



Implementing the GBEP indicators in Germany

Desk top study results

**AG 2 - Raising awareness and sharing of data
and experiences from the implementation of
the GBEP indicators**

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Susanne Köppen, Horst Fehrenbach, Stefanie Markwardt, Anna Hennecke (IFEU)
Ulrike Eppler, Uwe R. Fritsche (IINAS)

Approach

Step 1: Desk top study

- Data research in the national context addressing responsible authorities & agencies
 - What data is available and who can provide it?
 - What are corresponding laws and regulations?
 - Is there governmental control, monitoring, reporting, feedback to legislation and national sustainable development?

Step 2: Expert consultation

- Several meetings with selected experts who are responsible for national data collection / reporting
 - discuss single indicators

Approach

Step 3: Workshop phase

- 2 Workshops on environmental and socio-economic indicators
 - participants from policymaking, industry, experts, stakeholders
 - query the indicators, possibly to develop proposals how to sharpen them, improve practicality, raising acceptance + awareness

Which indicators are relevant for Germany (domestic perspective)

Pre-selection of indicators relevant for Germany

Environmental pillar	Social pillar	Economic pillar
1. Life-cycle GHG emissions	9. Allocation and tenure of land for new bioenergy production	17. Productivity
2. Soil quality	10. Price and supply of a national food basket	18. Net energy balance
3. Harvest levels of wood resources	11. Change in income	19. Gross value added
4. Emissions of non-GHG air pollutants, including air toxics	12. Jobs in the bioenergy sector	20. Change in consumption of fossil fuels and traditional use of biomass
5. Water use and efficiency	13. Change in unpaid time spent by women and children collecting biomass	21. Training and re-qualification of the workforce
6. Water quality	14. Bioenergy used to expand access to modern energy services	22. Energy diversity
7. Biological diversity in the landscape	15. Change in mortality and burden of disease attributable to indoor smoke	23. Infrastructure and logistics for distribution of bioenergy
8. Land use and land-use change related to bioenergy feedstock production	16. Incidence of occupational injury, illness and fatalities	24. Capacity and flexibility of use of bioenergy

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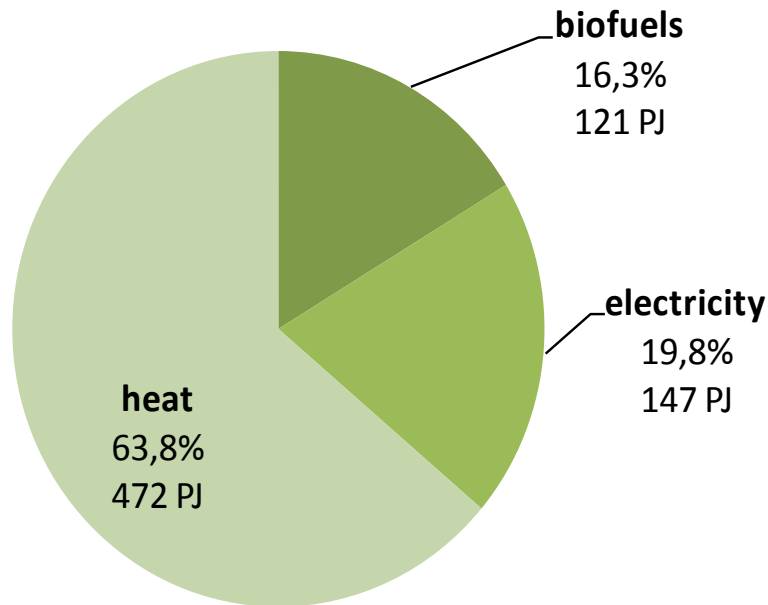
Indicators of identified minor relevance in DE

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General sector information about bioenergy in Germany

