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Issues in bioenergy, a European perspective

CBES Forum presentation
17th February 2014, Oak Ridge National Laboratory – United States

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And 1st of April
Academic Director Energy Academy Europe & Distinguished. Prof at Groningen University

Utrecht University – NL

Shanghai Ranking 2013: Utrecht, Groningen and Leiden University part of global top 100.

Of 56 leading universities in Europe, Utrecht University, with ETH Zurich, Imperial College London and Cambridge University make up the top 4 of the CHE Ranking.

Copernicus Institute - Faculty of Geosciences

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"Connecting knowledge for sustainability"

- Some 130 scientific staff
- Interdisciplinary; Key areas:
  - Energy & Resources (Energy Supply, Energy Demand, Integrating activities (e.g. modelling)
  - Innovation sciences & governance.
  - Environmental sciences
- Range of bachelor & master programs
- Diverse funding of research: govt. scientific, EC, industry, international bodies, NGO's, etc.

Biomass use in 2007 and vision 2020

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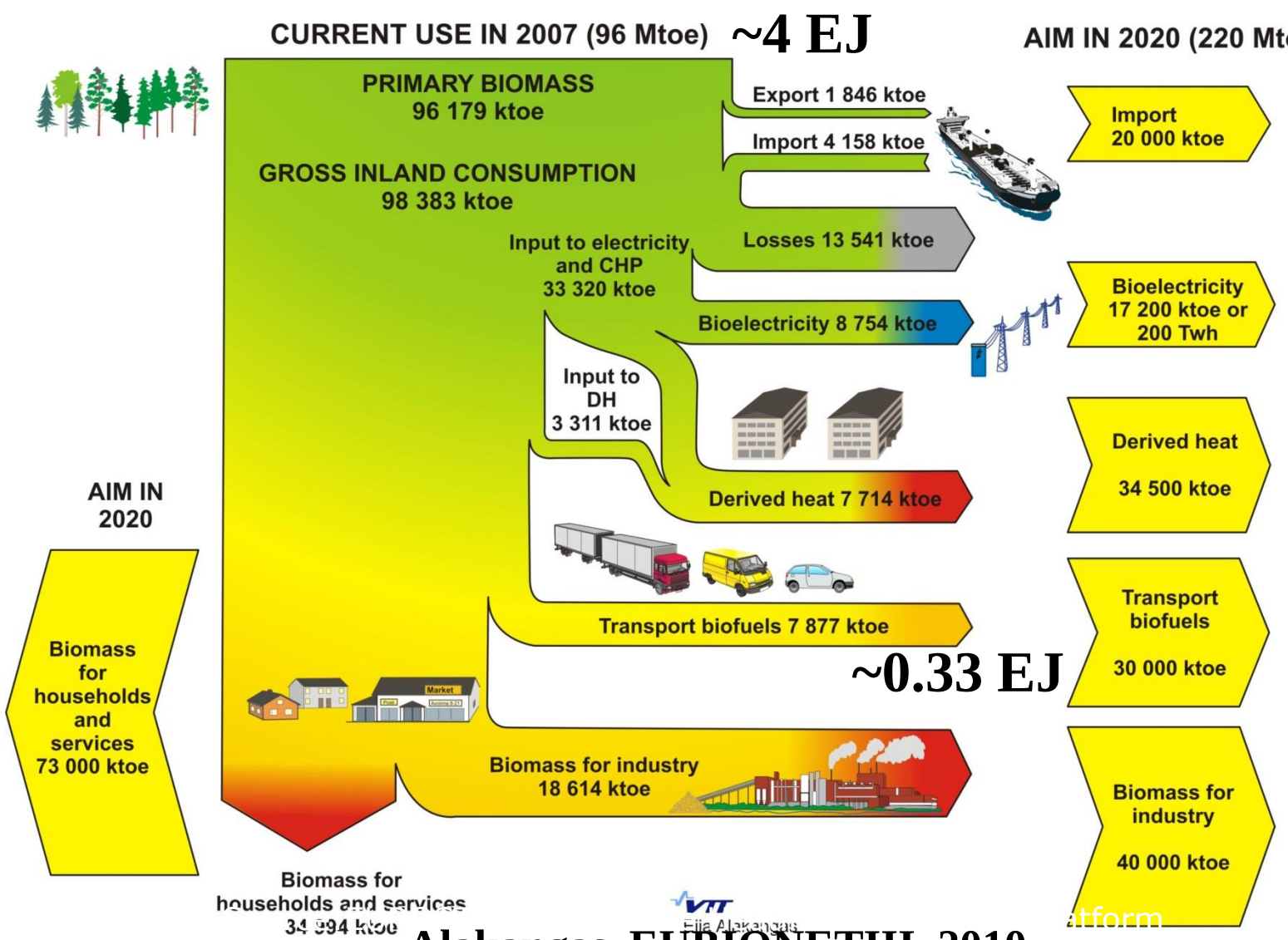
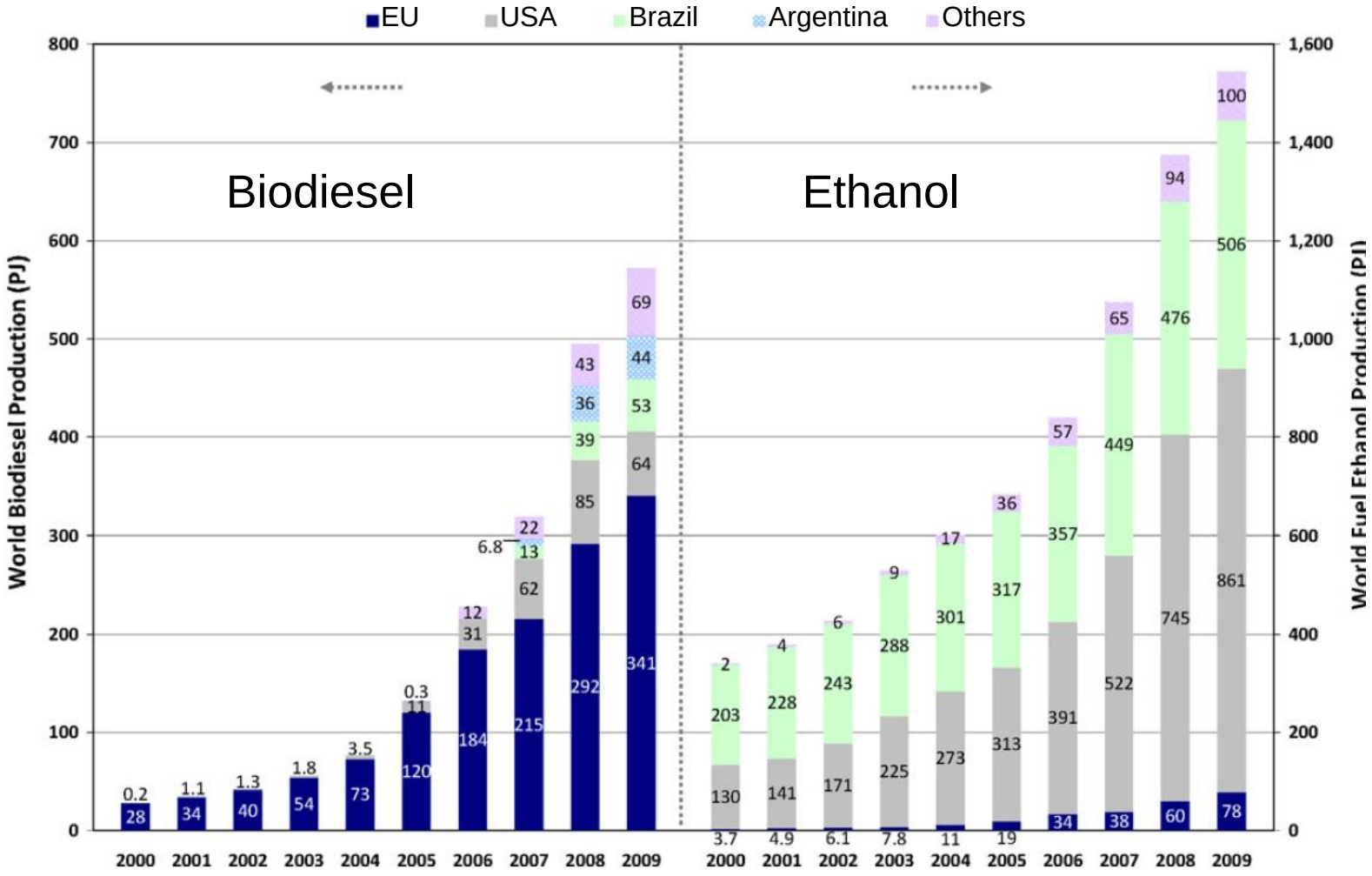


Alakangas, EUBIONETIII, 2010

Policy context:

- Renewable Energy Directive (RED):
  - 20% Renewable Energy in the EU in 2020 (+ specific for member states; e.g. 14% for the Netherlands).
  - Subtarget of at least 10% renewable energy transport (every member state).
- European Fuel Quality Directive: Fuel suppliers at least 6% less GHG in 2020 via: biofuels, efficiency refineries, or other energy carriers (gas, electricity, hydrogen, etc.).
- 20% less GHG in 2020 (possibly 30%) -> national targets + Emission Trading. Biomass in e.g. Refining, steel, etc. can contribute.
- June 2010 National Action Plans for implementation RED.
- Intervention in RED (…): CAP on 1st generation biofuels; iLUC discussion ‘’frozen’’.
- Evaluation in 2014.
- Now: Horizon 2020 activities (JTI’s/PPP’s, outlook to 2030; heavy emphasis on biobased economy; 30/30/30 targets?

Global biodiesel & fuel ethanol production 2000-2009



(Source: Lamers et al., RSER, 15 (2011) 2655– 2676)

