SAHYOG

Strengthening Networks on Biomass Research and Biowaste Conversion – Biotechnology for Europe – India Integration

(FKZ 3710 93 109)

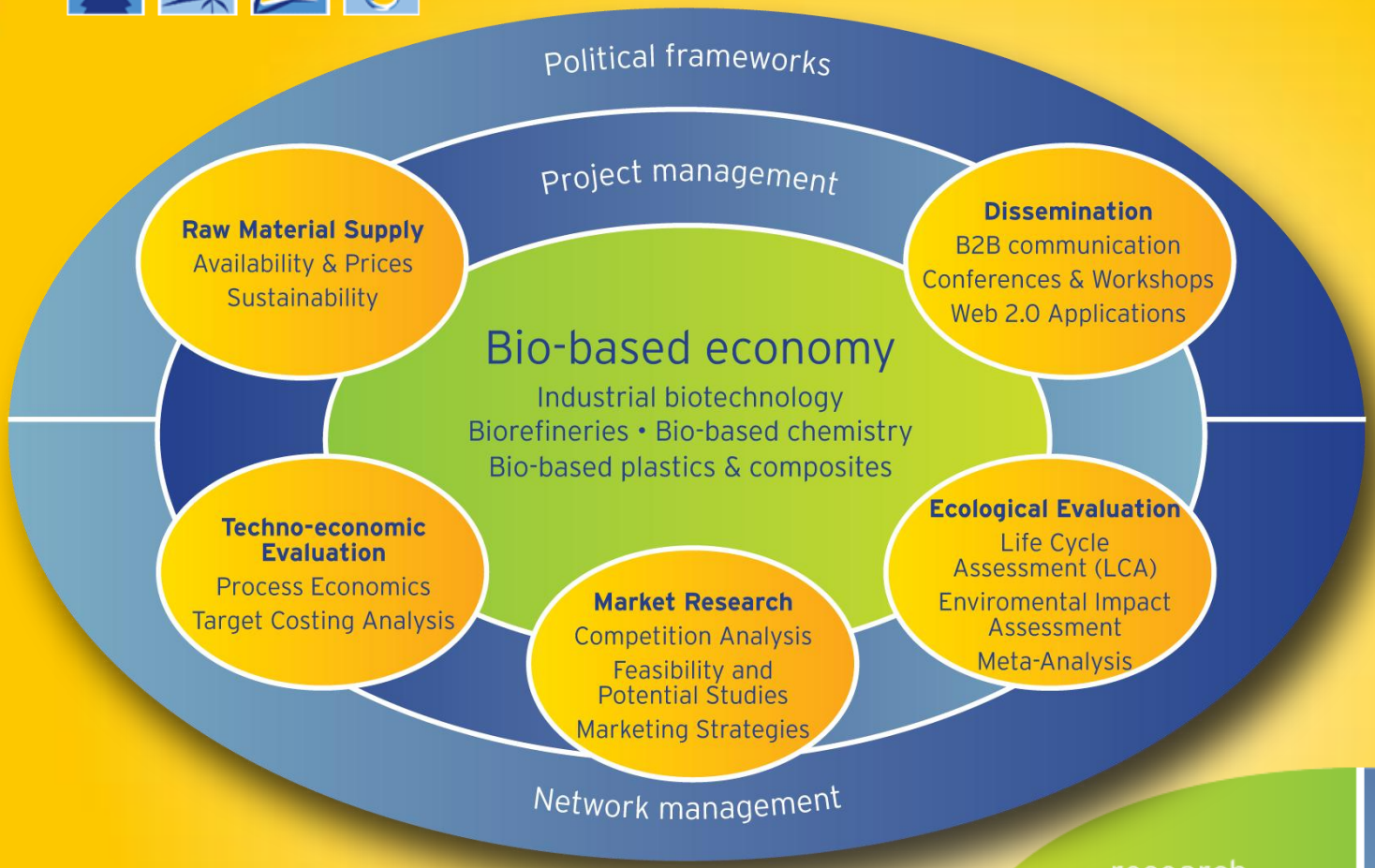
Achim Raschka

nova-Institut GmbH

1st Expert‘s Meeting, 10 May 2012, Bruges (Belgium)

Bio-based Economy – Bio-based Chemistry and Materials

- Raw Material Supply
- Techno-economic Evaluation
- Market Research
- Ecological Assessments
- Dissemination
- Policy


Political frameworks
Project management
Raw Material Supply
Availability & Prices
Sustainability
Dissemination
B2B communication
Conferences & Workshops
Web 2.0 Applications
Bio-based economy
Industrial biotechnology
Biorefineries • Bio-based chemistry
Bio-based plastics & composites
Techno-economic Evaluation
Process Economics
Target Costing Analysis
Ecological Evaluation
Life Cycle Assessment (LCA)
Enviromental Impact Assessment
Meta-Analysis
Market Research
Competition Analysis
Feasibility and Potential Studies
Marketing Strategies
Network management


research projects
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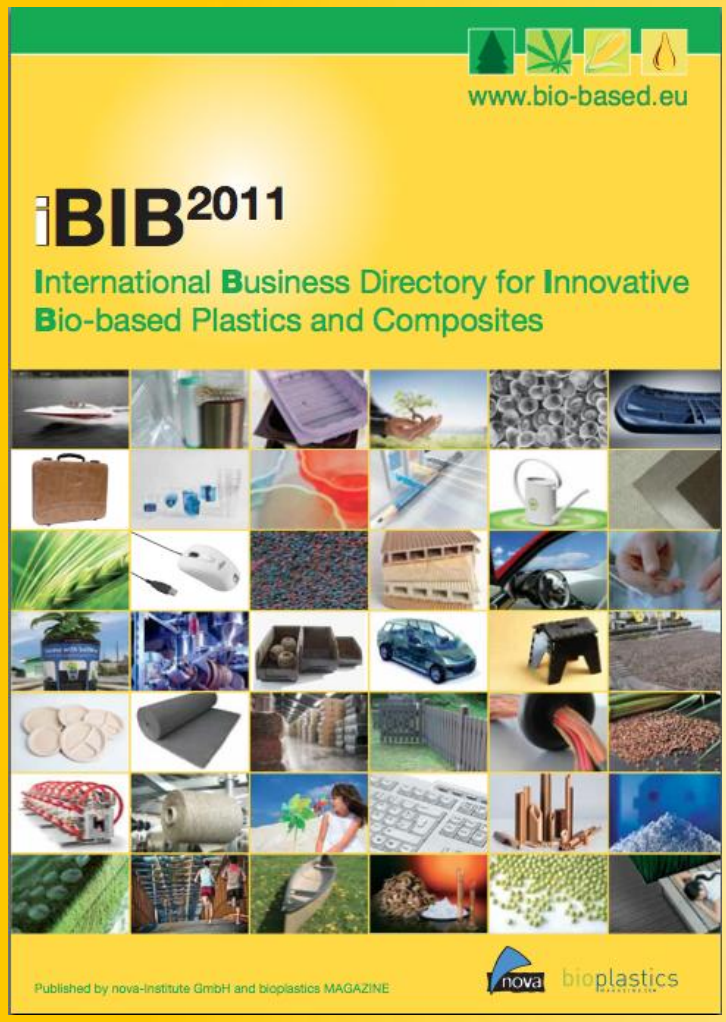

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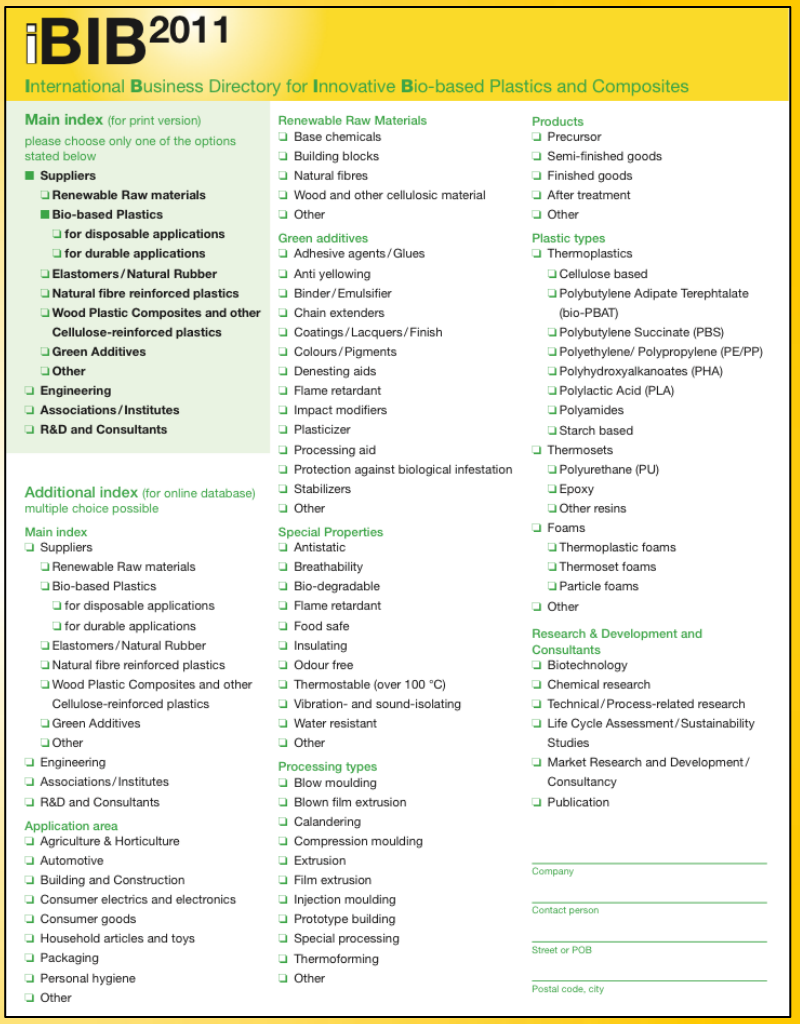

iBIB2011

International Business Directory for Innovative Bio-based Plastics and Composites

Main index (for print version)
please choose only one of the options stated below

- ■ **Suppliers**
  - ❑ **Renewable Raw materials**
  - ■ **Bio-based Plastics**
    - ❑ **for disposable applications**
    - ❑ **for durable applications**
  - ❑ **Elastomers / Natural Rubber**
  - ❑ **Natural fibre reinforced plastics**
  - ❑ **Wood Plastic Composites and other Cellulose-reinforced plastics**
  - ❑ **Green Additives**
  - ❑ **Other**
- ❑ **Engineering**
- ❑ **Associations / Institutes**
- ❑ **R&D and Consultants**

Additional index (for online database)
multiple choice possible

Main index
- ❑ Suppliers
  - ❑ Renewable Raw materials
  - ❑ Bio-based Plastics
    - ❑ for disposable applications
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  - ❑ Elastomers / Natural Rubber
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  - ❑ Green Additives
  - ❑ Other
- ❑ Engineering
- ❑ Associations / Institutes
- ❑ R&D and Consultants

Application area
- ❑ Agriculture & Horticulture
- ❑ Automotive
- ❑ Building and Construction
- ❑ Consumer electrics and electronics
- ❑ Consumer goods
- ❑ Household articles and toys
- ❑ Packaging
- ❑ Personal hygiene
- ❑ Other

Renewable Raw Materials
- ❑ Base chemicals
- ❑ Building blocks
- ❑ Natural fibres
- ❑ Wood and other cellulosic material
- ❑ Other

Green additives
- ❑ Adhesive agents / Glues
- ❑ Anti yellowing
- ❑ Binder / Emulsifier
- ❑ Chain extenders
- ❑ Coatings / Lacquers / Finish
- ❑ Colours / Pigments
- ❑ Denesting aids
- ❑ Flame retardant
- ❑ Impact modifiers
- ❑ Plasticizer
- ❑ Processing aid
- ❑ Protection against biological infestation
- ❑ Stabilizers
- ❑ Other

Special Properties
- ❑ Antistatic
- ❑ Breathability
- ❑ Bio-degradable
- ❑ Flame retardant
- ❑ Food safe
- ❑ Insulating
- ❑ Odour free
- ❑ Thermostable (over 100 °C)
- ❑ Vibration- and sound-isolating
- ❑ Water resistant
- ❑ Other

Processing types
- ❑ Blow moulding
- ❑ Blown film extrusion
- ❑ Calandering
- ❑ Compression moulding
- ❑ Extrusion
- ❑ Film extrusion
- ❑ Injection moulding
- ❑ Prototype building
- ❑ Special processing
- ❑ Thermoforming
- ❑ Other

Products
- ❑ Precursor
- ❑ Semi-finished goods
- ❑ Finished goods
- ❑ After treatment
- ❑ Other

