

# Bioenergy Potential Assessment

## State of the Art



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# Agenda



## 1. Biomass Potentials Assessment

### 1.1 Definitions

### 1.2 Mass Flow Analysis

### 1.3 Market Models

### 1.4 Availability of arable land

## 2. Results of Biomass Potential Analysis

### 2.1 Biomass from Agricultural Land

### 2.2 Biomass from Forestry

### 2.3 Residues

## 2. Uncertainties in the Methodology

## 3. Key Actions to Improve Biomass Mobilisation

# Biomass Potential

## - Definitions -

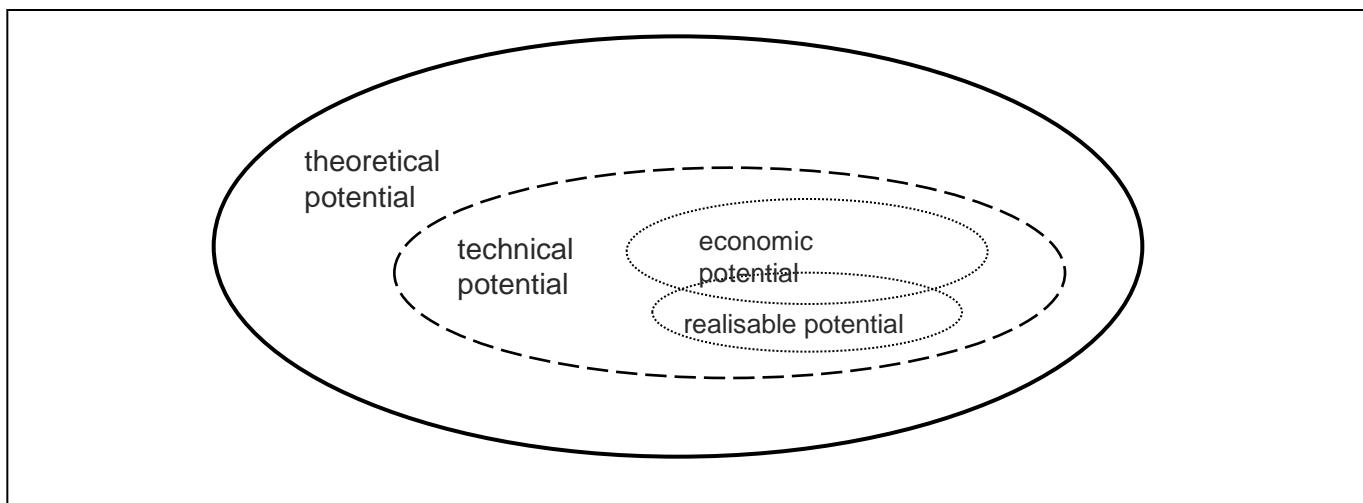


The **theoretical potential** refers to a theoretical limit of the available energy supply from biomass meaning all phytomass and zoomass in a defined area

The **technical potential** means the part of the present biomass (theoretical potential) that can be used given current technical possibilities as well as structural and ecological restrictions

The **economic potential** refers to the fraction of the technical potential that can be used economically in the context of the economic framework (development of conventional energy systems, prices of energy sources)

The **realisable potential** depicts the expected current use of bioenergy



# Biomass Potential

## - Definitions -



- Different biomass origin:
  - Forest biomass
  - Agricultural biomass
  - Residues
  - Land potentials (degraded lands)
  
- Different methodological approaches:
  - Mass Flow Analysis
  - Market Models
  - Land Use Models
    - (including Remote Sensing and GIS)

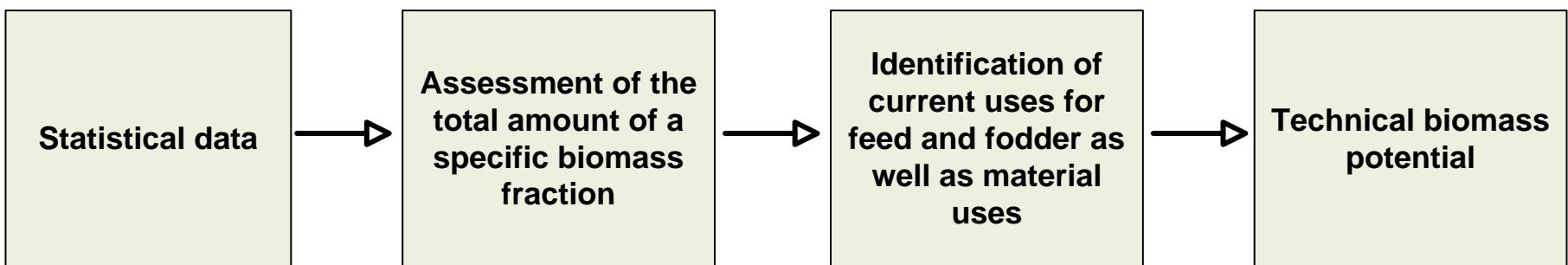


# Biomass Potential

## - Mass Flow Analysis -



- Analysis of statistical data
- Systematic identification of mass flows in a defined region
- The investigation compares resources and the current or expected demand for specific biomass fractions
- Scenarios can show prospective biomass potentials using different framework conditions



# Biomass Potential

## - Market and Land use Models -



- Variety of national and international economic, geographic or integrated models  
→ CLUE, AgLU, FASOM, IMAGE, FAPRI, GTAP...
- Market Models consider interactions between supply and demand, prices and trade and quantify spatial impacts on demand trends (iLUC, GHG emissions)
- Market Models study impacts of (trade) policies, technical change and global change on agricultural and/or forestry sector
- Individual strengths, but still limited to simulate all the complexities involved in the functioning of landscapes

### Uncertainties:

- spatial and temporal resolution
- Input parameter (raw material mix; which price leads to intensification of agricultural production; trend of yield increase) more important than model
- great variation of results

