Future perspectives of international bioenergy trade

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Global bioenergy scenarios

Implication of scenarios on future international bioenergy trade?

Source: IPCC SRREN, 2011
Objective

Provide insight into “possible futures” of bioenergy trade and discuss drivers, implications and challenges
Methodological approach

• Investigate to which extent various global energy models and scenarios take into account bioenergy trade

• Compare selected scenario results

• Identify the drivers and implications of different global bioenergy scenarios on bioenergy trade

• Derive conclusions
Comparison of models and scenarios

✓ Screening of existing models and studies
  ➢ 28 models have been screened in total
  ➢ Preselection of models
  ➢ Request (small questionnaire) to selected modeling groups

✓ Selection of models for further investigation: GFPM, IMAGE/TIMER, POLES

✓ Three biomass fractions to be covered:
  ➢ solid biomass
    ➢ based on residues and waste
    ➢ based on primary energy products
  ➢ liquid biomass distinction of three fractions

✓ Regional aggregation level: 20 world regions
Model selection

Whole range
All investigated models (studies)

Long List
Models dealing with bioenergy trade scenarios

Short List
Models highly relevant for analysis of trade scenarios

GFPM (EFSOS II)
IMAGE/TIMER POLES

USFPM
PULPSIM
EFSOS II
EFI GTM
PEEP
BEAP
Lundmark, 2010
IBSAL
WISDOM
CINTRAFOREF
MESSAGE
GLOBIOM
IIASA/GGI-Scenario Database
Witch
Muñoz, 2009
MERGE
GEAMERGE
WEO

GLUE
GM-Modell
Heinimö, 2008
Hofnagels, 2011a
HofnagelsII, 2011b
Lamers, 2011
Models I – GFPM (EFSOS II)

Short Description: Partial Equilibrium Model

Coverage Biomass Trade: Global – Trade between country and world market rather than between individual countries

Assumptions regarding trade:
- equilibrium calculation determine the direction of change of trade flow
- Institutional and other constraints limit the adjustment that can take place in any given year.
- Effect of tariffs change the cost of transportation.

Sectoral Coverage: Limited to the forest and forest biomass sectors
- covers 14 principal categories of forest products

Regional Aggregation: 180 countries,
- 50 from Africa, 35 from North Central and South America, 50 from Asia and Oceania, and 45 from Europe and former USSR

Scenario Time Frame Up to 2060
Models II – IMAGE/TIMER

Short Description: Systems dynamic Integrated assessment model

Coverage Biomass Trade: Yes

Assumptions regarding trade: Bilateral trade available
- n regions, n markets. Each region imports from wherever offers the lowest price
- Imports have transport costs, plus a factor determining how "open" they are to that region (i.e. indicating OECD countries or closed economies)

Sectoral Coverage: Traditional biomass (no trade), modern solid biofuel, liquid biofuel

Regional Aggregation global 26 regions

Scenario Time Frame: up tp 2100
Models III – POLES

Short Description: Partial Equilibrium Model, hybrid, recursive dynamic

Coverage Biomass Trade: Yes; global (imports from one single international market)

Assumptions regarding trade: Competition between domestic supply and imports from international. Competition occurs over part of the demand each year (infrastructure lifetime, trade inertia).
- Internat. solid biomass price: cost curve (biomass use wrt total biomass potential)
- Internat. biofuels price: world avg production costs (explicit technologies)
- Transport costs

Sectoral Coverage: Traditional biomass (no trade); modern solid biomass (consumed as inputs for biofuels, power sector, industry, buildings); liquid biofuels (transport)

Regional Aggregation Global, 57 regions

Scenario Time Frame: up to 2100
Selected scenarios

- **Ambitious bioenergy scenarios**
  - TIMER: OECD 450 ppm scenario, OECD 100$ per t CO2 scenario
  - POLES based on EMF scenarios: 450 ppm, 100$ per t CO2
  - GFPM: high

- **Moderate bioenergy scenarios**
  - TIMER: OECD environmental outlook, OECD EO trade barriers, OECD 650 ppm, OECD 20$ per t CO2
  - POLES: based on EMF scenarios G1 Reference, G4 BAU, BAU+trade barriers, 650 ppm, 20$ per t CO2
  - GFPM: low
Bioenergy production in selected scenarios

