



Nordic Energy Outlooks WP1

Bioenergy and links to agriculture and LULUCF in a Nordic context
Pavinee Nojpanya, Elvira Molin and Akram Sandvall



Agenda

- Background and aim
- ON-TIMES model
- Biomass potential from agriculture
- Environmental impacts of biomass from agriculture
- Comments to NECPs
- Promising future work

Background

In Sweden and the other Nordic countries:

- Biomass contributes to a large share of the energy supply.
- Existence of policy incentives to increase the domestic agricultural production
- Transition to a bioeconomy increases the demand for biomass in the energy sector.
- These could contribute to intensified and competing land use, followed by adverse environmental effects, e.g., declining biodiversity.

In energy system models:

- Biomass potential from the agricultural sector is less investigated and not well integrated.
- Upstream emissions from different biomass sources such as production and application of fertilizers are missing.

Aim

- How agricultural biomass and the associated emissions are currently represented in the Open Nordic TIMES (ON-TIMES) model?
- What is the estimated potential of agricultural biomass in the Nordics?
- What are the key aspects affecting the biomass potential from agriculture in the Nordics, and how could the findings be integrated into ON-TIMES model?
- What are the environmental impacts of the agricultural biomass based on different LCA framework and how could these be included in the ON-TIMES model?

Description of ON-TIMES

In the model:

- The biomass sources from agriculture, including straw, grass, corn, rapeseed, sugar beet, deep litter, manure and the corresponding potentials for 2015, 2030 and 2050 are represented.
- Conversion technologies that fulfil the agriculture sector heat demand as well as tractors, trucks, fishing boats, forestry machines, forklifts, electric light appliances and motors are represented.
- There is no emissions associated with biomass use. However, the emissions from LULUCF for different types of land use in the Nordic countries have not been modelled, but these are exogenously included in the model in an aggregated way.

Biomass potential from agriculture in literature

- Potential
- Biomass sources
 - **Sweden:** Straw, Blast, Cereals, Chaff, Crop residue, Grass, Hemp, Legumes, Manure, Oilseed, Organic waste, Potatoes, Rapeseed, *Rörflen*, Salix, Sly, Straw, Stubble, Sugar beet.
 - **Denmark:** Straw, Grassland, Industrial residue, Waste, Manure, Animal fat, Rapeseed, Willow, Meat and Bones
 - **Norway:** Straw, Crop residues, Energy crops



LCA on agricultural biomass

- Some upstream emission data on the agricultural biomass are still missing – LCA can be used as a tool
- Many frameworks of LCA exists – ISO14040/44, RED and EPD
- Different frameworks affect the outcome of results

Biomass source	Global warming potential (GWP100) (gCO ₂ eq/kg DM)	Eutrophication potential (EP) (gPO ₄ eq/kg DM)	Applied framework	Reference
Straw				
NO (wheat straw)	37.4-43.4	-	REDII	[73]
DK (wheat straw)	152	0.61	EPD International	[74]
Grass				
SE	136-178		ISO14040/44	[75]
DK (grass-clover)	354	2.04	EPD International	[74]
DK (ryegrass)	410	1.76	EPD International	[74]
Maize				
DK	315	1.44	EPD International	[74]
Rapeseed				
NO	960-1240	10.7-16.1	ISO14040/44	[76]
DK	638	-	RED	[77]

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Integration of the LCA results

- Climate change results cannot be integrated directly to the TIMES model due to
 - Separation between CO₂ and non-CO₂ emissions in the model
 - Risks of double counting
 - Lack of consensus on which framework to be used
- Other impact categories can in theory be integrated
- LCA approach is currently not well compatible with how the energy system is modelled
- Further investigation on integration of LCA and energy system model is needed as well as a more harmonised LCA framework that can be used for the energy system as a whole

Sweden's NECP

- ON-TIMES model is used in the NECP to assess the energy supply and analyse climate scenarios - to maintain cost-effective and sustainable energy supply
- Increased level of details in the model can lead to improved decision making
- Large amount of biofuels are imported – lack of policy that controls the balance between the import and domestic production – further improvement in TIMES model can contribute to an update of scenarios
- More awareness about the environmental cost of agricultural biomass is needed – they are not truly climate neutral
- Collaboration between the Nordic countries are mentioned – sharing of knowledge, no specific national target for market integration.

Take aways

- Bio-resources in Nordic countries, except forest sector (ON-TIMES inputs)
- LCA factors may lead to double-accounting in energy system models (ON-TIMES inputs)

Future studies

- Finding a method to disaggregate the total potential of biomass to development of the ON-TIMES model
- Developing a method to include emissions from biomass in the model by making some changes in the LULUCF
- Further investigating the missing link between the use of bioenergy and the demand of energy resources relating to the production of biomass
- Integrating other environmental impacts in the TIMES model and using planetary boundaries framework as a benchmark



