BAU Biomass/waste resources

PJ	2000	2010	2020	2030	2040	2050
Straw	74	78	81	86	90	94
Beet top	0.2	0.2	0.2	0.2	0.2	0.2
Animal manure	27	27	27	27	27	27
Fiber fraction	2.0	2.0	2.0	2.0	2.0	2.0
Mill residues	0.9	0.9	0.9	0.9	0.9	0.9
Beet pulp	1.7	1.7	1.7	1.7	1.7	1.7
Molasses	1.2	1.2	1.2	1.2	1.2	1.2
Potato pulp	0.3	0.3	0.3	0.3	0.3	0.3
Brewer's grain	0.6	0.6	0.6	0.6	0.6	0.6
Whey	2.8	2.8	2.8	2.8	2.8	2.8
Wood chips	7.3	7.4	7.4	7.5	7.6	7.7
Fire wood	25	25	26	26	25	26
Unutilized forest increment	16	16	16	17	17	17
Wood pellets	2.6	2.6	2.6	2.6	2.6	2.6
Wood residues	6.3	6.3	6.3	6.3	6.3	6.3
Waste	35	40	44	47	47	47
Total	203	212	220	228	232	238

Data from Niclas S. Bentsen and Thomas Astrup

BAU Biomass/waste resources

- Data on reference/BAU situation available (WP2, WP5)

  YES

- Technology catalogue available (WP2)

  ALMOST

- Distribution of resources on technologies according to scenarios (WP1, WP2)

  TO BE DONE...?

- Data on alternative land use, crops, practices, biomass, etc. (WP2)

  TO BE DONE in fall 2009 or 2010...

- LCA on energy scenarios (WP5)

  TO BE DONE likely in 2010

- Inclusion of land use aspects in LCA (WP5)

  TO BE DONE in 2010

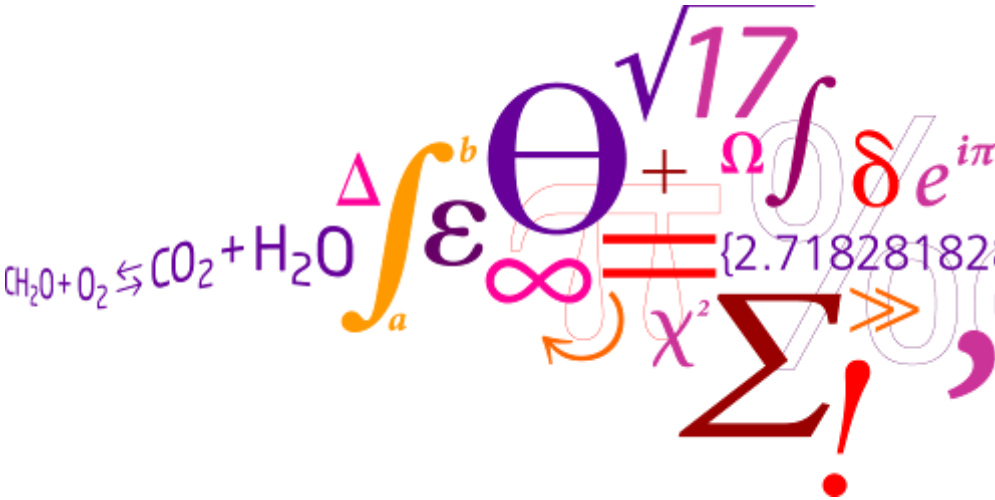
Danmarks Tekniske Universitet

WP5
Overview of LCA of the energy scenarios

Thomas Astrup

Wednesday 3 June, 2009

Hotel Haraldskær, Vejle



DTU Miljø
Institut for Vand og Miljøteknologi

Outline

- Summary of activities so far
- Important considerations, system perspective
- Example of LCA on energy technologies (waste)
- Intended approach for LCA on energy scenarios
- Conclusions so far...
- Next actions (DTU)

Summary

- Task 5.1
  System equivalence and comparability - discussions with WP1 (energy import/export, interaction with other markets, (inter)national boundaries)
- Task 5.2
  Discussions of system boundaries - needs to include biomass markets when identifying marginal processes (land use, alternative uses of biomass) - id of marginal processes is ongoing
- Task 5.3
  Collection of data - ongoing
- Task 5.4
  Draft LCA without land use aspects done in 07, final LCA of energy and biomass scenarios not yet started

Important considerations (I)

- Various impact categories, e.g.:
  - Global Warming
  - Acidification
  - Nutrient Enrichment
  - Human Toxicity (via air, water, soil)
  - Ecotoxicity (via water, soil)
  - ...
- Depends on LCA methodology
- Recent focus on CO_2 and Global Warming puts more emphasis on Greenhouse Gas emissions
- Other emissions, e.g. NOx, SOx, heavy metals, dust, etc. etc.

