Biomass Potential and Cost Assessment through the European Forest and Agricultural Sector Optimization Model

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EUFASOM Model Presentation

- Partial equilibrium model (endogenous prices)
- Bottom-up approach
- Computes agricultural and forest market equilibrium (optimization model)
- Constrained by resource endowments, technologies, policies
- Spatially explicit, dynamic
- Data intensive, comprehensive
- Integrates environmental effects
- Programmed in GAMS, Solved as LP
The EUFASOM Model

• General Objective
  To advice policy makers about the agricultural and forestry sector response to structural changes based on:
  
a) Policies
b) Environmental change
c) Technical change
d) Socioeconomic change

• Specific Objective
  EUFASOM aims at integrated assessments of food, climate, biodiversity, bioenergy and water issues from different land use options.
Biomass and Bioenergy Investigations in EUFASOM

• Objectives

– investigate biomass and bioenergy technical and competitive economic potentials in Europe

– analyze the impacts of biomass and bioenergy production on food sustainability, biodiversity, regional and international trade and its related marginal costs

– assess CO$_2$ mitigation potentials in Europe
Economic Potentials of Biomass and Bioenergy

• Direct Production Costs
• Opportunity Costs (land scarcity, markets)
• External Costs (Non-market impacts)
  – GHG Emissions (Offsets, Leakage)
  – Biodiversity and Ecosystems
  – Soil Quality
  – Food Security
  – Landscape
Biomass and Bioenergy Economics in EUFASOM

• Farm and Processing Plant level economics - Microeconomics

• Economics of international agricultural and forest markets – Macroeconomics

• Externalities – Policy Analysis
Microeconomic Data
1: Conventional Technologies

• Sources:
  – Farm Accountancy Data Network Database
  – Food and Agriculture Organization of the United Nations Statistical Databases & Data-sets

• Farm budgets
  – Yields
  – Inputs
  – Costs

• Automated Data Processing & Integration
Microeconomic Data
2: Adaptation Technologies

- New Technologies
  - New agricultural production methods
  - New bioenergy processes
- Existing Technologies without data
  - Crop management adaptations
  - Processing plants
Macroeconomics in EUFASOM

Price

P*

Consumer Surplus

Producer Surplus

Supply

Demand

Q*

Quantity
EUFASOM Model Structure

- **Resources**
- **Inputs**
- **Supply Functions**
- **Land Use Technologies**
- **Environmental Impacts**
- **Processing Technologies**
- **Products**
- **Markets**
- **Demand Functions, Trade**
- **Limits**

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## Technological Data: Biomass

- **Indicative producer prices**

<table>
<thead>
<tr>
<th>Biomass Type</th>
<th>Average Cost (EUR/ tone)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miscanthus</td>
<td>~ 53</td>
</tr>
<tr>
<td>RCG</td>
<td>~ 40</td>
</tr>
<tr>
<td>Willow</td>
<td>~ 70</td>
</tr>
<tr>
<td>Pulp</td>
<td>~ 50</td>
</tr>
<tr>
<td>Timber</td>
<td>~ 100</td>
</tr>
</tbody>
</table>

Sources: Defra/DTI (2007), UK Biomass Strategy
Technological Data: Bioenergy

- Indicative market prices

<table>
<thead>
<tr>
<th>Sector</th>
<th>Price</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioelectricity</td>
<td>30-40</td>
<td>EUR/MWh</td>
</tr>
<tr>
<td>Bioheat</td>
<td>10-20</td>
<td>EUR/MWh</td>
</tr>
<tr>
<td>Biofuels</td>
<td>50-70</td>
<td>EUR/hL</td>
</tr>
<tr>
<td>Biogas for transport</td>
<td>~ 100</td>
<td>EUR/hL</td>
</tr>
<tr>
<td>Biogas for electricity</td>
<td>15-20</td>
<td>EUR/MWh</td>
</tr>
</tbody>
</table>

Sources:
- http://www.eubia.org/
- http://www.ebio.org/
- ENFA Consortium (2008)
European Biomass Resources

