The potential of energy crops in Germany and Poland

Workshop "Optimal land use for bioenergy production without jeopardising food self-sufficiency and food security"
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Outline

- Introduction on sustainable biomass potential
- Objective: potential of agricultural area for bioenergy production
  - in Poland and Germany
  - temporal development until 2030
- Approach:
  - land use model HEKTOR
  - scenario development
- Results:
  - available area
  - primary energy potential

Overview Agriculture and Energy 2009

	Poland	Germany
Utilized agricultural area (UAA) [Mio. ha]	16	17
UAA per head [m^2/head]	4 100	2 200
Fallow and abandoned land [Mio. ha]	0.7	0.3
Main agricultural product [€] selfsufficiency rate	cereals 80-120%	milk 115-120%
Cereal production [Mio. t]	10	25
Total primary energy supply (TPES) [EJ]	4	14
Share of biomass in energy supply	6%	6%

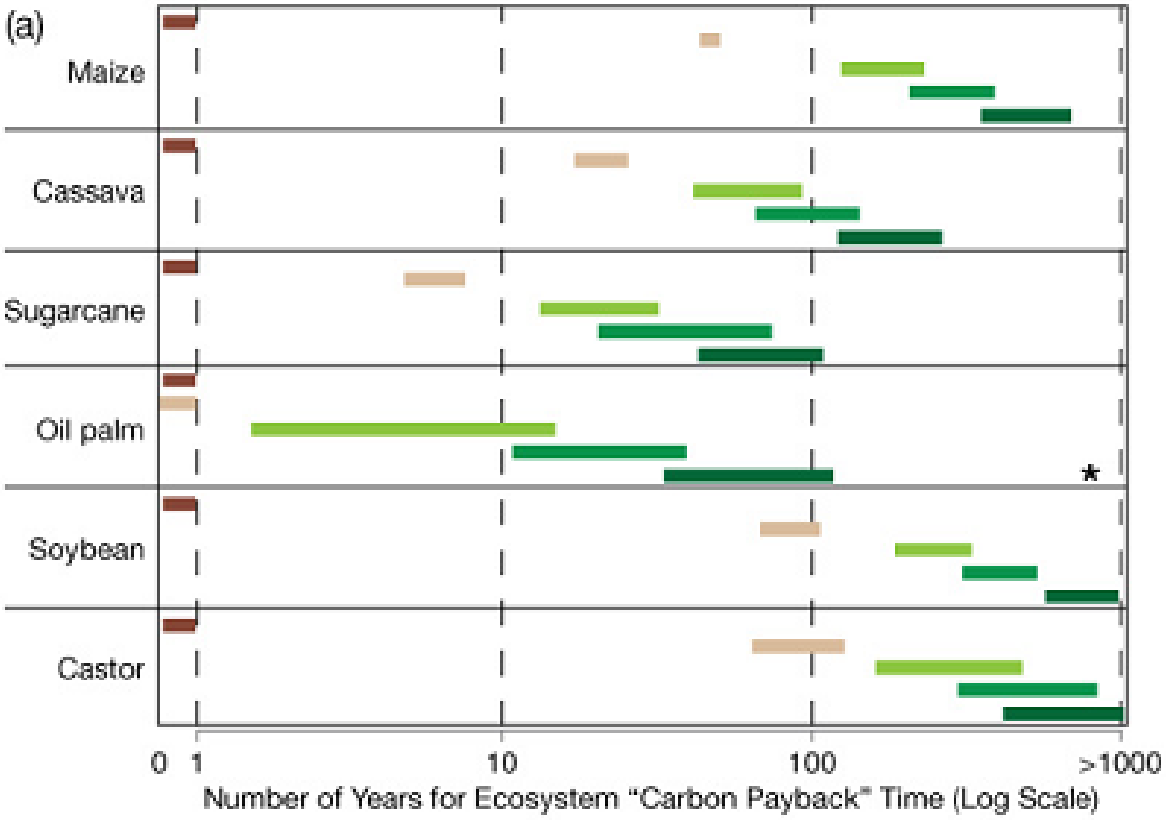
Germany, Poland and France together produce half of the cereals in the EU-27.

Source: Eurostat 2010, IEA 2009

Introduction: Sustainable biomass potential

- Advantages of biomass:
  → applicable in all sectors, on demand, also for process heat
  → leads to high competition for restricted biomass potential
- Residues and Wastes → limited by primary use
- **Energy crop production**
  - **variable biomass production on demand**
  - **increases land use competition**
    - **risk for markets of food, feed and fibre**
    - **risk of direct and indirect land use change**
      → CO2 emissions with long carbon payback time

Carbon payback time for land use change: Assumptions by IPCC



Source: IPPC SREN (2011)

Ecosystem carbon payback time for potential biofuel crop expansion pathways across the tropics for the year 2000 agricultural system

Objective: the sustainable energy crop potential

Basic assumptions

- Indirect and direct land use change must be avoided to keep biomass a low-carbon energy source --> only on existing agricultural land
- All agricultural land not in use e.g. for food and fiber is available for energy crops

Assessment of land use development in a country for a specific period

→for Poland and Germany

→until 2030

The modeling and scenario approach

Potentially available agricultural area

- **varies over time → trends**
- **depends on political targets**

Trends on food demand, agricultural productivity etc.