Plastic types
- ❑ Thermoplastics
  - ❑ Cellulose based
  - ❑ Polybutylene Adipate Terephtalate (bio-PBAT)
  - ❑ Polybutylene Succinate (PBS)
  - ❑ Polyethylene/ Polypropylene (PE/PP)
  - ❑ Polyhydroxyalkanoates (PHA)
  - ❑ Polylactic Acid (PLA)
  - ❑ Polyamides
  - ❑ Starch based
- ❑ Thermosets
  - ❑ Polyurethane (PU)
  - ❑ Epoxy
  - ❑ Other resins
- ❑ Foams
  - ❑ Thermoplastic foams
  - ❑ Thermoset foams
  - ❑ Particle foams
- ❑ Other

Research & Development and Consultants
- ❑ Biotechnology
- ❑ Chemical research
- ❑ Technical / Process-related research
- ❑ Life Cycle Assessment / Sustainability Studies
- ❑ Market Research and Development / Consultancy
- ❑ Publication

Company

Contact person

Street or POB

Postal code, city

Book, eBook, App (iPad), PDF & Online-Database

Pictures (left to right): Teijin, Polyone, Staedtler, Propper, Biotex, Fujitsu, Werzalit

Bio-based News

The portal for bio-based economy, bio-based plastics & composites and industrial biotechnology

Established service:

www.bio-based.eu/news

new price 495,- €/year

Get a comprehensive overview about recent developments in the field of biomaterials and industrial biotechnology: fast – exclusive – solid – relevant

- online portal with daily news articles
- weekly newsletter
- supplier & stakeholder directory (more than 2,000 entries)
- data base with 10,000 news
- full text and index search

Your unique source of expert information on bio-based plastics & composites, industrial biotechnology, biorefineries and green chemistry

- new investments
- new product placements
- market data
- policy framework
- Research & Development

One year subscription for only: 1,000 € plus 19% VAT. The search engine as well as all keywords are fully available in English and German. The news articles themselves are 60% in English and 40% in German.

www.bio-based.eu/news

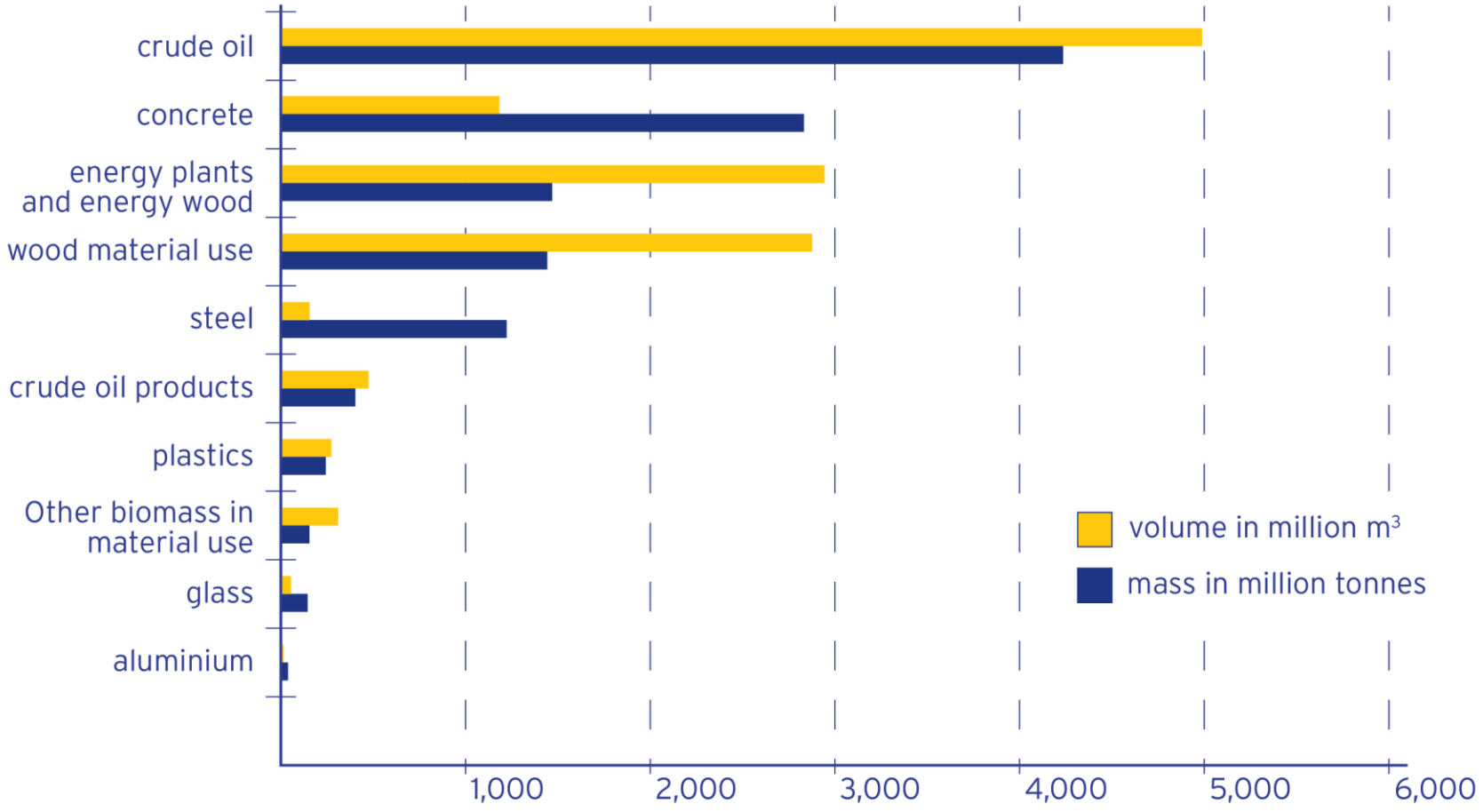
TYPICAL NEWS

- NEW **Clariant plans acquisition of Süd-Chemie AG** [2011-02-16]
  Cooperation to focus on innovation and growth in emerging markets
- NEW **Clariant AG plant Erwerb der Süd-Chemie AG** [2011-02-16]
  Zusammenarbeit soll Forschung in den Zukunftsmärkten Neue Materialien und Biotechnologie stärken
- NEW **Novozymes sucht zweites Standbein im Biobusiness** [2011-02-16]
  Kauf der EMD-Agrosparte des Chemiekonzerns Merck KGaA erlaubt neue Wachstumsziele
- NEW **LANXESS steps up commitment to biobased raw materials** [2011-02-15]
  10-year exclusive supply agreement with Gevo
- NEW **Coca-Cola says biodegradable packaging ‚not a viable option'** [2011-02-15]
  New report from Zenith International finds not all manufacturers to agree with

nova Institute

Feedstock for a Bio-based Economy Europe and worldwide

Relation of selected raw materials in material and energy use worldwide 2008

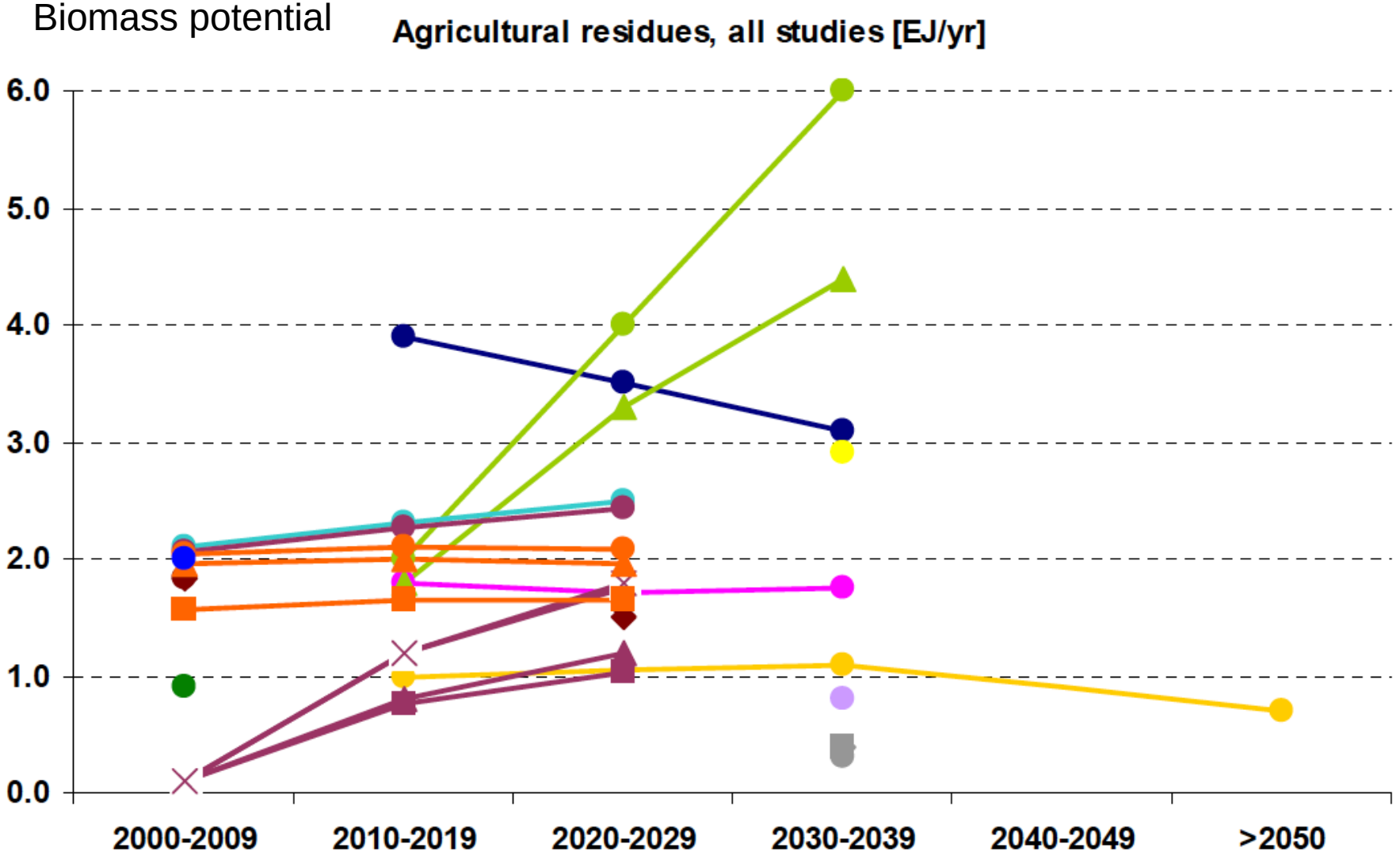


Sources: nova 2011 based on FAO, USDA and others

Biomass availability in Europe

According to the results of the Biomass Energy Europe (BEE) European project, the available estimates in various studies for biomass availability and potential are very widely scattered due to the framework of the surveys, and are therefore only of limited value as actual indicators of biomass potential (Koch et al. 2011).

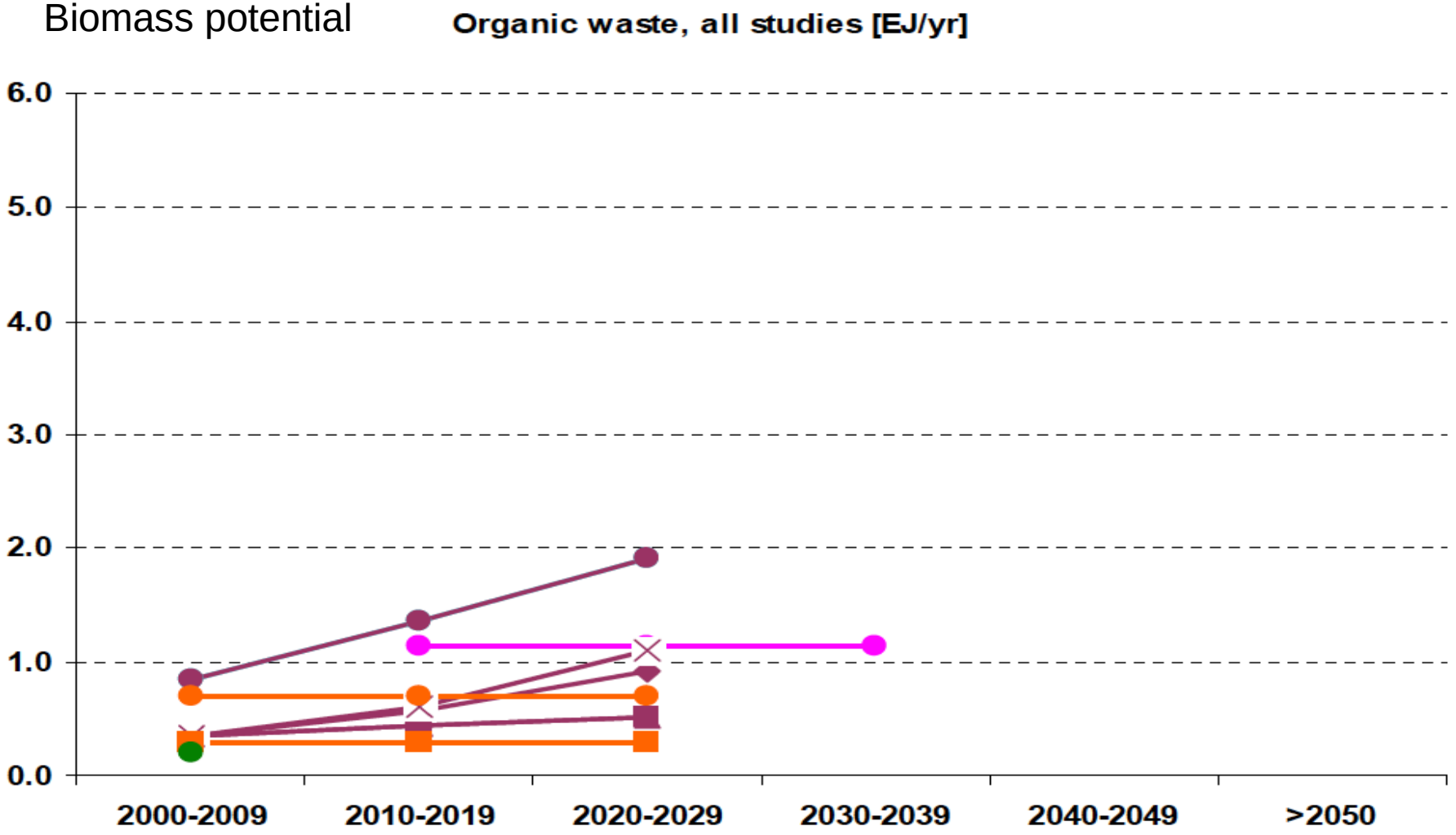
Biomass potential



EJ = Exa-Joule (10^{18} Joule)

