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Modelling ILUC of biofuels with the GLOBIOM model

Stakeholder meeting

13/11/2013

Meeting agenda

- > Introduction, project description, project context
- > Description of the GLOBIOM model (IIASA)
- > Which elements of ILUC modelling are important and should be taken into account
- > Providing information to improve the consistency of our modelling exercise
- > Conclusions

Project description

> Ecofys, IIASA and E4tech quantify ILUC emissions of conventional and advanced biofuels consumed in de EU
> Assignment by DG ENER, European Commission, other DGs involved
> GLOBIOM partial equilibrium model, developed by IIASA
> Study results available by early 2015
> Transparent process, stakeholders requested to provide input
> All documentation on GLOBIOM published on project website www.globiom-iluc.eu

Project timeline

> September `13: brief description of GLOBIOM sent to stakeholders, invitation to provide input via ILUC@ecofys.com
> October: detailed description of GLOBIOM and comparison with MIRAGE-BioF circulated
> November: stakeholder meetings
> January: list of changes to GLOBIOM and draft *baseline* en *policy* scenario's
> Dialogue with Advisory Committee
> 1st half 2014: IIASA amends GLOBIOM model
> 2nd half 2014: modelling ILUC emissions

Project context

- > Project separate from current policy discussion
- > Outcomes may be used by policy makers, e.g. for discussion on post-2020 biofuels policy
- > Project aims to include stakeholders

International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

science for global insight

ILUC modelling with GLOBIOM

Hugo Valin, Petr Havlik, Nicklas Forsell, Stefan Frank, Aline Mosnier, Michael Obersteiner et al.

In partnership with Ecofys and E4Tech

Outline

1. The GLOBIOM model: Summary of characteristics
2. Our approach in modelling ILUC
3. How stakeholders can help us to improve