**→ no own calculation of Market Models at DBFZ**

➤ BUT: Biomass and available land potentials from **land use models**

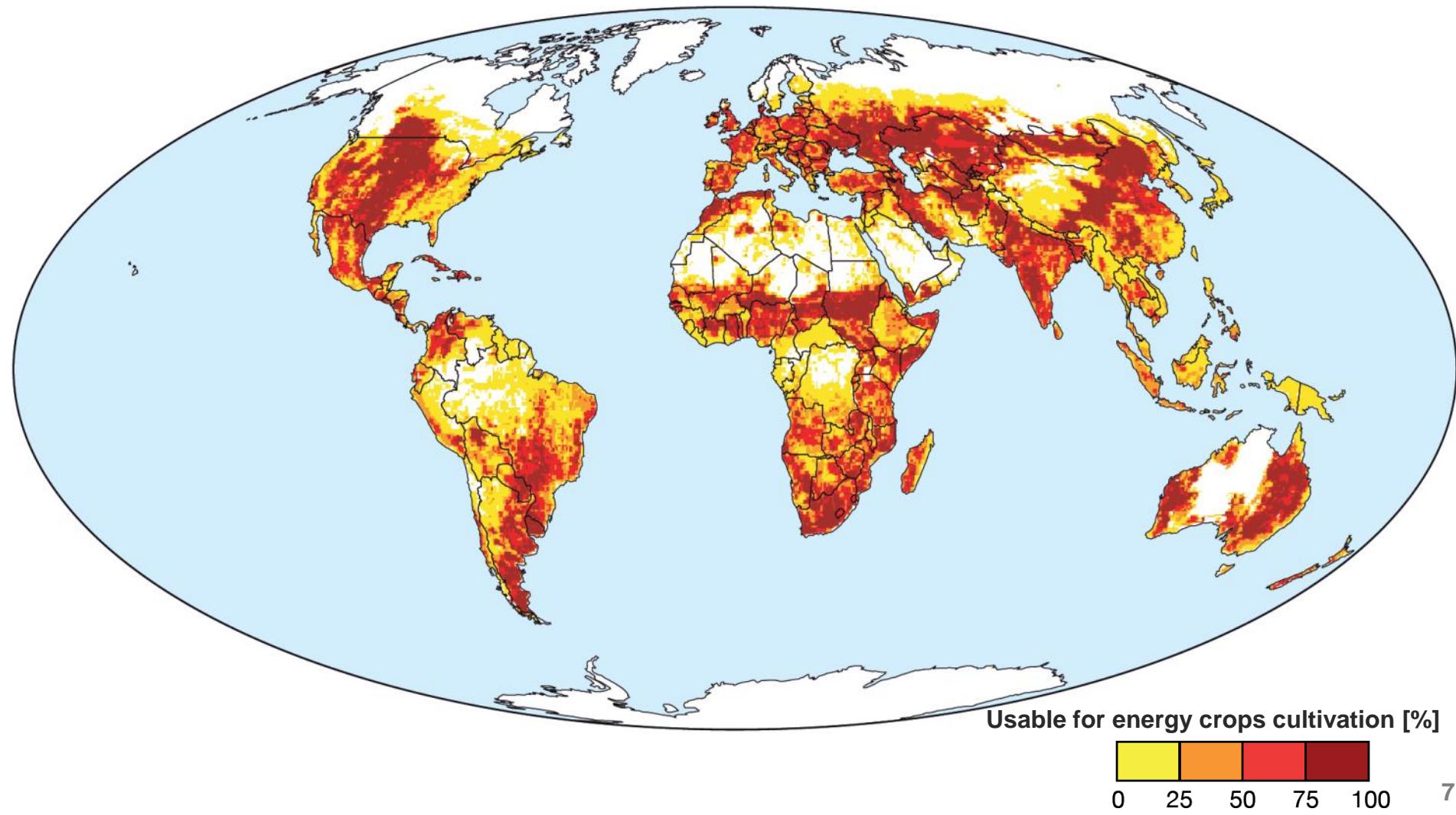
# Biomass potentials

## - Land use models -



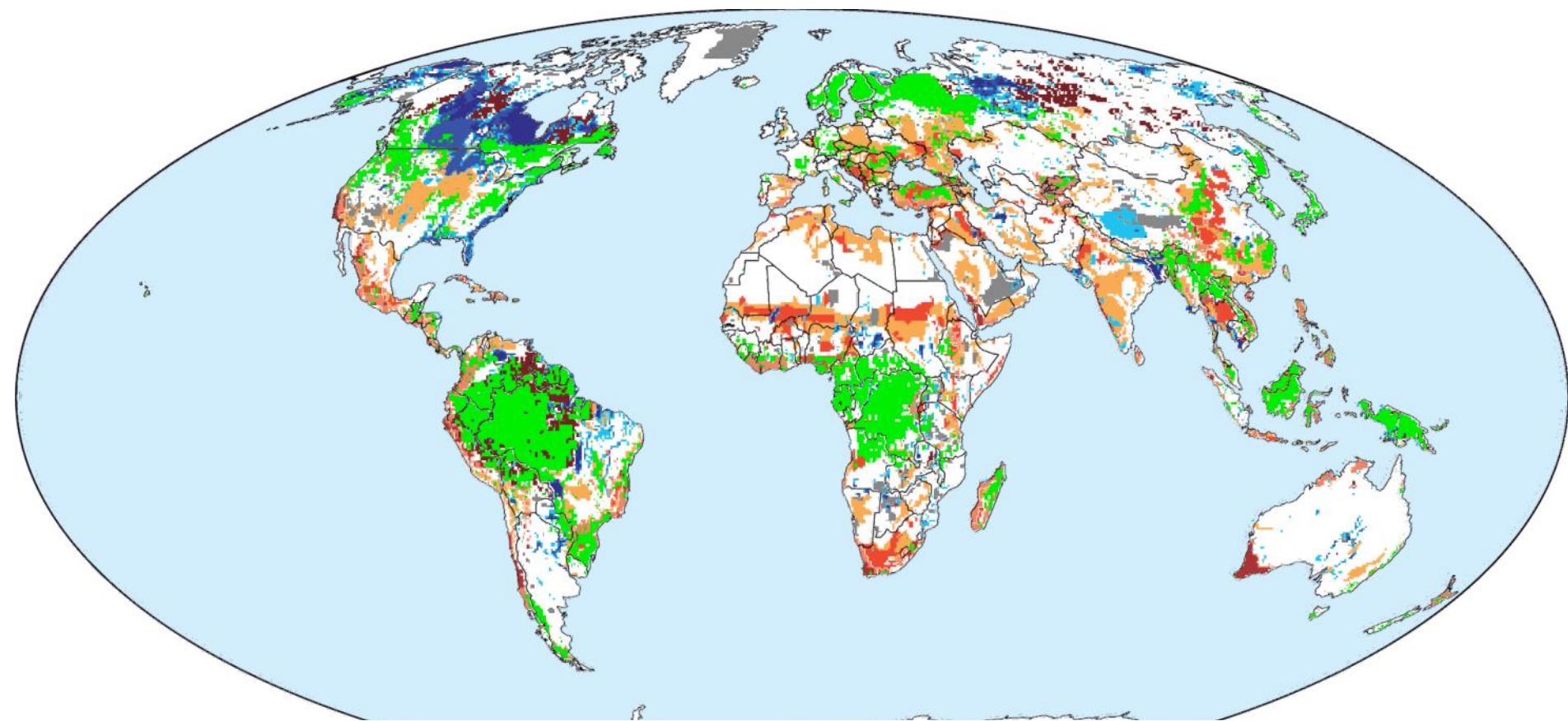
Source: Beringer & Lucht, 2008

### Possible regions for energy crop cultivation





### Some restriction factors and elements



Extreme degraded areas (no use)  
Highly degraded areas (30% use possible)  
Protected Areas (no use)

