TEST OF GERMAN METHODS
GHG Methodologies Taskforce: LCA Framework for Bioenergy

There is a large variety of GHG methods on the German scientific scene. Those cannot be covered here sufficiently.

Testing has been performed on:

1. The German Sustainability Regulation (draft is available on http://www.erneuerbare-energien.de/inhalt/3860/
   this approach refers widely to the Renewable Energy Sources Directive
2. the methodology approach, that what recommended by IFEU to be included within the German Sustainability Regulation

Step 1: GHGs Covered

	German Sustainability Regulation (adopted from EU RED)	IFEU methodology proposed for Regulation
CO_2	Yes (1)	Yes (1)
CH_4	Yes (23)	Yes differentiation made betw. fossil: (21) and non-fossil CH_4 (18.25) (values acc. to Kyoto-Prot.)
N_2O	Yes (296)	Yes (310) (value acc. to Kyoto-Prot.)
HFCs	Considered to be negligible	Considered to be negligible
PFCs	Considered to be negligible	Considered to be negligible
SF_6	Considered to be negligible	Considered to be negligible
Other	Considered to be negligible	Considered to be negligible

Please report global warming potential used for each GHG covered.

Step 2: Source of biomass

WASTE	German Sustainability Regulation	IFEU methodology proposed for Regulation
Please explain definition of waste:	No explanation, but waste is understood to include any feedstock of less (or equal) "value" like agricultural crop residues (straw, husks, nut shells and even bagasse and non refined glycerine)	In principle considering: Substance that the holder intended to discard, which cannot be marketed by a positive econ. value and not recovered for internal use. e.g.: Bagasse energetically used with surplus is considered to be co-product, not a waste.
Substance that the holder intended to discard	Not regarded	Taken into account (basic but a mandatory criterion)
Substance that had zero or negative economic value	Not regarded	Taken into account (not a basic criterion)
Substance for which the use was uncertain	Not regarded	Taken into account (if really uncertain, in doubt a waste)
Substance that was not deliberately produced and not ready for use without further processing	Not regarded	Taken into account (basic but a mandatory criterion)
Substance that could have adversely affected the environment	Not regarded	Taken into account (only if utilization is uncertain to avoid any harm)

Step 3: Land use change

	German Sustainability Regulation	IFEU methodology proposed for Regulation
Direct land use changes are taken into account	Yes	Yes
Indirect land use changes are taken into account	(in line with a European amendment the German regulation will adopt this)	Yes (to a limited extent; need for improvement; refers to preliminary proposal of a "adder" (U. Fritsche, Öko-Institut)
A combination of both is included	Yes (bonus for production on previously degraded land will subtracted from dLUC value	No

3a: Direct Land use Change

	German Sustainability Regulation	IFEU methodology proposed for Regulation
Direct land use changes are accounted for	Yes	Yes
1. Identify the reference period or scenario		
- Historic (identify year or period)	Yes (after 1.1.2008)	Yes (after 1.1.2005) choice of year is a pragmatic compromise, mere scientific recommendation: earlier reference date
- Business-as-Usual (BAU) scenario (identify time frame:	BAU, no trends considered	BAU, no trends considered (reason, direct LUC happens in "real-time" on defined locations; any trend analysis will be based on a large

		number of assumptions)
2. Describe how the methodology attributes this type of land use change to biofuels	By tracing back the biofuel to the biomass production site (by traversing the geographical coordinates by an accuracy of 20 m)	By tracing back the biofuel to the biomass production site
3. Explain key reference assumptions and characteristics relevant to estimating GHG emissions from direct land use change. Examples include (but are not limited to) identifying or describing:	Identical with EU RES-Directive: Annualised emissions from carbon stock changes caused by land use change, e_l, shall be calculated by dividing total emissions equally over 20 years. For the calculation of these emissions the following rule shall be applied: $e_l = (CS_R - CS_A) \times 3.664 \times 1/20 \times 1/P - e_B$, where e_l = annualised greenhouse gas emissions from carbon stock change due to land use change (measured as mass of CO_2-equivalent per unit biofuel energy); CS_R = *the* carbon stock per unit area associated with the reference land use (measured as mass of carbon per unit area, including both soil and vegetation). The reference land use shall be the land use in January 2008 or 20 years before the raw material was obtained, whichever was the later; CS_A = *the* carbon stock per unit area associated with the actual land use (measured as mass of	Generally identical with left column: A selection of default values has been created by taking data from IPCC guidelines for carbon stock of natural land cover (probable to be replaced by biomass production) and of relevant agricultural/forestal biomass production systems