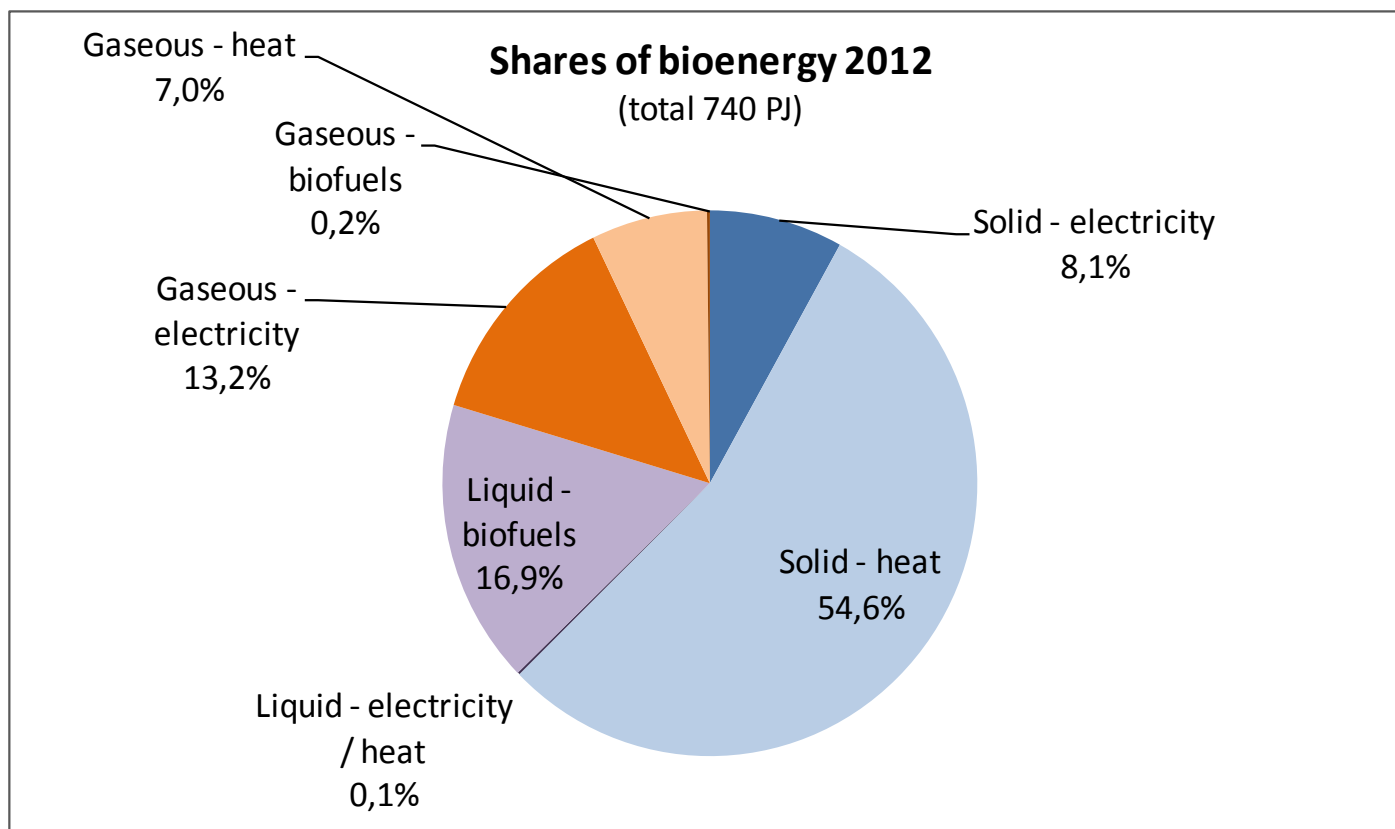
Bioenergy production in Germany

Shares of bioenergy 2012
(total 740 PJ)

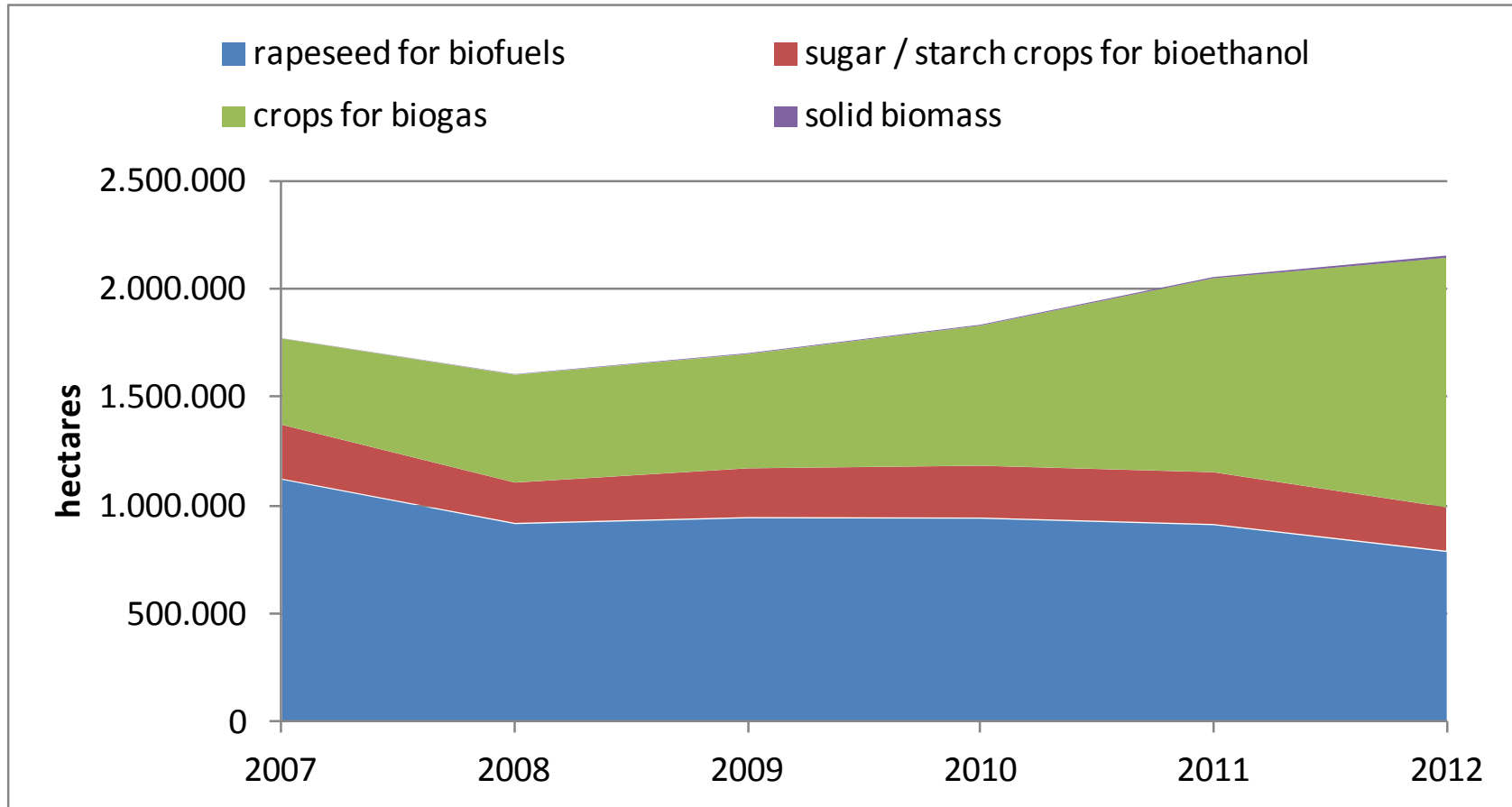


- 12.6 % of final energy provided by renewable energies,
- 66 % of r.e. produced from biomass