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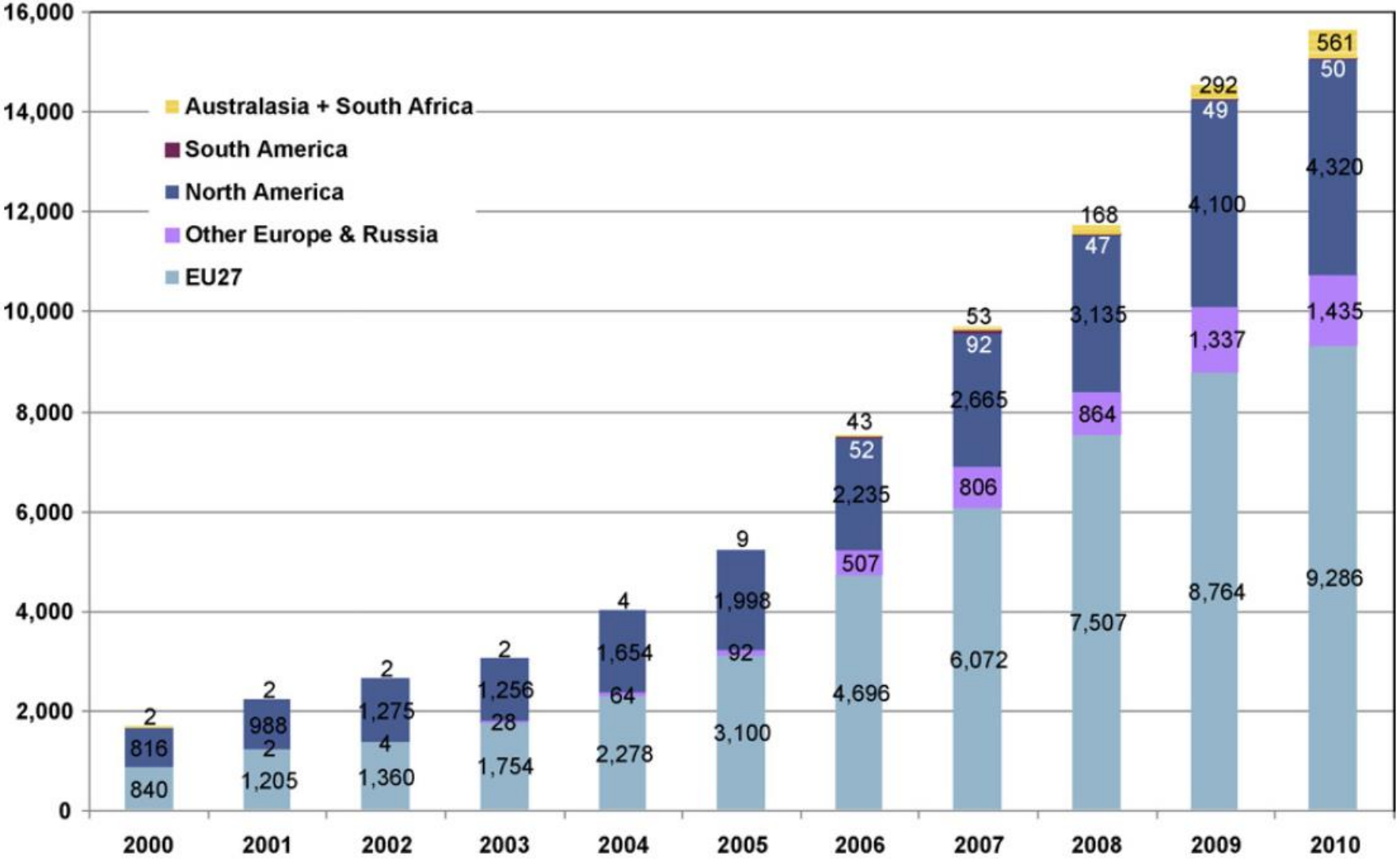
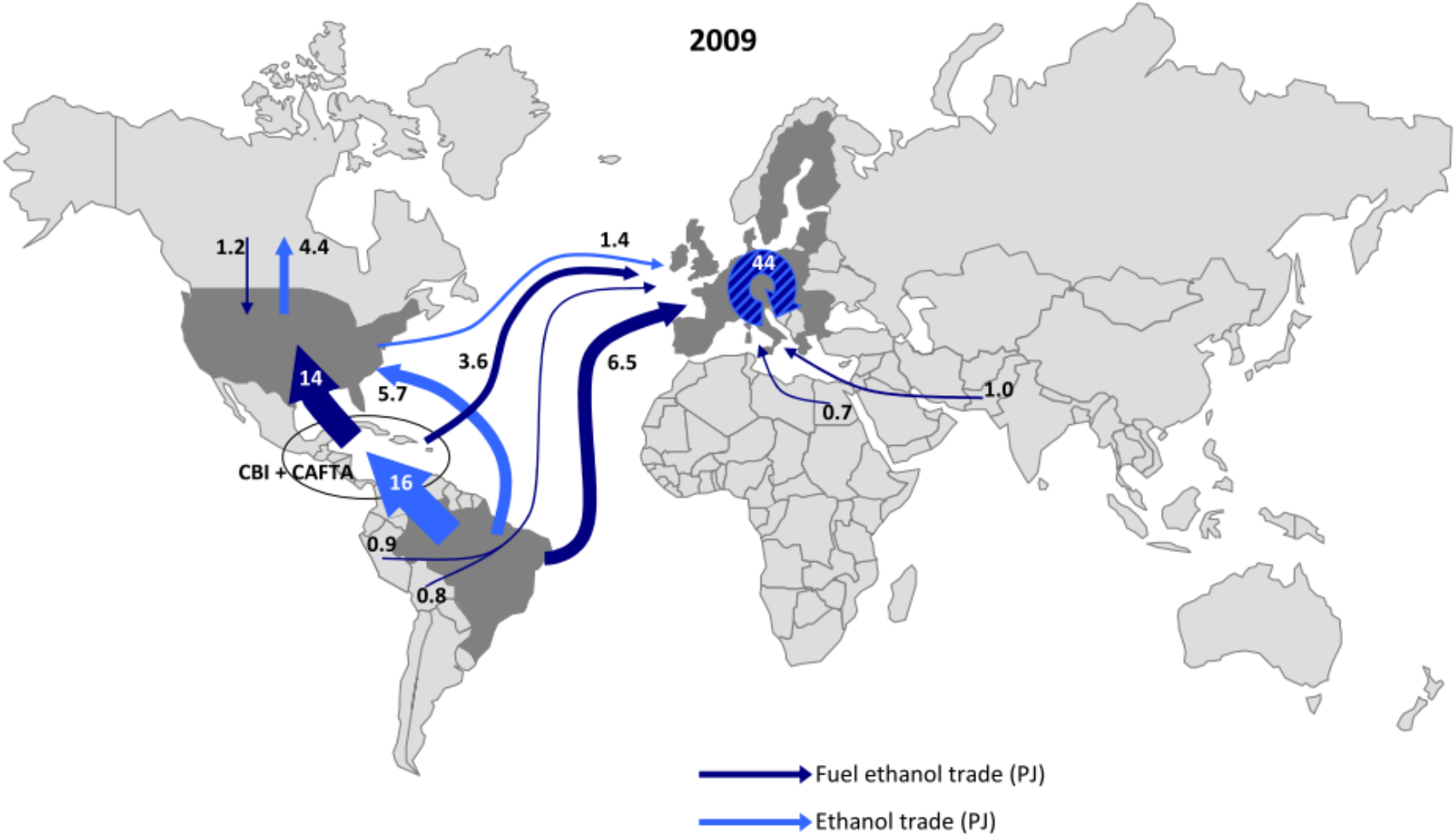
Global wood pellet production 2000 - 2010



(Source: Lamers et al. RSER, 16(2012) 3176-3199

Global (fuel) ethanol trade streams of minimum 1 PJ in 2009.



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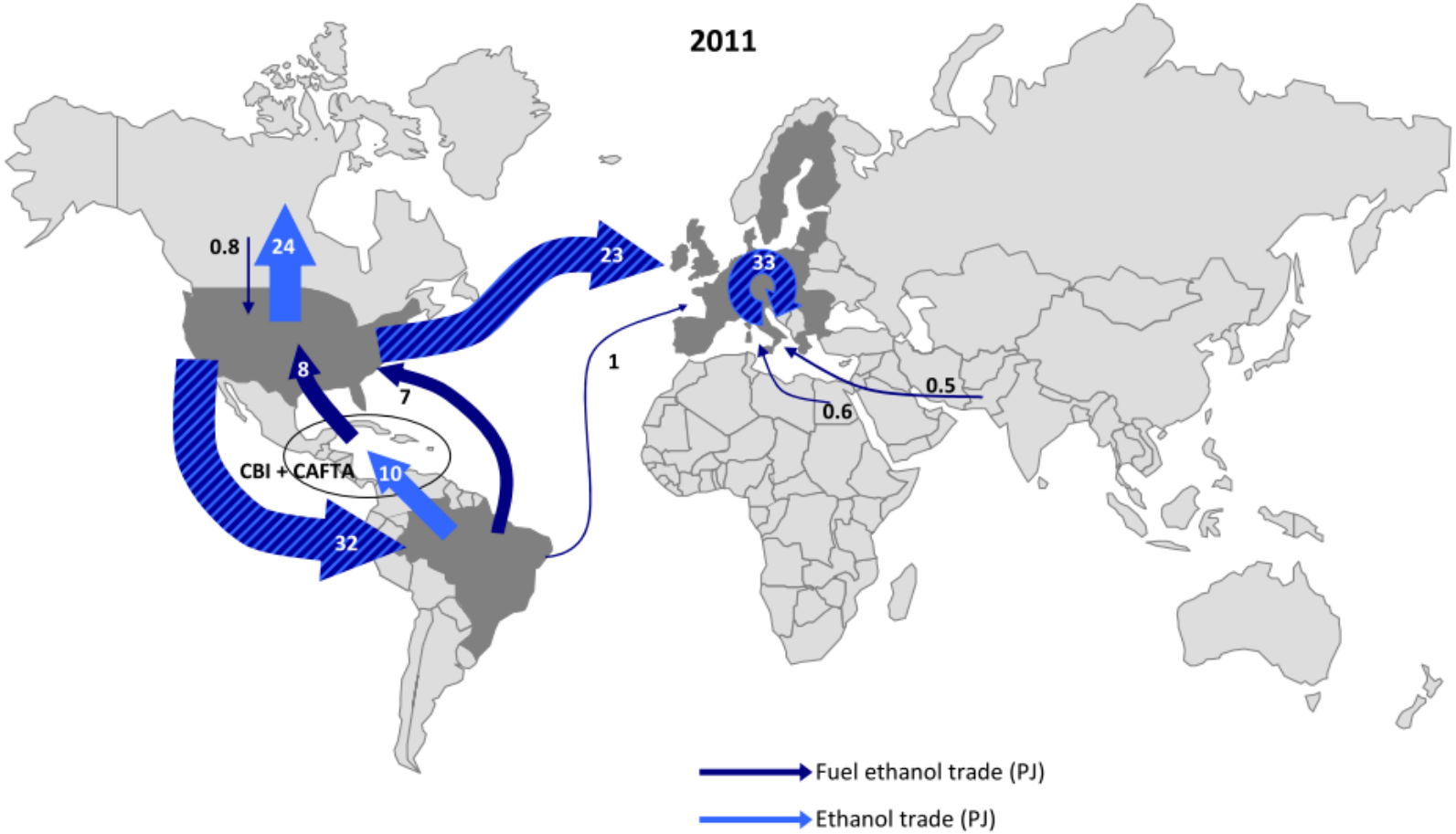

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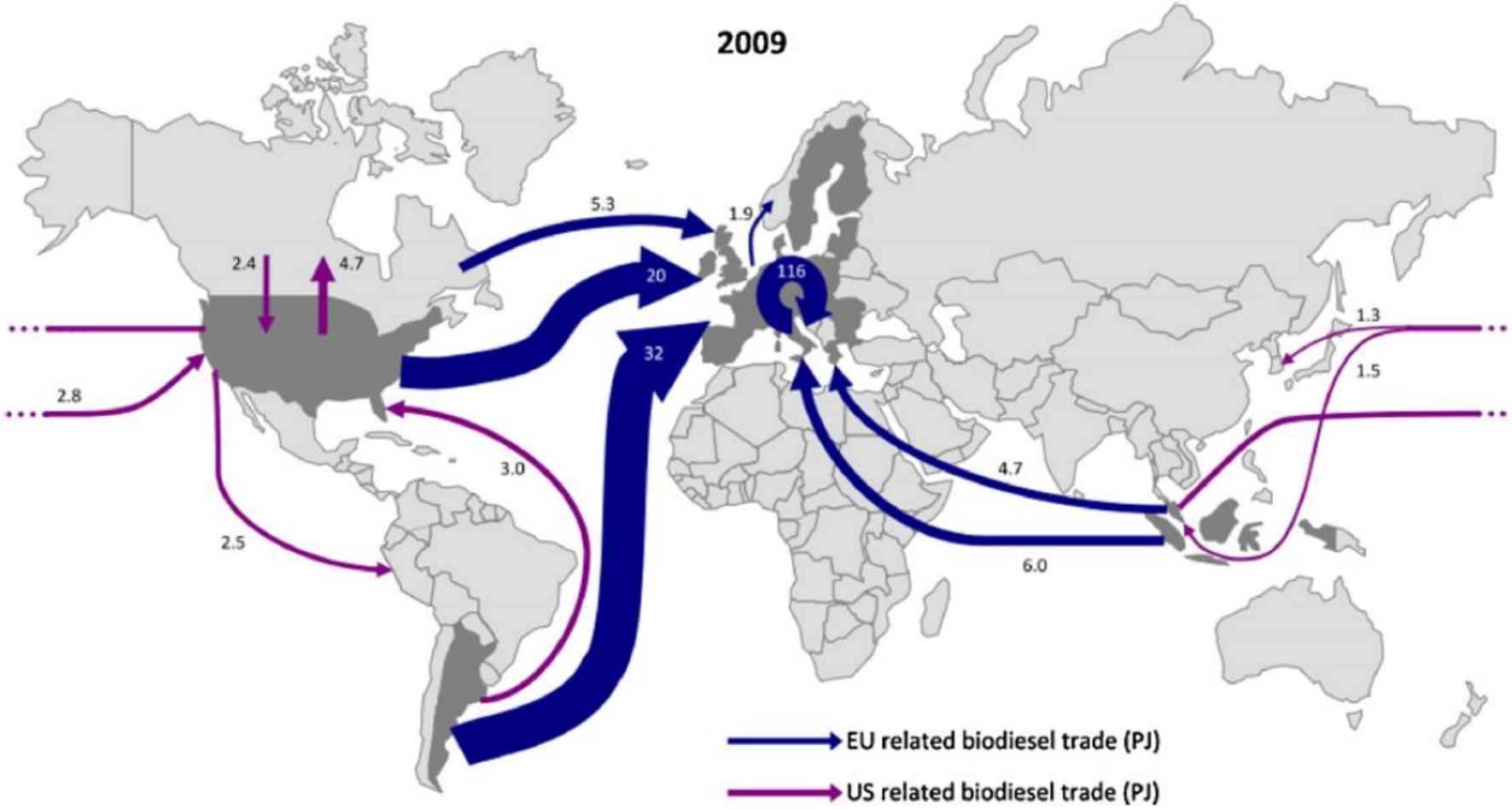