	carbon per unit area, including both soil and vegetation). In cases where the carbon stock accumulates over more than one year, the value attributed to CS_A shall be the estimated stock per unit area after twenty years or when the crop reaches maturity, whichever is the earlier; * *P* = the productivity of the crop (measured as biofuel or other bioliquid energy per unit area per year); and	
System boundaries:	Sector, activity: → each batch of biofuel Geogr. coverage: → global scope, no limits Time period: → 20 years	Sector, activity → each batch of biofuel Geogr. coverage: → global scope, no limits Time period: → 20 years
4. Briefly describe the type of direct land-use changes accounted for identifying or describing:	Biomass is produced on land that has not been cropland before 1.1.2008.	Biomass is produced on land that has not been cropland before 1.1.2008.
• Areas of land that change land use by type (such as forest, grassland, peat lands, pasture, to feedstock production	Yes, exactly that	Yes, exactly that
• Carbon stocks, before shift to feedstock production, on lands that change land use by type	Yes, exactly that	Yes, exactly that
5. The following impacts of DLUC are accounted for:		
• Accounted for net changes of carbon stocks in:	Yes	Yes
• ___ living biomass, ___ dead organic matter, ___ soils	Yes	Yes
• ___ Changes in carbon sequestration in	Yes	Yes

products (such as harvested wood products)		
6. The methodology and data used are publicly available:		
• Methodology	Yes	Yes
• Data	Not yet	Yes, Largely by addressing an exemplary number of defaults

Step 3b: Indirect Land use Change

	German Sustainability Regulation	**IFEU methodology proposed for Regulation**
GENERALLY	Will be included in line with the ongoing development at EU level → answers below are preliminary and notional	Still under development (cooperation with Öko-Institut, U. Fritsche) → answers below are preliminary
___ Domestic indirect land use change is taken into account **OR**	YES	YES
___ International indirect land use change is taken into account **OR**	YES	YES
___ Both are taken into account separately **OR**	No	No
___ Both are taken into account without making the distinction	YES	YES
Explain the choice.	ILUC is a global transboundary phenomena, so the effect are assessed internationally	ILUC is a global transboundary phenomena, so the effect are assessed internationally
Domestic and international indirect land use changes are accounted for (Y or N).		

If yes:		
1. Identify the reference period or scenario		
___ Historic (identify year or period)	after 1.1.2008	after 1.1.2005 choice of year is a pragmatic compromise, mere scientific recommendation: earlier reference date
___ Business-as-Usual scenario (identify time frame: _____)	open	Historic analysis for interrelations between biomass markets and other agricultural commodities for determining ILUC factors LUC GHG emissions don not considered trends (analogously to DLUC)
___ Other (explain)		
2. Describe how the methodology attributes this type of land use change to biofuels	Upcoming method Open Existing status method: granting a bonus of 29 g CO_2/MJ biofuel if the biomass is produced on degraded land	Open
3. Explain key reference assumptions and characteristics relevant to estimating GHG emissions from domestic indirect land use change. Examples include (but are not limited to) identifying or describing:		
• System boundaries	global	
• For BAU scenarios, assumed trend in key variables and land uses	Yes (ILUC factor concept allocates 25% of maximum BAU scenario estimation to biofuel taking increasing yield and other trends into account)	