Rettenmaier et al. 2010 (BEE)

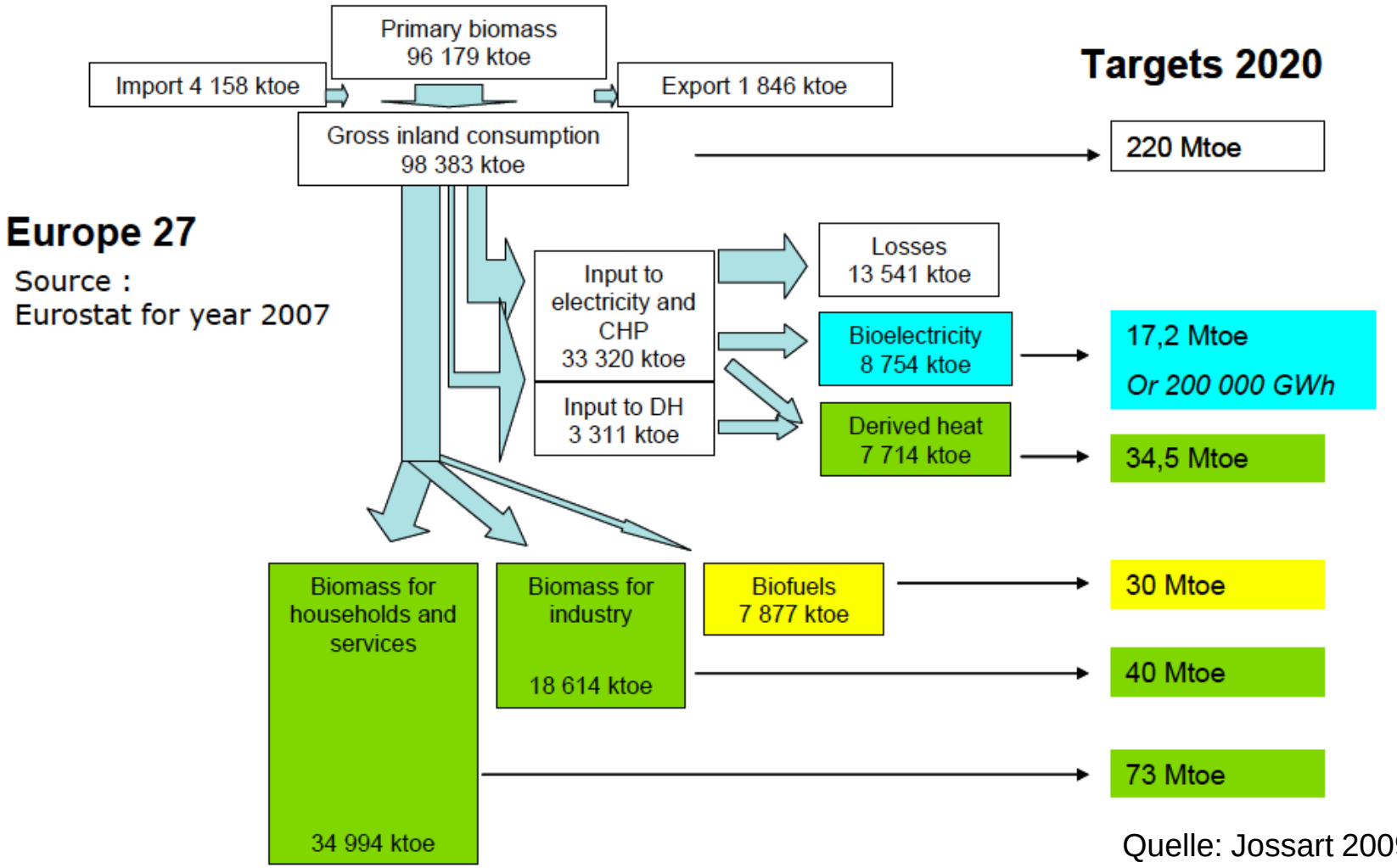
Biomass potential



EJ = Exa-Joule (10^{18} Joule)

Rettenmaier et al. 2010 (BEE)

Agricultural Biomass in the EU and targets



Quelle: Jossart 2009

Wood in the EU 2010

Potential in M m³	2010	in %	2010	in %	Demand in M m³
Stemwood C, ME	362	36.4	196	23.8	Sawmill industry
Stemwood NC, ME	182	18.3	11	1.3	Veneer plywood industry
Forest residues, ME	118	11.9	143	17.3	Pulp industry
Bark, ME	24	2.4	92	11.1	Panel industry
Landscape c. w. (USE) ME	59	5.9	15	1.8	Other material uses
Short rotation plantation	-	-	21	2.5	Producer solid wood fuels
Sawmill by products	87	8.8	86	10.4	Forest sector intern. use
Other industrial residues	30	3.0	83	10.1	Biomass power plants
Black liquor	60	6.0	23	2.8	Households (pellets)
Solid wood fuels	21	2.1	155	18.8	Households (other)
Post consumer wood	52	5.2	0	0.0	Liquid biofuels
Total	994	100.0	825	100.0	Total

Mantau et al. 2010 (EUWOOD)

Wood in the EU 2010

685 M m³
331 M odt
5,973 PJ

Forest woody biomass

Material uses

57 %
458 M m³
229 M odt
3,994 PJ

308 M m³
166 M odt
2,686 PJ

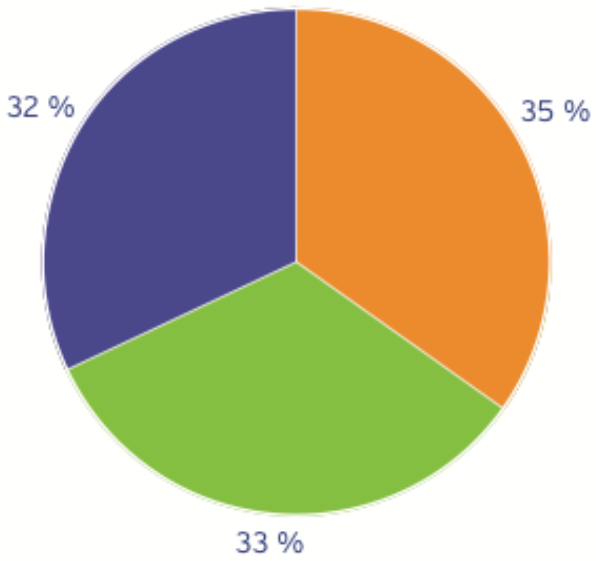
Other woody biomass

Energy uses

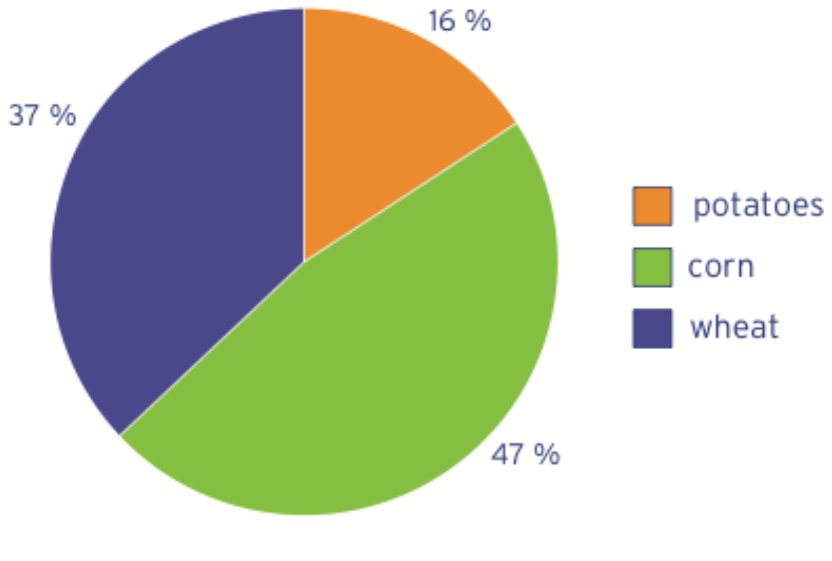
43 %
346 M m³
173 M odt
3,017 PJ

Mantau et al. 2010 (EUWOOD)

Percentage of different starch plants in agricultural production and in starch production in Europe 2008



raw materials 2008:
21.6 million tonnes

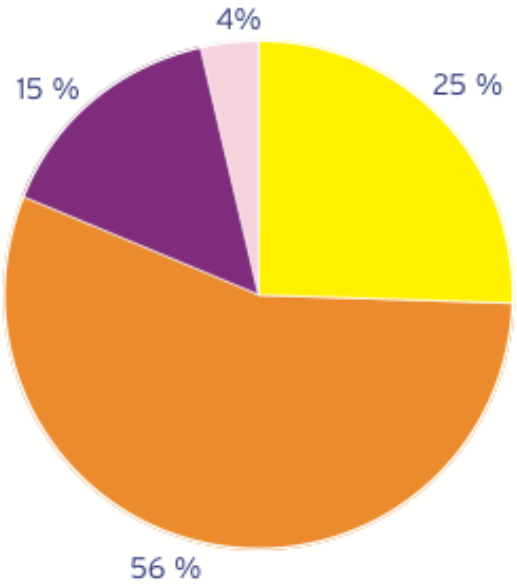


starch production 2008:
9.4 million tonnes

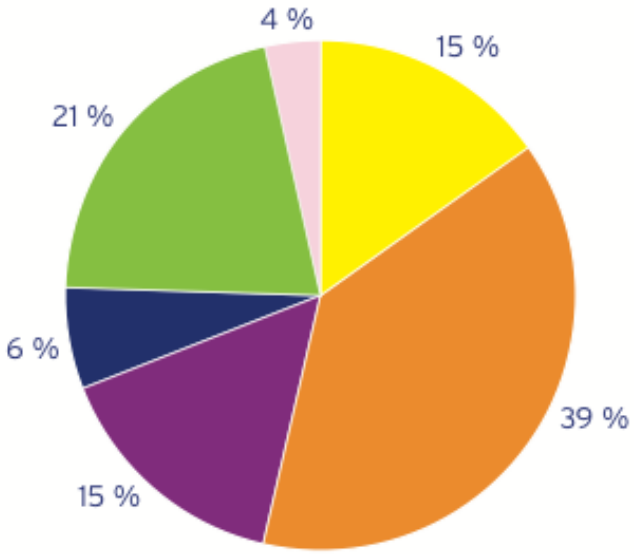
As for the sugar sector, roughly 17.5 million tonnes of refined sugar were produced in 2008, 98% of it used in the food industry. As a result, only about 350,000 tonnes were used in the non-food sector in 2008.