1. The GLOBIOM model

Summary of characteristics

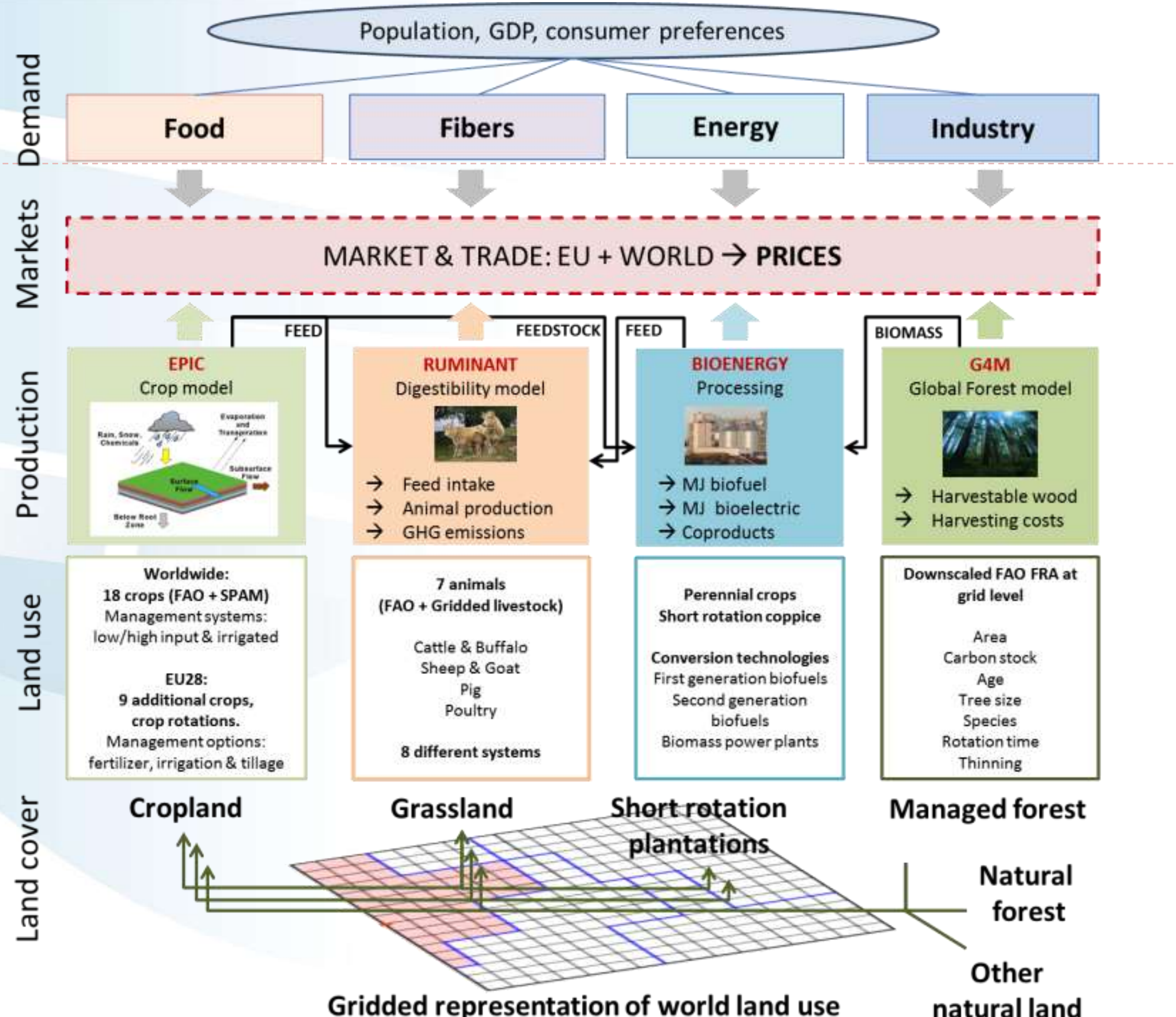
GLOBIOM context

- GLOBIOM will be used for this ILUC assessment exercise
  - Developed at IIASA since 2007
  - By a team of now 10 researchers with different backgrounds (economists, crop modellers, forest experts)
- Team experienced with the ILUC debate (several papers)
- Access to wide range of disciplines of relevance within IIASA
  - Agronomists, remote sensing, carbon accounting experts…
  - Access to large international network of researchers
- Significant involvement on land use change projects
  - Reduction of Emissions from Deforestation and Degradation (REDD)
  - Agricultural prospective
  - Climate change impact, adaptation and mitigation
  - Bioenergy
  - Collaborations with Brazil and Congo Basin

Model structure

- Global scale model based on grid cell resolution (50 x 50 km)
- Partial equilibrium
  - agricultural, wood and bioenergy markets
  - for 28 Member states + 25 world regions
  - bilateral trade flows based on spatial equilibrium approach
- Linear programming approach
  - Maximisation of consumer + producer (incl. trade costs) surplus
  - Non linear expansion costs
  - Optimisation constraints
- Base year 2000
- Time-step: 10 years, typical time-horizon 2020/2050

- Setting tested in several assessments exercises (Havlik et al., 2011; Frank et al., 2012; Mosnier et al., 2013)



Population, GDP, consumer preferences
Demand
Food
Fibers
Energy
Industry
Markets
MARKET & TRADE: EU + WORLD → PRICES
FEED
FEEDSTOCK
FEED
BIOMASS
Production
EPIC
Crop model
RUMINANT
Digestibility model
→ Feed intake
→ Animal production
→ GHG emissions
BIOENERGY
Processing
→ MJ biofuel
→ MJ bioelectric
→ Coproducts
G4M
Global Forest model
→ Harvestable wood
→ Harvesting costs
Land use
Worldwide:
18 crops (FAO + SPAM)
Management systems:
low/high input & irrigated
EU28:
9 additional crops,
crop rotations.
Management options:
fertilizer, irrigation & tillage
7 animals
(FAO + Gridded livestock)
Cattle & Buffalo
Sheep & Goat
Pig
Poultry
8 different systems
Perennial crops
Short rotation coppice
Conversion technologies
First generation biofuels
Second generation biofuels
Biomass power plants
Downscaled FAO FRA at grid level
Area
Carbon stock
Age
Tree size
Species
Rotation time
Thinning
Land cover
Cropland
Grassland
Short rotation plantations
Managed forest
Natural forest
Other natural land
Gridded representation of world land use