• Rules or methods used to assign indirect land use changes to biofuels (Such as, whether emissions allocated to products using a marginal, average, or other approach)	"25% rule" (see above) as a best estimate (will be substantiated and updated by empirical data)	
• Time period over which land use change emissions are allocated	20 years	
4. Briefly describe the type of indirect land-use changes accounted for (2 – 3 paragraphs). Examples include (but are not limited to) identifying or describing:	All types of areas are included concerning the previous land-use type (forestland, grassland, peatland, cropland) and the type of cropland that is created by the land-use change. Carbon stock values are assigned to all these types of land-use by using default values (for the time being referring to IPCC);	
• Areas of land that change land use by type (such as forest, grassland, peat lands, pasture, to commodity production)	See above	
• Carbon stocks, before shift to feedstock production, on lands that change land use by type	See above	
5. The following impacts of indirect domestic land use change are accounted for:		
Accounted for net changes of carbon stocks in[1]:	YES	

[1] Depending on choice of methodology and temporal system boundary, the net changes in carbon stock in these carbon pools from land use conversion may be positive (increased carbon stock) or negative (decreased carbon stock). In responding to this question, please indicate the reason for including or disregarding changes in any of the carbon pools.

___ living biomass, ___ dead organic matter, ___ soils	YES	
___ Changes in carbon stocks in products (such as harvested wood products)	YES	
6. The methodology and data used are publicly available: Methodology (Y or N), Data (Y or N)	Methodology and data for "bonus-value" is not yet publicly available	

Step 4: Biomass feedstock production

	German Sustainability Regulation	**IFEU methodology proposed for Regulation**
1. Sources of direct GHG emissions and removals are accounted for:		
___ Emissions from operating farm/forestry machinery	YES	YES
___ Emissions from energy used in irrigation	YES	YES
___ Emissions from energy used to prepare feedstocks (drying grains, densification of biomass, etc.)	YES	YES
___ Emissions from energy used in transport of feedstocks	No, this is included in step 5	No, this is included in step 5
___ CO2 emissions from lime/dolomite applications	YES	YES
___ N2O emissions resulting from the application of nitrogen fertilizers:	YES	YES
__direct; __volatilization; __runoff/leaching	YES (according to a model by JRC)	YES (according to IPCC)
___ CH4 emissions from lands (especially wetlands)	YES	YES

___ Net changes in soil organic carbon (due to management practices, not land use conversion (step 3a.5 and 3b.5, for both domestic and international))[2]	YES	YES
___ Other (please specify)	GHG emissions from N, P, K, Ca-fertilizer production	GHG emissions from N, P, K, Ca-fertilizer production
2. For all checked, clarify assumptions and emissions reference values used		
3. The methodology and data used are publicly available: Methodology (Y or N), Data (Y or N)	Partly	YES
Embodied Emissions:		
1. Sources of GHG emissions embodied in inputs accounted for:		
___ Emissions embodied in the manufacture of farm/forestry machinery	NO	NO
___ Emissions embodied in buildings	NO	NO
___ Emissions embodied in the manufacture of fertilizer inputs.	YES	YES
___ Emissions embodied in the manufacture of pesticide inputs	YES	YES
___ Emissions embodied in purchased energy:	YES	YES
___ electricity; ___ transport fuels; ___ other (e.g., fuel for heat)	YES	YES
___ Emissions embodied in the production of seeds	YES	Net yield
___ Other (please specify)		

[2] Depending on choice of methodology and temporal system boundary, the net changes in carbon stock in these carbon pools from land use conversion may be positive (increased carbon stock) or negative (decreased carbon stock). In responding to this question, please indicate the reason for including or disregarding changes in any of the carbon pools.

2. For all checked, clarify assumptions		
3. The methodology and data used are publicly available: Methodology (Y or N), Data (Y or N)	Partly	Yes

Step 5/8: Transport of biomass/biofuel

	German Sustainability Regulation	**IFEU methodology proposed for Regulation**
1. ___ The biomass transported in a different commodity type.	No	No
1a. ___ A description of intermediate processing steps is available.	No	No
1b. ___ Emissions associated with intermediate processing are accounted for (including, e.g., electricity used for processing).	See processing into fuel	See processing into fuel
2. ___ There is a multi-stage transport chain (e.g. truck to ship to truck or train).	Yes	Yes
2a. List all stages in the transport chain.	Depends on pathway, generally included: Truck, sea vessel,	Depends on pathway, generally included: Small truck (tipper), medium truck, large truck, sea vessel, inland XXXX, train
2b. Specify the stages for which emissions are accounted.	All stages	All stages
3. Transport from production site to use/processing plant is dedicated to this purpose (Y or N)	Can be applied according to the case	Can be applied according to the case
If Yes:		