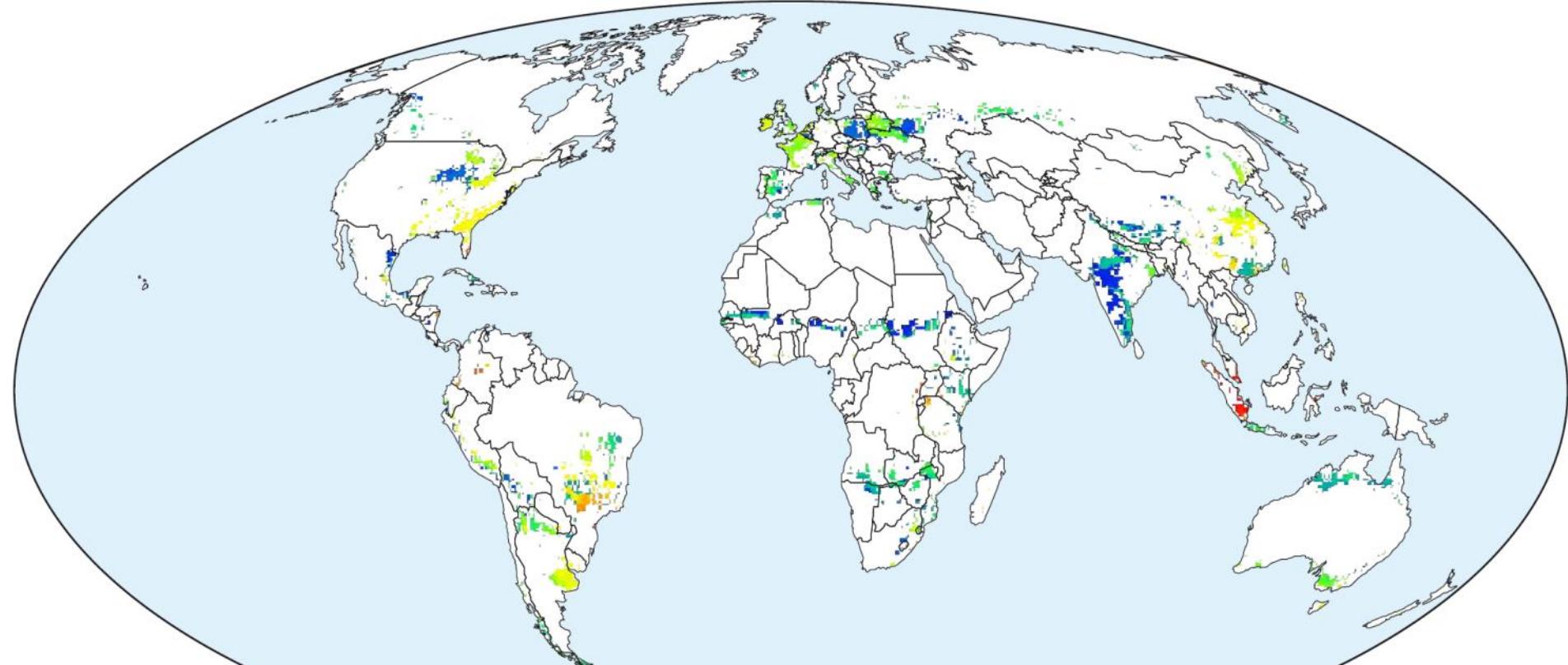
Areas with high biodiversity (no use)  
Wetlands (no use)  
Compensation of the CO<sub>2</sub>-release by changes  
in land use not possible within 10 years

# Biomass potentials

## - Land use models -

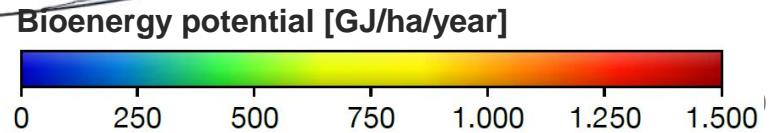


Sustainable available bioenergy potential from energy crops in 2050 (with watering)



Governance is needed to establish the production in the promising regions

Note: potentials from residues, waste and traditional cultivation are not shown!



# Biomass from Agricultural Land



⇒ to secure the global food: global balance of trade is essential

Land	Nationales Potenzial					verbleibendes Potenzial bei Ernährungssicherung (Welt)				
	Ø 2002 - 2005	2010	2015	2020	2050	Ø 2002 - 2005	2010	2015	2020	2050
								Tsd ha		
Deutschland	2.051,4	1.725,6	2.322,0	2.899,8	5.571,6	2.047,4	993,4	1.150,9	1.339,8	2.013,2
EU-27	24.541,2	18.045,8	21.989,4	25.767,9	35.589,9	24.493,3	11.460,2	11.943,2	12.986,5	15.237,3
Europa andere	92.642,4	93.151,0	108.461,1	122.272,8	167.810,9	92.461,6	53.656,6	53.816,6	56.574,2	61.461,8
Europa	117.183,6	111.196,8	130.450,6	148.040,7	203.400,7	116.954,9	65.116,8	65.759,8	69.560,7	76.699,1
Nordamerika	101.377,0	71.829,1	71.712,8	72.450,7	73.248,0	101.179,1	41.350,8	35.545,3	33.473,5	26.466,6
Mittelamerika	15.299,2	-1.443,1	-7.323,3	-11.820,0	-23.818,1	15.269,3	1.711,5	1.478,0	1.383,9	1.525,3
Südamerika	42.886,2	45.304,3	48.280,1	52.648,7	85.709,0	42.802,5	32.499,8	33.256,8	35.971,2	53.645,9
Amerika	159.562,4	115.690,3	112.669,6	113.279,4	135.138,9	159.251,0	75.562,2	70.280,0	70.828,6	81.637,7
Ozeanien	42.440,5	33.486,6	28.837,5	24.329,8	-4.048,6	42.357,7	19.277,7	14.293,7	11.240,8	2.038,3
Asien	61.664,3	-37.680,5	-63.644,5	-79.605,8	-136.509,7	64.038,7	28.699,3	24.351,2	23.815,7	24.559,1
Afrika	39.322,8	-40.498,5	-58.729,8	-73.857,7	-227.533,7	39.290,1	10.957,4	14.785,8	19.128,4	25.618,7
Gesamt 134 Länder	420.173,7	182.194,8	149.583,4	132.186,4	-29.552,3	421.892,4	199.613,4	189.470,5	194.574,1	210.553,0
Bei Berücksichtigung der Produktivität	433.125,2	203.468,9	191.622,2	195.122,1	209.902,7	433.125,2	203.468,9	191.622,2	195.122,1	209.902,7