Bioenergy production in Germany

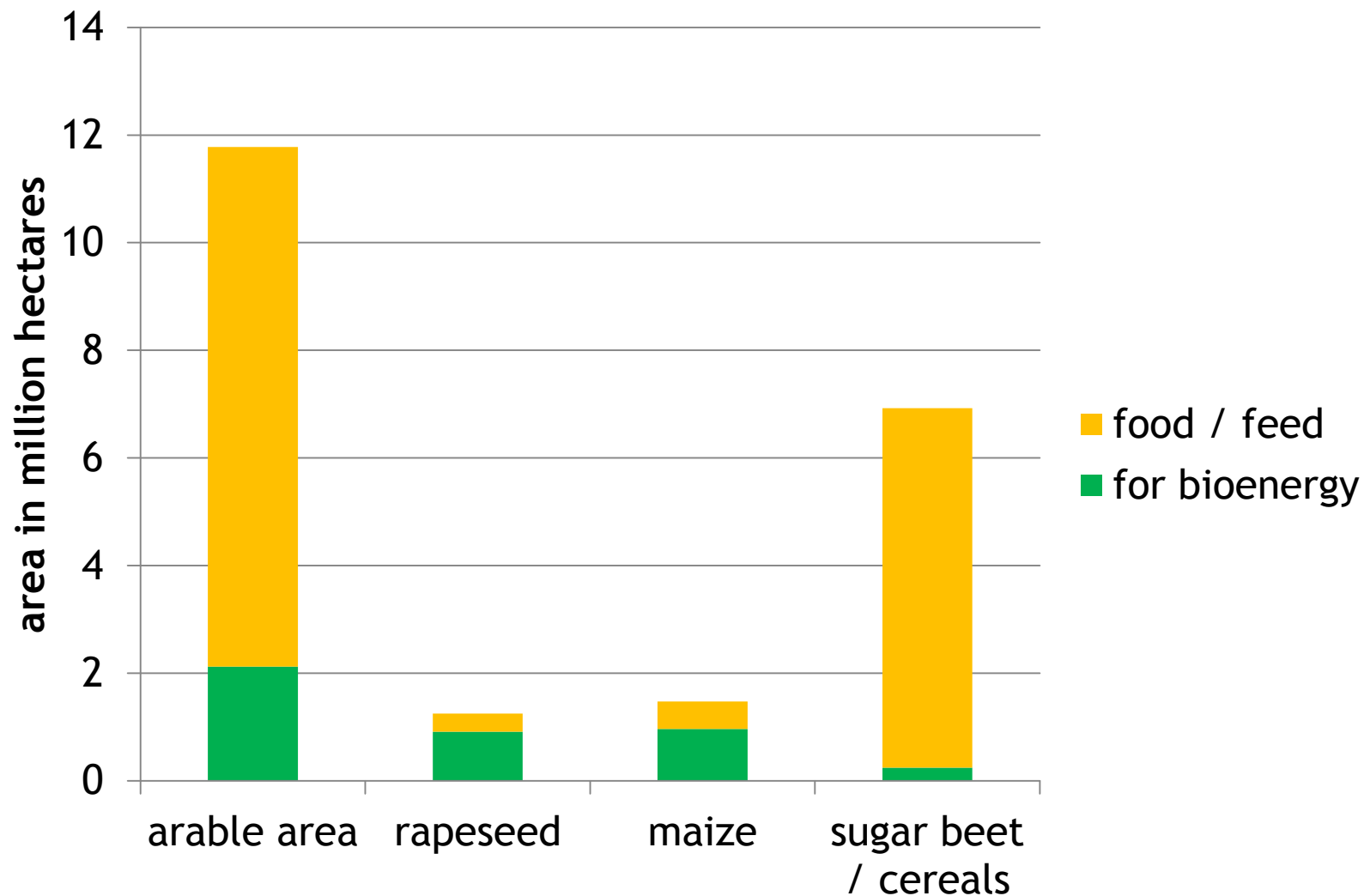


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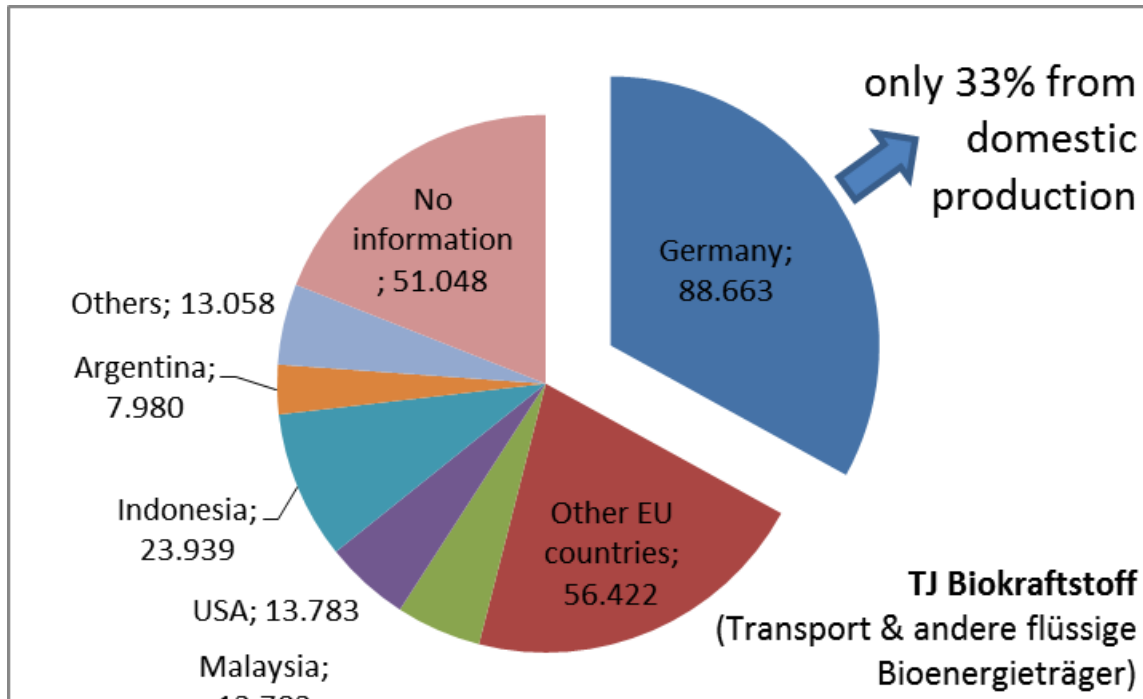