→Development of the HEKtar kalculaTOR Model

Assessment of „uncertain“ driving factors

→Development of Scenarios

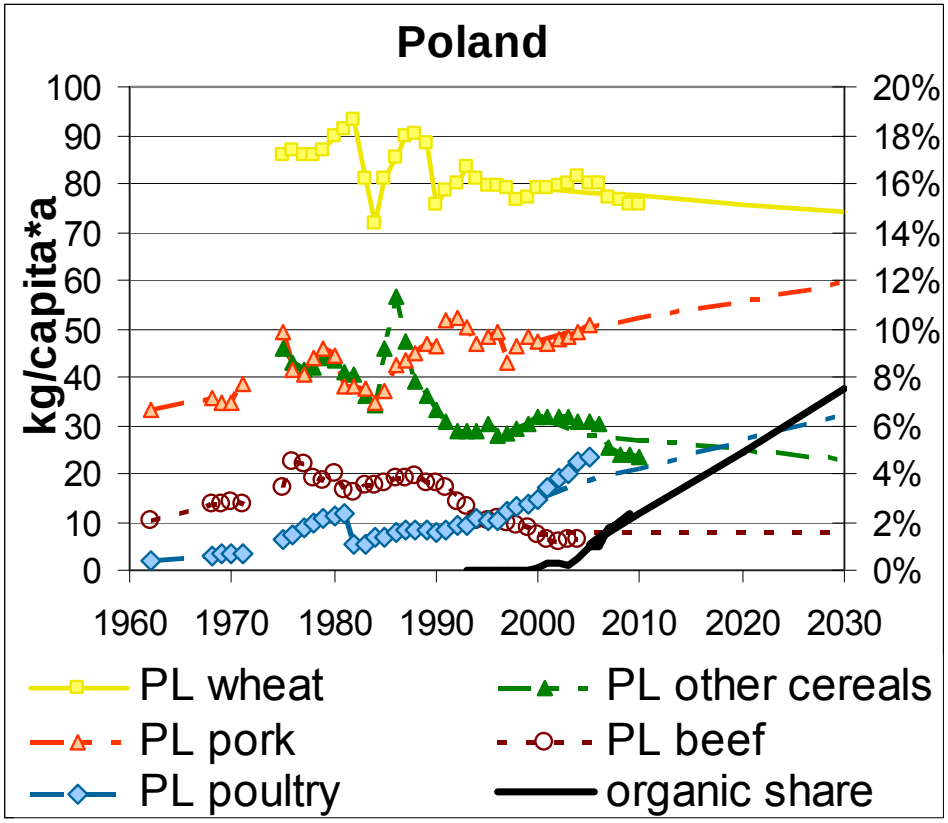
Biomass potential model HEKTOR

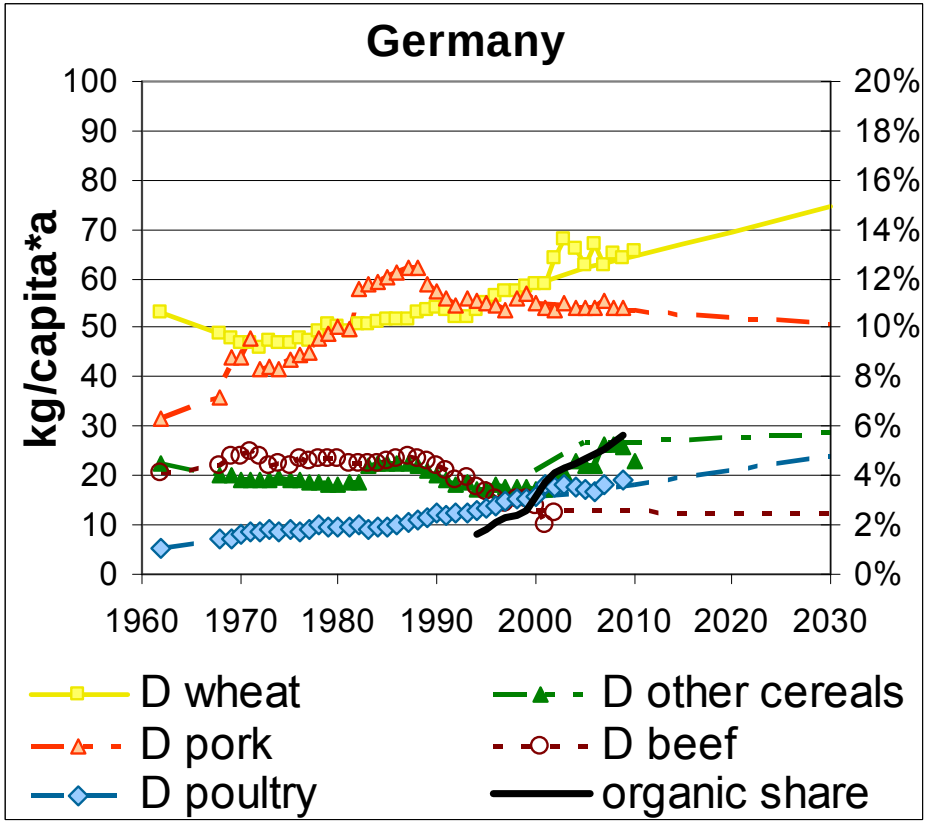
Biomass potential model HEKTOR

food demand:

- population
- food consumption

Trends in food supply





- Poland: increase in meat, decrease in wheat
- Germany: stagnation in meat, increase in wheat

Biomass potential model HEKTOR

food demand:

- population
- food consumption

land use for food:

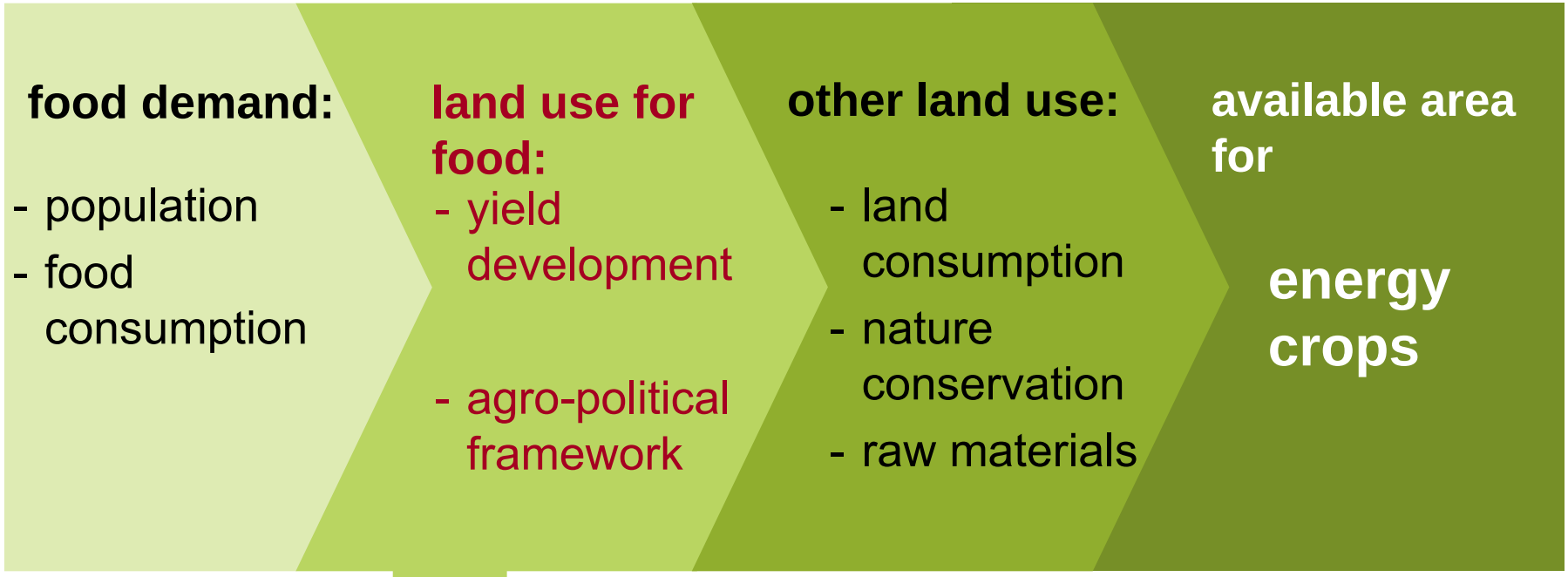
- yield development
- agro-political framework

- Increase in crop yields
- Increase in milk production/cow

→**Future development along trends**

- Phasing out of milk quotas
- Gras land conservation

Biomass potential model HEKTOR



available agricultural residues:
straw, manure

Scenario development

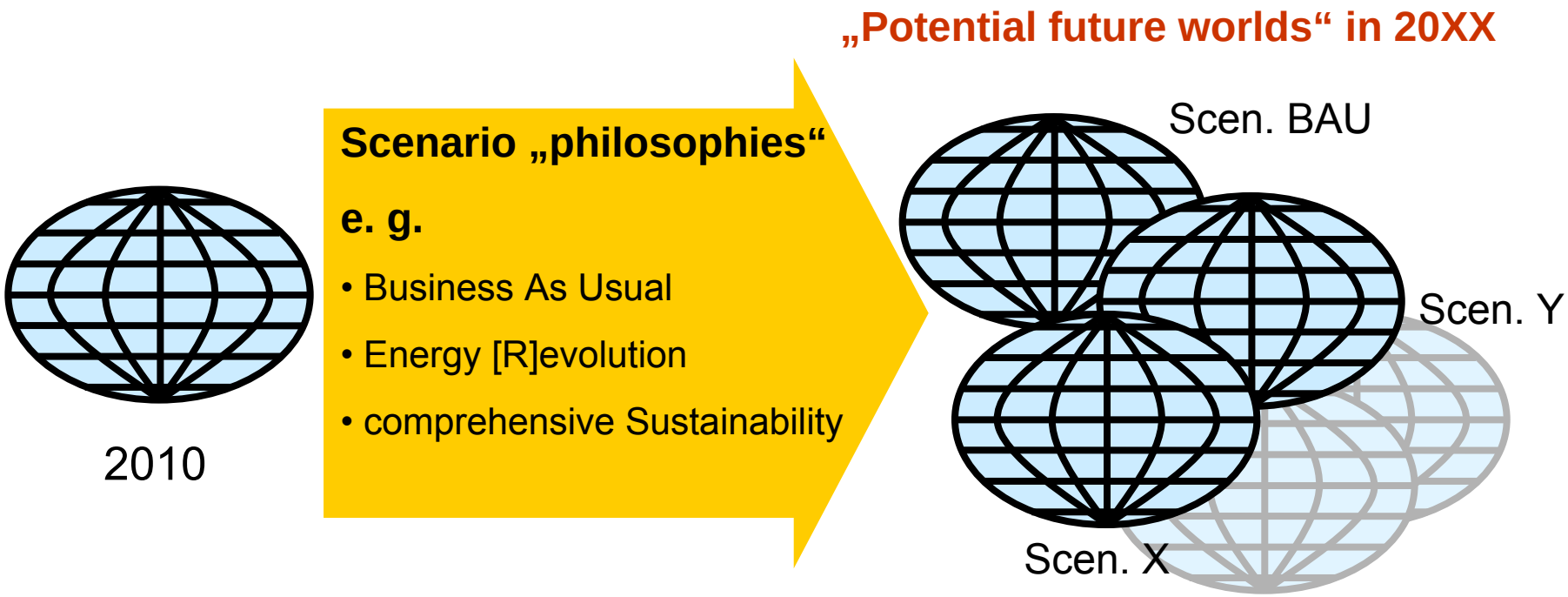
Policy dependent aspects, e.g:

- Agricultural market prospects
- Organic farming
- Nature conservation targets

→ Assessment via different scenarios

Scenario approach

- Scenarios are if-then assumptions
- Story lines describe sets of uncertainties
- No prognosis!!