Important considerations (II)

- We have most data on GHG emissions, less on other emissions
- Potential impacts related to toxicity categories are generally less certain
- We should realize that focus may change and that other emissions may become relevant in the future
- Consistency in data between individual technologies may mean that we cannot meaningfully include all data (if they exist...)

WP5:
Focus on GHG emissions and non-toxicity impact categories (e.g. Global Warming)

System perspective

Upstream contributions	Direct contributions	Downstream contributions
For example: provision of materials land use alternative uses of biomass construction of buildings etc.	For example: emissions from combustion processes at the energy technology NOx metals etc.	For example: utilization of residuals bi-products (animal feed, high value products, etc.) use of transport fuels etc.

Opstrøms	Direkte	Nedstrøms
GWF (kg CO_2-eq/ton affald) 59-158	GWF (kg CO_2-eq/ton affald) 347 - 371	GWF (kg CO_2-eq/ton affald) -818 til -1374
(kg CO_2-eq/ton affald) Fremskaffelse af: • El: 59-108 • Støttebrændsler: 0-3 • Røggasrensning: 0-47	(kg CO_2-eq/ton affald) • CO_2 støttebrændsel: 0-21 • Fossilt CO_2 fra affald: 345 • N_2O emissioner: 2-5	(kg CO_2-eq/ton affald) Substitution: • El: -372 til -743 • Varme: -446 til -631
Inkluderet (pr. ton affald) •El: 65-120 kWh •Naturgas: 0-7 Nm^3 •Olie: 0-2 l •$CaCO_3$: 0-8 kg •$Ca(OH)_2$: 0-12 kg •NaOH: 0-7 kg •NH_3: 0-5 kg •Vand: 0-1 m^3	Inkluderet (pr. ton affald) •Naturgas: 0-7 Nm^3 •Olie: 0-2 l •Fossilt C i affald: 94 kg •Biogent C i affald: 191 kg (ca. 70 % biogent) •N_2O: 8-18 g	Inkluderet (pr. ton affald) •Elproduktion (15-30% af LHV): 413-825 kWh • Varmeproduktion (60-85% af LHV): 5940-8415 MJ
Ikke inkluderet •Transport •Forbehandling •Anlægskonstruktion •Dioxinrensning	Ikke inkluderet •Anlægskonstruktion •Emissioner fra oplagret affald •Emissioner af sporgasser	Ikke inkluderet •Restproduktdisponering

Astrup et al. (2009): Incineration and co-combustion of waste: Accounting greenhouse gases and global warming contribution. *Submitted to Waste Management & Research*

Modeling approach

- Focus on fuel conversion and energy technologies
- Based on available data, DTU will set up a model with a range of important technologies defined, e.g.:
  - biomass combustion
  - biogas, diesel, ethanol
  - methanol
  - wind
  - solar
  - ...
- Inputs:
  - 'Ratios' of the various technologies in the scenarios
  - Technology data (efficiencies, emissions)

Conclusions so far...

- Biomass will most likely be a limited resource in the future
- We should therefore limit the dependance on biomass in the scenarios!
- Crop changes and biomass use in the scenarios do not change this!
- Land as a resource (land use) is however a critical aspect when quantifying the environmental consequences
- Future land use is however also rather untertain...
- Differences between individual biomass/waste technologies (direct contributions) are somewhat less important from a GHG perspective

Next actions DTU

- Based on technology catalogue from WP2 + additional technology data to set up the LCA model
- Add ratios of the individual technologies in the scenarios from WP1 and WP2
- Implement impacts of upstream land use aspects from WP5 (SDU)
- Implement impacts of biodiversity from WP5 (AAU)