➔ Amount of agricultural land used for bioenergy feedstock production steadily increased over the past years

Agricultural land in Germany



Origin of biomass for biofuels in German market



- > 50 % of biofuels based on imported biomass

- still high uncertainty in data

→ Relevant for evaluating German bioenergy policy by GBEP indicators

The indicators - selected results

Indicator 1: Life-Cycle Greenhouse Gas Emissions

Lifecycle greenhouse gas emissions from bioenergy production and use, as per the methodology chosen nationally or at community level, and reported using the GBEP Common Methodological Framework for GHG Lifecycle Analysis of Bioenergy 'Version One'.

Unit: g CO_{2eq}/MJ

Indicator 1: GHG emissions

Legal regulations and reporting commitments

- Germany has to fulfil GHG reduction goals defined in the Kyoto Protocol / ist implementation in Europe
- Requires yearly reporting commitments to EU on GHG emissions and shares of renewable energies
- Reporting commitments under Renewable Energy Directive (2009/28/EC)
 - Share of biofuels / liquid bioenergy
- Federal Environment Agency (UBA) responsible for reporting; Working Group on Renewable Energy Statistics (AGEE-Stat) responsible for data collection on renewable energy

Indicator 1: GHG emissions

Methodological approach

- Calculation of emissions / savings follows principles of life cycle analysis (LCA)

$$\underbrace{\text{Bioenergy [GWh/year]} * SF * EF_{\text{fossil}}}_{\text{Emissions avoided}} - \underbrace{\text{Bioenergy [GWh/year]} * EF_{\text{biogenic}}}_{\text{Emissions caused}}$$

- Takes into account whole life cycle including all direct and indirect emissions
- Takes into account direct land use change for all energy types covered by RED (liquid bioenergy)

Indicator 1: GHG emissions

Methodological approach

- Calculation of substitution factors
 - **Electricity:** modelling of electricity market with and without renewable energies; calculation of fossil energy replaced (lignite, hard coal, natural gas)
 - Heat: specific substitution factors for each pathway (great diversity) based on various sources
 - Transport: 1 MJ biofuel replaces 1 MJ fossil fuel;
co-product allocation based on LHV



Indicator 1: GHG emissions

Result

- The GHG emissions and emission savings for 2012 are as follows

- 20 553 t CO_{2eq} emissions from bioenergy production
- 86 226 t CO_{2eq} emission savings

= **65 732 t CO_{2eq} total emission savings**

Indicator 1: GHG emissions

Result

		Amount of bioenergy [GWh]	Emissions from bioenergy use [Mt CO ₂ equ]	Avoided emissions [Mt CO ₂ equ]	Balance / GHG emission savings [Mt CO ₂ equ]
Solid	Electricity	11,600	294	9,494	9,200
	Heat	102,700	2,890	32,549	29,659
Liquid	Electricity	400	127	325	199
	Heat	800	48	240	192
	Transport	34,924	5,153	10,536	5,383
Gaseous	Electricity	31,550	10,555	25,924	15,369
	Heat	23,100	1,459	7,070	5,670
	Transport	350	29	88	59
TOTAL		205,424	20,553	86,226	65,732

Indicator 1: GHG emissions

Data basis

- Use of different data sources
 - Amount of bioenergy: statistical offices, the Federal Network Agency, associations, research projects and the German Federal Agency for Agriculture and Food (BLE)
 - Emission factors (direct and indirect): data bases (e.g. GEMIS, ecoinvent), research projects
 - Substitution factors: see above
- Continuous improvement of data basis; still major data gaps:
 - Emissions from land use / land use change
 - Amount and size of bioenergy plants, emissions from plants
 - Co-firing, combined heat and power

Indicator 1: GHG emissions

Results and recommendations

- Life cycle emissions include whole life cycle, i.e. also emissions outside Germany (imported biomass)
- For Germany:
 - Further improvement of data base, especially on imported biomass (solid)
- For GBEP
 - Discussion on distinction between domestic and foreign emissions
 - Additionally to bioenergy emissions also emission savings from replacing fossil fuels should be reported

Indicator 6: Water quality

(6.1) Pollutant loadings to waterways and bodies of water attributable to fertiliser and pesticide application for bioenergy feedstock production, and expressed as a percentage of pollutant loadings from total agricultural production in the watershed

(6.2) Pollutant loadings to waterways and bodies of water attributable to bioenergy processing effluents, and expressed as a percentage of pollutant loadings from total agricultural processing effluents in the watershed

Unit: kg/ha/year; %

Indicator 6: Water quality

Legal regulations and reporting commitments

- European Nitrates Directive (91/676/EEC)
 - Shall protect water against pollution by nitrates from agricultural sources
 - Implementation via fertilisation ordinance (Düngeverordnung)
 - Every four years state of surface and groundwater has to be reported
 - Annual measurement / reporting of nitrate concentration in water bodies
- Water Framework Directive (2000/60/EC)
 - EU member states have to achieve good quantitative and qualitative status of all water bodies until 2015
 - Extensive measuring network in Germany
- Waste Water Ordinance
 - Regulates discharge of waste water into water bodies
 - Thresholds for different substances specifically for different industrial sectors