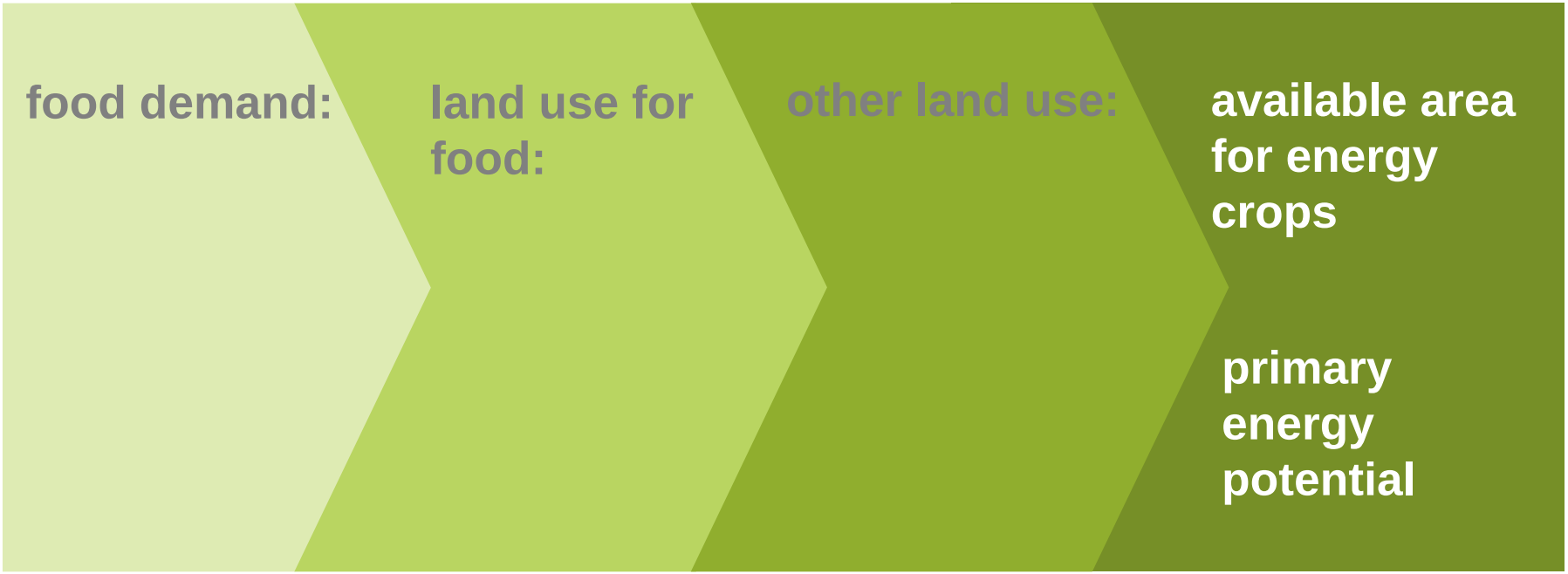


Scenario development

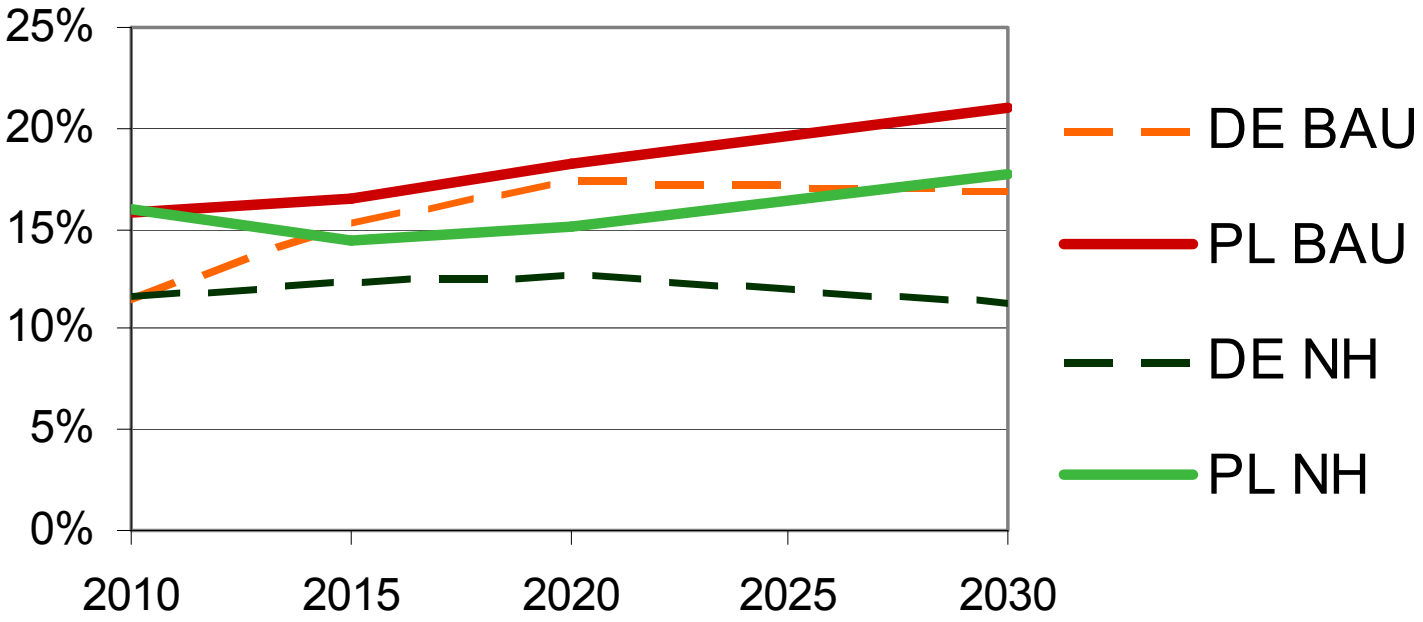
Scenario	Business as usual Scenario (BAU)	Sustainability Scenario (NH)
Story line	**Development along current trends, no further measures**	**consistent sustainability targets in various sectors**
Organic farming/ High Nature Value farming*	PL 8% DE 12%	PL10% + high share of HNV farming DE 30%
Land consumption for building activity	PL ~25 ha/d ↑ DE ~80ha/d ↓	PL 20 ha/d DE 30 ha/d by 2020
Land for Nature conservation	trend	PL forest area ↑ + HNV farming DE 10% of land area
Market prospects (DG AGRI)	Shifting to pork and poultry; good prospects for milk + products	
Self sufficiency	stagnation	