Sources: DSV 2010

Percentage of different oil plants in agricultural production and utilization in Europe 2008



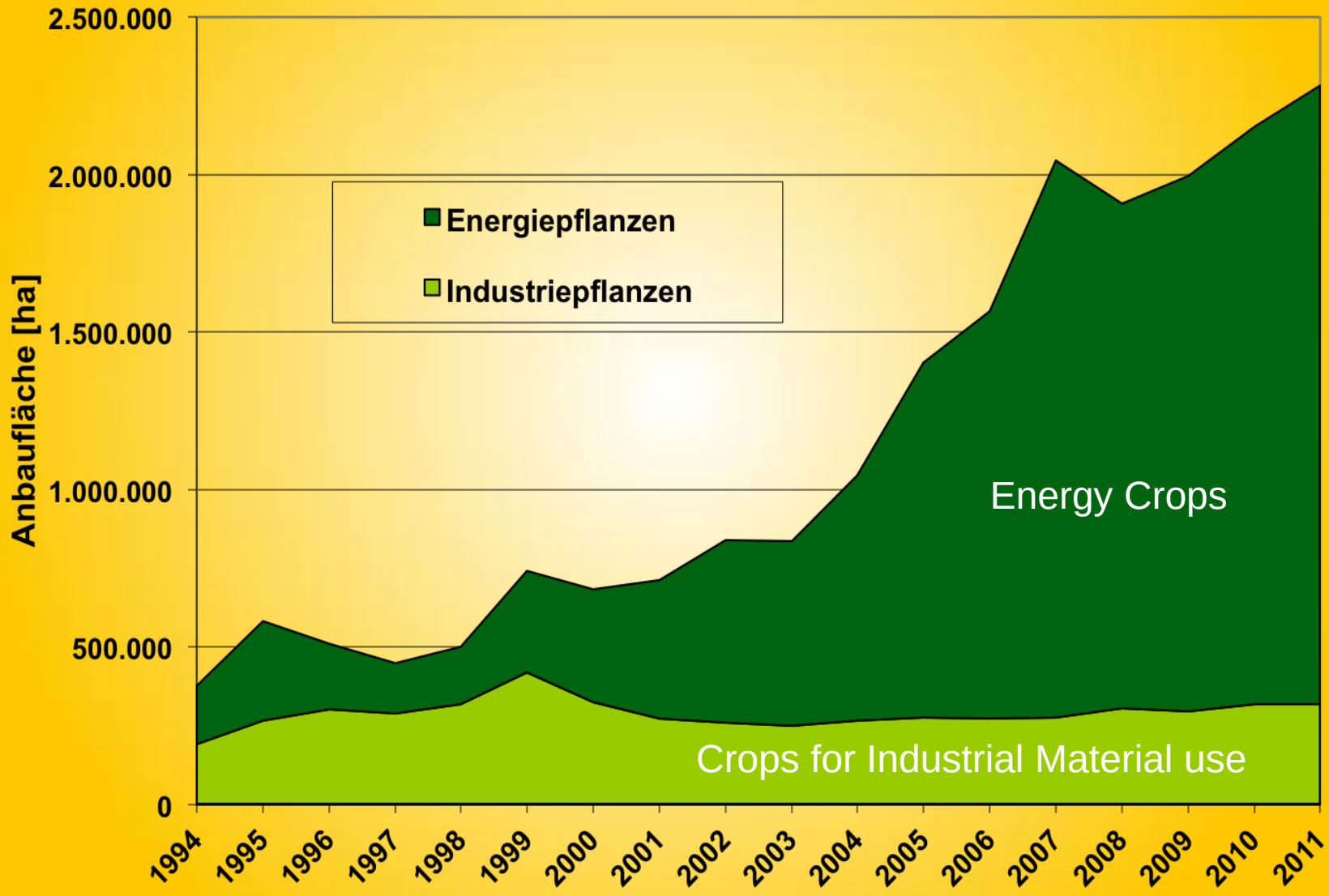
plant oil production 2008:
ca. 13 million tonnes



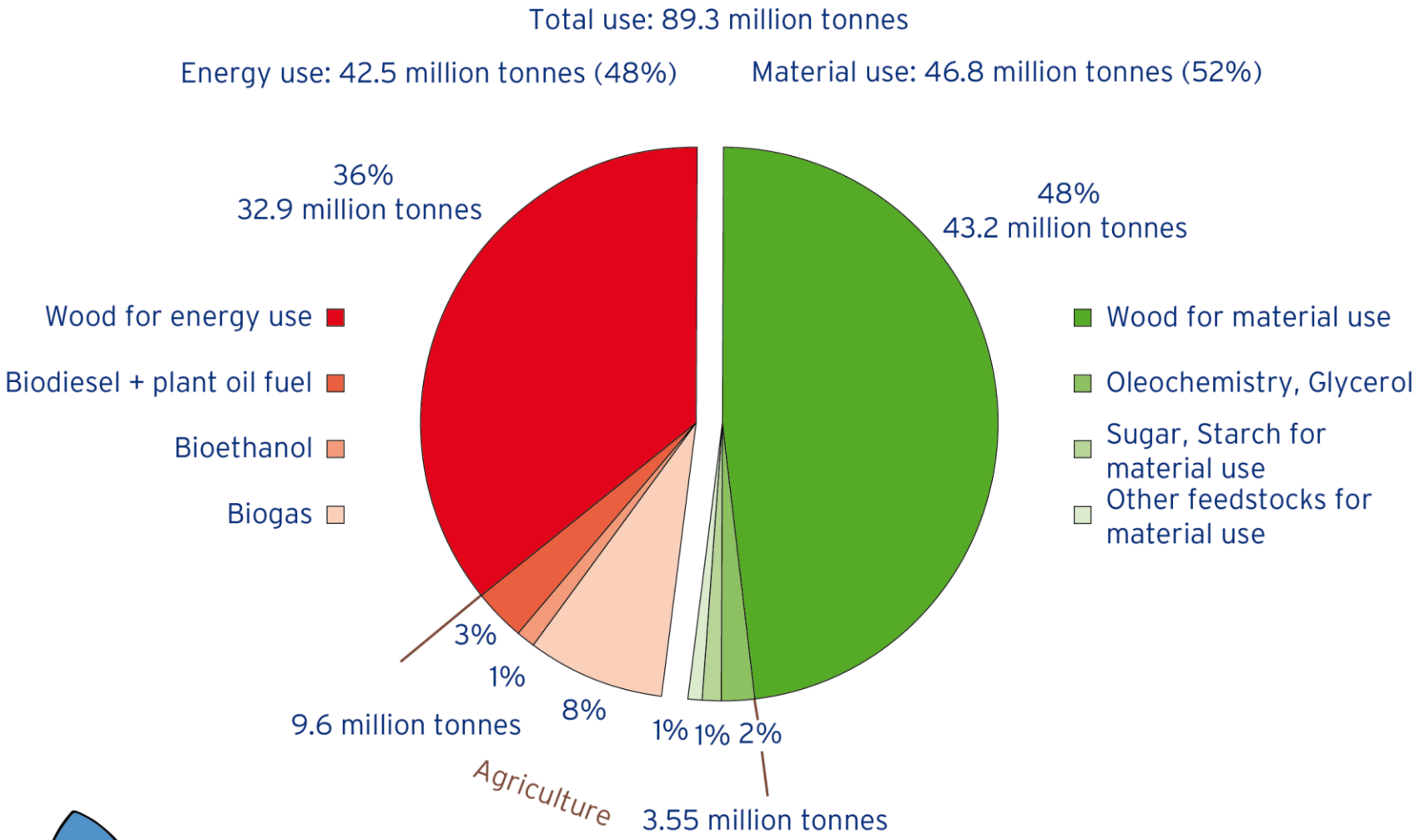
plant oil utilization 2008:
20.4 million tonnes

Sources: FEDIOL 2010

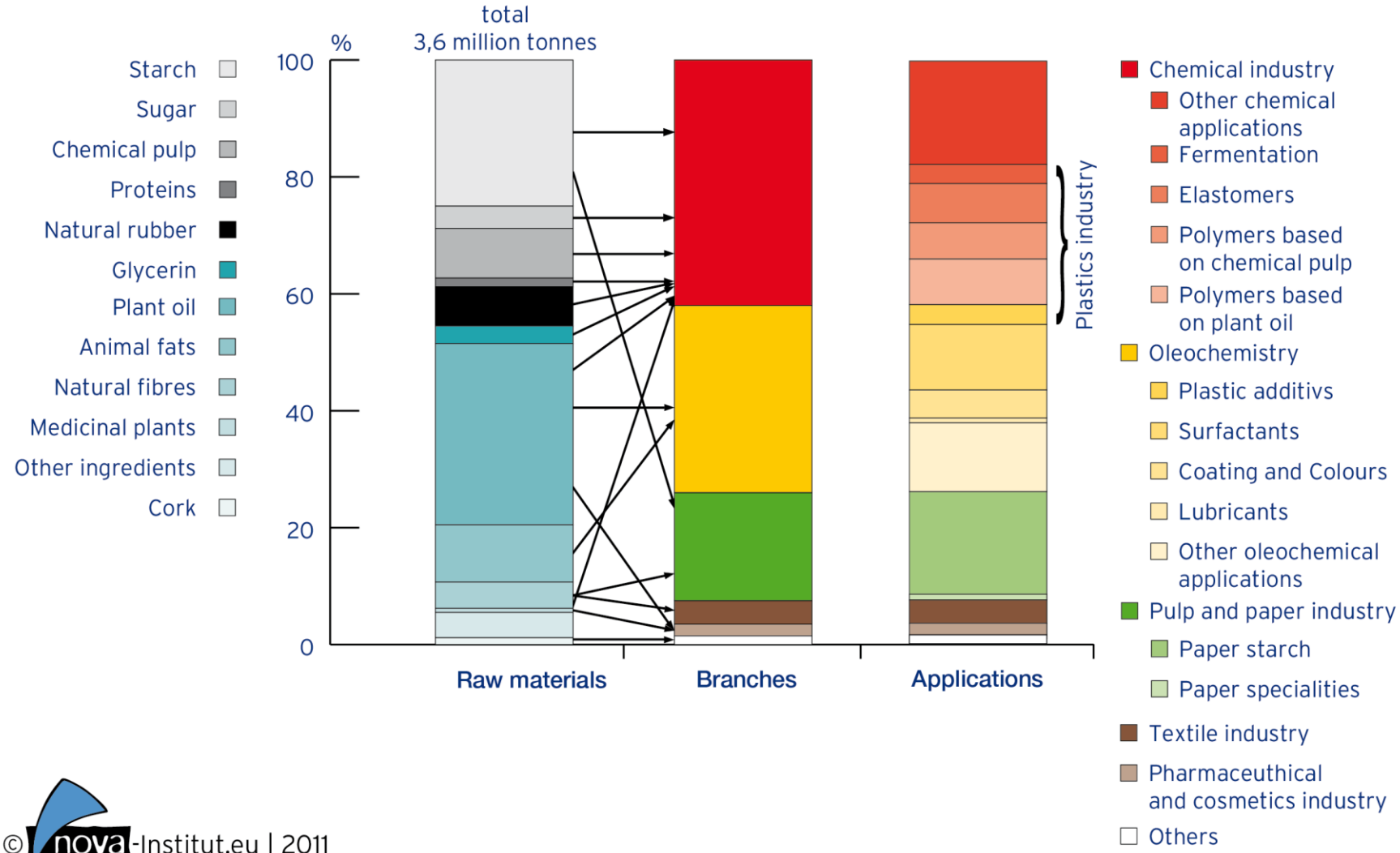
Energy and Industry Crops Cultivation in Germany



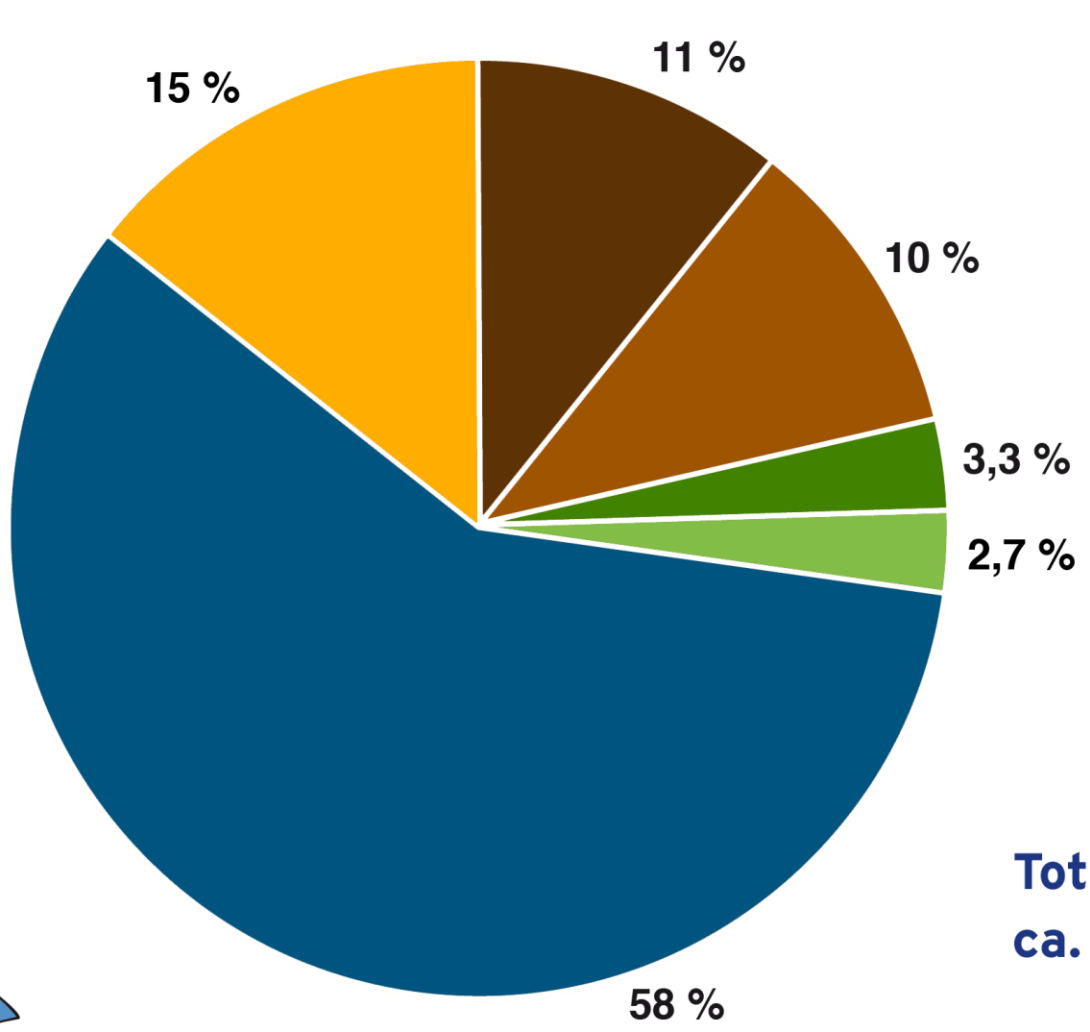
Use of renewable raw materials in Germany 2008