World Biomass Production

<table>
<thead>
<tr>
<th>Year</th>
<th>EJ Biomass</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
<th>2070</th>
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<tr>
<td>2010</td>
<td>Image /Timer OECD Env. Outlook</td>
<td>100$ per tCO2</td>
<td>100$ per tCO2</td>
<td>100$ per tCO2</td>
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<tr>
<td>2030</td>
<td>Image /Timer OECD 100$ per tCO2</td>
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<tr>
<td>2050</td>
<td>Image /Timer OECD 450</td>
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<tr>
<td>2070</td>
<td>GFPM High</td>
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<td>100$ per tCO2</td>
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</tr>
<tr>
<td>2010</td>
<td>GFPM Low</td>
<td>100$ per tCO2</td>
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<td>POLES BAU</td>
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<tr>
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<td>POLES 100$ per tCO2</td>
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</tr>
</tbody>
</table>
Regional bioenergy demand, selected scenarios

Total biomass, ambitious scenarios, 2030*

Total biomass, ambitious scenarios, 2050

(*) GFPM scenarios cover only solid biomass

Sources: POLES, TIMER, GFPM
Regional bioenergy trade balances

Total biomass, ambitious scenarios, 2030*

14-26% (10-45 EJ) of global bioenergy demand is traded between regions

Total biomass, ambitious scenarios, 2050

14-30% (15-70 EJ) of global bioenergy demand is traded between regions

(*) GFPM scenarios cover only solid biomass
Selected drivers

- **Regional balancing of supply and demand**
  - Barriers and drivers of bioenergy demand (in current supply and demand regions): oil price, policies, technological learning, GDP …
  - Barriers and drivers of bioenergy supply
  - Regional development of bio-based industry

- **Barriers and drivers of bioenergy trade**
  - Logistics
  - Trade policies
  - Sustainability requirements
  - …

- **Technological change**
  - Traditional biomass => modern biomass
  - Change in resource base
Shift from traditional to modern biomass

Global structure of bioenergy use, 2009

- Fuelwood: 33.5 EJ, 67%
- Black liquor: 0.5 EJ, 1%
- Charcoal: 3.5 EJ, 7%
- Recovered products and residues: 6.1 EJ, 12%
- Municipal solid waste: 1.5 EJ, 3%
- Agro-energy crops: 1.5 EJ, 3%
- Woody sources: 0 EJ, 0%

Share of traditional biomass in 2050: 13%-18%

Source: estimation according to FAO 2010

Global structure of bioenergy use according to selected scenario results Image/Timer, 2050

- Solid biomass, traditional biomass
- Liquid Biomass
- Solid biomass primary energy products
- Solid biomass residues and waste

OECD EO
OECD 450 ppm
OECD 650 ppm

2050
Conclusions (1)

- Quantities of produced biomass are rising in all investigated scenarios.
- All investigated scenarios show a strong increase in total internationally traded biomass (in a range of 20-90 fold increase from 2010 to 2050).

- The development of international bioenergy trade will be driven strongly by
  - Climate policies
  - Regional differences of policies, GDP
  - Supply of biomass resources
  - Technological change and thus shift in the biomass resource base
  - Sustainability requirements
  - Overall global energy demand, GDP, population, …
Conclusions (2): robust results in most scenarios

- **Key potential future bioenergy export regions according to model scenarios in 2050:**
  - Russia + former USSR (40% of trade, 10% of global demand)*,
  - Canada, South-America, Central and Rest Africa, Oceania (40% of trade, 10% of global demand)*

- **Key future bioenergy import regions in 2050:**
  - India (33% of trade, 8% of global demand)*
  - Western Europe, China (39% of trade, 9% of global demand)*

- USA: relevant importer of liquid biofuels, small exporter (or balanced) for solid biomass
- China: high difference between ambitious and non-ambitious scenarios

(*) values refer to 2050, average of ambitious bioenergy scenarios
Conclusions (3)

- **Open questions:**
  - Impact of different supply and demand functions in the models
  - Impact of other energy technologies in the scenarios
  - Consideration of bioenergy trade barriers in the models?
  - Impact of trade patterns on future bioenergy scenarios?
  - ...

- Only a few number of global energy models explicitly simulate international bioenergy trade.
- Nevertheless, all global energy scenarios need to make an assumption on the future development of bioenergy trade.
- A further investigation and integration of international bioenergy trade, barriers and drivers into existing modeling frameworks is highly needed.
Further questions:

www.bioenergytrade.org

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