3a. ___ All transport emissions are included	Yes	Yes
4. ___ Return run of transport equipment is accounted for.	Can be applied according to the case	Can be applied according to the case
4a. During the return run, transport equipment is:	Can be applied according to the case	Can be applied according to the case
___ empty ___ otherwise utilized	Can be applied according to the case	Can be applied according to the case
5. For relevant sections, clarify assumptions		

Step 6: Processing into fuel

	German Sustainability Regulation	**IFEU methodology proposed for Regulation**
1. ___ GHG emissions associated with material inputs used in the conversion process (e.g. chemicals, water) are accounted for.	Yes	Yes
2. ___ GHG emissions associated with the energy used in the conversion process are accounted for.	Yes	Yes
2a. Specify the method used to account for grid-related emissions (e.g. average/marginal, national/regional, actual/future): _____	Average, European/ national, actual	Average, national, actual
3. ___ GHG emissions from wastes and leakages (including waste disposal) are accounted for.	Yes	Yes
4. ___ Other GHG emissions from the process are accounted for.	Yes	Yes
4a. List which ones: ___	Direct, if given	Direct, if given
5. ___ GHG emissions associated with the plant construction are accounted for.	No	No

Step 7: By-products and co-products

	German Sustainability Regulation	IFEU methodology proposed for Regulation
By-products or co-products are produced (Y or N)	Yes	Yes
1. ___ By/Co-products from the biomass are accounted for.	Yes	Yes
2. ___ By/Co-products from non-biomass feedstocks are accounted for.	Yes	Yes
3. Explain definition of by/co-products: _____	No specific definition	
4. An allocation method is used (Y or N):	Yes	Yes
___ Allocation by energy content	Yes	Yes
Method to determine energy content: _____	Lower heating value of fresh substances	Lower heating value of fresh substances
5. A substitution method is used (Y or N)	No	No
6. Another method or combination of methods is used (Y or N)	No	No

Step 9: Fuel use

	German Sustainability Regulation	IFEU methodology proposed for Regulation
1. Analysis addresses electricity and/or heat	Yes	Yes

(thermal energy)? (Y or N)		
1a. Facility is a CHP plant? (Y or N)	Depends on case	Depends on case
1b. Electric efficiency of the use process _____	No	Yes
1c. Thermal efficiency of the use process _____	No	Yes
1d. Electricity sent to a general grid (Y or N)	Depends on case	Depends on case
1e. In case of CHP, indicate method used to account for electricity and heat (i.e., allocation, substitution, etc.), as in LCA Step 7.	No analysis at level of useful energy but fuel	HP-Allocation by efficiency method (referring to CHP directive)
2. Specific emissions are addressed by the usage (Y or N)	No	Methane when biogas is used
2a. Identify conversion/combustion technology	Depends on case	Depends on case
3. The technique specifically causes significant non-CO2 emissions of:		
___ N2O (e.g. CFB-type boilers)	Depends on case	Depends on case
___ CH4, (e.g. low level technique or small-scale)	Depends on case	Depends on case
___ Other	None	None
3a. Describe evidence to exclude the occurrence of such specific GHG emissions.		
4. Biomass is tainted with fossil material (e.g. in case of waste sources) (Y or N)	Depends on case	Depends on case
4a. If yes, provide analysis on degree of fossil content, if available	Depends on case	Depends on case
5. The analysis addresses a technology upgrade (e.g. pile burning to modern energy technology)	Depends on case	Depends on case
5a. If yes, provide emissions data on the	Depends on case	Depends on case

replaced way of biomass burning, if available.		
6. For relevant sections, clarify assumptions		
For transport fuels:		
1. Miles (km) per energy unit are addressed (Y or N)	No	No
1a. Miles (km) per energy unit: ____	No (can be an option)	No
1b. Describe how energy efficiency is factored into fuel use analysis.		
2. Tailpipe gas is addressed (Y or N). If yes, describe methodology:	No	No
e.g.: CO2 emissions associated with combustion source and feedstock sink are netted out; CH4 and N2O emissions from combustion are included.	Yes; no	Yes; no