# Biomass from Agricultural Land



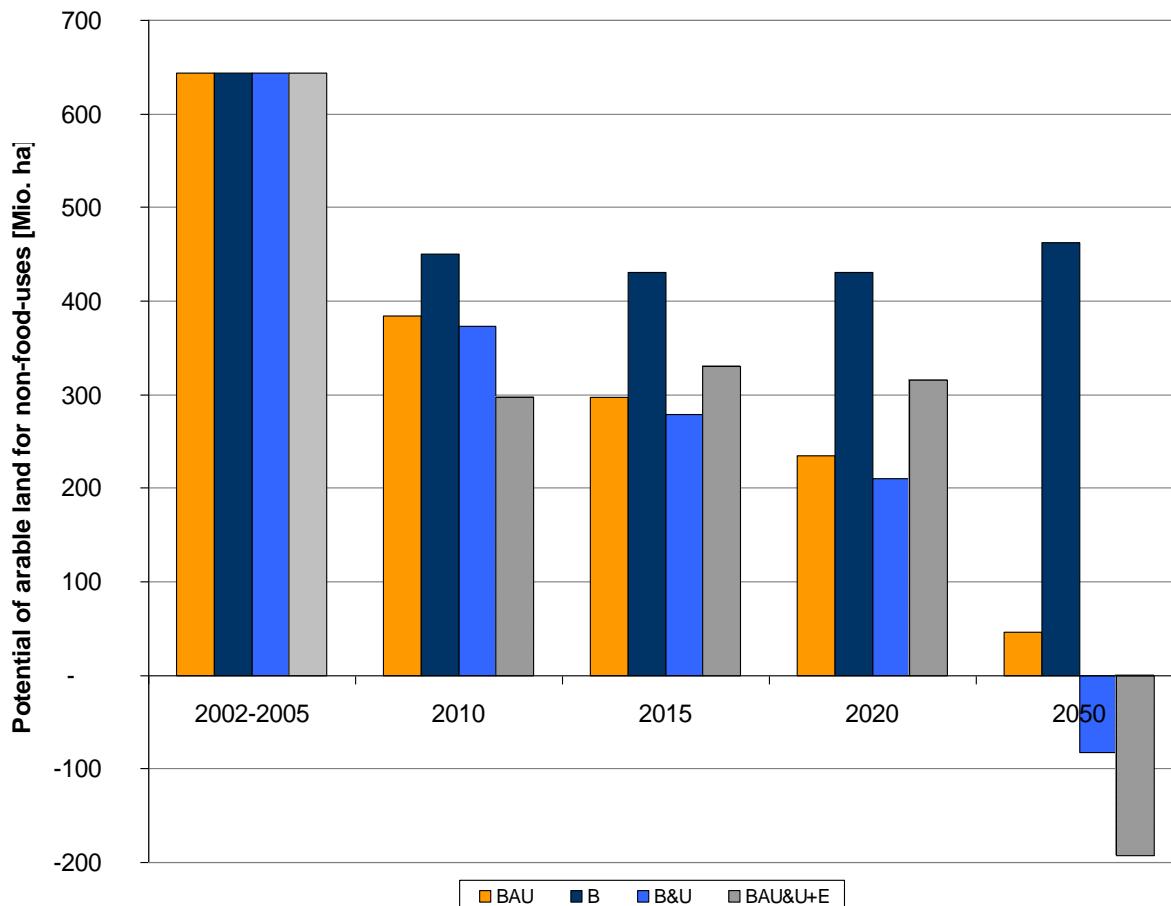
⇒ to secure the global food: global balance of trade is essential

Country	National Potential					Remaining Potential with Global Food Security (Scenario B)				
	Ø 2002 - 2005	2010	2015	2020	2050	Ø 2002 - 2005	2010	2015	2020	2050
	1.000 ha					1.000 ha				
Germany	2.051,4	1.725,6	2.322,0	2.899,8	5.571,6	2.047,4	993,4	1.150,9	1.339,8	2.013,2
EU-27	24.541,2	18.045,8	21.989,4	25.767,9	35.589,9	24.493,3	11.460,2	11.943,2	12.986,5	15.237,3
In Europe, North- und South America stable and significant areas of arable land						167.810,9	92.461,6	53.656,6	53.816,6	56.574,2
America	159.562,4	115.690,3	112.669,6	113.279,4	135.138,9	101.179,1	41.350,8	35.545,3	33.473,5	26.466,6
In Asia und Africa increasing demand for food imports						-4.048,6	42.357,7	19.277,7	14.293,7	11.240,8
134 countries	420.173,7	182.194,8	149.583,4	132.186,4	-29.552,3	421.892,4	199.613,4	189.470,5	194.574,1	210.553,0
Including productivity	433.125,2	203.468,9	191.622,2	195.122,1	209.902,7	433.125,2	203.468,9	191.622,2	195.122,1	209.902,7