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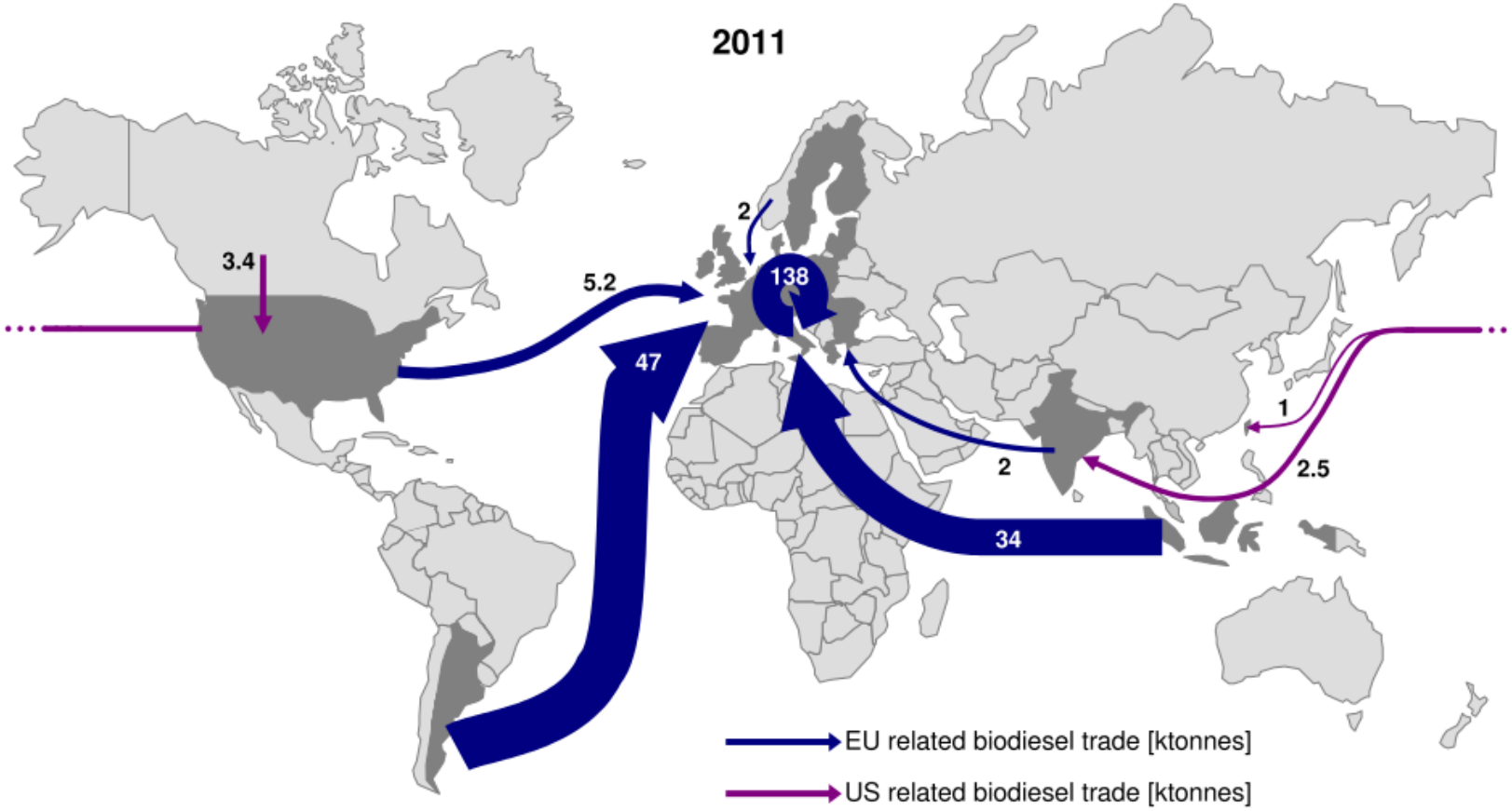

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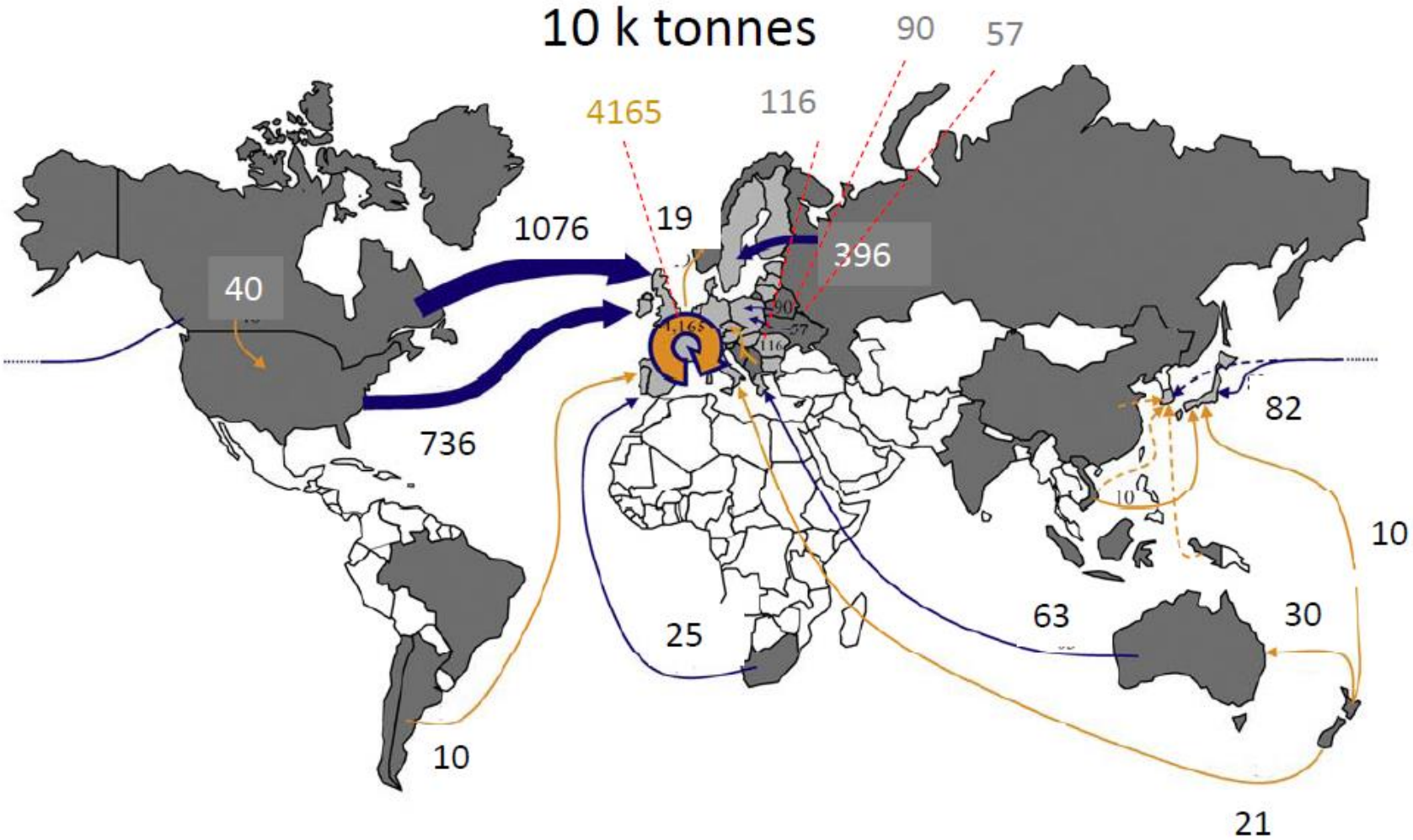
Global wood pellet trade 2010



Mainly industrial / brown pellets

Mainly residental / white pellets

Source: Lamers et al., RSER, 16(2012) 3176-3199

Advancing markets…pushed by technological progress and pulled by high oil prices

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- 2nd generation biofuels…
- Biorefining, biochemicals, biomaterials…
- Aviation and shipping…

- Likely to compete for the same resources…
- Should meet the same sustainability criteria…(but that is not the case today!)
- Competition or synergy?