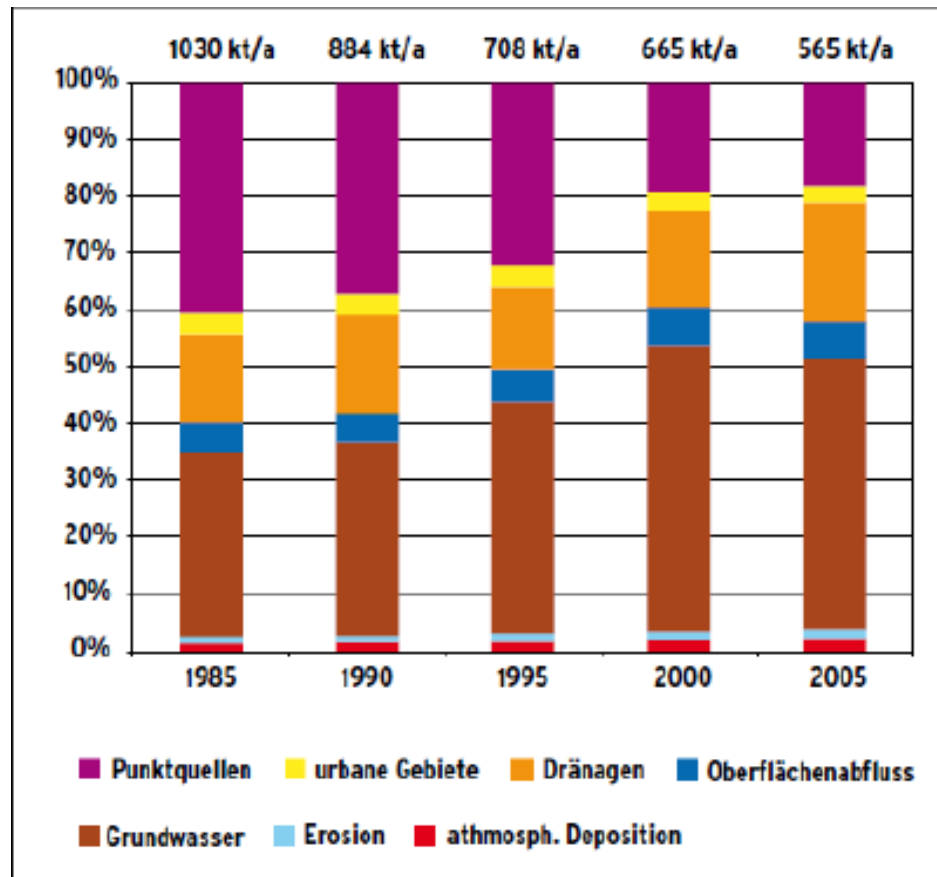
Indicator 6: Water quality

Methodological approach - agriculture

- Relevant: nitrate, phosphorous, pesticides
- Different responsibilities and approaches in data measuring (ground water, surface water, rivers, lakes)
- Measurement of pollutant concentrations
 - For pesticides concentrations for single substances are measured
- Modelling of pollutant inputs only for rivers
 - Based on MONERIS model
 - Allows identifying role of agriculture
 - No allocation to bioenergy production possible

Indicator 6: Water quality

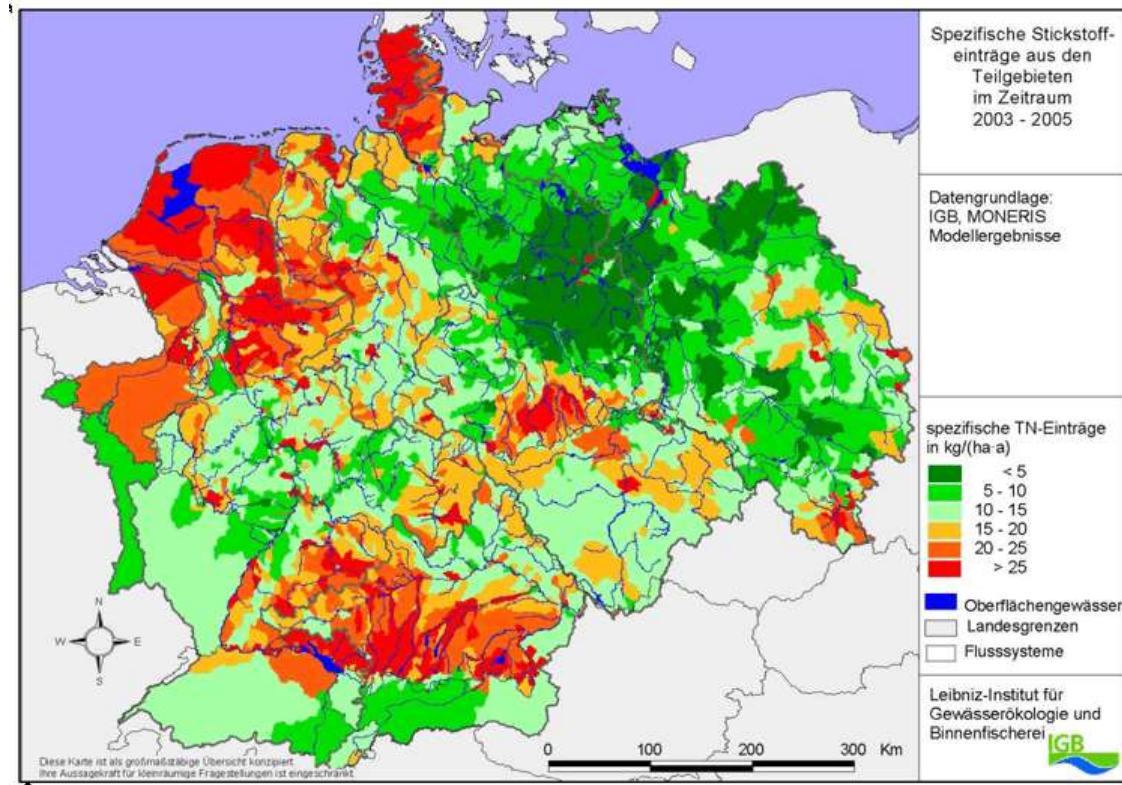
Methodological approach - agriculture



Indicator 6: Water quality

Recommendations

- For Germany
 - Adding a module to MONERIS to estimate role of bioenergy feedstock production
 - Concentration on risk areas