GLOBIOM-EU version

	World non EU	EU
Economic markets	25 regions	28 Member States
Land cover	Global Land Cover 2000	CORINE Land Cover
Lowest grid level	10 x 10 km	1 x 1 km
Running resolution	< 2 x 2 degrees	< NUTS2 regions
Agricultural accounts	FAOSTAT SUA	EUROSTAT
Crops	EPIC: 18 crops, 3 management systems	EPIC + CropRota: 25 crops, 2 fertilizer, 2 irrigation, 3 tillage levels
Livestock	ILRI/FAO: 8 management systems for ruminant, 2 for monogastrics	ILRI/FAO: 8 management systems for ruminant, 2 for monogastrics Harmonisation with CAPRI
Forestry	FRA 2010 (FAO)	FRA 2010 (FAO)

Differences with MIRAGE-BioF

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EC project ENER/C1/428-2012 - LOT 2
Assessing the land use impact of EU biofuels policy

Description of the GLOBIOM (IIASA) model and comparison with the MIRAGE-BioF (IFPRI) model

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Maarten van den Berg (E4tech)

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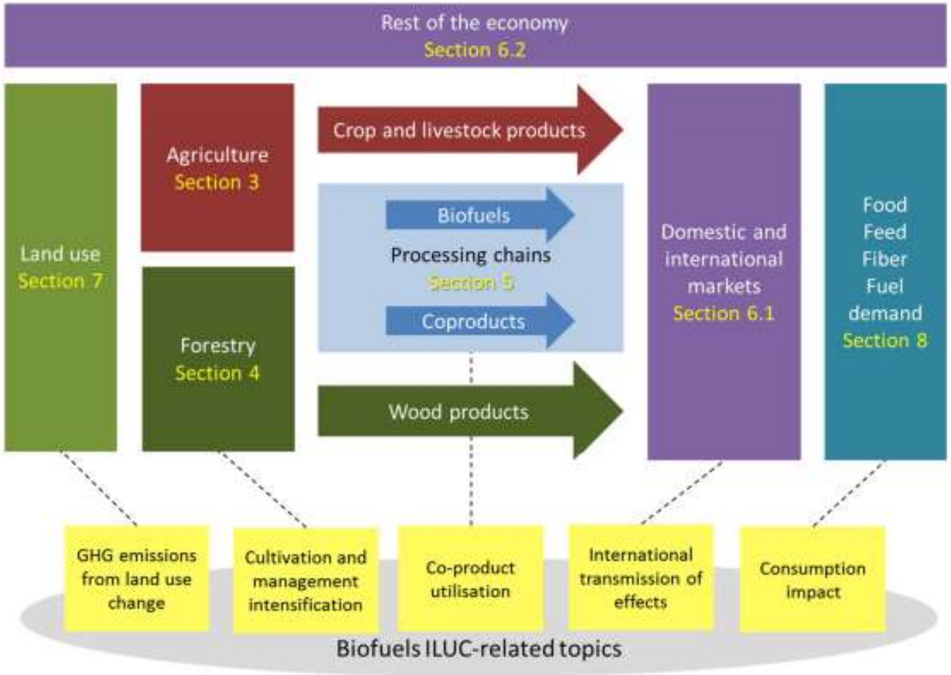
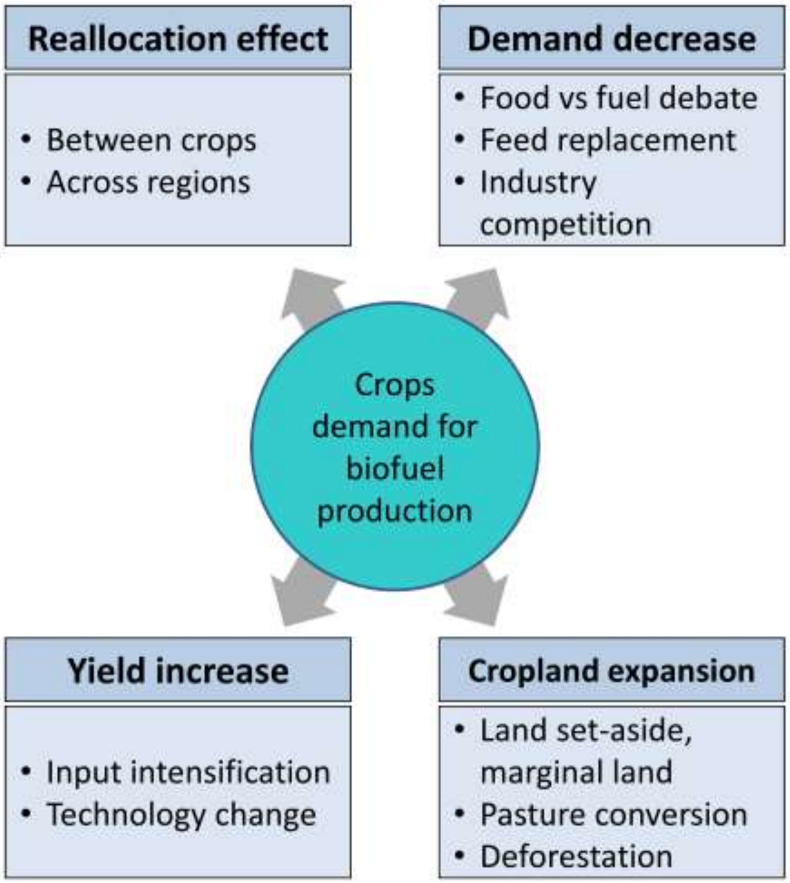
30 October 2013