# Biomass from Agricultural Land



## Global potential of arable land for non-food uses (DBFZ, Uni Hohenheim)



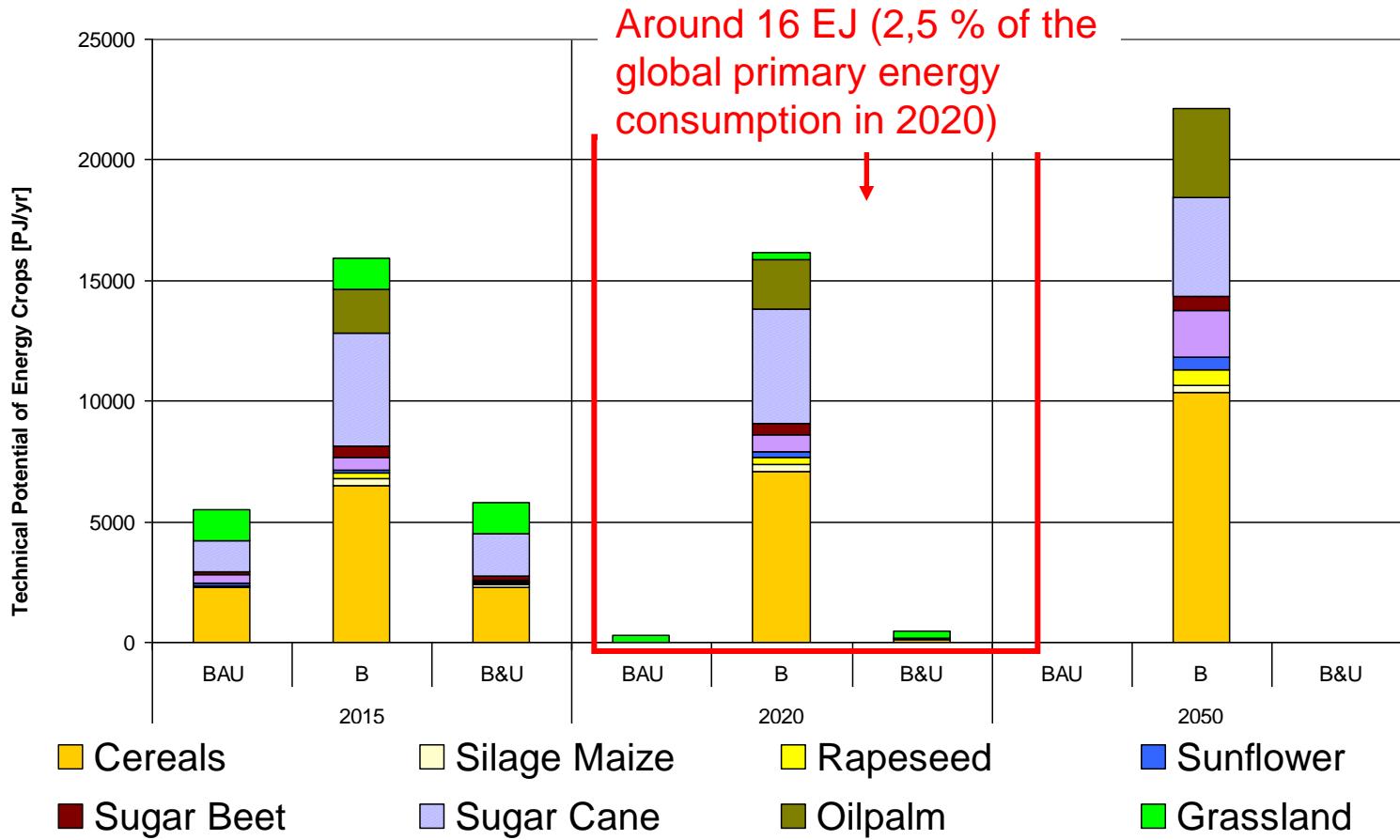
- ⇒ Significant areas of arable land available in the global context
- ⇒ all scenarios show huge national potentials