Simulated Biomass trade flows 2020

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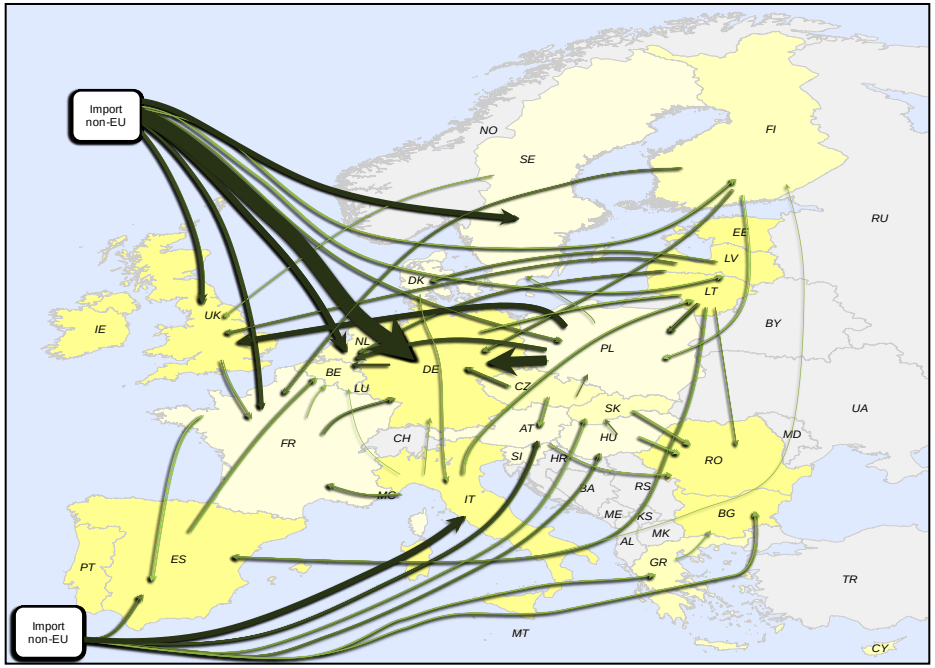
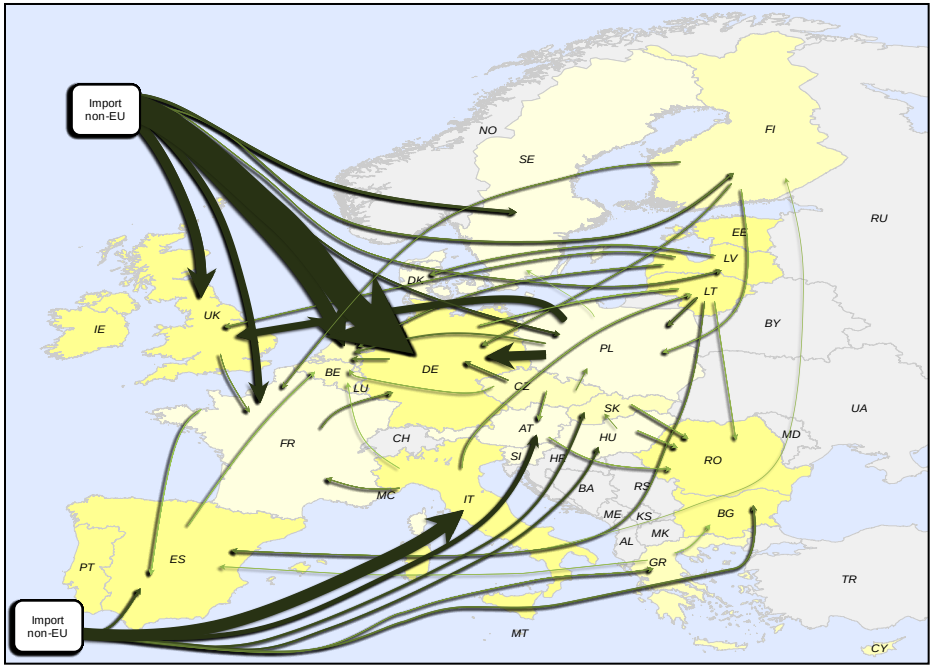
	2009 (pellets)	2015 Low Import	2015 High Import	2020 Low Import	2020 High Import
Total trade (Mtoe)	1.6	5.4	6.2	12.6	17.4
Total trade (Mt wood pellet eq.)*	3.8	12	14	29	40
Of which Intra-EU	55%	38%	32%	52%	32%
Of which Inter-EU	45%	62%	68%	48%	68%

*) *Mt eq. = million metric tonne pellet equivalent (18 MJ/kg)*

Low Import scenario



High Import scenario

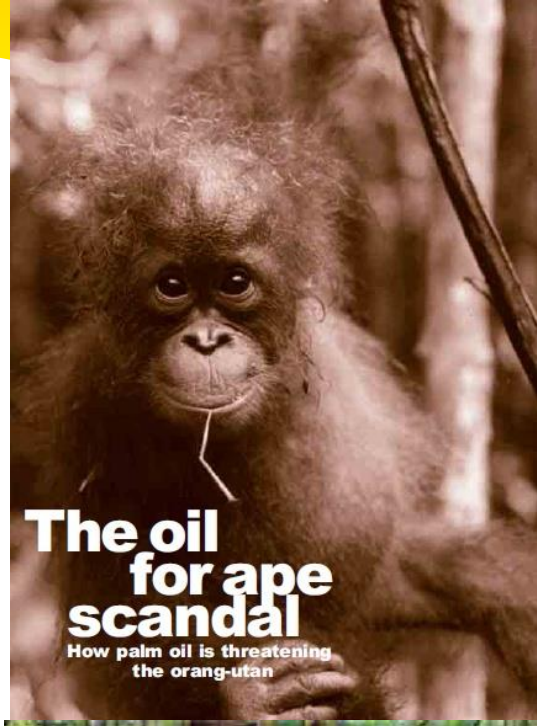


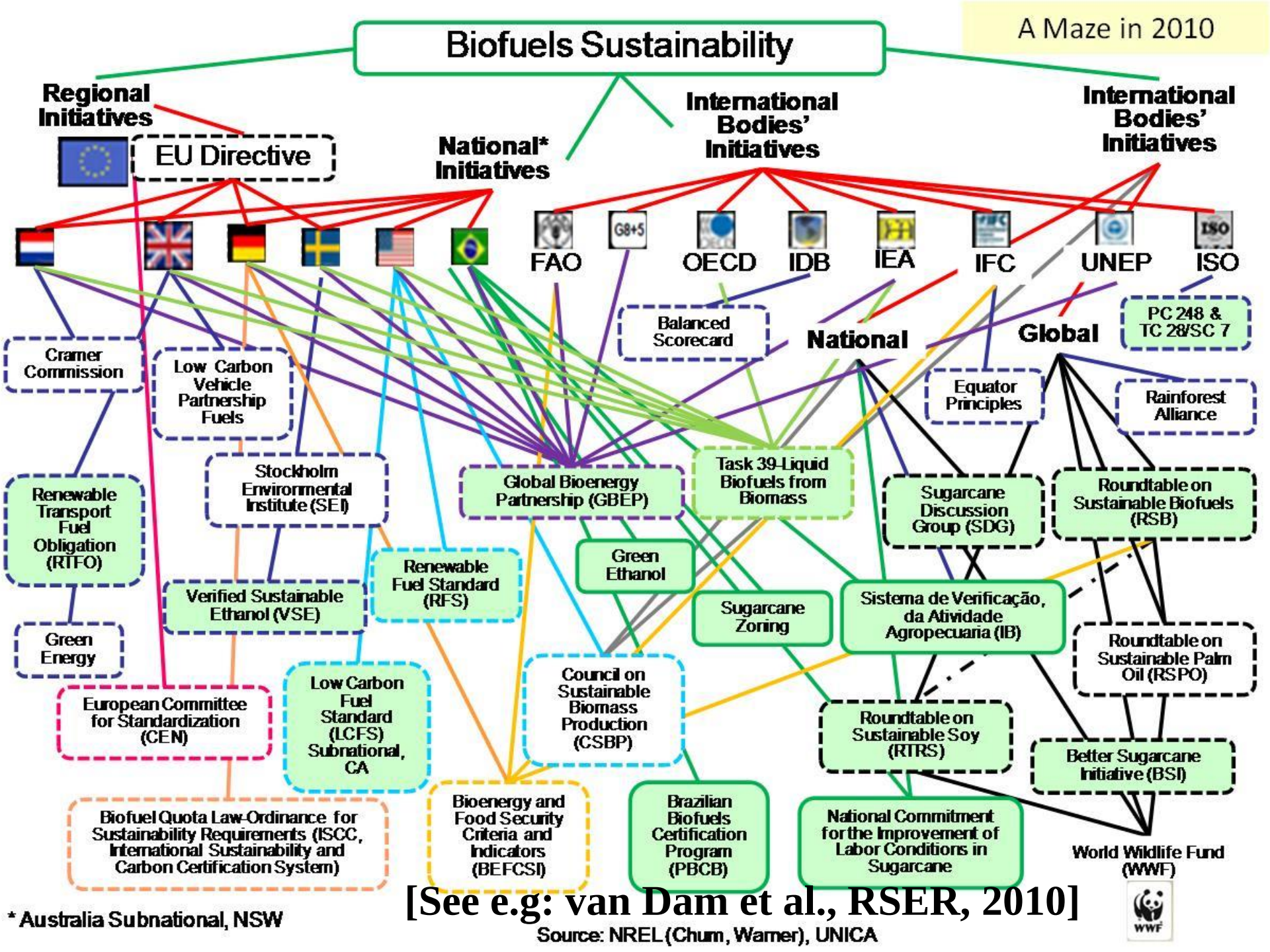
Year: 2014

[Hoefnagels et al, UU/Task 40, 2011]

Biobased economy; friend or foe?

- Food vs. Fuel
- Biofuels a *crime against humanity*
- Threats for biodiversity, water, farmers…
- LUC & iLUC, Carbon Payback… result in poor GHG balances
- Large number of external damages.





[See e.g: van Dam et al., RSER, 2010]

Snapshot on certification

- RED crucial; CAP 1st gen biofuels. iLUC factors 'put aside'. Evaluated in 2014 (likely to expand). Runs till 2020.
- ISCC gained ground. RSB lags behind. Variety of other systems RED approved.
- ISO process ongoing…
- EC follows a meta-standard approach
- Criteria for solid biomass to be introduced (meets resistance as well).
- Response from SBP (former IWPB) (large utilities).
- Attention for iLUC prevention and carbon payback (additional criteria?)

Confrontation bottom-up vs. top down iLUC modelling

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Key steps iLUC modelling efforts:

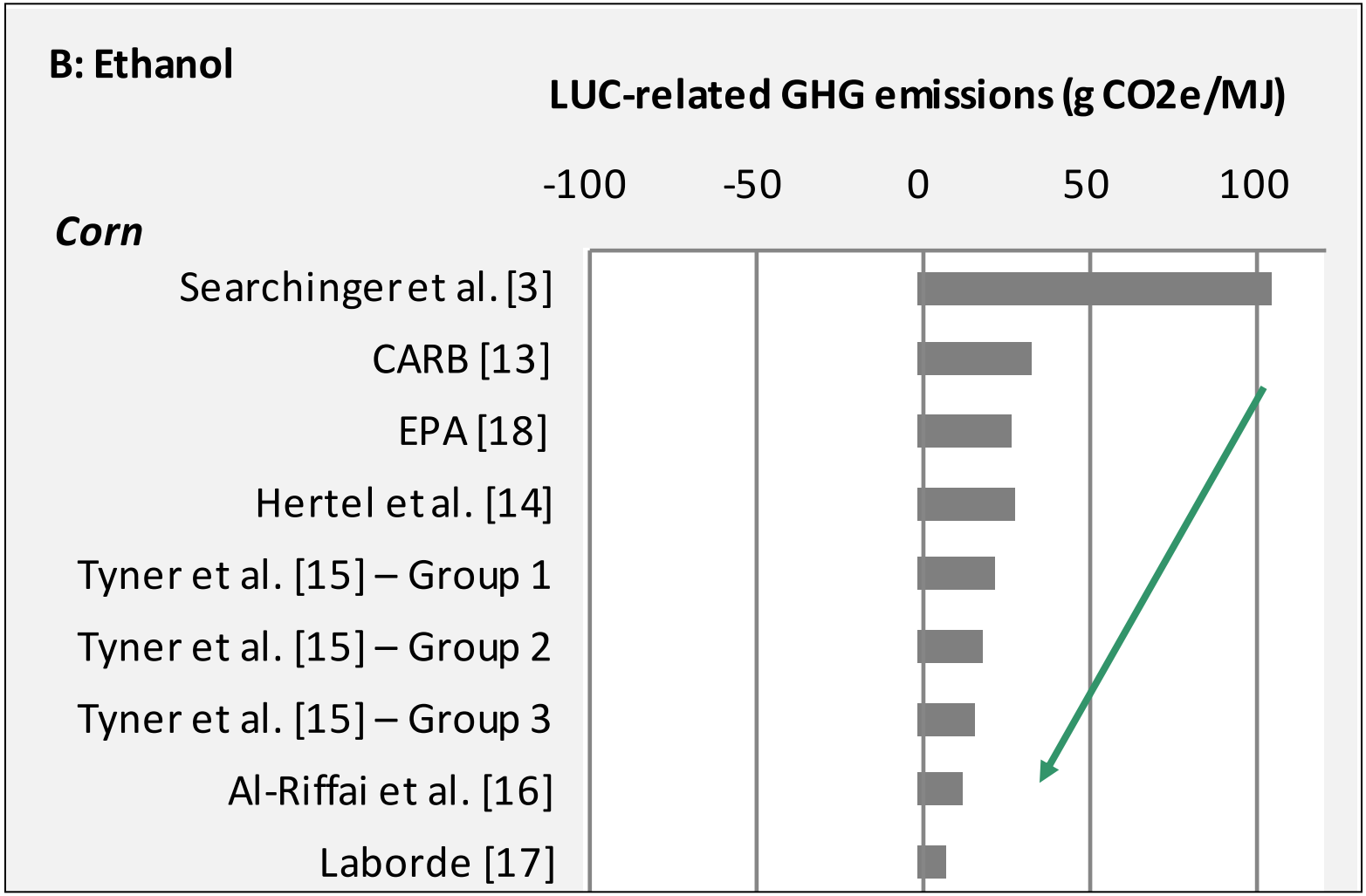
- CGE; historic data basis
- Model shock, short term, BAU, current technology.
- Quantify LUC
- Quantify GHG implications (carbon stocks)

Bottom-up insights:

- Coverage of BBE options, advancements in agriculture, verification of changes (land, production)
- Gradual, sustainability driven, longer term, technological change (BBE, Agriculture
- LUC depends on zoning, productivity, socio-economic drivers
- Governing of forest, agriculture, identification of ‘’best’’ lands.