Indicator 3: Harvest levels of wood resources

Annual harvest of wood resources

3.1 by volume and

3.2 as a percentage of net growth or sustained yield, and

3.3 the percentage of the annual harvest used for bioenergy

Unit: tonnes/ha/year; m³/ha/year; %

Indicator 3: Wood harvest levels

Legal regulations and reporting commitments

- German Forest Law
 - Principle of (quantitative) sustainability
- Reporting requirements under the EU and UNFCCC; data provision to UN-ECE/FAO as well as for national reporting
- Wood use for energy purpose part of annual reporting on renewable energy
- Thünen Institute responsible for wood balance for emission reporting; additionally own compilations on wood energy use

Indicator 3: Wood harvest levels

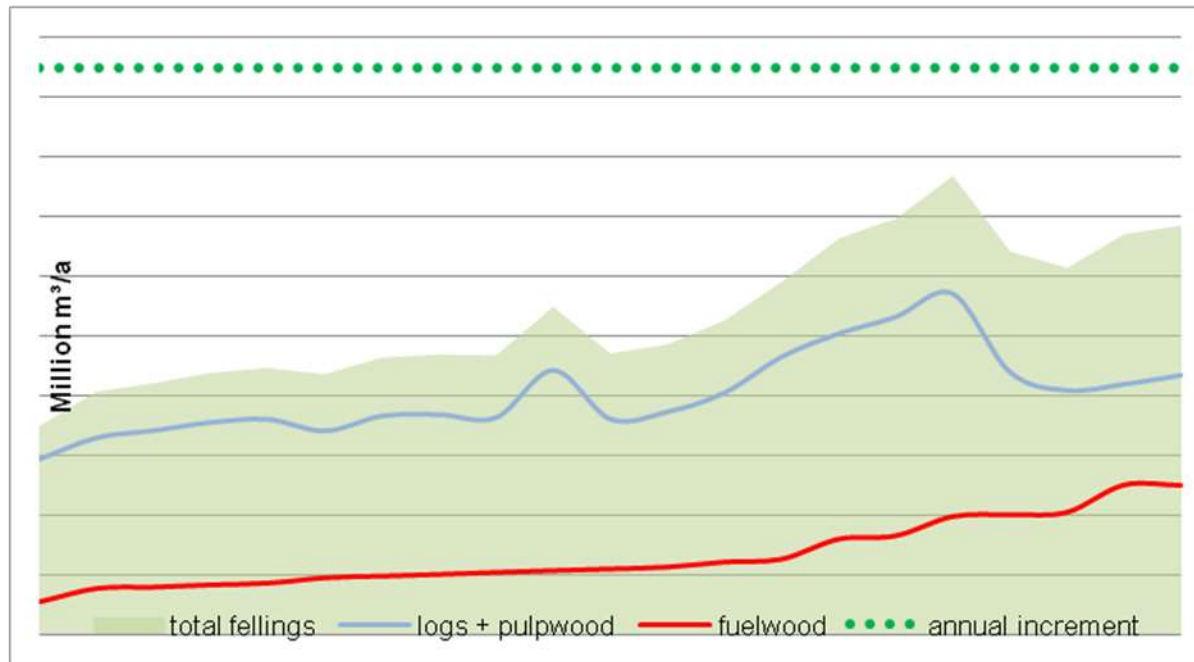
Methodological approach and results

- Two scenarios for wood logging:
 1. Based on official DESTATIS data (,standard‘) and
 2. on Thünen institute (,refined‘)

No.	Indicator	2010		2011		2012	
		standard	refined	standard	refined	standard	refined
3.1	Wood harvest, [Mm ³ /year]	54.4	67.7	56.1	68.2	52.3	66.6
3.2	harvest as share of annual increment	57%	71%	59%	72%	55%	70%
3.3	bioenergy as share of harvest	39%	38%	36%	36%	42%	40%
3.4 *	bioenergy as share of annual increment	22%	27%	21%	26%	23%	28%

Indicator 3: Wood harvest levels

Results (based on DESTATIS and TI 2013)