*HNV farming: low intensity but no organic label

Results of the Scenarios

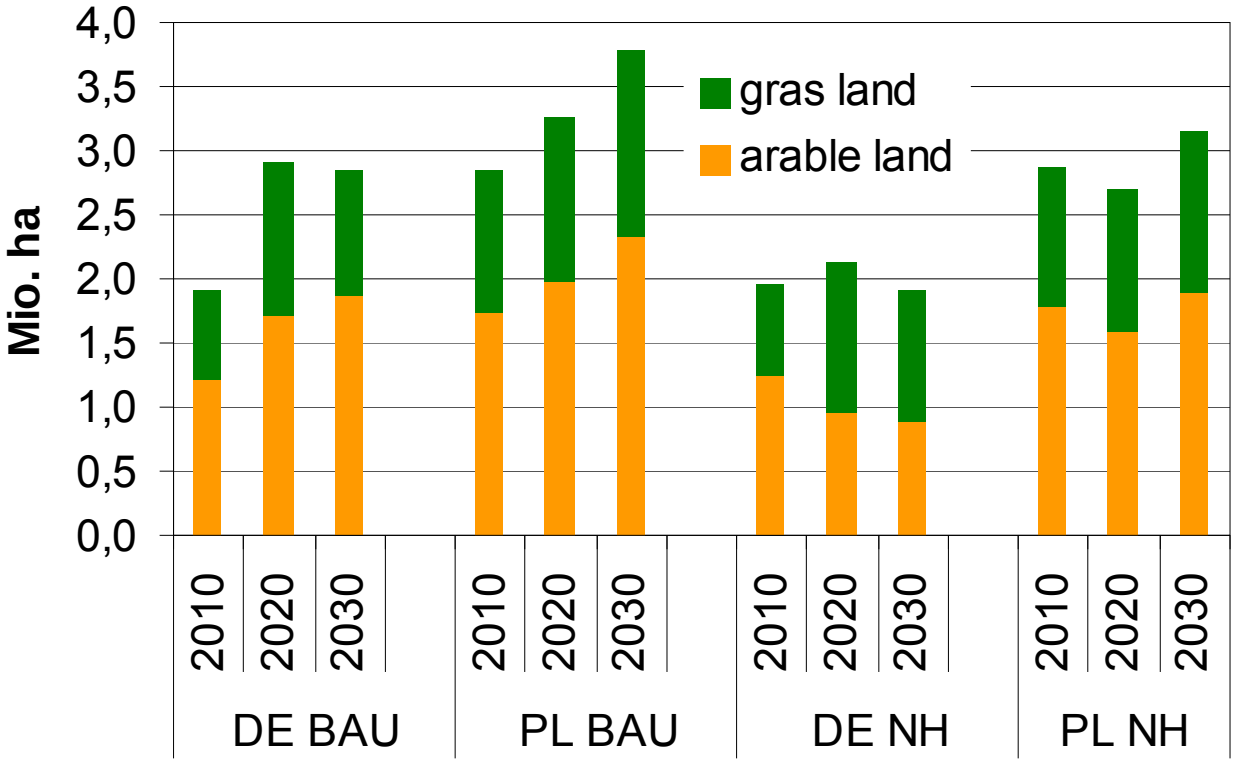


share of ulilitzed agricultural area available for energy prodcution



- 15-20% of UAA is available for bioenergy under the BAU and NH scenario
- Slow increase in PL
- Stagnation in DE