Industrial material use of renewable raw materials in Germany 2008 (without wood)



Use of harvested forestal and agricultural biomass worldwide (2008)



- Wood material use
- Wood energy use
- RRM material use
- RRM energy use
- Animal feed
- Food

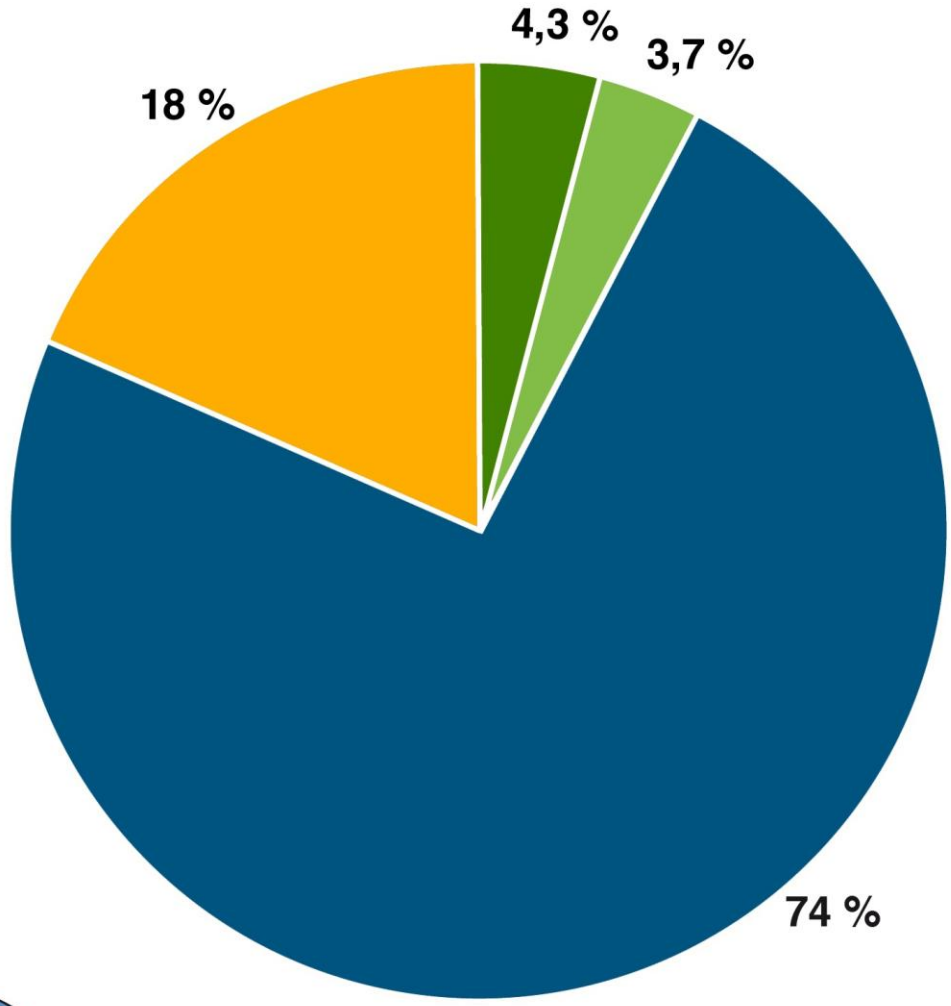
RRM = Renewable Raw Materials

Allocation of biomass to production target (main product). Respective amounts include raw materials and by products, even if their use fall into a different category.

Total biomass
ca. 13 billion tonnes

Sources: nova-Institute 2011, FAO 2011, Krausmann et al. 2008

Use of harvested agricultural biomass worldwide (2008)



- RRM material use
- RRM energy use
- Feed
- Food

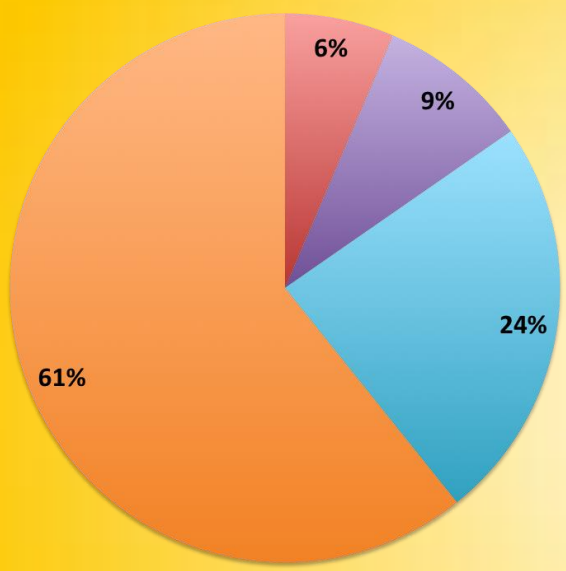
RRM = Renewable Raw Materials

Allocation of biomass to production target (main product). Respective amounts include raw materials and by products, even if their use fall into a different category.

Total biomass
ca. 10 billion tons

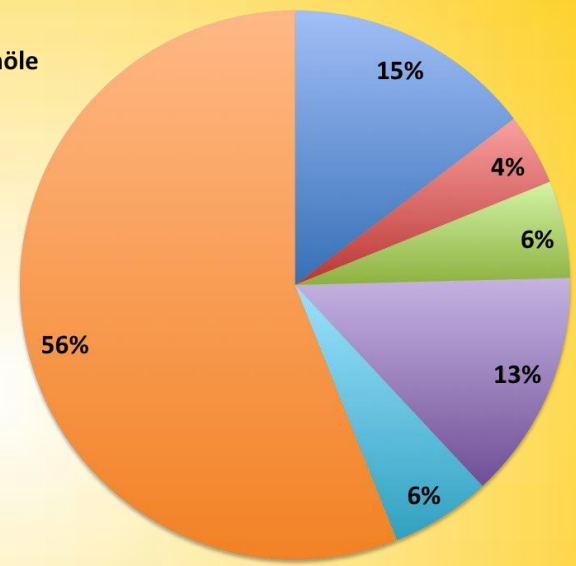
Sources: nova-Institute 2011, FAO 2011, Krausmann et al. 2008

Energetic and material use



Energetic use (without wood)

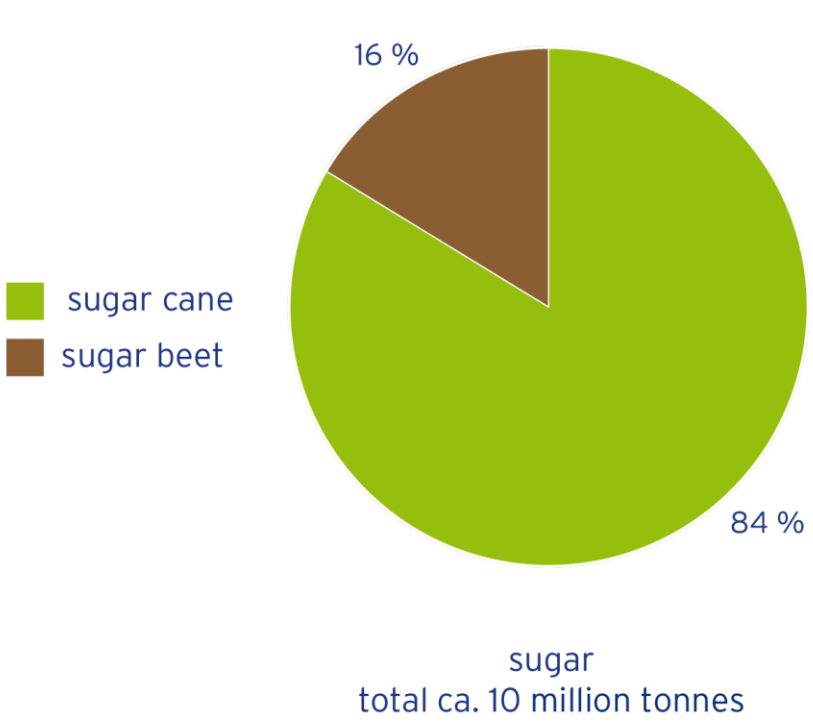
Total ca. 147 Mio. t (Wood 1.33 Mrd. t)



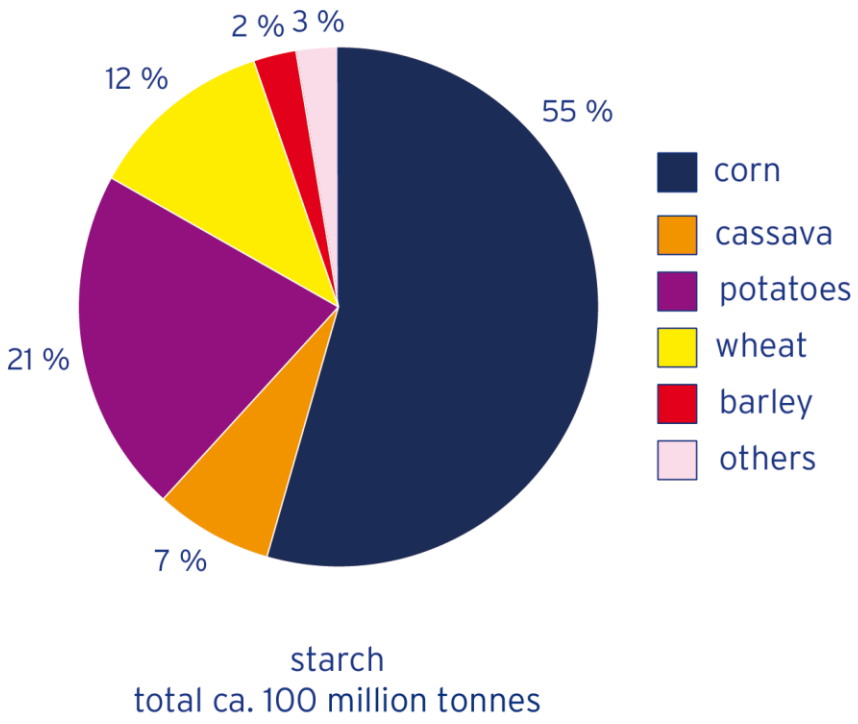
Material use (without wood)

Total ca. 175 Mio. (Wood 1.44 Mrd. t)