[IEA & other workshops, 2011-2013; Wicke et al, GCB-Bioenergy 2014]

Example: Corn ethanol
Results from PE & CGE models



[Wicke et al., Biofuels, 2012]

ilUC mitigation options…

- Controlling (i)LUC
  - Increasing efficiency in agriculture, livestock and bioenergy production
  - Integrating food, feed and fuel production
  - Increasing chain efficiencies
  - Minimizing degradation and abandonment of agricultural land

- Controlling type of LUC
  - Sustainable land use planning (incl. monitoring)
  - Excluding high carbon stock and biodiversity areas
  - Using set-aside, idle or abandoned agricultural land
  - Using degraded and marginal land

Further investigations… (KIS project)

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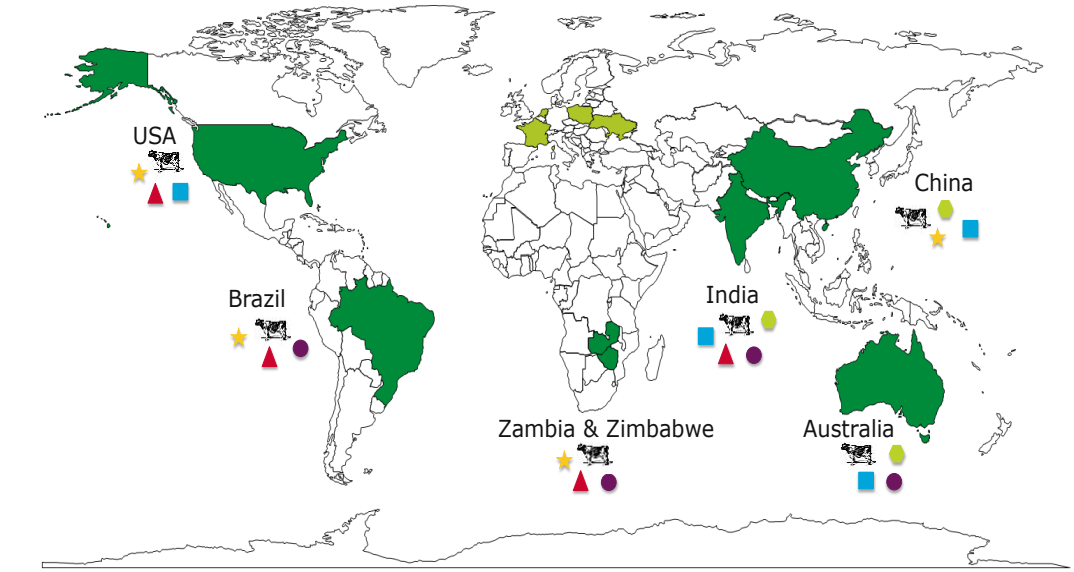
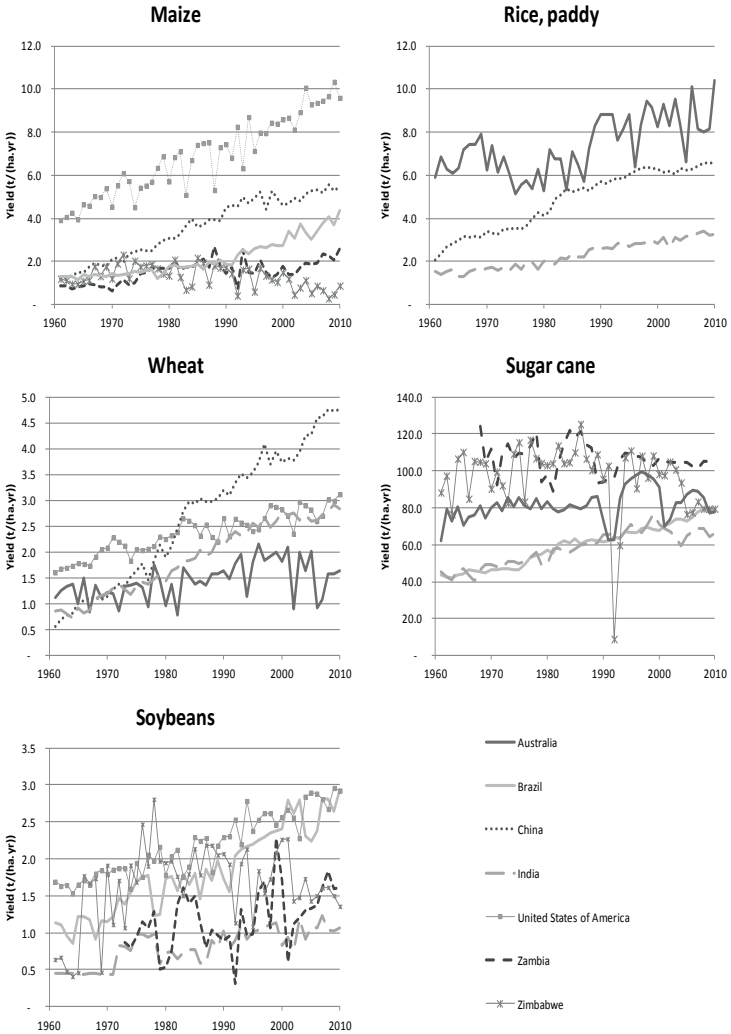
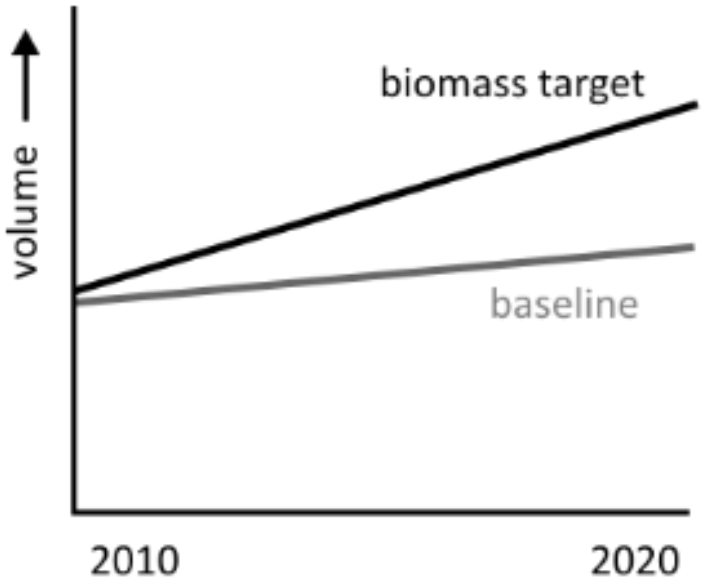


Legend:
- Countries assessed in this study
- Countries assessed by De Wit et al. [1]
- Maize
- Wheat
- Rice
- Sugarcane
- Soybean
- Beef and milk



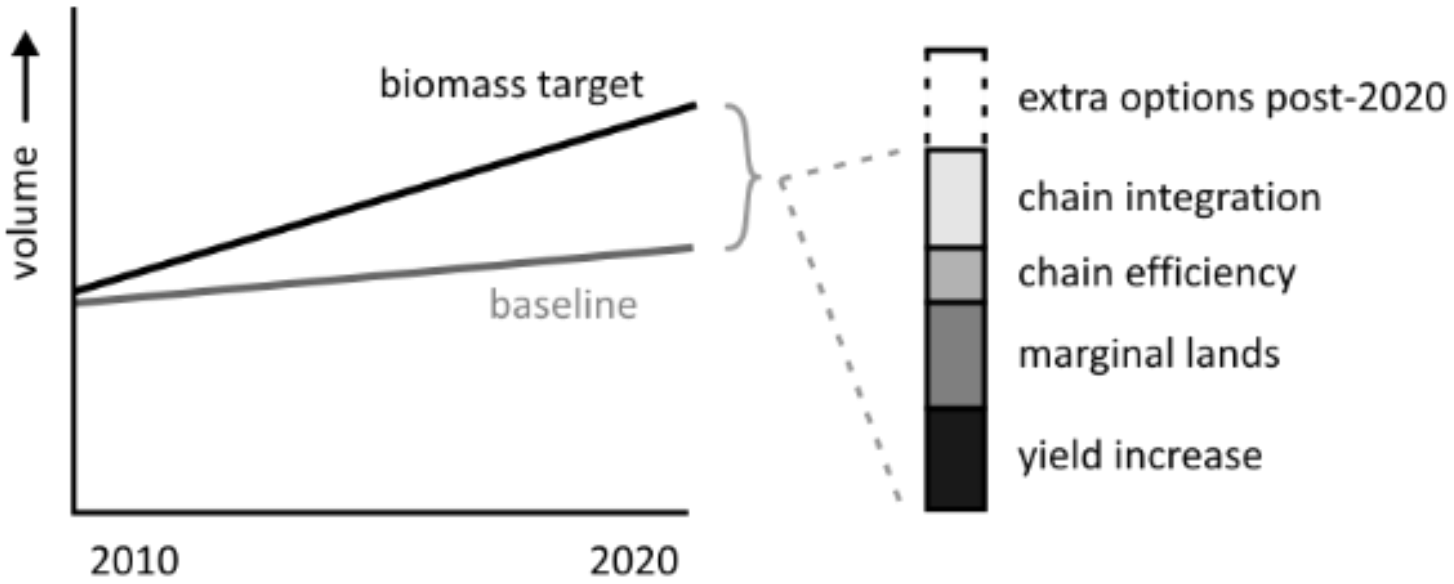
[Gerssen-Gondelach, et al. (in progress)]

General approach

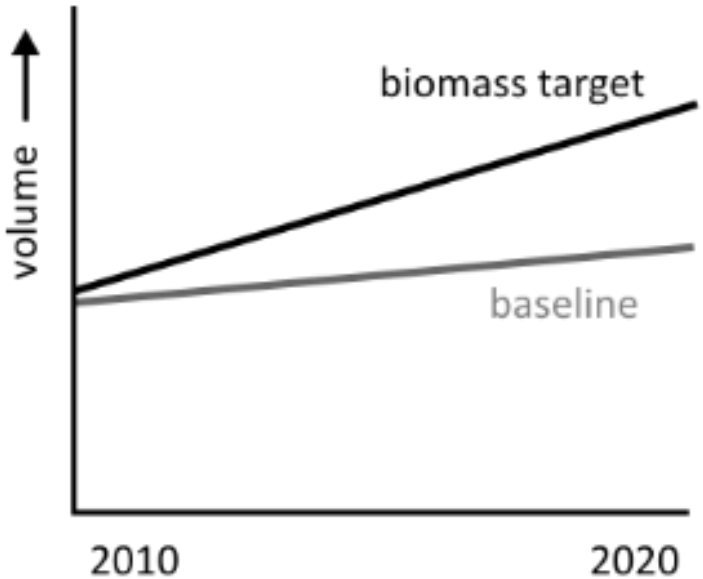


- From economic models
  - Baseline: developments in food, feed and fibres
  - Biomass target: the amount required to meet targets such as RED.