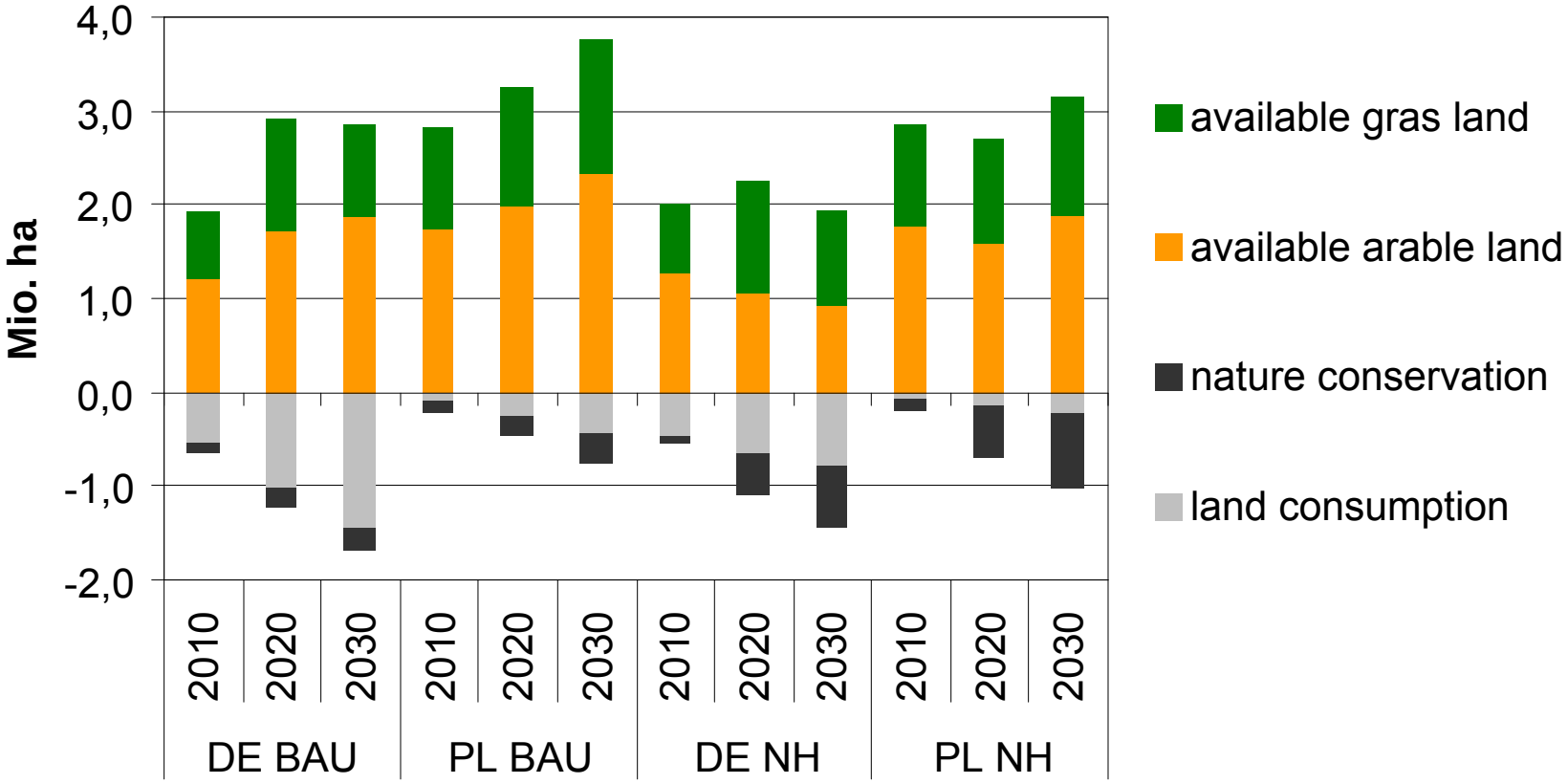
Availability of grasland and arable land