	GLOBIOM (2013)	MIRAGE-BioF (2011)
Model framework	Bottom-up, starts from land and technology	Top-down, starts from macroeconomic accounts
Sector coverage	Agriculture (incl. livestock), forestry and bioenergy (Partial equilibrium)	All economic sectors with agriculture disaggregated (General equilibrium)
Regional coverage	Global (28 EU Member states + 25 regions)	Global (1 EU region + 10 world regions)
Resolution on production side	Detailed grid-cell level (>10,000 units worldwide)	Regional level, land split into up to 18 agro-ecological zones
Time frame	2000-2030 (ten year time step)	2004-2020 (one year time step)
Market data source	EUROSTAT and FAOSTAT	GTAP economic accounts, harmonised with FAOSTAT
Factor of production explicitly modelled	More detailed on natural resources (land, water)	More detailed on economic resources (labour, capital, land)
Land use change mechanisms	Geographically explicit. Grid-cells with suitability, protected areas, conversion costs.	Not geographically explicit Substitution of land use at regional and agro-ecological zone level.
Representation of technology	Detailed biophysical model estimates from biophysical models. Literature reviews for biofuel processing	Input-output coefficient from GTAP or national statistics at regional level. Literature reviews for biofuel processing
Demand side representation	On consumer per region and per good, only reacting to price	One agent per region, adjusting its consumption between goods depending on prices and level of income
GHG accounting	12 sources of GHG emissions: crop, livestock, land use change, soil organic carbon. Peatland based on IPCC default emission factors.	Only land use change emissions. Deforestation and soil organic carbon from default IPCC emissions factors. Peatland revised upward from IPCC emission factor