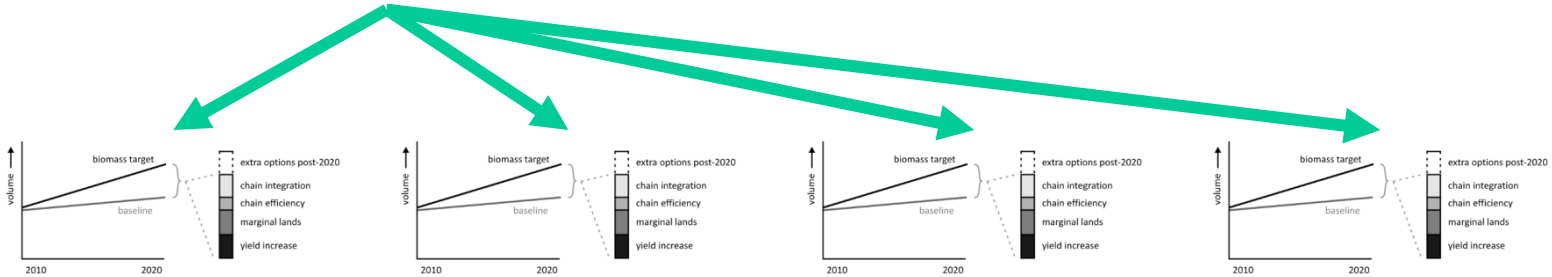
General approach



Regional assessment



Each region has its own target. If all reach the target without displacing production ILUC can be avoided.



Region 1 Region 2 Region 3 Region …

Yield projections Europe

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Observed yield

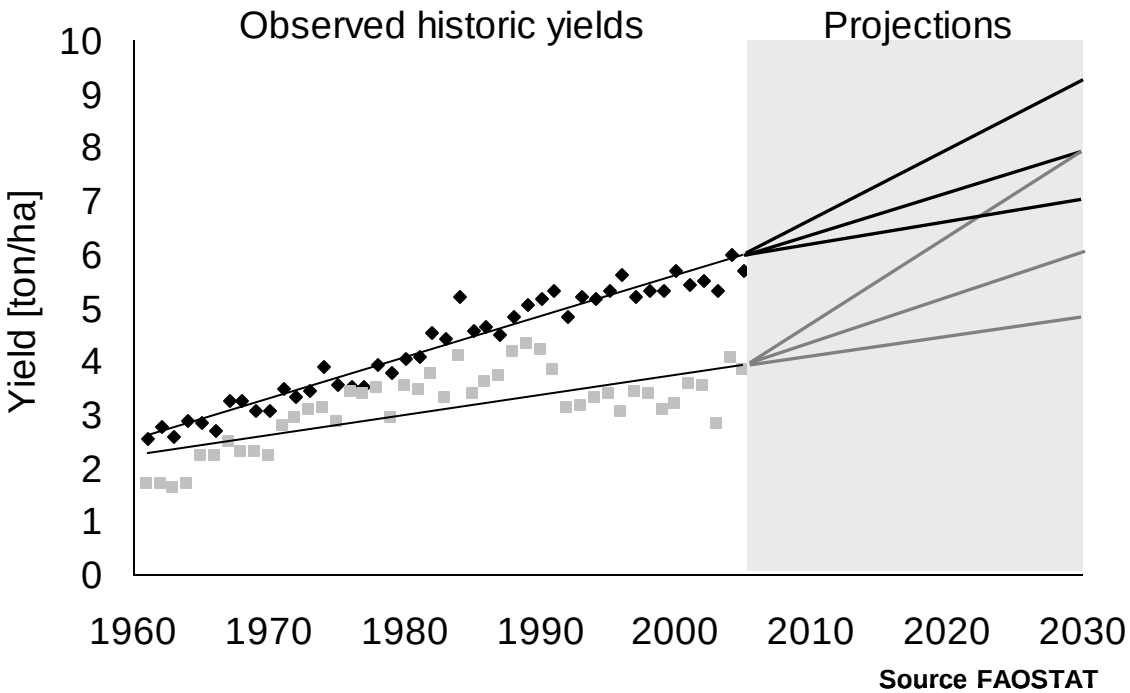
CEEC and WEC

Linear extrapolation of historic trends

Widening yield gap

Applied scenarios

Low, baseline and high



[Wit & Faaij, 2010]

Biofuel yields for 1st and 2nd gen. crops

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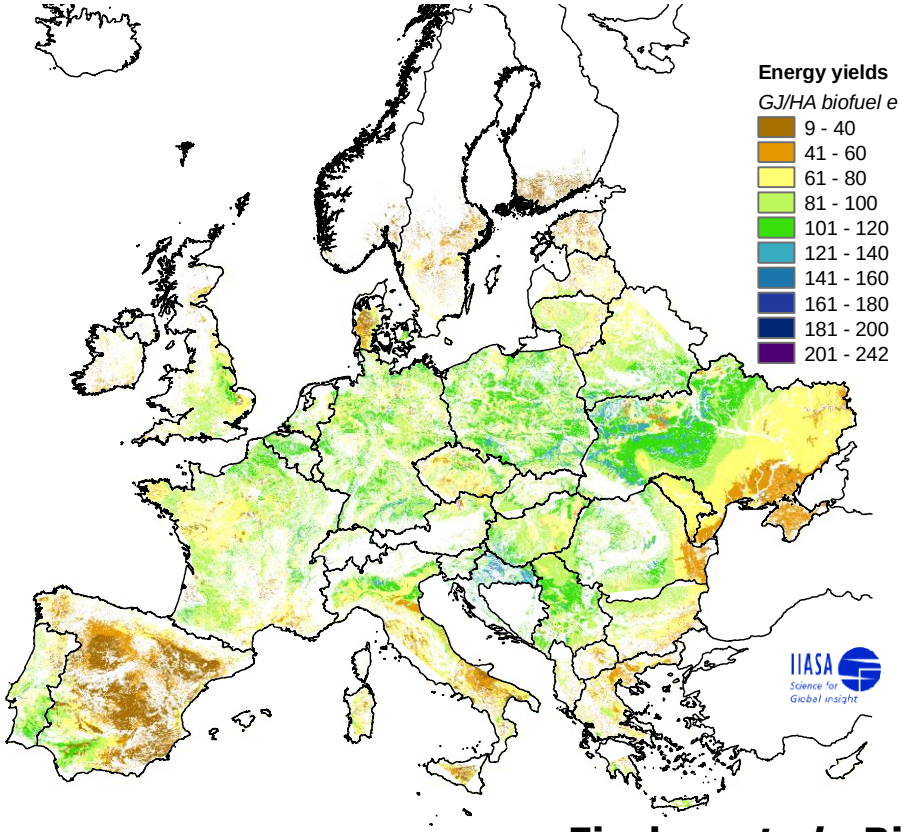
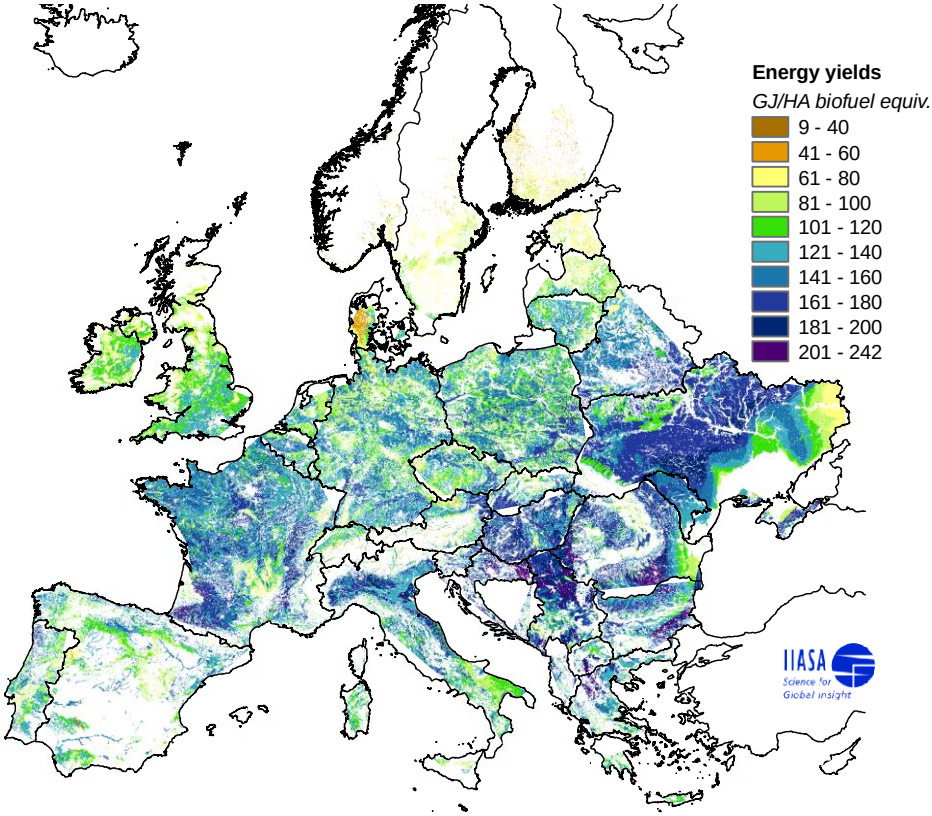
1st generation



2nd generation



Fischer *et al.*, Biomass and Bioenergy 34 (2010) 159-72

Results - spatial production potential

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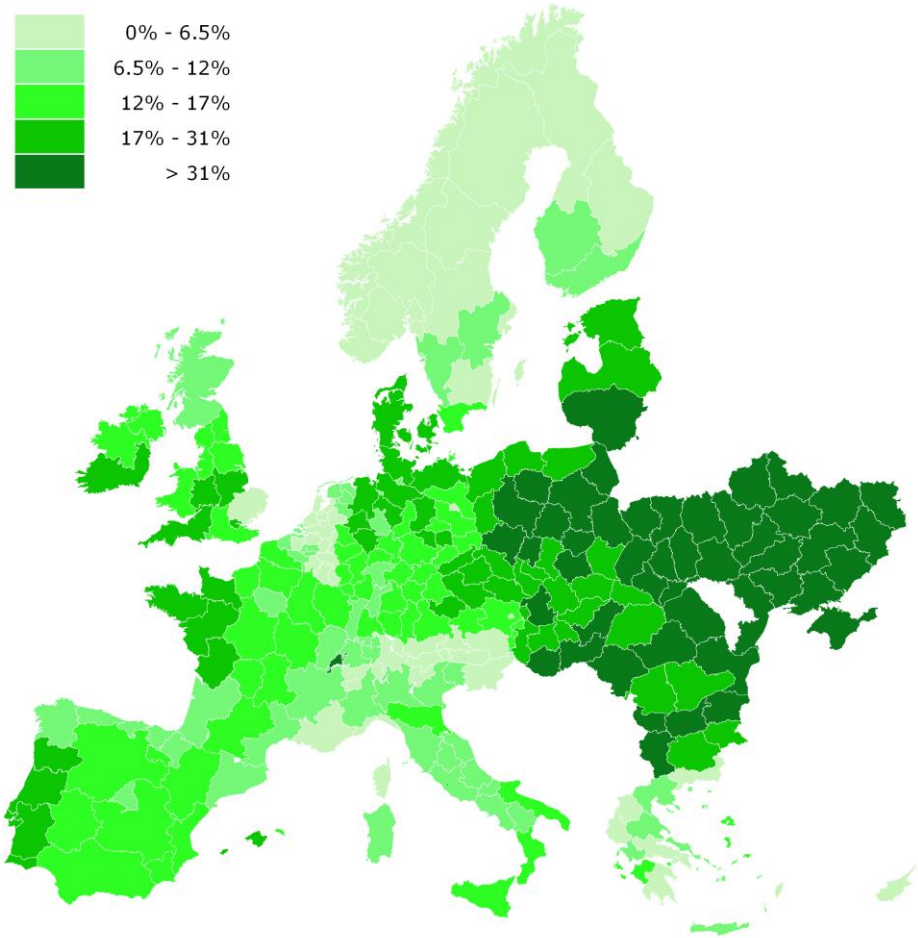
Arable land available for dedicated bio-energy crops divided by the total land