→Sustainability scenario mainly decreases availability of arable land

→Share of availabe arable land depends on system intensity

Availability of grasland and arable land



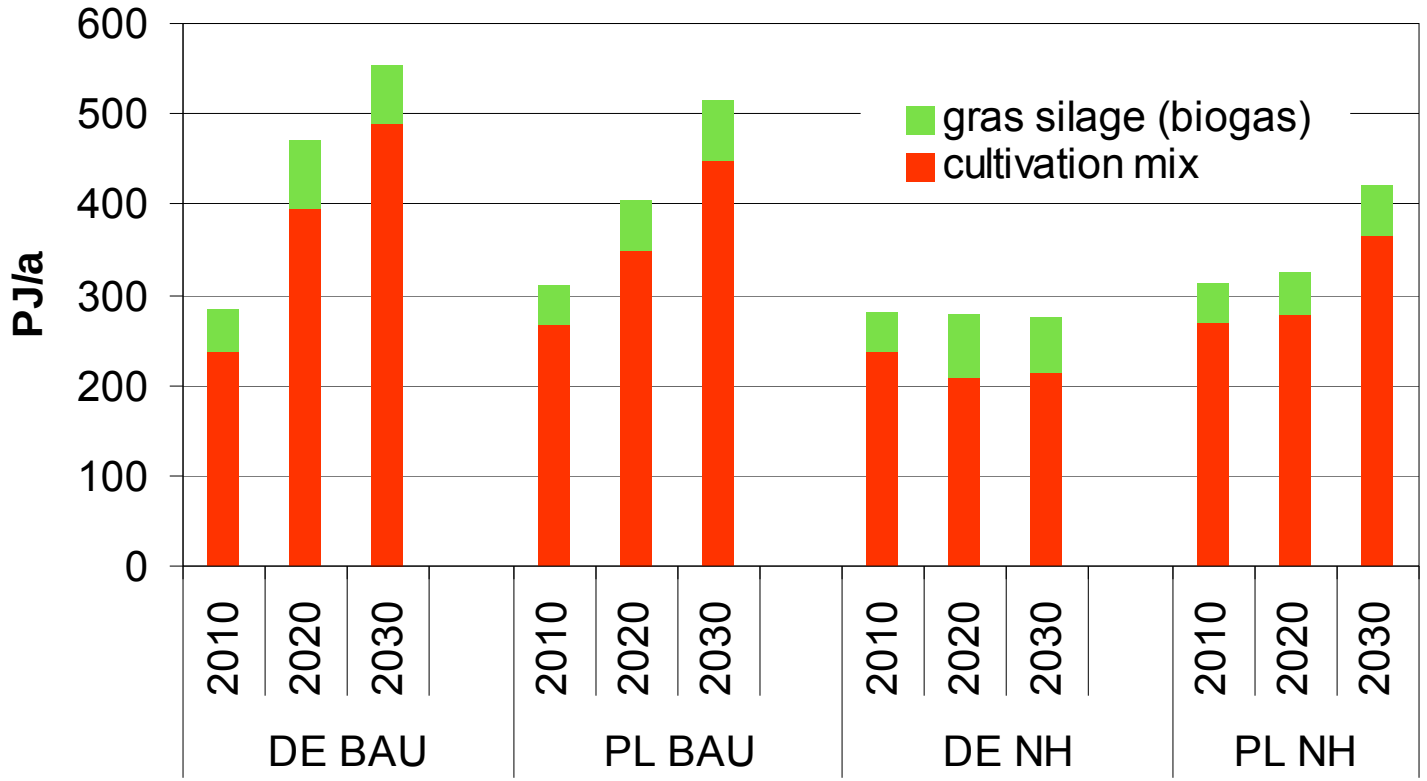
Results of the Scenarios

Primary energy potential on available land

Transformation of area into energy

- On arable land calculated by a cultivation mix of 6 major crops:
  - Wheat (+ straw)
  - Sugar beet (+ residues)
  - Rapeseed (+ straw)
  - Short rotation coppice
  - Maize silage (for biogas)
  - Twin cultivation/mixed cultivation (for biogas)
- On gras land: gras silage for biogas

Primary energy potential on available land



→Primary energy yield is variable

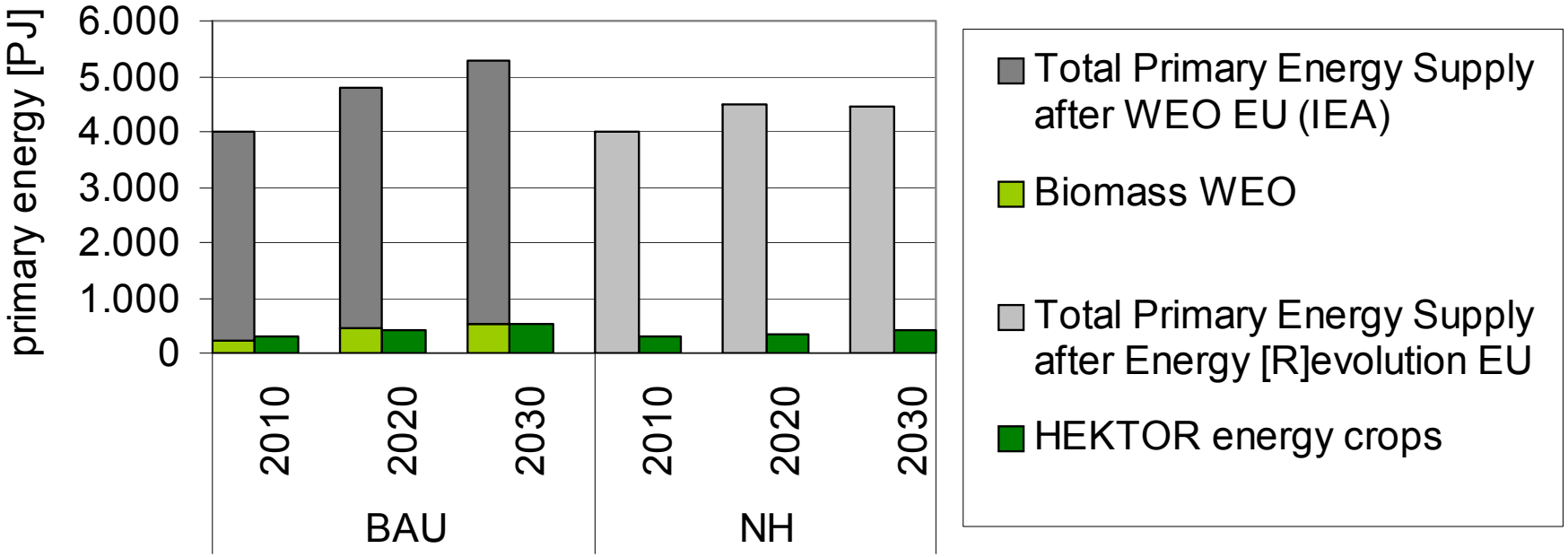
→Depends strongly on applied cultivation systems

Outlook

How relevant is the potential of energy crops for the whole Energy System?