Use of sugar and starch in material use worldwide 2008



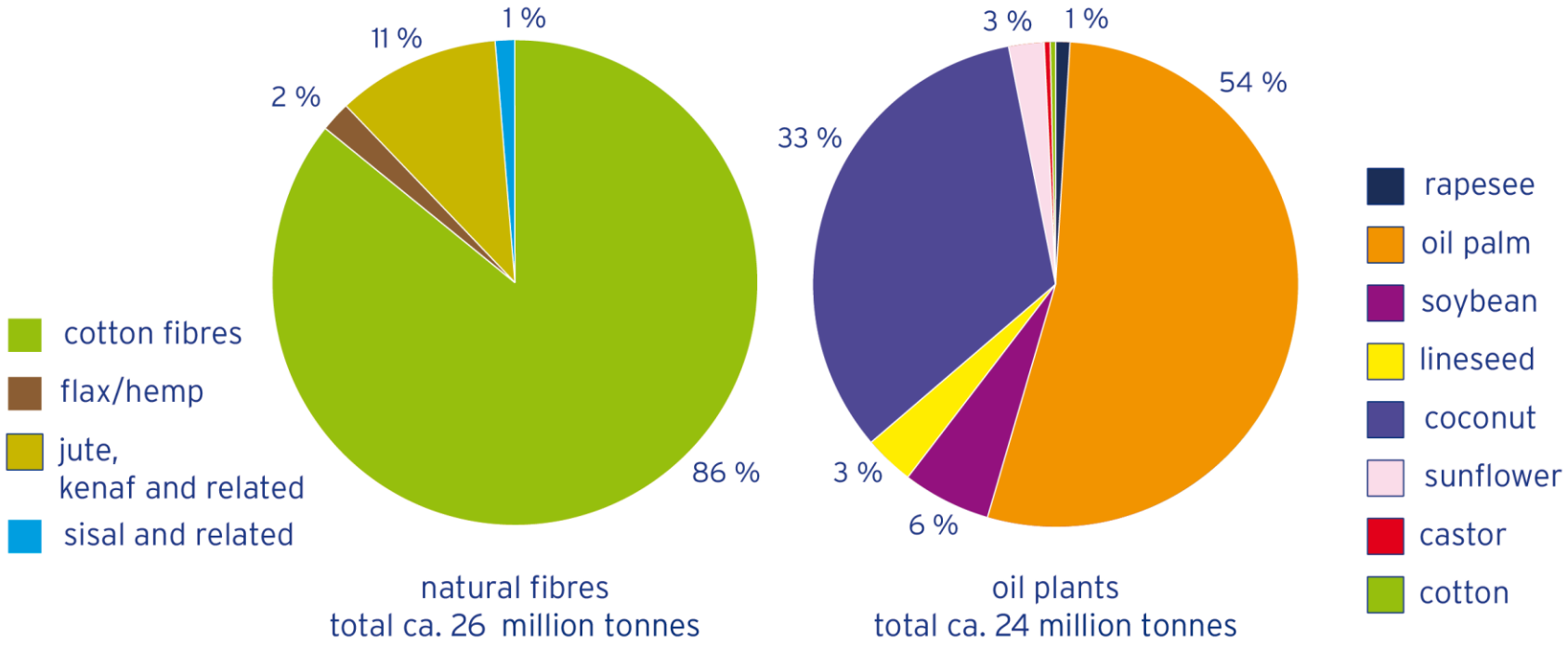
sugar
total ca. 10 million tonnes



starch
total ca. 100 million tonnes

Sources: nova 2011 afterFAO, USDA and others

Use of natural fibres and oil plants in material use worldwide 2008



Sources: nova 2011 after FAO, USDA and others

Thank you for your attention!

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All mentioned nova-studies can be free downloaded: www.nova-institut.de/bio

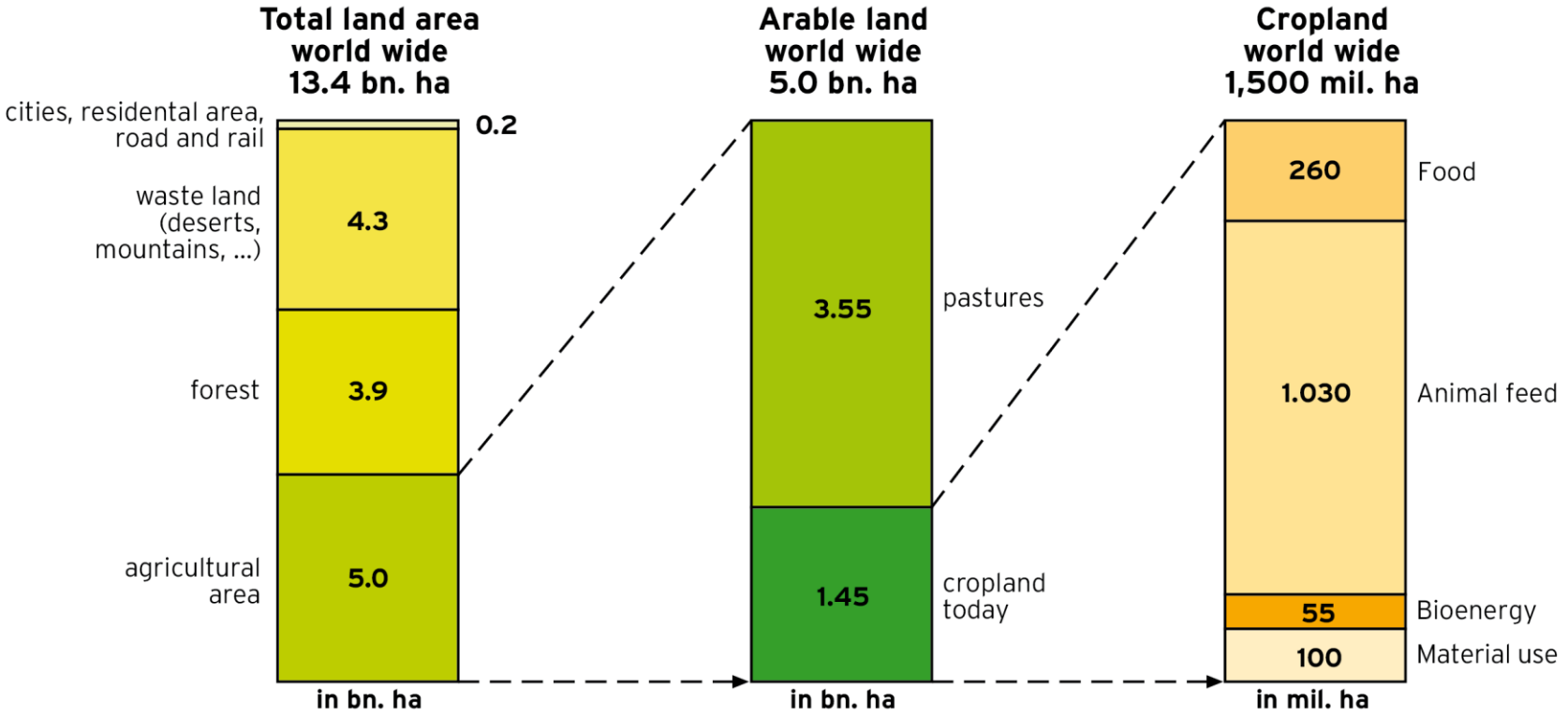
For discussion

Prices, drivers, GHG

Food versus Non-Food crops for industry

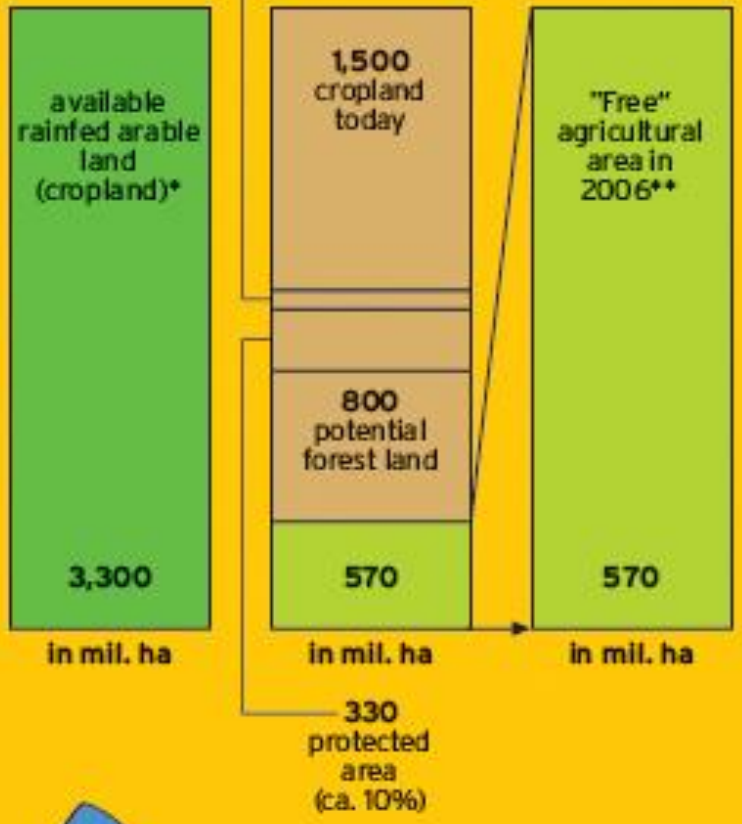
- **The question of food versus non-food crops for industry is itself oversimplified and misleading.**
- **Question 1: Are there - in the EU, in the member state or in the region – free agricultural areas left, which are not necessary for food and feed, domestic use and export? If yes, continue:**
- **Question 2 (the real question): How can we use these free areas for industry with the highest resource efficiency and the highest climate protection?**
  In many cases food crops will best fulfil these criteria (just because they are breaded to produce maximum yields over many, many years).
- **Food crops for industry can also serve as an emergency reserve for food and feed supply – second generation lignocellulose cannot!**
- **So "No food crops for industry" can lead to a misallocation of agriculture resources. We need a comprehensive concept for feedstock for food, feed, industrial material use and bioenergy.**

Global land use for food production and renewable resources 2008



Sources: OECD 2007, nova 2007 & 2011, Schmidhuber 2007, FAO 2007 & 2011

"Free" agricultural area in 2006 and the global demand of area in 2020



The global demand on land use in 2020:

1	increasing demand of food per capita due to an increase in purchasing power (more meat,...)	ca. 96 mil. ha
2	increasing demand of food due to population growth	ca. 64 mil. ha
3	residential area, road and rail	ca. 32 mil. ha
4	Biofuel in the most important Biofuel countries***	ca. 18 mil. ha
		Σ 210 mil. ha

* FAO 2000 indicates a potential of 4.2 bn. ha

** De facto parts of the "free" crop lands could be considerably disadvantageous in terms of natural resources or market access

*** The calculation is based on OECD-FAO 2007: It is assured that most of the resources are from the demand region; yield increase of 1%/a, extrapolation of production from 2006 to 2020

Sources: FAO 2000, 2008 & 2011, OECD 2007
OECD-FAO 2007, FAPRI 2007, nova 2007

Agricultural Feedstock worldwide – How to increase the production?

1. **Increasing the yields**

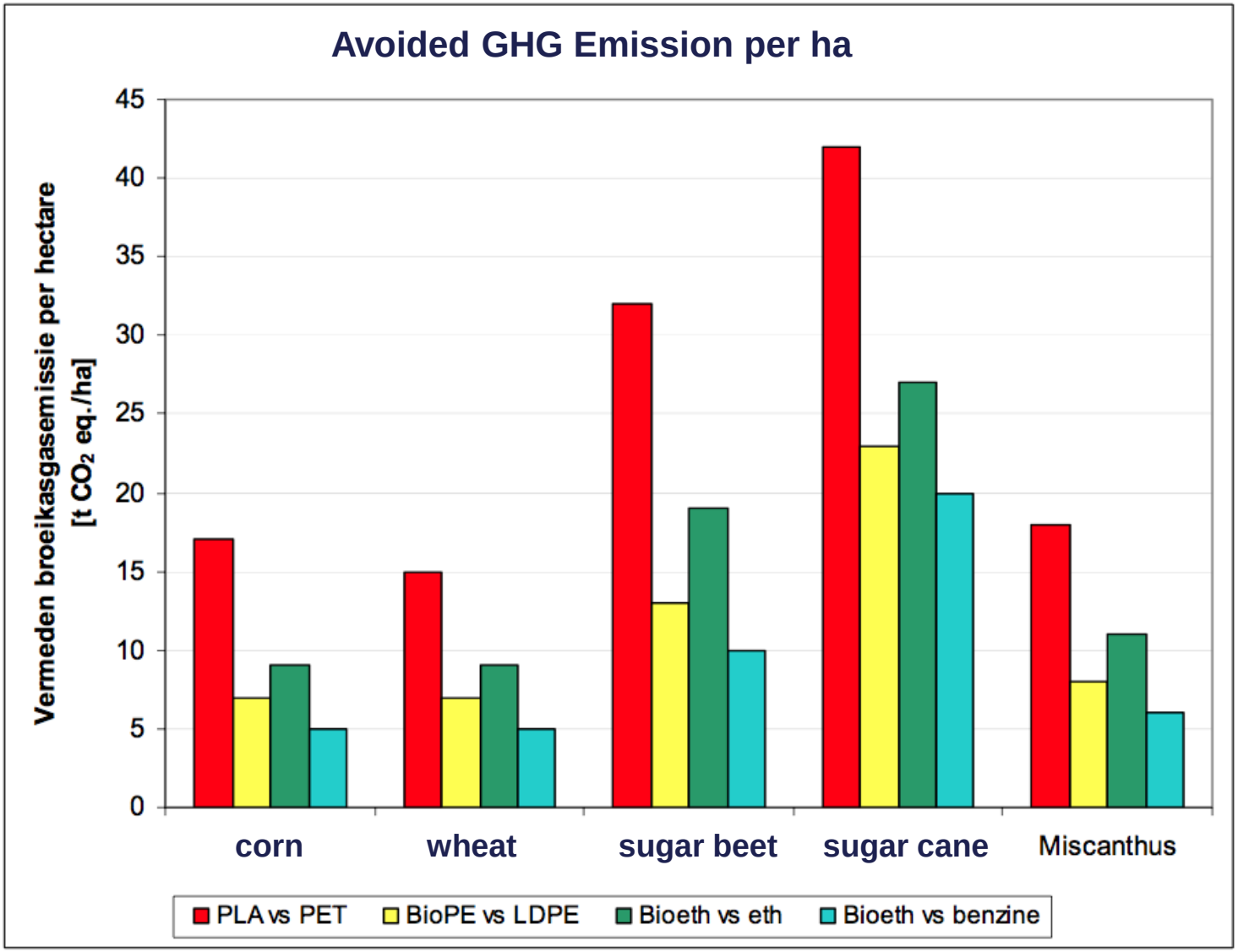
The tremendous potential for increasing yields in the developing countries is hindered by lack of technology and infrastructure unfavourable agricultural policies like no access to credits, an insufficient transmission of price incentives, poorly enforced land rights.