ILUC modelling features

- Detailed representation of land
  - associated uses (and non-uses)
  - carbon stocks
- Yield endogenous response
  - Intensification (change in systems)
  - Irrigation
  - Intra-regional reallocation
- Endogenous demand response
- Bilateral trade
- Marginal yield values from biophysical model



2. Modelling ILUC

Our approach

Our approach to the study

- Using the current state of literature
- Consultation with stakeholders and experts to refine and adapt the model to the ILUC question
  - Bioenergy supply chains and technologies
  - Utilisation of products and co-products
  - Technical and economic constraints
- Information and transparency on assumptions and results
  - Dedicated website: www.globiom-iluc.eu
  - Model documentation
  - Downloadable results
  - Email address for questions and comments: ILUC@ecofys.com
- Scientific research
  - Accepting uncertainty
  - Acknowledging knowledge gaps

Simulating LUC: Baseline and scenario

1. Defining the baseline 2010-2030
   - Drivers (macro/future demand, productivity, technology)
   - Policies for EU and Rest of the world
     - Bioenergy
     - Agriculture and trade
     - Protected areas
2. Reference values
   - EU and rest of the world land use change
   - GHG emissions from agriculture and land use change
3. Applying a shock in demand for biofuels
   - Increase in 1 feedstock with 1 technology
   - Increase in all feedstocks with predefined portfolio of technologies
   - Increase in all feedstocks with cost-efficiency scenario

Simulating LUC: Impacts

4. Analysing policy impacts
    - Additional demand drives prices up for biofuel feedstocks

Different effects:

- Increase in production
    - Increase in harvested area
    - Increase in yields (intensification, reallocation within regions)
    - In Europe but also in the rest of the world through trade
- Changes in demand for food, feed and industrial products
    - Buffers production side effects
    - Food security issues?
    - Cheaper and more abundant feed for livestock through co-products

