	18,7	MJ/kg (0% water)
Soybean oil	36,6	MJ/kg (0% water)
Sugar beet pulp	15,6	MJ/kg (0% water)
Sugar beet slops	15,6	MJ/kg (0% water)

2 Transport efficiencies

Truck for dry product (Diesel)	0,94	MJ/ton,km
Truck for liquids (Diesel)	1,01	MJ/ton,km
Truck for FFB transport (Diesel)	2,01	MJ/ton,km
Tanker truck MB2218 for vinasse (Diesel)	2,16	MJ/ton,km
Tanker truck with water cannons for vinasse (Diesel)	0,94	MJ/ton,km
Dumpster truck MB2213 for filter mud (Diesel)	3,60	MJ/ton,km
Ocean bulk carrier (Fuel oil)	0,20	MJ/ton,km
Ship /product tanker 50kt (Fuel oil)	0,12	MJ/ton,km
Rail (Electric, MV)	0,21	MJ/ton,km

Indirect land use change effects are not included

But the RED and FQD include obligation to review the impact of ILUC to GHG emissions, and if needed to accompaign with a policy proposal by 2010

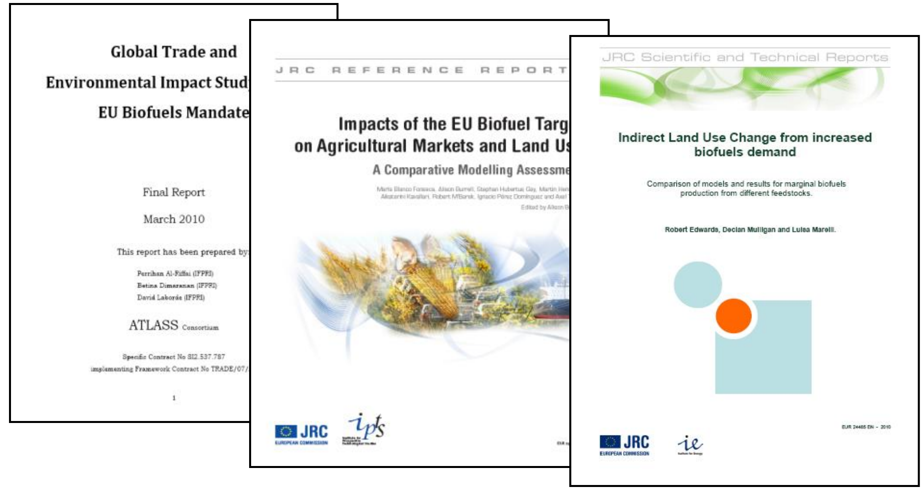
Commission's report (Dec.2010) concluded that:

Although with uncertainties,

- ILUC can reduce GHG savings
- it should be addressed with precautionary approach
- **Impact Assessment to be prepared by July 2011** !

Modelling work:

- IFPRI (MIRAGE-BioF) - 2010
- JRC (AGLINK-COSIMO) - 2010
- JRC (modelling comparison) - 2010
- **New IFPRI report in publication**



GHG Emissions:

- JRC “Spatial Allocation Methodology” - 2010

  + new report in publication

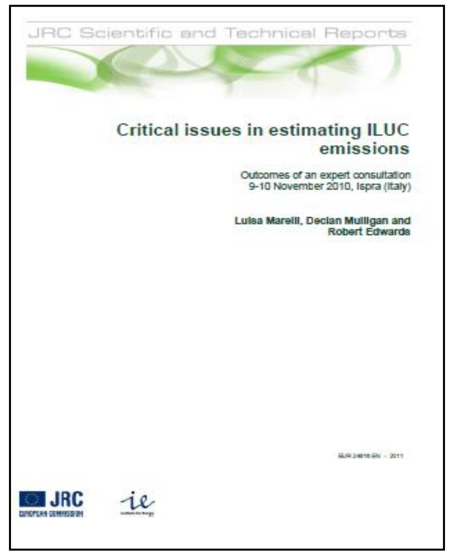
Other studies:

- DG ENER – Literature survey - 2010

CONSULTATIONS:

- **Public consultations on ILUC (2009 and 2010) followed by stakeholders meeting**

- **JRC experts consultations (February and November 2010)**



In publication

MORE ON JRC+IFPRI ILUC RESULTS S IN R. EDWARDS' PRESENTATION THIS AFTERNOON

Identified policy options:

A) Taking no action while continuing monitoring		Preferred by stakeholders as industries, farmers' associations and 3° countries BF producers
B) Increase ther minimum GHG threshold		Not preferred by any specific stakeholder group
C) Introduce additional sustainability requirements	C1) Introducing requirements to reduce deforestation	Assessed also in combintation with B) and C2) Supported by most stakeholders
	C2) measures to improve farming practices that reduce ILUC risks	Assessed in combination with D) Supported by NGOs as potential exemption of option D)
D) "ILUC factors"		Preferred by most NGOs, a few stakeholders from non-biofuels sector and **JRC experts consultation**

CONCLUSIONS

- Sustainability *sine qua non* condition for biofuels promotion in the EU
    - No negative environmental and social impacts
    - No negative impacts on food availability

- Life Cycle Analysis methodology is defined, but economic operators need additional tools (e.g. N_2O emissions methodology) to calculate GHG emission savings

- Harmonised standard values and are necessary (and “cherry picking” must be avoided).

- Scientific studies indicated that ILUC affects GHG saving and should be acocunted for in legislation.