2. **Expansion of arable land**

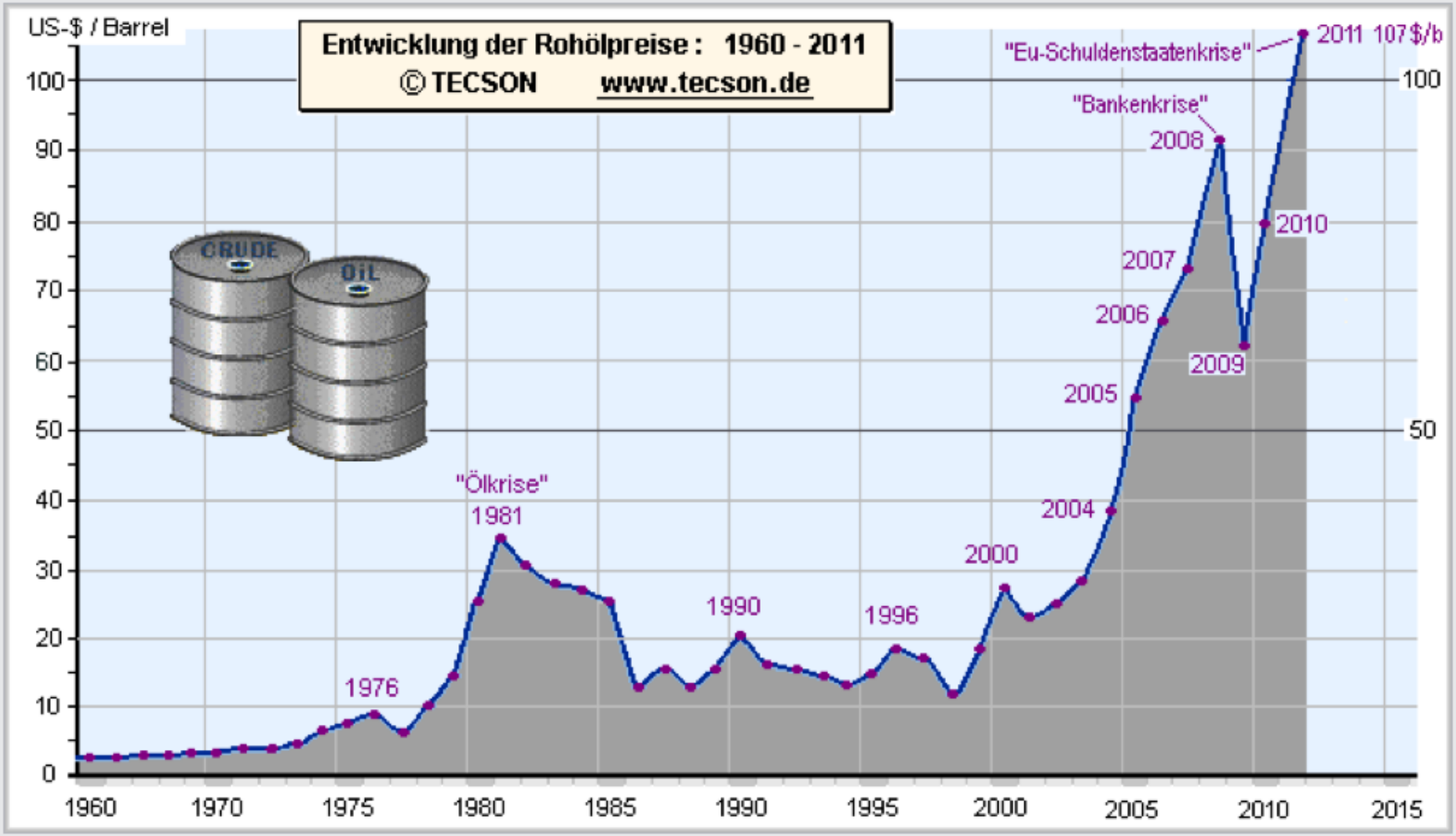
Some 0.6 (nova 2008) to 1.6 billion (FAO 2009) ha could be added to the current 1.4 billion ha of cropland (excluding forests, urban areas, protected areas).

The solution for 1 & 2: Political reforms, investment in agro-technologies

3. **GMO (less important)**



Sources: Bos et al. 2011



Entwicklung der Erdölpreise / Rohölpreise im Jahresmittel

nova-indices

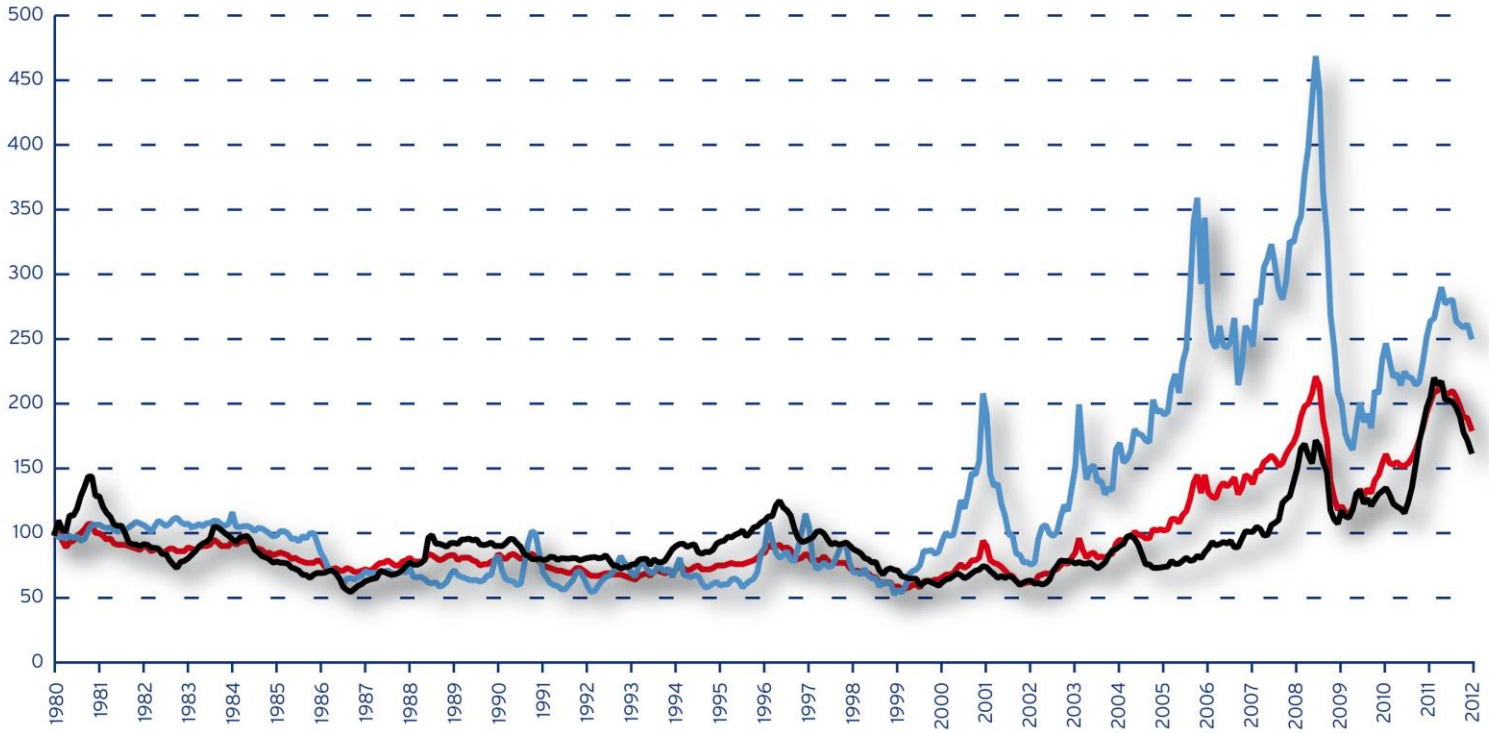
January 1980 = 100 %

All raw materials are equally weighted in all indices

nova-Index 18
Beef
Cocoa
Coffee
Copper
Cotton
Crude Oil
Gold
Heating oil
Maize
Natural gas
Orange juice
Platinum
Pork
Silver
Soybeans
Sugar
Uranium
Wheat

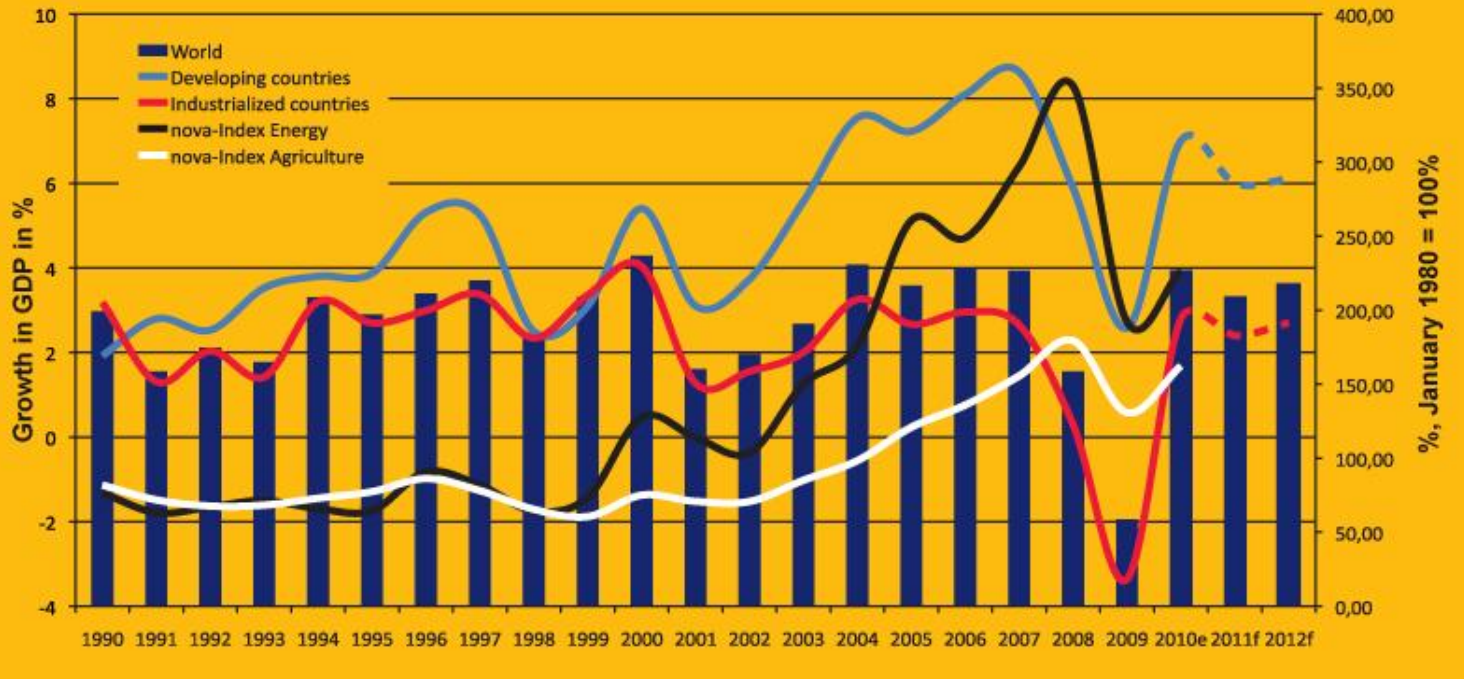
nova-Index Energy
Crude oil
Heating oil
Natural gas
Uranium