Simulating LUC: Sensitivity and comparison

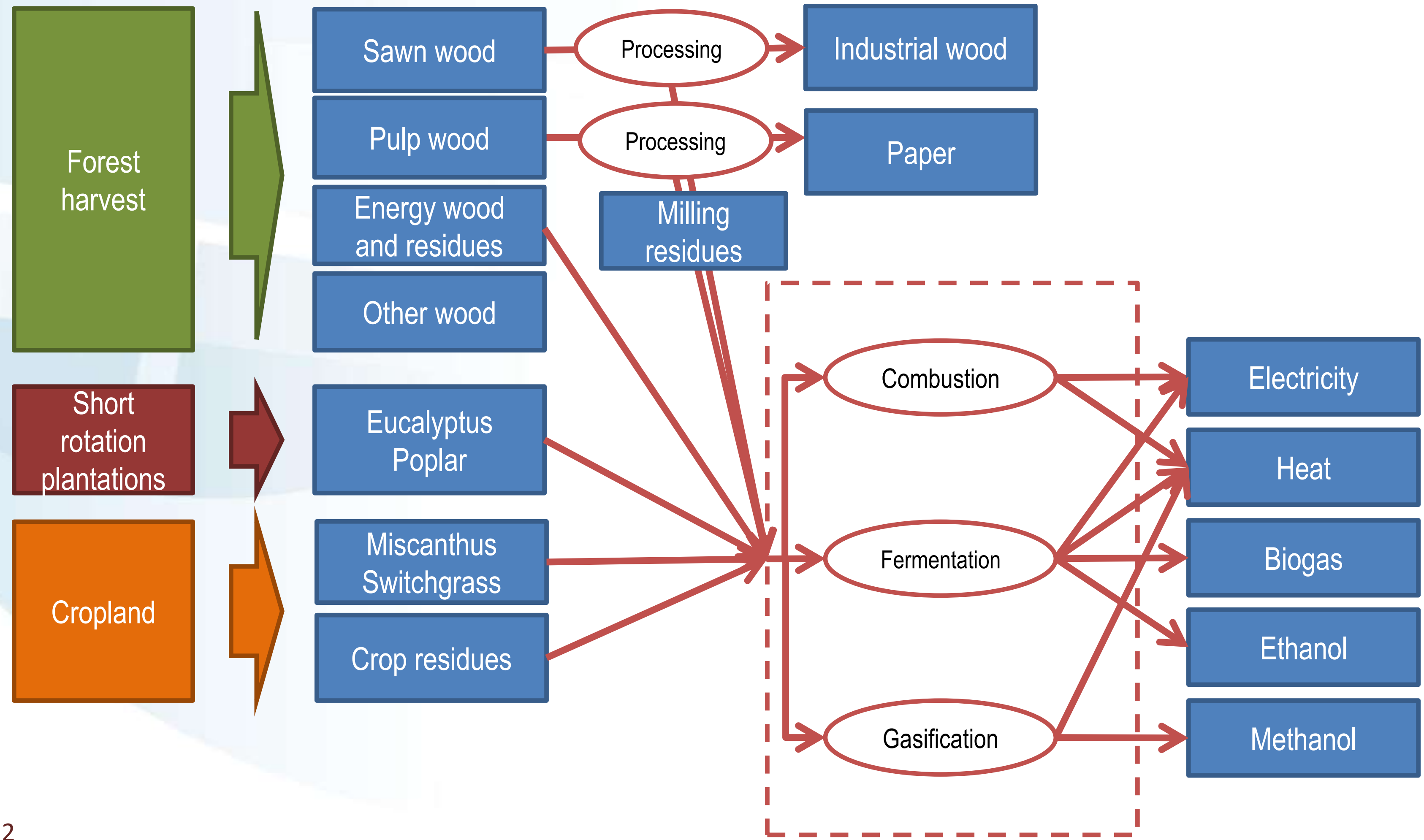
5. Accounting GHG emissions from land use change (and others?)
6. Sensitivity analysis
   - Technical coefficients
   - Economic parameters on supply, demand and trade
   - Emission factors
7. Decomposition of effects
   - Net displacement factor (NDF, Plevin et al., 2010)
   - Contribution of demand, expansion, and yield response
8. Comparison with literature
   - IFPRI-MIRAGE
   - Other models

3. Role of stakeholders

How you can help us improve the tools?

Bioenergy supply chains
(current version of the model)

- 2^{nd} generation



Pathways in the RES directive (2009)

Biofuel production pathway	Typical greenhouse gas emission saving	Default greenhouse gas emission saving
wheat straw ethanol	87 %	85 %
waste wood ethanol	80 %	74 %
farmed wood ethanol	76 %	70 %
waste wood Fischer-Tropsch diesel	95 %	95 %
farmed wood Fischer-Tropsch diesel	93 %	93 %
waste wood dimethylether (DME)	95 %	95 %
farmed wood DME	92 %	92 %
waste wood methanol	94 %	94 %
farmed wood methanol	91 %	91 %
the part from renewable sources of methyl-tertio-butyl-ether (MTBE)	Equal to that of the methanol production pathway used	

What information can help us

- Refineries
  - Current pathways / future pathways
  - Coefficient of conversion of feedstocks
  - Input requirements
  - Feedstocks and processing costs
  - Output and co-products
- Feedstocks availability constraints
- Downstream market bottlenecks
- Competition from foreign markets and pathways
- Any information on current developments deemed of interest
  - Market information
  - Literature

Conclusion

- This modelling exercise is not a new assessment but an additional assessment
- Wish to model ILUC as consistently as possible
  - Stakeholder inputs can help us with this
- New models may bring new results but land use change is still likely to happen
- What will not change:
  - Results are feedstock specific
  - Uncertainty analysis will remain a major aspect
  - Models are not predictive tools but a simplified representation of a complex reality