Potential		Countries
Low potential	< 6,5%	NL, BE, LU, AT, CH, NO, SE and FI
Moderate potential	6,5% - 17%	FR, ES, PT, GE, UK, DK, IE, IT and GR
High potential	> 17%	PL, LT, LV, HU, SL, SK, CZ, EST, RO, BU and UKR



[Wit & Faaij, Biomass & Bioenergy, 2010]

Results - spatial cost distribution

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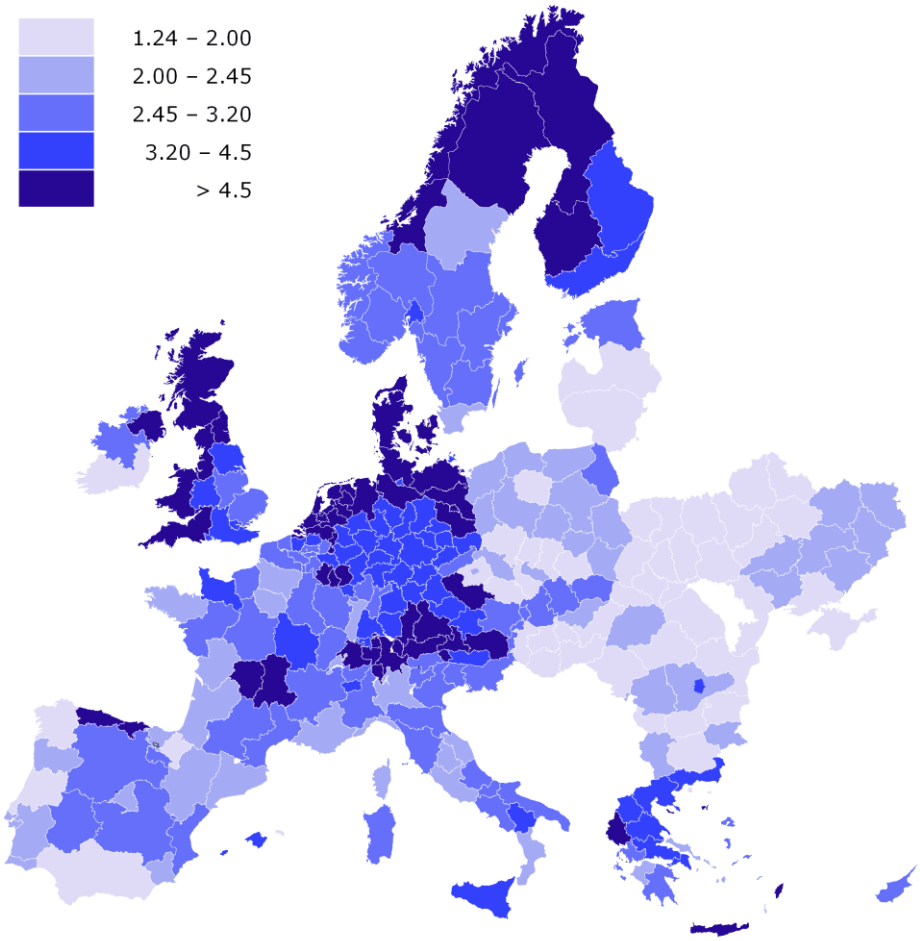
Production cost (€ GJ^{-1}) for Grassy crops

Potential		Countries
Low Cost	< 2,00	PL, PT, CZ, LT, LV, UK, RO, BU, HU, SL, SK, EST, UKR
Moderate Cost	2,00 – 3,20	FR, ES, GE, IT, SE, FI, NO, IE
High Cost	> 3,20	NL, BE, LU, UK, GR, DK, CH, AT



[Wit & Faaij, Biomass & Bioenergy, 2010]

Crop specific supply curves

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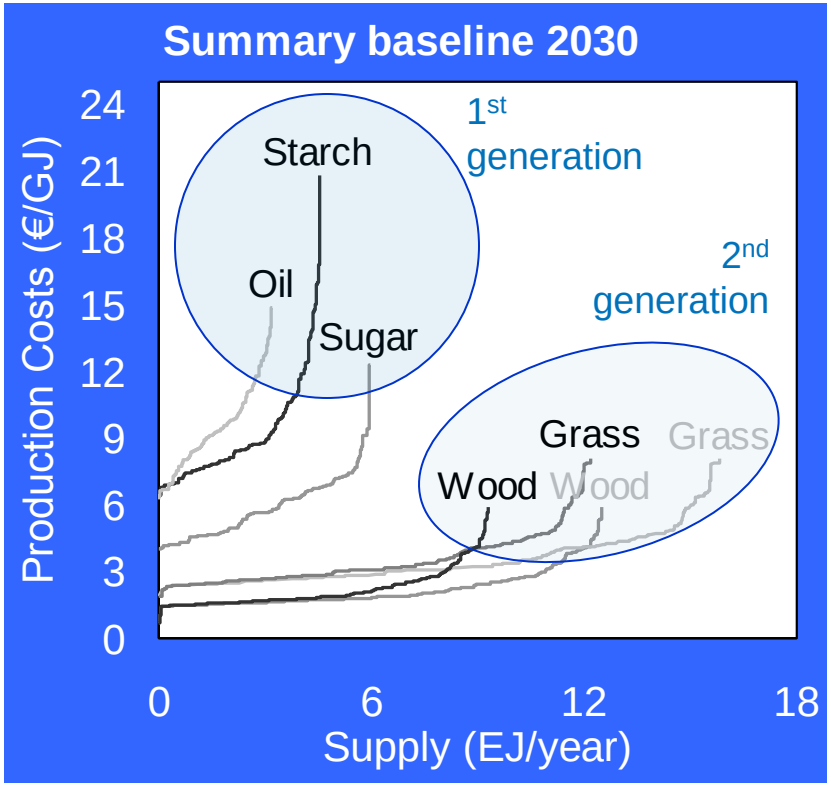
- Feedstock potentials
  Produced on 65 Mha arable and 24 Mha on pastures (grass and wood)

- Significant difference between '1st and 2nd generation crops'

- Supply potentials high compared to demand
  2010 (0,78 EJ/yr) and 2020 (1,48 EJ/yr)



1 EJ (ExaJoule) = 24 Mtoe

[Wit & Faaij, Biomass & Bioenergy, 2010]

Total energy potential under three different crop schemes.

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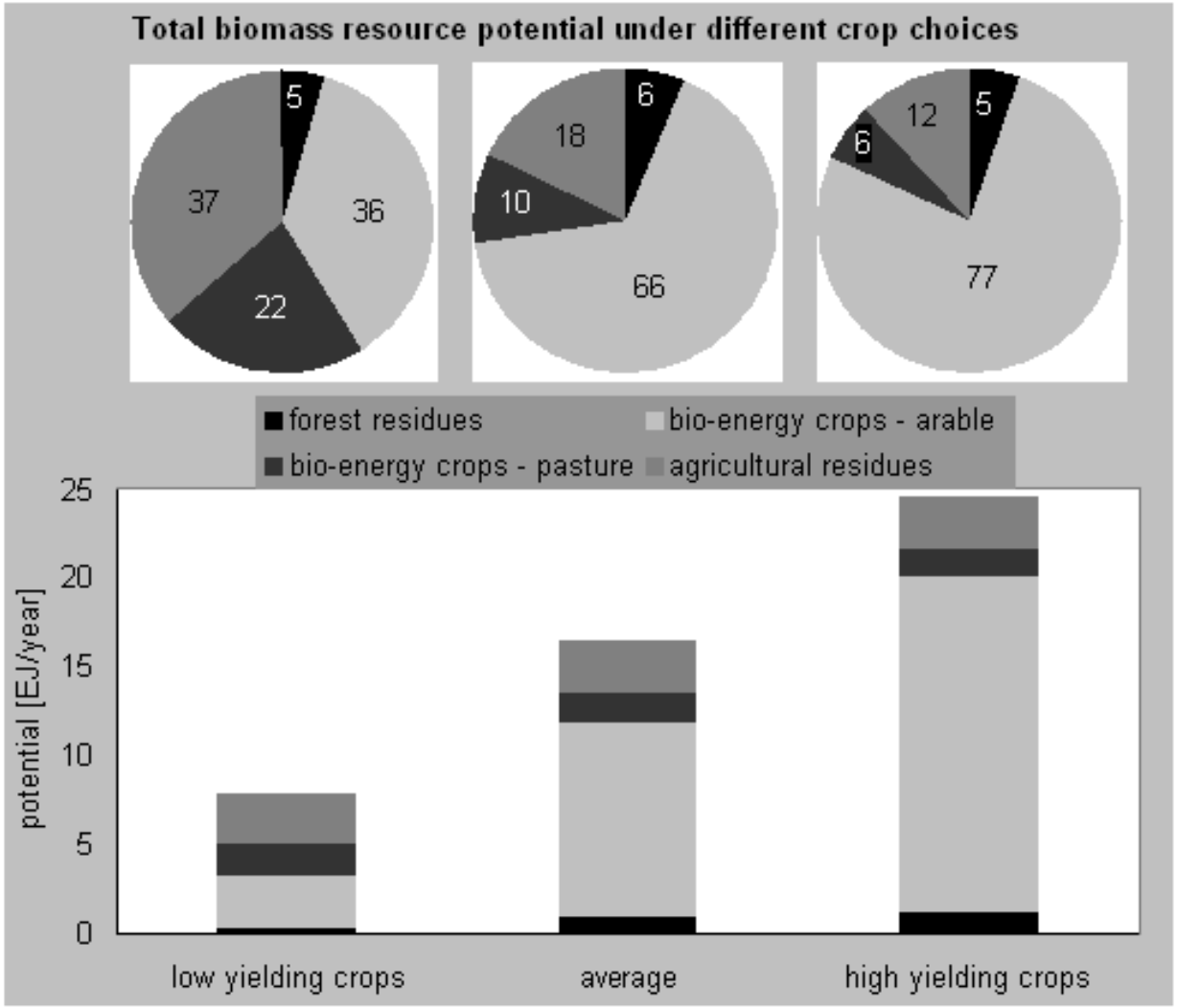
Low yielding crops': all arable land available planted with oil crops. 'High yielding crops': all available land planted with grass crops.