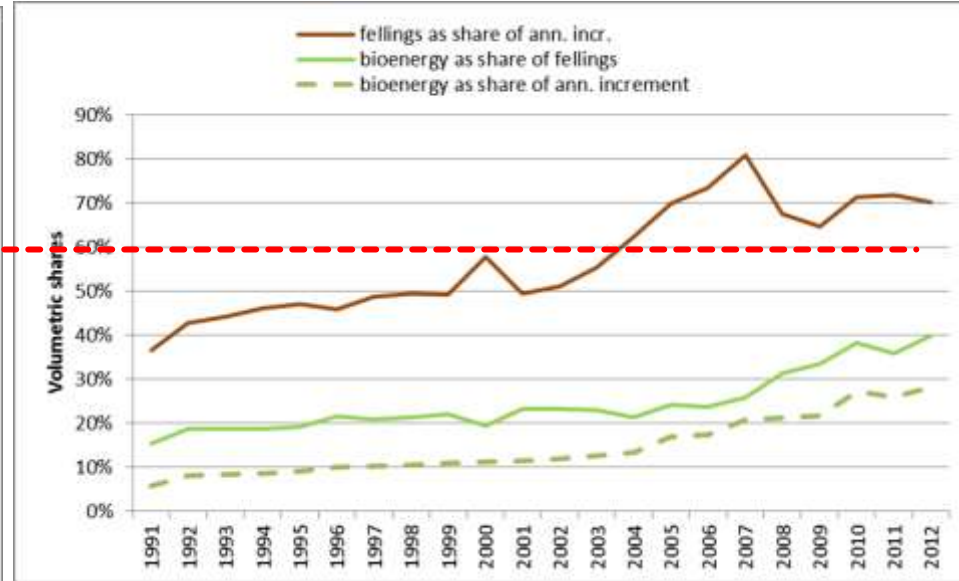
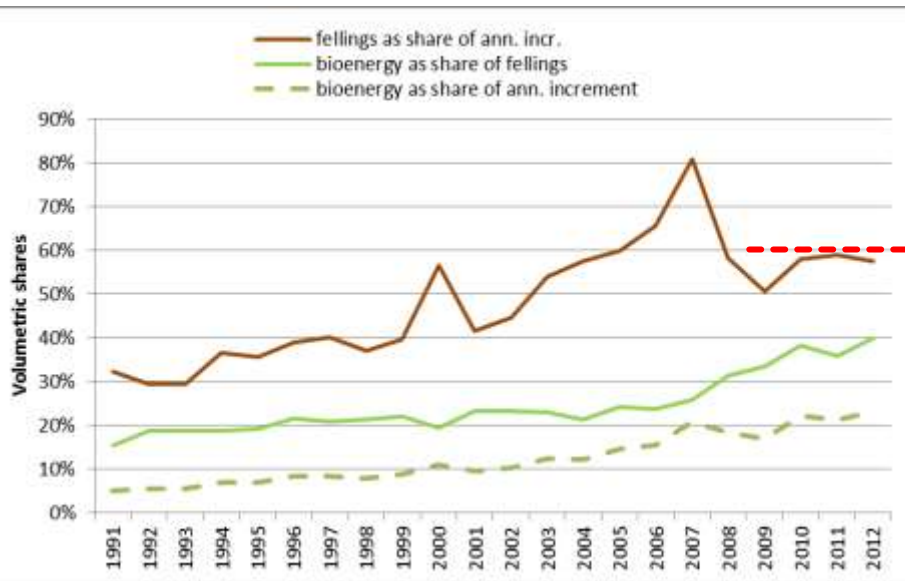


Indicator 3: Wood harvest levels

Indicators 3.3 and 3.4 (new)

„standard“ (DESTATIS)

„refined“ (TI)



Indicator 3: Wood harvest levels

Recommendations

- For Germany
 - More evaluation on logging (small / private owners) and on wood use (fire wood used in households, private wood buyers)
- For GBEP
 - Additional sub-Indicator 3.4 "Bioenergy as share of annual increment" to reflect that (typically) annual wood increment is more stable as a base for the percentage (harvest levels might fluctuate due to non-energy demands)

Overview - environmental indicators 1-4

	Indicator	Results	Validity	Remarks - Recommendations
2	Soil	Humus balance at equilibrium	medium	Original indicator not applicable – no data covering that
4	Air pollutants [kt / year]	SO _{2eq} : 181 SO ₂ : 49 NO _x : 170 Particulates: 17 CO: 243 NMVOC: 28	good	Upstream emissions from imported biomass are included
5	Water resources	<1%	good	Upstream emissions from imported biomass are included

Overview - environmental indicators 5-8

	Indicator	Results	Validity	Remarks
7	Biodiversity	Few data available invasive species: no	Medium	Allocation of bioenergy feedstocks Intensification needs to be addressed
8	Land use, LUC	1) 2.21 Mha (5.9 % of national surface). 2) 12.7 % agr. land; 19.1 % forest 3.) bioenergy from yield increases cannot be determined; 65% of bioenergy production from residues/waste; No data on degraded/contaminated land 4.) conversion cannot be quantified	good to bad	2) → Disaggregation more appropriate : agricultural bioenergy feedstocks / agricultural land area, forest bioenergy feedstocks / area of managed forests. 3) Not possible to distinguish between residues and waste

Indicator 9: Allocation and tenure of land for new bioenergy production

Percentage of land - total and by land-use type - used for new bioenergy production where: (9.1) a legal instrument or domestic authority establishes title and procedures for change of title; and

(9.2) the current domestic legal system and/or socially accepted practices provide due process and the established procedures are followed for determining legal title

Unit: %

Indicator 9: Allocation and tenure of land

Legal regulations and reporting commitments

- No reporting commitments
- German Land Registration Code
 - Regulates land tenure
 - Documentation of all land property in the land title register
 - Close cooperation with land surveying offices if land properties are separated
 - Transfer of land ownership only becomes effective with registration in land title register
 - All sale or lease of land has to be legalised by respective contracts

➔ Indicator not relevant in Germany

Indicator 9: Allocation and tenure of land

Structural changes

- Shift of farm structure in agriculture
 - Number of farms decreasing while size of single farms increasing
 - ➔ concentration of capital in few hands
- Shift of ownership structures
 - In certain regions ncreasing investments by non-agricultural and supra-regional investors
 - Difficult to buy land as non-farmer, but buying (large) capital shares from companies possible
 - Effects on production, employment and regional value added
 - Influences land prices and leases

Indicator 9: Allocation and tenure of land

Recommendations

- For Germany
- For GBEP
 - Include reasons for and effects of structural changes within agriculture , land akquisition
 - Include changes in prices of land / leasing prices

Overview - social indicators

	Indicator	Result	Validity	Recommendation for indicator improvement
10	Price and supply of national food basket	No influence	good	
11	Change in income	Not applicable	medium	data do not differentiate between bioenergy and other activities
12	Jobs in the bioenergy Sector	1) 128 900 jobs 2) All skilled 3) All permanent and full-time 4) See 1.) 5) All adhere to ILO	good	