nova-Index Agriculture
Cotton
Maize
Soybeans
Sugar
Wheat



vailable at: www.nova-institut.de/nr

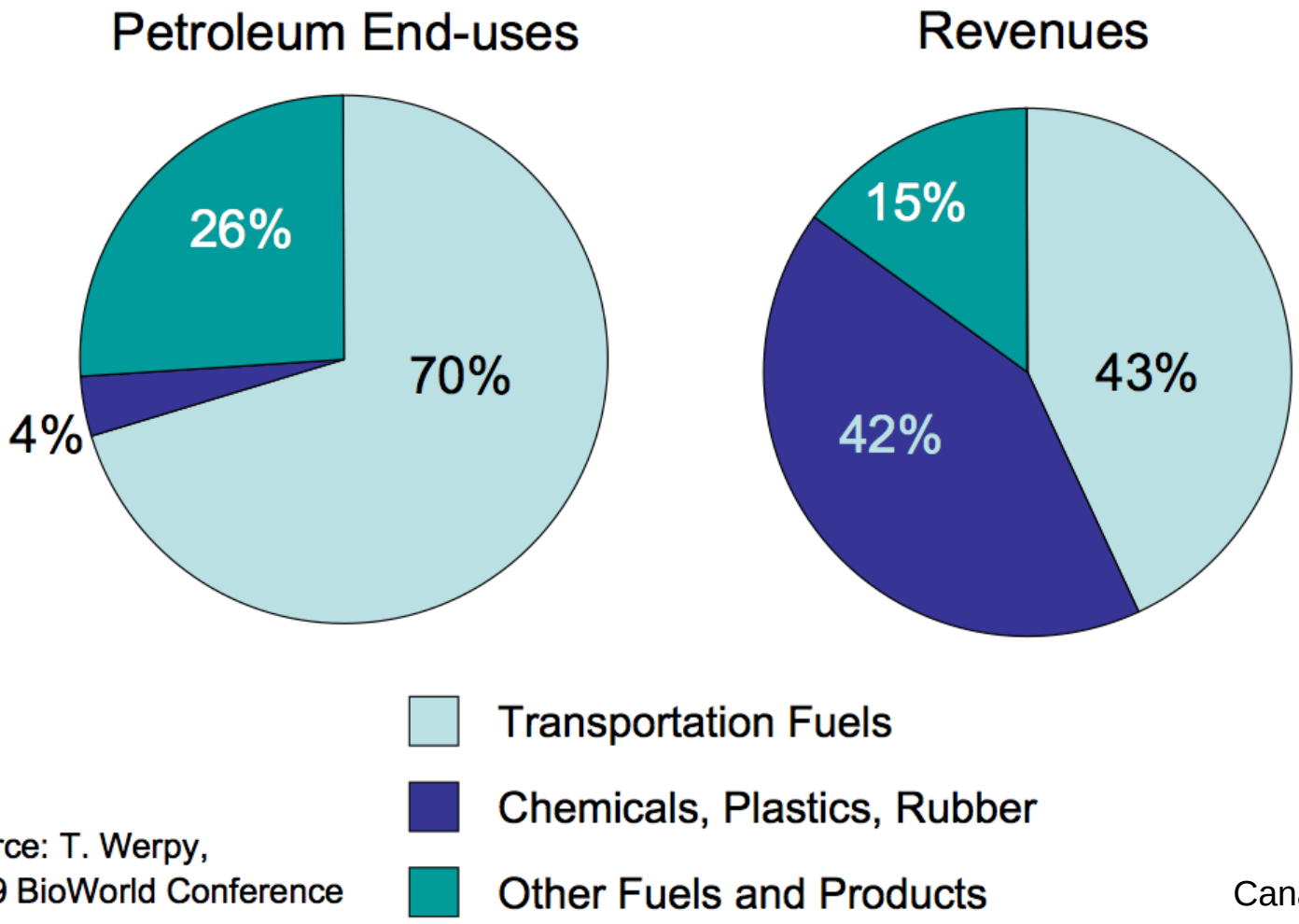
Source: IMF, World Bank, Silver Institute, EIA, FDOC, Johnson Matthey Plc


Growth in GDP in % p.a.
World
Developing countries
Industrialized countries
nova-Index Energy
nova-Index Agriculture
Growth in GDP in %
%, January 1980 = 100%
10
8
6
4
2
0
-2
-4
400,00
350,00
300,00
250,00
200,00
150,00
100,00
50,00
0,00
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010e 2011f 2012f
© nova-Institut.de | 2011
Sources: World Bank, World Development Indicators 2010, Global Economic Prospects 2011; e = estimate, f = forecast

Drivers of the price development

- **The price peaks in 2008/2009 were mainly driven by the demand of the developing countries (China, India, Brazil, Russia with raw material intensive industries), strengthened by speculation.**
- **The prices of agricultural raw materials are mainly driven by supply.**
- **The prices of crude oil are mainly driven by demand (the supply could not really be increased).**
- **The price levels in 2012 will mainly depend on the GDP in the developing countries. Further increases are expected, whether the peaks will reach or exceed the peaks in 2008/2009 is a question of market regulation and speculation.**

A Lesson from Petroleum Refineries

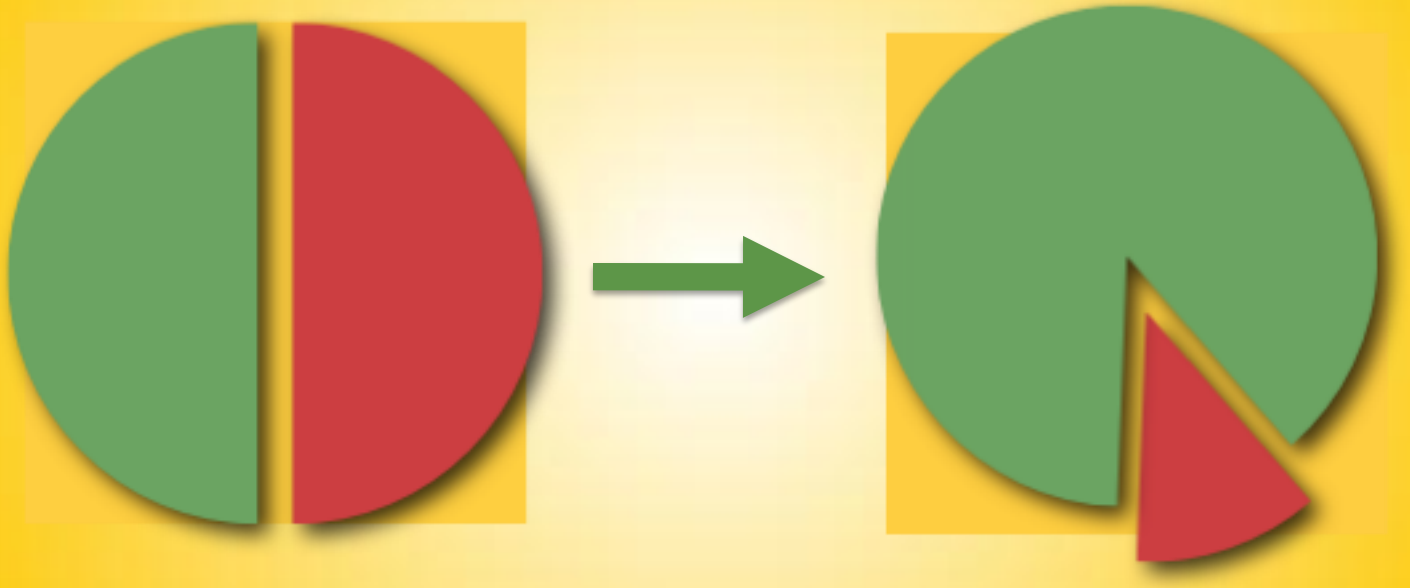


Source: T. Werpy,
2009 BioWorld Conference

Canada
FPInnovations

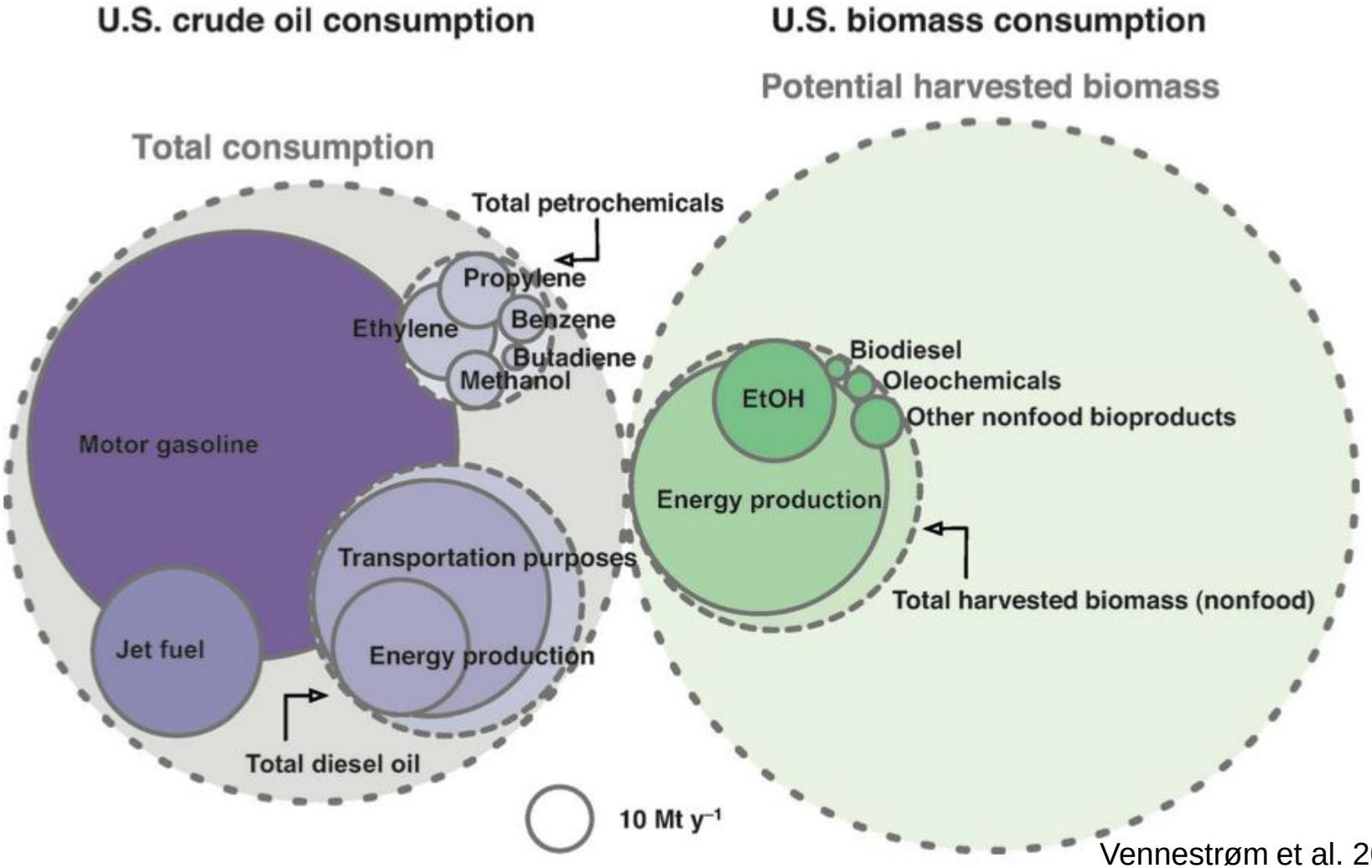
Biomass

Value added / Employment



green: Industrial Material Use
red: Bioenergy / Biofuels

The Raw Material Switch



Vennestrøm et al. 2011

Why bio-based products?

- **Green materials** – environmental advantages (CO_2 saving) and positive marketing image
- **Innovation:** EU “Innovation Union”, Lead Markets Initiative (LMI) for bio-based products (DG Enterprise)
- **Avoiding health risks** – no or green plasticizer, no “great pacific garbage patch” (as from fossil based plastics – except Bio-PP/PE)
- **Interesting material properties** – for example biodegradable, but also other specific properties like lightweigth, special haptics, barriere properties
- **Feedstock diversification** – less depending on mineral oil and less depending on oil price
- **Saving finite resources** – by using renewable feedstock
- **Rural development** – more added value and jobs in the processing line

Main Drivers

- **Support of Policy** – US: Public procurement, Japan: Quotas, EU: Lead Market Initiative, Targets? Quotas? (more details are discussed later); many countries ban non-biodegradable plastic bags.
- **Customers** – are interested in more sustainable materials and products; bio-based materials and products have (still) the image to be a sustainable option
- **Multinational companies** – using bio-based materials and products because of positive marketing effects (“sustainable company”); because of limited supply of bio-based materials multinational companies often try to get exclusive access.
  And: Resource diversification!
- **SME** – realising more and more bio-based solutions for niche applications, some could develop to mainstream markets (like in food packaging)