[Wit & Faaij, Biomass & Bioenergy, 2010]

Source: FAOSTAT and own calculations

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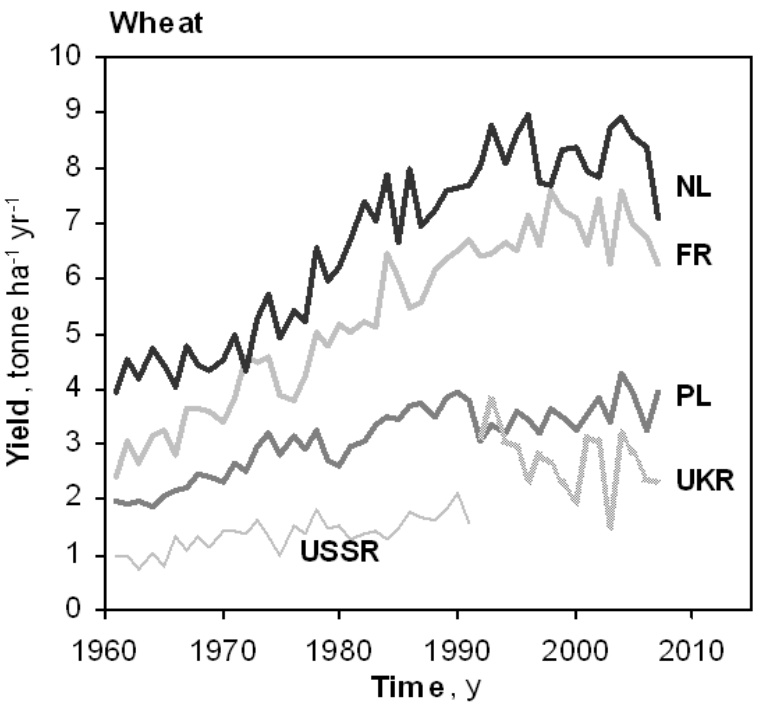
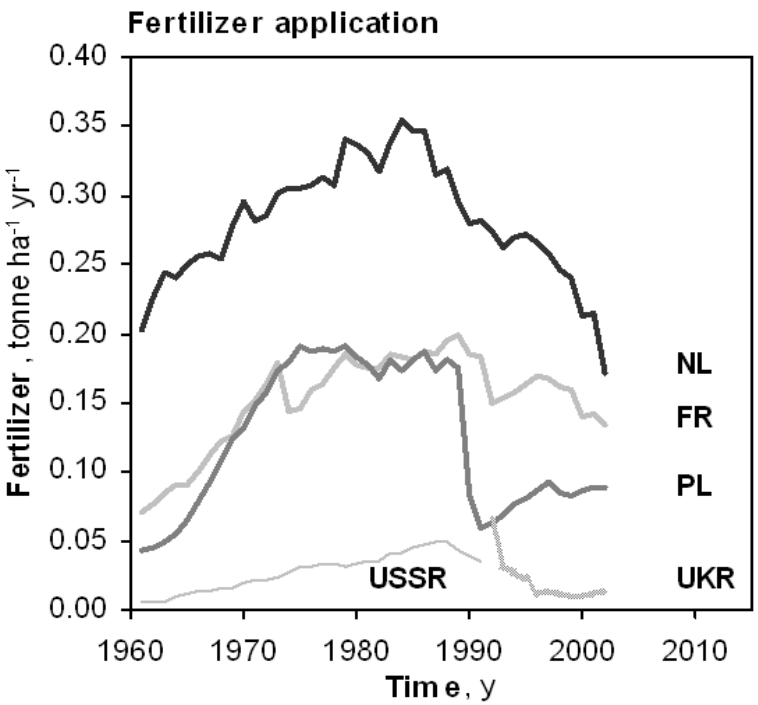
Developments in yields and inputs





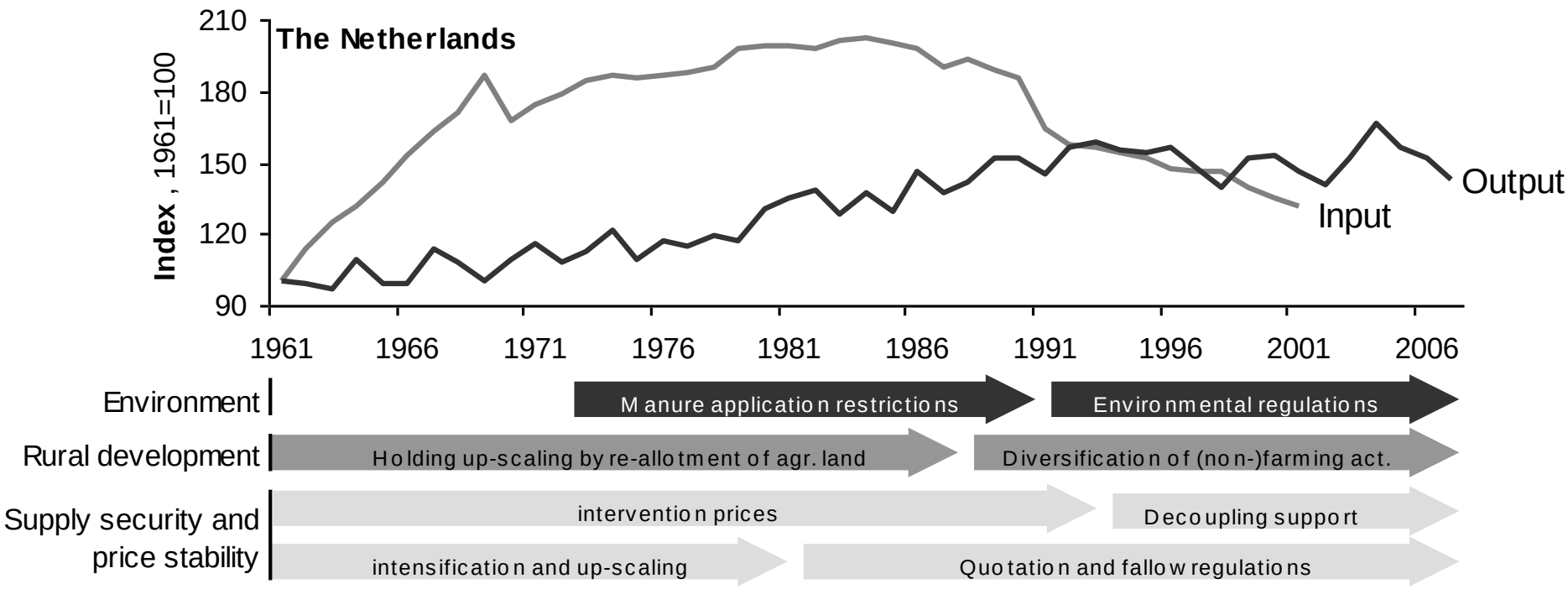
[De Wit et al, RSER 2011]

Developments coupled to drivers

Example: the Netherlands

Inputs (fertilizer, machinery, labour and pesticides)

Outputs (wheat, sugarbeet, rapeseed and cattle)



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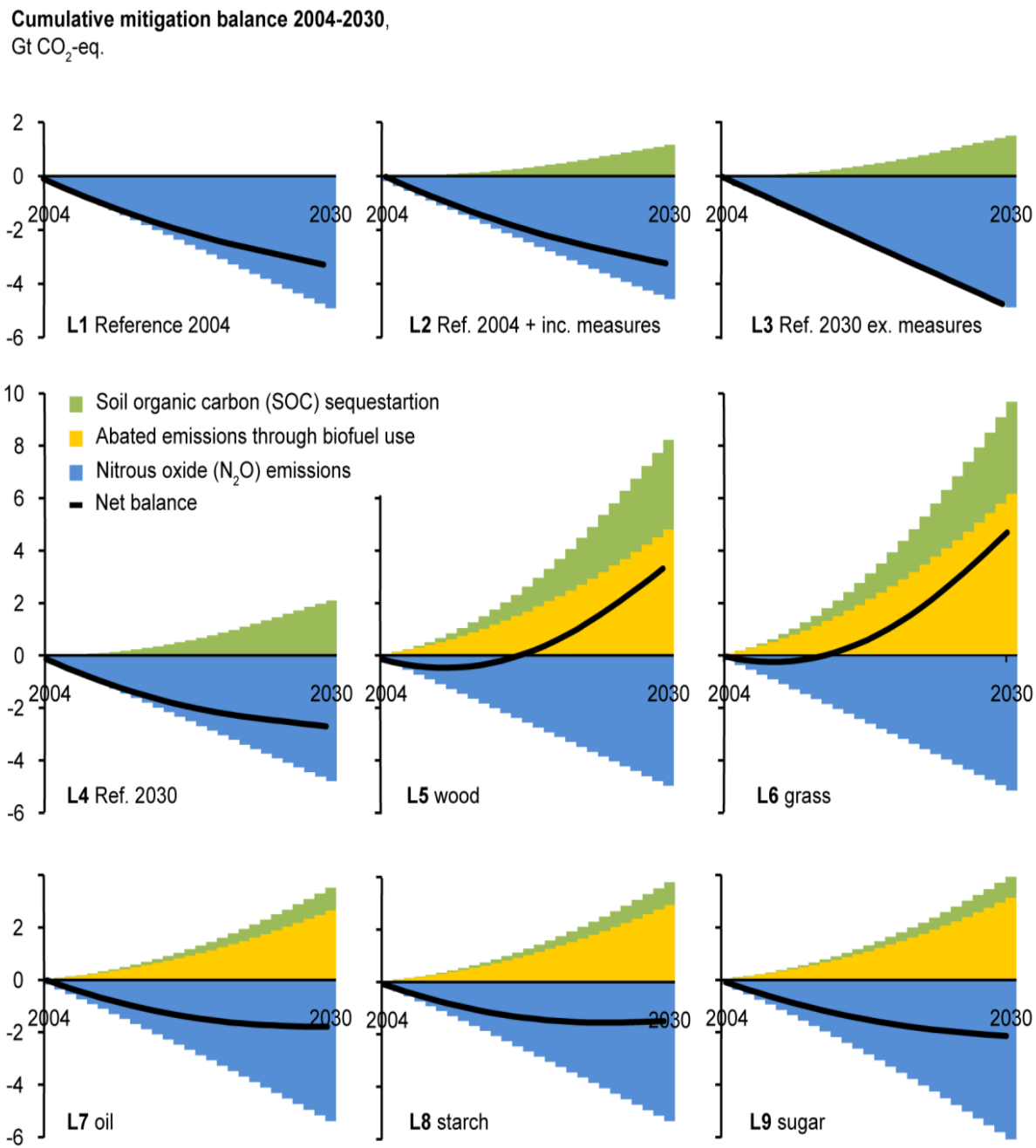

Example:
GHG balance of combined agricultural intensification + bioenergy production in Europe + Ukraine

[Wit et al., BioFPR, 2014]

Typically Europe:

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- Energy security and related trade balance impacts key.
- GHG mitigation policies (ETS) important (& erratic) driver.
- Europe does have considerable biomass supply potentials (but does not fully realize it).
- Some countries global leaders in bioenergy (Scandinavia...)
- European biomass markets are developing, including impact on global trade and supplies…
- …but rely heavily on non-harmonized policy support.
- Eastern Europe offers a major opportunity on short and longer term.
- EC, via RED a key driving force of sustainability criteria (ongoing process for coming years).
- Push for 2nd generation biofuels and biorefining (H2020).
- Power and heat markets key stepping stones.

The challenges (I)

- Gradual harmonisation targets, monitoring and support in EU (e.g. trading).
- Integrated policy covering agriculture (CAP), forestry, waste, environment, energy, various key industrial sectors (biomaterials).
- The Common Agricultural Policy of the EU should fully incorporate bio-energy; especially perennial crops.
- Consistent, long running RDD&D trajectories (supranational); advanced biofuels, biorefining, (advanced) bioelectricity, bio-CCS....

The challenges (II)

- Further develop the international biomass market.
- Further development and deployment of standardization and certification procedures on EU but preferably on global level.
- Specific regional (but also bi- or multilateral) efforts to deploy biomass production and supply systems adapted to regional conditions.
- Key role for energy cropping in CEEC and intra-european trade.

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Thanks for your attention

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Publications; Sciencedirect & Scopus.

www.bioenergytrade.org