Overview - social indicators

	Indicator	Result	Validity	Recommendation for indicator improvement
13	unpaid time spent by women and children collecting biomass	These indicators are not relevant in Germany; <ul style="list-style-type: none"> • biomass is not collected by women and children, at least not for covering the demand, since ... • Energy services are covering all regions of Germany, access is available by everybody • Even though there is again an increase of wood-stoves in Germany, these mostly pellet fired equipment don't cause indoor smoke at a relevant level. 		
14	Bioenergy used to expand access to modern energy services			
15	Change in mortality and burden of disease attributable to indoor smoke			
16	Incidence of occupational injury, illness and fatalities	Not applicable	medi um	No differentiation between bioenergy and other agricultural/forest activities

Indicator 22: Energy diversity

Change in diversity of total primary energy supply due to bioenergy.

Measured with the Herfindahl index

Indicator 22: Energy diversity - results

in PJ	with bioenergy (real data)			without bioenergy (hypothetical)		
	2010	2011	2012	2010	2011	2012
coal	3226	3279	3414	3545	3550	3699
oil	4684	4525	4540	5377	5218	5327
gas	3171	2911	2954	3291	3005	3050
nuclear	1533	1178	1085	1533	1178	1085
others	190	245	173	190	245	173
non-bio RE	293	356	406	293	356	406
solid bioenergy*	593	532	568			
gaseous bioenergy*	241	188	193			
liquid bioenergy*	297	339	408			
total	14229	13552	13740	14229	13552	13740

*= as primary energy equivalent

Source: own calculation by IINAS

Indicator 22: Energy diversity - results

Indicator 22 Energy diversity effects of bioenergy in Germany

TPES share of	2010		2011		2012	
	with bio	w/o bio	with bio	w/o bio	with bio	w/o bio
Coal	22.7%	24.9%	24.2%	26.2%	24.8%	26.2%
Oil	32.9%	37.8%	33.4%	38.5%	33.0%	38.5%
gas	22.3%	23.1%	21.5%	22.2%	21.5%	22.2%
nuclear	10.8%	10.8%	8.7%	8.7%	7.9%	7.9%
others	1.3%	1.3%	1.8%	1.8%	1.3%	1.3%
non-bio RE	2.1%	2.1%	2.6%	2.6%	3.0%	3.0%
solid bioenergy	4.2%	0.0%	3.9%	0.0%	4.1%	0.0%
gaseous bioenergy	1.7%	0.0%	1.4%	0.0%	1.4%	0.0%
liquid bioenergy	2.1%	0.0%	2.5%	0.0%	3.0%	0.0%
Herfindahl Index	0.224	0.271	0.227	0.275	0.227	0.271

Overview - economic indicators

	Indicator	Result	Validity	Recommendation for indicator improvement
17	Productivity	1) 46.4 t Maize/ha/yr 3.7 t rape/ha/yr 7.3 t wheat/ha/yr 68.9 t beet/ha/yr 2) 13.7 GJ/t (RME) 7.84 GJ/ (EtOH wheat) 3) 50.9 GJ/ha (RME) 75 GJ/ha (EtOH wheat)	good	
18	Net energy balance	1-3): see result tables 4) bioelectricity: 0.10 bioheat: 0.07 biofuels 0.37 Ratio: $MJ_{\text{prim}}/MJ_{\text{end}}$	good	non-renewable energy input per renewable energy output should be reported instead of the energy ratio (ER) - ER does not make sense for fossil systems

Overview - economic indicators

	Indicator	Result	Validity	Recommendation for indicator improvement
19	Gross value added	total bioenergy investment (2012): 2.55 M€; total turnover: 10,730 M€	good	German national accounts do not allow to disaggregate GVA effects of bioenergy; suggested proxy for GVA: investment and economic turnover
20	Change in the consumption of fossil fuels and traditional use of biomass	1a) 496 TWh 1b) not relevant 2) not relevant	good	

Overview - economic indicators

	Indicator	Result	Validity	Recommendation for indicator improvement
21	Training and re-qualification of the workforce	Not relevant in Germany: no differentiation between bioenergy and other activities		
23	Infrastructure and logistics for distribution of bioenergy	Not relevant in Germany, since there is sufficient logistics and infrastructure for energy in place.		
24	Capacity and flexibility of use of bioenergy	no relevant data available	low	Data on capacity exists, but only few studies on flexibility

Summary of key findings

Key findings and recommendations

- In general the GBEP indicators are mostly applicable and cover the whole scope of sustainability at large
 - Difficult to predict follow-up at this point in time
- Five indicators (13, 14, 15, 21, 23) excluded from the beginning due to low relevance for German bioenergy sector
- Assessment has shown that six more indicators (5, 9, 10, 11, 16, 19, 24) are of minor relevance in Germany
 - In sense that there is no particular risk
- For several indicators data are not available in a form that can directly inform the indicator (e.g. water quality, soil quality)
 - But regulatory framework ensures sustainability across agricultural activities (including bioenergy production)

Key findings and recommendations

- For several indicators concrete recommendations on additional sub-indicators have been made (e.g. wood harvest, land tenure)

Problem of attribution:

- Many indicators lack of a provable approach to **attribute** the effects of bioenergy against biomass used for food, feed or other purposes.
- Approach: allocate effects proportionally between bioenergy and other uses of the same feedstock material (approved by workshop participants)

Key findings and recommendations

Problem with imported biomass:

- Transfer of impacts to exporting countries
 - E.g. food prices, water use
 - For indicators with low relevance in Germany
- Concentration on domestic effects not always feasible
 - E.g. GHG and non-GHG air emissions include emissions from whole life cycle
 - ➔ including those caused elsewhere