Step 10: Comparison with replaced fuel

	German Sustainability Order	**IFEU methodology proposed for Regulation**
1. Identify Methodology for LCA of replaced fuel(s) / energy production system(s).	Generic Default value	Generic Default value
2. This methodology is publicly available (Y or N)	No, taken from EU directive	No (due to strong reference to regulation)
• If yes, provide references		
3. Gases covered:		
CO2 ___	Yes	Yes
CH4 ___	Yes	Yes
N2O ___	Yes	Yes

HFCs ___	No	No
PFCs ___	No	No
SF6 ___	No	No
Other _____	No	No
Please report global warming potential used for each GHG covered.	See step 1	See step 1
4. An LCA is performed on the replaced fuel(s) / energy production system(s). (Y or N)	Yes	Yes
4a. Please list any sources of inconsistency between LCA of biofuel and LCA of replaced fuels/systems.		
4b. Describe the system boundaries.	Roughly known: extraction, transportation, refining, distribution	Roughly known: extraction, transportation, refining, distribution
5. Specify which sources of emissions embodied in infrastructure are accounted for and clarify assumptions.	None	None
I. Biofuel is used to replace transport fossil fuel (for stationary use, skip to section II)		
6. Relevant characteristics of crude:		
6a. Type of crude:		
___ Conventional crude		
___ Canadian oil sands		
___ Canadian/Venezuelan heavy oil		
___ Other		
___ Not specified	Yes	Yes
7. Emissions prior to extraction/production are accounted for (Y or N)	No (but unclear)	No (but unclear)
8. Emissions from extraction/production are accounted for (Y or N)	Yes	Yes
8a. Direct and embodied emissions in extraction/production accounted for:		
___ Fuel combustion from drilling	Yes (but unclear)	Yes (but unclear)

___ Fugitive methane emissions from equipment	Yes (but unclear)	Yes (but unclear)
___ Fuel combustion from turbines and compressors	Yes (but unclear)	Yes (but unclear)
___ Transportation emissions from helicopters and supply vessels	Yes (but unclear)	Yes (but unclear)
___ Use of electricity (e.g., gasoil or fuel oil generators)	Yes (but unclear)	Yes (but unclear)
___ Use of chemical inputs	Yes (but unclear)	Yes (but unclear)
___ Other		
8b. Natural gas emissions accounted for:	Yes (but unclear)	Yes (but unclear)
___ Emissions from flaring natural gas	Yes (but unclear)	Yes (but unclear)
___ Emissions from combustion equipment (specify gases included)	Yes (but unclear)	Yes (but unclear)
___ Emissions from reinjection of natural gas	unclear	unclear
___ Emissions from direct use of natural gas	Yes (but unclear)	Yes (but unclear)
___ Emissions from other processing of natural gas	Yes (but unclear)	Yes (but unclear)
___ Emissions from gas processing point to remove liquids	Yes (but unclear)	Yes (but unclear)
___ Emissions from extracted liquids	Yes (but unclear)	Yes (but unclear)
___ Emissions from electricity production	Yes (but unclear)	Yes (but unclear)
8c. Describe method for allocating emissions between crude oil and natural gas production	unclear	unclear
8d. Emissions for other extraction/production by/co-products are accounted for (Y or N)	unclear	unclear
• If yes, describe methodologies for calculating emissions and for allocating emissions between crude and by/co-products.		
9. Crude is transported to the refinery (Y or N)	Yes	Yes
9a. Specify transport distance and mode(s) of transport (pipeline, tanker, etc.).	Combination of all (but unclear)	Combination of all (but unclear)