# Biomass from Agricultural Land

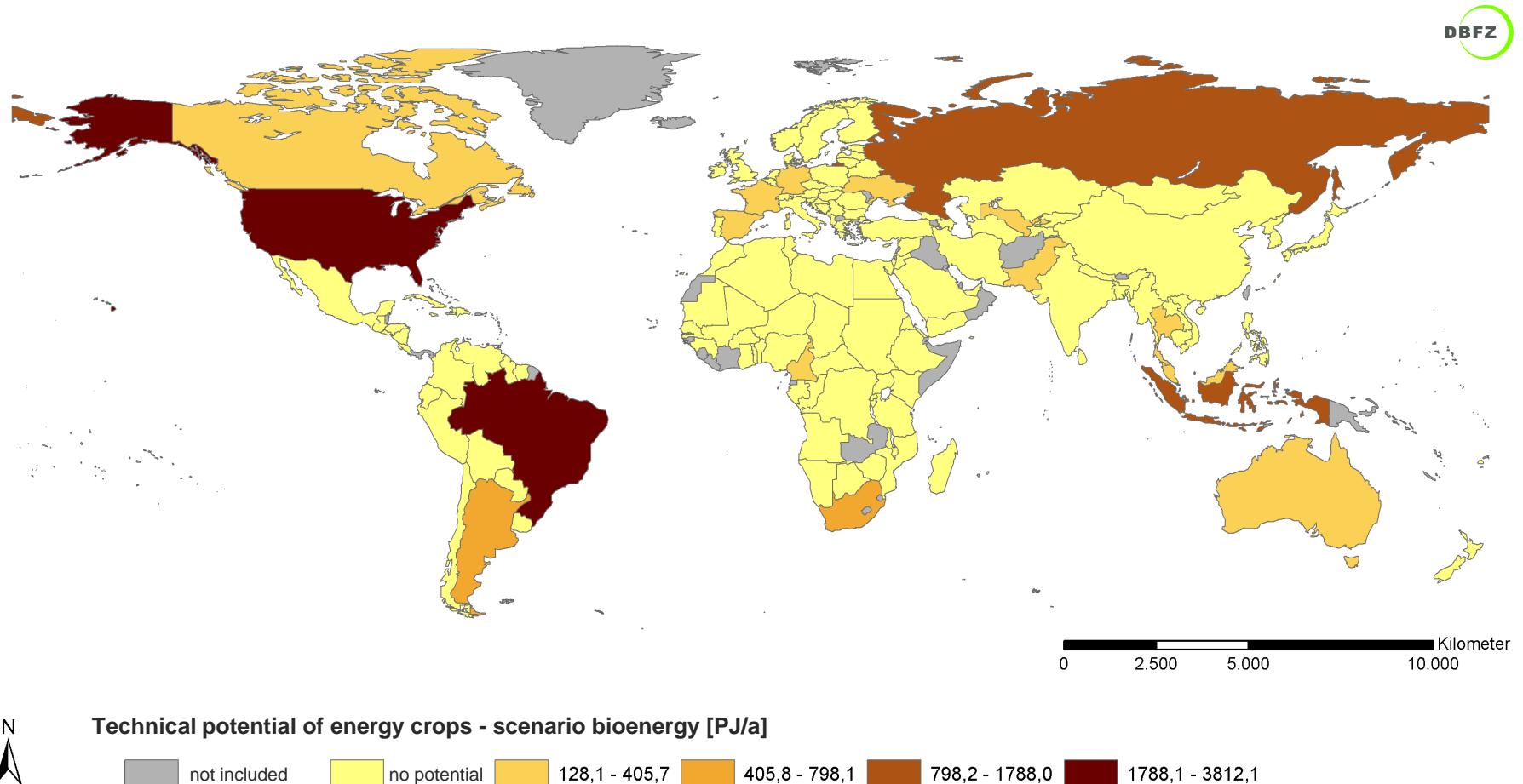


## Potential from Energy Crops

⇒ only scenario „bioenergy“ shows biomass potentials in 2020 from energy crops



# Biomass from Agricultural Land

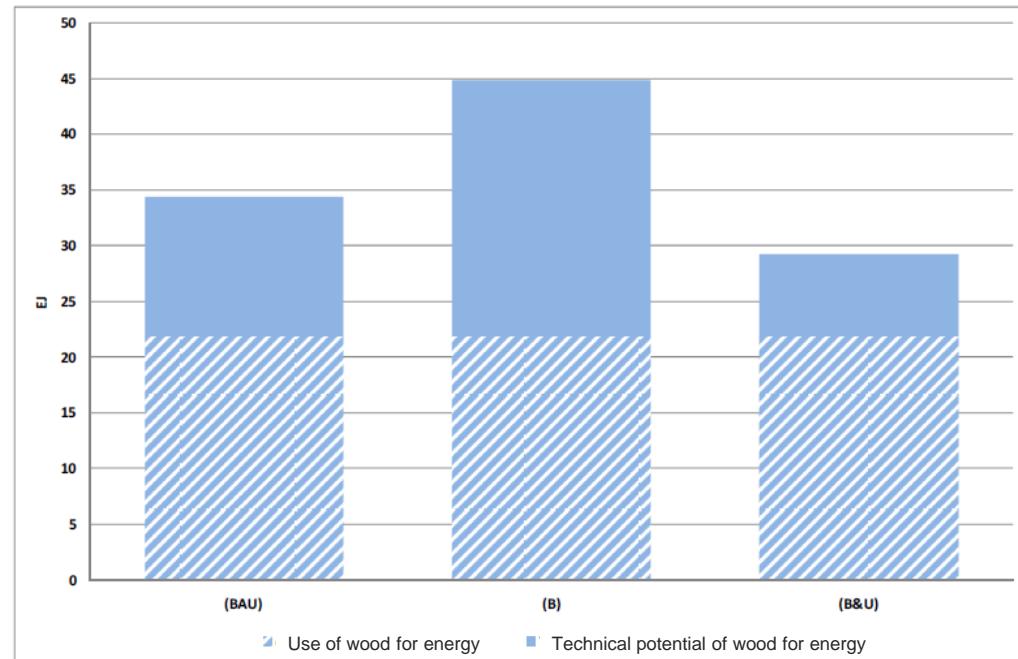


Source: „Global and regional spatial distribution of biomass potentials“, a project financed by the German Federal Government, 2008-2009  
 Publication in Preparation

# Biomass from Forestry



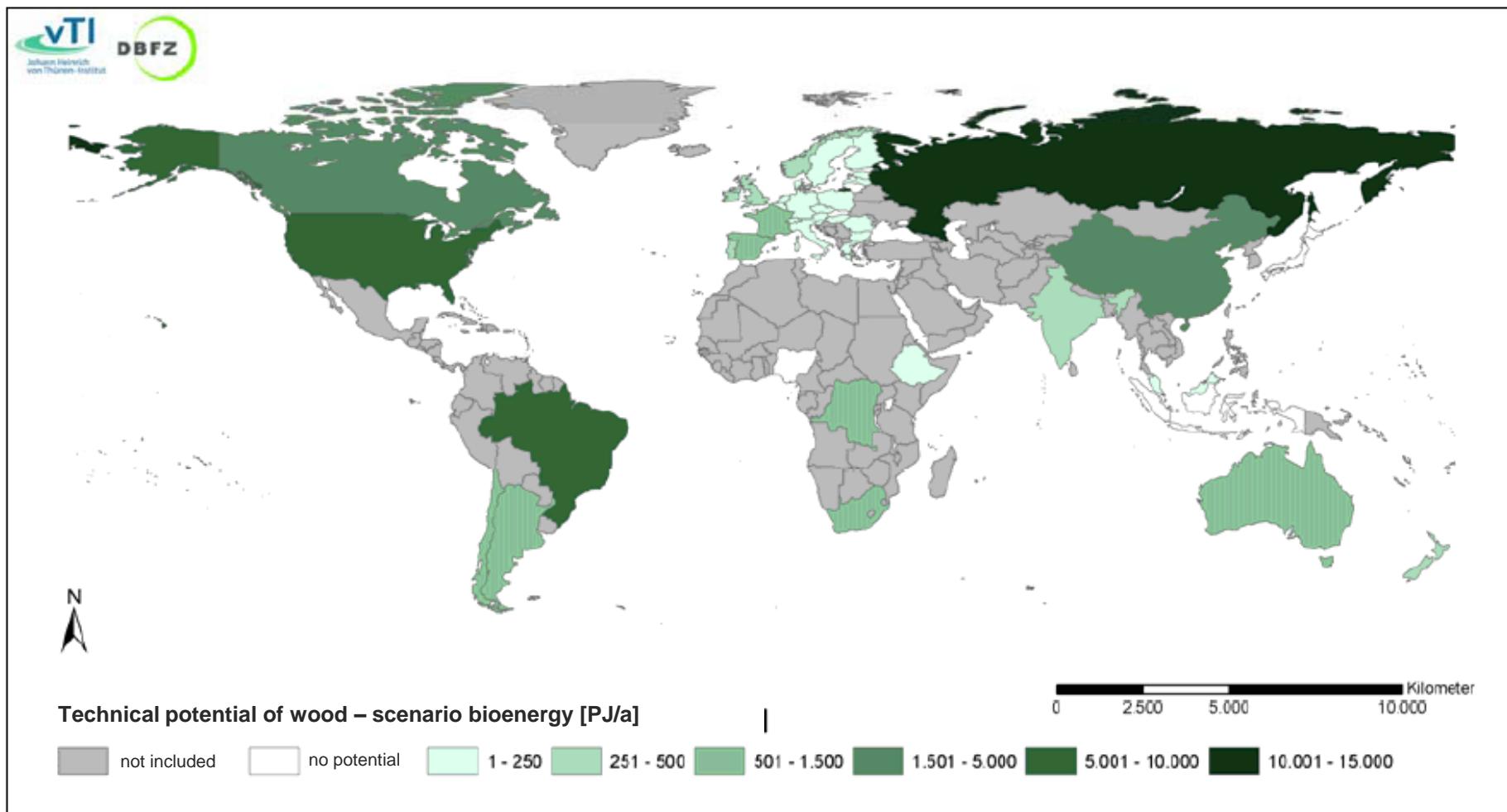
- ⇒ Worldwide forest areas are decreasing until 2020, plantation areas are increasing
- ⇒ Global potential of raw wood in 2020: around 3,2 to 4,2 bn t<sub>DM</sub>
- ⇒ There are still potentials of forestry biomass even if the material use of wood is included in the investigation