- Compared to Energy scenarios
- Compared to the National Renewable Action plan

Evaluation of primary energy potential in PL



- Primary energy from energy crops alone ~ 10% of TPES

Sources: World Energy Outlook (IEA 2009); Energy [R]evolution (Greenpeace 2008)

Evaluation of primary energy potential

- **National Renewable Action Plan**
  Overall Biomass availability: **283** PJ in 2020
  → **123** PJ from agricultural crops+residues

- Primary energy from energy crops from HEKTOR
  - NH 2020: **325** PJ
  - REF 2020: **400** PJ

→ Still some potential can be developed

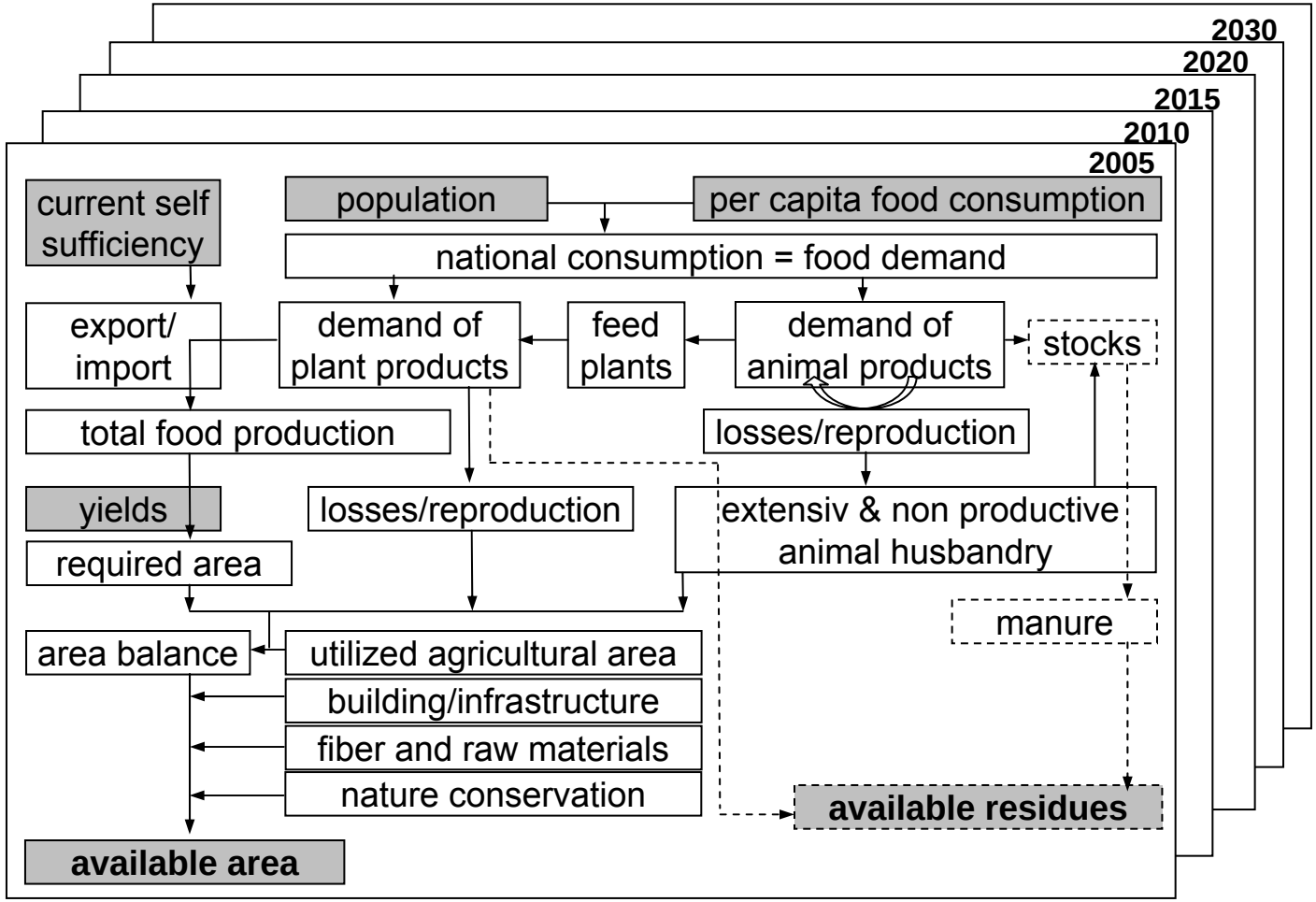
Conclusions

- available area for energy crops in Poland is increasing over time
- 15-20% of agricultural area is available for biomass production
- Other sustainability targets strongly restrict energy potential
- Without a comprehensive sustainability approach cultivation of energy crops can pose a serious risk to sustainability

Thank you for your attention!

References

- Simon, S. (2007). Szenarien nachhaltiger Bioenergiepotenziale bis 2030 - Modellierung für Deutschland, Polen, Tschechien und Ungarn. Lehrstuhl für Wirtschaftslehre des Landbaues. Freising, Technische Universität München
- Simon, Sonja und Wiegmann, Kirsten (2009) Modelling sustainable bioenergy potentials from agriculture for Germany and Eastern European countries. Biomass and Bioenergy, 33 (4)
- Teske, Sven und Pregger, Thomas und Simon, Sonja und Naegler, Tobias und Graus, Wina und Lins, Christine (2011) Energy [R]evolution 2010 - a sustainable world energy outlook. Energy Efficiency, 4 (3),
- NREAP Poland: National Renewable Action Plan http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm


2030
2020
2015
2010
2005
current self sufficiency
population
per capita food consumption
national consumption = food demand
export/ import
demand of plant products
feed plants
demand of animal products
stocks
total food production
losses/reproduction
yields
losses/reproduction
extensiv & non productive animal husbandry
required area
manure
area balance
utilized agricultural area
building/infrastructure
fiber and raw materials
nature conservation
available residues
available area

Competition for agricultural area

Energy crops face **increasing** competition due to

- Restricted overall land availability
- Increasing demand for food and feed
- Increasing demand for raw materials
- Goals for organic/high nature value farming (lower yields)
- Targets for nature conservation
- Land consumption for building activity

Competition can be **decreased** by

- Productivity increase in agriculture
- Political targets limiting land consumption

Sustainable Biomass potential depends on situation and targets of other sectors

Biomass potential model HEKTOR