9b. For internationally transported crude, specify whether domestic, international, or total transport emissions are accounted for.	unclear	unclear
• Describe use of country-specific parameters in calculating transport emissions.		
9c. Fugitive emissions during transport are accounted for (Y or N)	unclear	Unclear
9d. Return journeys of transport fleet are accounted for (Y or N)	unclear	Unclear
9e. The production/transport system involves liquified natural gas (Y or N)	No (but unclear)	No (but unclear)
9f. Emissions from the regasification plant are accounted for (Y or N)	No (but unclear)	No (but unclear)
10. Refinery emissions are accounted for (Y or N)	Yes	Yes
10a. Describe assumptions on refinery characteristics (e.g., existing, typical, local average)	unclear	unclear
10b. Describe method for calculating direct refinery emissions	unclear	unclear
10c. Emissions embodied in chemicals (catalysts, solvents, etc.) are accounted for (Y or N)	No (but unclear)	No (but unclear)
• If yes, describe method.		
10d. Fugitive emissions accounted for (Y or N)	Yes (but unclear)	Yes (but unclear)
• If yes, describe method.		
10e. Emissions for hydrogen production are accounted for (Y or N)	Yes (but unclear)	Yes (but unclear)
• If yes, specify the production process.		
10f. Emissions for purchased and generated electricity are accounted for (Y or N)	Yes (but unclear)	Yes (but unclear)
• If yes, specify electricity mix of the purchased electricity		
10g. Emissions from wastes and leakages are accounted for (Y or N)	Yes (but unclear)	Yes (but unclear)

• If yes, describe method		
10h. Emissions for refinery by-products and co-products are accounted for (Y or N)	Yes (but unclear)	Yes (but unclear)
• If yes, describe methodologies for calculating emissions and for allocating emissions between fuel and by/co-products.		
11. Fuel is transported or distributed prior to use (Y or N)	Yes (but unclear)	Yes (but unclear)
12. Fuel use emissions are accounted for (Y or N)	Yes (but unclear)	Yes (but unclear)
(please consider consistency with Step 9)		
If no:		
12a: Please explain how equivalency with the biofuel system is defined (e.g. lower heating value)	LHV	LHV
If yes:		
12b: Please explain how equivalency with the biofuel system is defined.	equal energy value of fuels	equal energy value of fuels
Do you refer to energy content of the fuel ___	Yes	Yes
Do you refer to Miles (km) per energy unit ___	No	No
12c: Describe how energy efficiency is factored into fuel use analysis.	Netted out	Netted out
12d: Tailpipe gas is addressed (Y or N). If yes, describe methodology.	Yes, Fossil C to CO_2	Yes, Fossil C to CO_2
II. Stationary use of biofuel for electricity/heat		
7. Describe technologies, methodologies and data for calculating the extraction/production/transport of replaced energy source, using Transport Fuel questions 6-11, above, as guidance where appropriate.		

8. Fuel use emissions are accounted (Y/N)	Yes	Yes
(please consider consistency with Step 9)		
If no:		
8a: Please explain how equivalency with the biofuel system is defined (e.g. lower heating value of utilized fuel)	Due to adoption of EU RES directive: equivalency of energy content (LHV) of applied/replaced fuel	Useful energy taking actual efficiency of biofuel system and default average efficiency of replaced electricity and/or heat production into account
8b: What type of fossil fuel is assumed to be replaced by the biofuel system?	European average mix of fossil fuels applied for electricity production/ heat production	European average mix of fossil fuels applied for electricity production/ heat production
Explain the assumption.	Broad baseline	Broad baseline
If yes:		
8c: Please explain how equivalency with the biofuel system is defined.		
Do you refer to energy content of the fuel (Y/N)	Yes	No
Do you refer to useful energy taking end use efficiency into account (Y/N)	No	Yes
If yes:		
8d: Which method is used to define the production of replaced electricity/heat?		
___ national average mix		
___ marginal production		
___ other _____		European Mix
please explain your choice and assumptions.		Broad baseline
8e: Report energy efficiency for electricity generation, and/or heat generation and describe how it is used in emissions analysis.		Default efficiency for power only/heat only generation, in case of CHP of biofuel system, combine HP by the

		efficiency method referred to the EU CHP directive
8f: Describe methodology for calculating evaporative emissions.		
8g: Describe conversion/combustion technologies and method for calculating associated emissions, including trace gases.		
9. Please identify any elements of the fossil fuel LCA not included in the above questions and describe methodology used to calculate emissions.		