Global Potential:  
around 36 to 57 EJ

Fig.: Technical potential of wood in selected countries (vTI Hamburg)

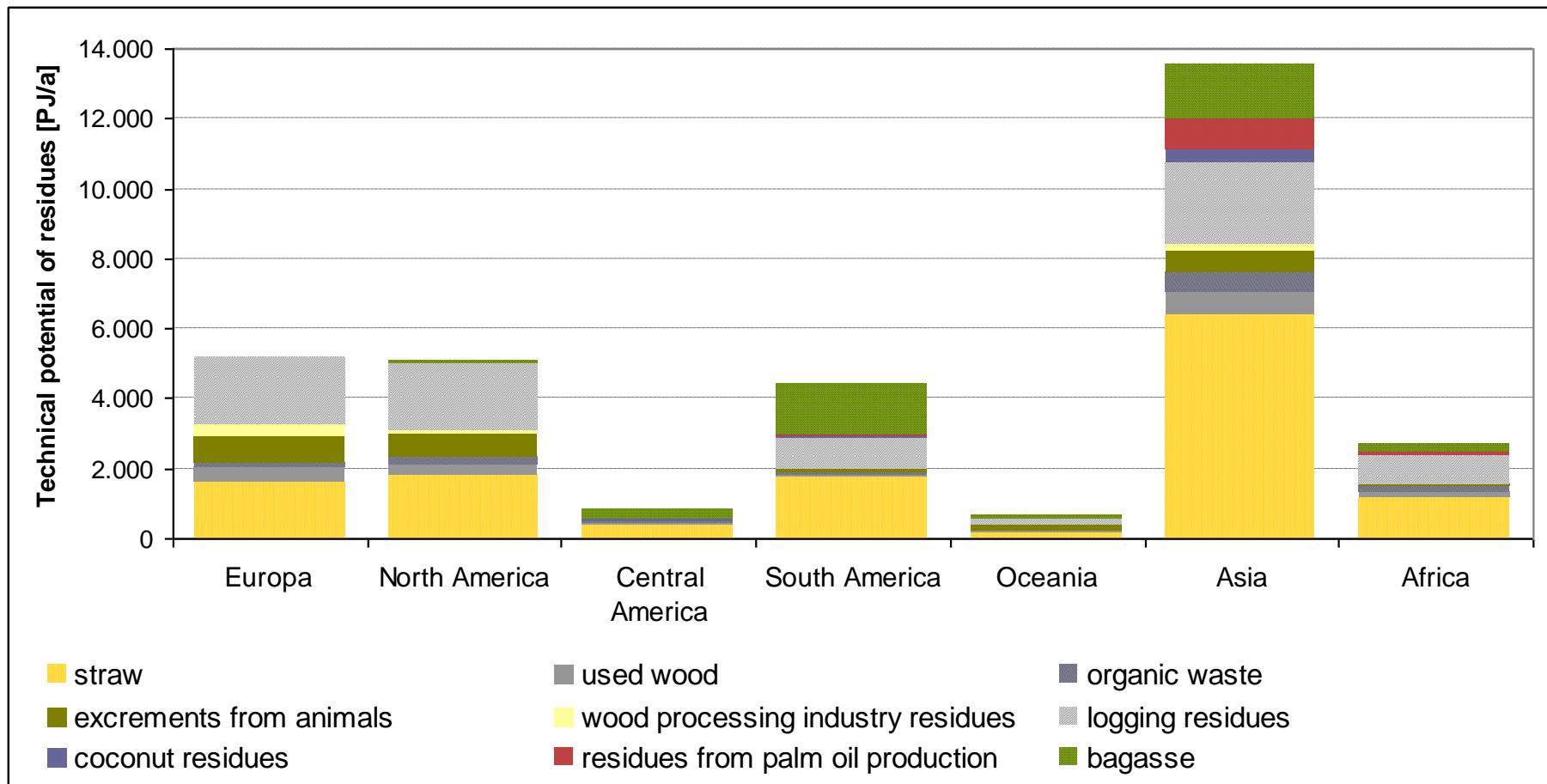
# Biomass from Forestry



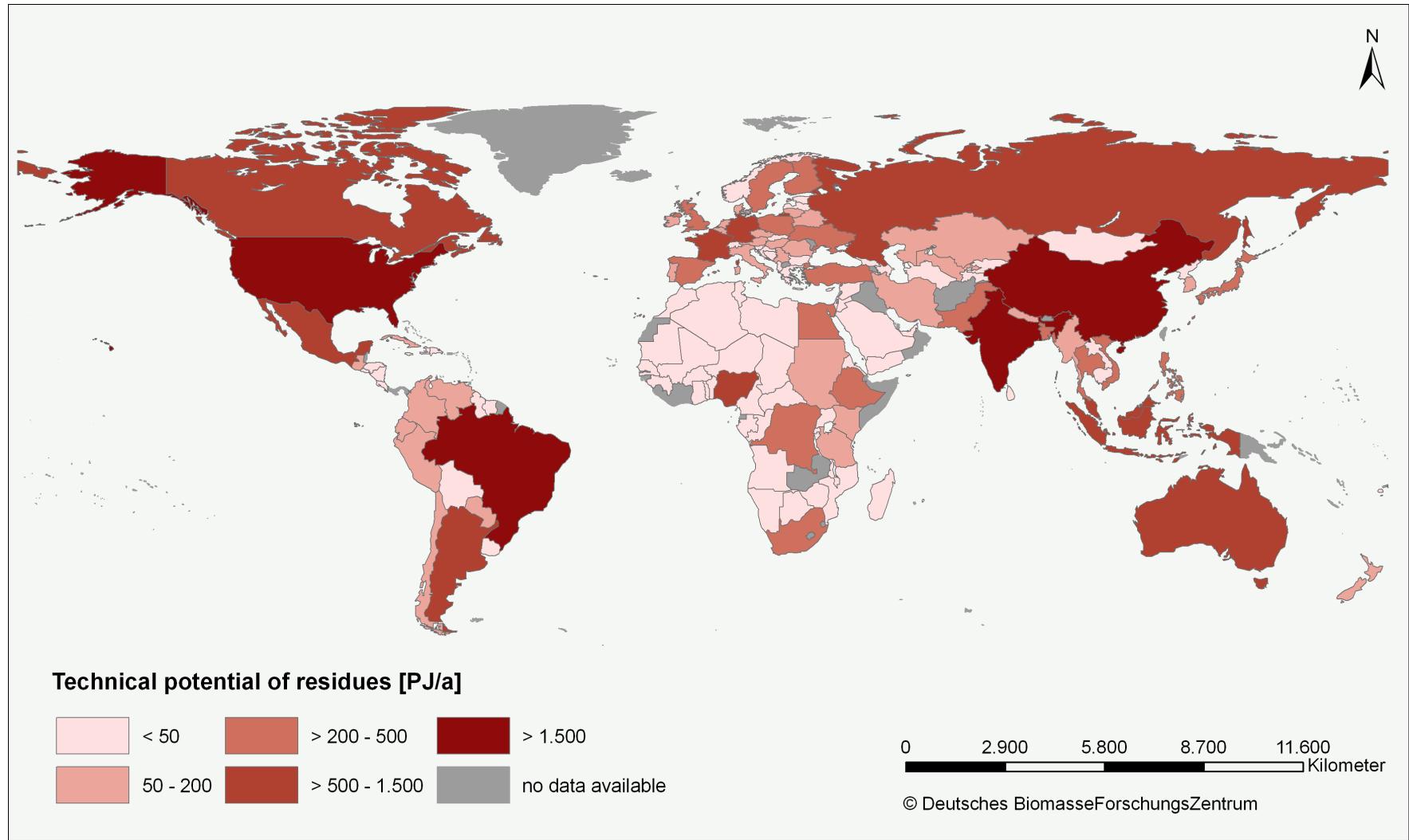
# Residues



Global Technical Potential of Residues: 30 EJ



# Residues

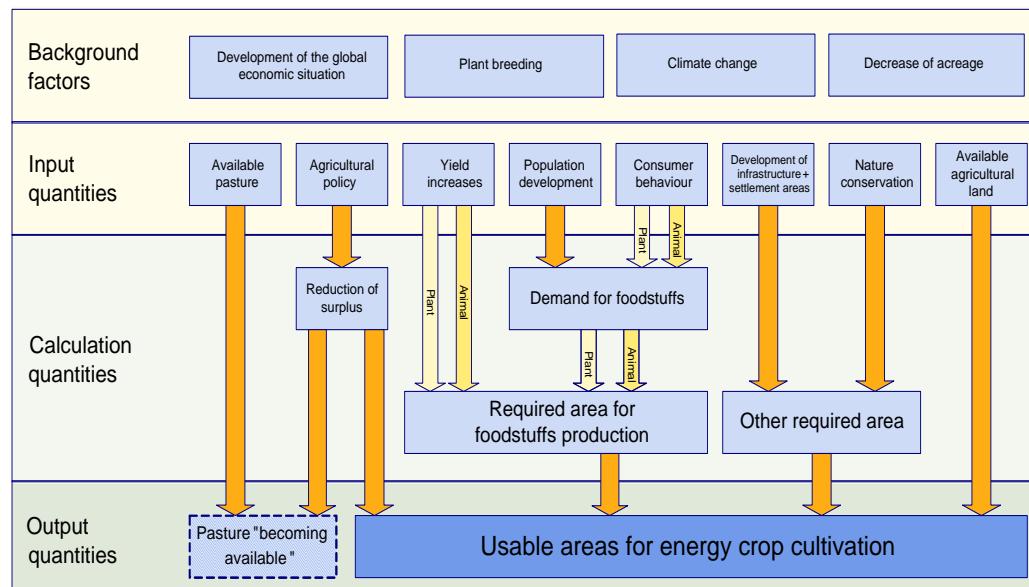


# Biomass Potential

## - Uncertainties -



- Local conditions are not included in the analysis
  - these can be important especially regarding the amounts of residues resulting from production processes
  - Locally differing manufacturing processes
    - e. g. collection systems for wastes
    - handling of wood for industrial uses (decortication in the forest or in the sawmill)
  - data quality and lack of data
  - Interactions between bioenergy and nature/environment
    - 👉 Risk and opportunity
      - e. g. biodiversity, riparian zones, degraded lands...



# Results

## - Conclusions -



- Available potential assessments differ in several aspects like the evaluation period, the framework conditions and the bioenergy sources
- Unclear political developments and insufficient data availability (developing countries)
- Main factors influencing food and feedstock demand: global population growth, future per-capita consumption, development of the specific yields for food, fodder and biomass production, climate change
- Lack of consistent definitions for specific biomass fractions such as logging residues
- Scenario approach can be regarded as the most appropriate means in order to handle the existing uncertainties
- Assessment of future biomass potentials depends mainly on global political agreements concerning food security and sustainability, as well as consumer behaviour in rich countries

# Biomass Mobilisation

## - Key Actions -



- Energy saving
- Increase energy efficiency
- Manage the high demand for wood
  - plantation wood from extensive systems, increase research regarding SRC
  - forest management
- Improvement of political, technical and economic framework
- Development of technologies for non-food crops (straw, perennial grasses)
- Improvement of cultivation systems and techniques (food & non-food)
- International, sustainable agreement on securing of resources (food & bioenergy)



Thank You!

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