- EU Consumption (2006):
  Source: http://www.eubia.org/
  - Primary energy: > 2000 mtoe
  - Solid biomass*: ~ 62.4 mtoe (3.7%)

- EU guideline on biomass use (EU25):
  - by 2010^: ~ 150 mtoe ~ 360 M dry ton biomass
  - by 2020: ~ 217 mtoe ~ 520 M dry ton biomass

* Includes biomass to heat, electricity, biofuels
^ Conversion: 1 toe ~ 2.4 dry ton biomass
Bioenergy Indicative Targets by 2010

- 15% ~ 62 mtoe for heat/electricity
- 5.75% ~ 18 mtoe for biofuels

Scenario Analysis Results

- Economic Potentials
- Technical Potentials
- Impact on Food, Consumption and Trade
- Impact on Biodiversity
  - Grasslands
  - Wetlands
**Scenario: Biomass Potential Assessment**

- **Technical Potential**: By 2010
  - Biomass Price in Euro/ton
  - EU25 Biomass Demand in million dry tons

- Competitive Economic Potential
- Technical Potential (simulated)
- 2006 consumption

*2006 consumption ~150 M dry tons*  
*Broek van den et al (2003)*
Scenario: Bioenergy Potential Assessment

EU25 Bioenergy Demand in 1000 MWh (all sectors)

Bioenergy Price in Euro/MWh

Technical Potential

Competitive Economic Potential
Scenario: Biofuel Cost-Supply Functions

Marginal Biofuel Cost in Euro/hl vs. EU25 Biofuel Production in mill hl

- Bioethanol (red)
- Biodiesel (green)
- Biofuel (blue)
Impact on Food Price, Consumption and Trade

- Net Export Volume in Billion Euros
- Fisher Index for Food Price and Consumption
- EU25 Bioenergy Demand in million MWh

- Price
- Consumption
- Net Export

Impact on Food Price, Consumption and Trade

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Impact on Biodiversity: Grassland

Bioenergy Subsidy in Euro/MWh

EU 25 Bioenergy Demand in 1000 MWh

KeepGrassland_Biofuel
KeepGrassland_Biogas
KeepGrassland_BioElec
KeepGrassland_AllBioEn
ConvertGrassland_AllBioEn
Impact on Biodiversity: Grassland

EU25 Energy crop area in million ha

Bioenergy Subsidy in Euro/ha

Protect existing grassland areas

- Northern Europe
- Western Europe
- Central Europe
- Eastern Europe
- Southern Europe
- EU25 Countries

Protect existing grassland areas
Impact on Biodiversity: Grassland

EU25 Energy crop area in million ha

Bioenergy Subsidy in Euro/ha

Northern Europe
Western Europe
Central Europe
Eastern Europe
Southern Europe
EU25 Countries

Unprotect existing grassland areas
Scenario: Bioenergy and Wetlands

Wetlands = 40 Mha

EU25 Biomass Production in million wet tons

Marginal Biomass Cost in Euro/ton

10 Mha

30 Mha

40 Mha
Impact on Biodiversity: Wetlands

![Graph showing the impact on EU25 wetland area in Million ha with incentives in Euro/ha. The graph includes lines for different biomass targets: 0%, 25%, 50%, 75%, and 100%. Each line represents the increase in wetland area at different incentive levels.]

Protect existing wetland areas

Biomass Targets:
- 0%
- 25%
- 50%
- 75%
- 100%
Impact on Biodiversity: Wetlands

EU25 Wetland area in Million ha

- Biomass Target 0%
- Biomass Target 25%
- Biomass Target 50%
- Biomass Target 75%
- Biomass Target 100%

Unprotect existing wetland areas

Incentive in Euro/ha

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EUFASOM Applications

• Applied in a number of EU Projects
  – EC4MACS (EU-LIFE Program)
  – FP6
    • NEEDS
    • European Non-Food Agriculture
    • TranSust.Scan
    • GEO-BENE
  – FP7
    • Biomass Energy Europe
    • EuroGEOSS
    • CCTAME
    • LULUCF Projections (in cooperation with EC-JRC)
Thank you!

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