Life Cycle Assessment of Energy Conversion from Reed

Sustainable Energy Conversion from Reed Biomass

Reed as a Renewable Resource 2013, Greifswald
ENEREED (Sustainable Energy Conversion from Reed Biomass)

- Research project to investigate harvesting, processing technologies and thermal utilization possibilities for reed

- Technology investigation was done for harvesting (1st step)
  - see presentation Georg Beckmann “Harvesting technologies for reeds in Austria”

- Technology investigation was done for pelletising, combustion (2nd step)
  - see presentation Jürgen Krail “Sustainable energy conversion from reed biomass overview of laboratory and field test results”

- Ecologic and economic evaluation (3rd step)
Objective

- Reed from the Lake Neusiedl in Austria is examined as an energy source for thermal utilization.
- Evaluation of different harvesting technologies, treatments, supply chains and conversion possibilities.

→ Which is the best ecologic application scenario?
→ Compare this to wood and fossil reference (fuel oil and natural gas).
Method

Environmental life-cycle assessment:

- System function: energy supply of 1 MJ thermal energy from reed as a renewable fuel
- System boundaries:
  - Include upstream processes to manufacture technical devices, infrastructure for storage and transportation devices, transportation between the supply steps
  - $\text{CO}_2$ from biomass GWP = neutral
- Impact assessment, use of CML and ReCiPe methodology
  - Human toxicity (HTP), stratospheric ozone depletion (ODP), global warming potential (GWP 100), acidification potential (AP) and fine particulate matter emissions (PM)
Method, cont’d

- Data source:
  - Foreground data based on **field tests and own measurements** (harvesting, combustion)
  - Background data (infrastructure) & foreground data (transportation, fossil fuel systems, ash disposal) from the ecoinvent database version 2.1 (Swiss Centre for Life Cycle Inventories, St. Gallen, Switzerland)

- Data used:
  - Austrian or German origin
  - Background processes European and worldwide
  - Most data used are more recent than 2005
System description - application scenarios

- Two references using 100% wood (pellets and chips)
- Two references using 100% fossil fuel (oil and natural gas)
- 8 different application scenarios using 100% reed

Can be differed in 2 particular cases:

- 4 use reed in district heating plants (chips)
- 4 use reed in domestic heating boilers (pellets)
Supply chains - reed pellets, chopped reed
Results, first operation run - application scenario (pellets)

- Results are within less than +/- 10% of the arithmetic average in each category.
- Differences are caused by the chosen harvesting and chopping technology.
- Different result if transport takes place before or after chopping (bulk density).
Supply chains - reed pellets
Best scenarios reed pellets compared to wood pellets

- Wood pellets harvesting of timber is not included ⇒ waste wood from timber industry (material supply)
- Wood has a higher energy density per mass (pelletising, transport)
- Reed pellets have a higher sulphur content - AP and PM (thermal utilisation)
Best scenario reed pellets compared to fossil

- Reed scenario has the lowest overall specific GWP 100
- High ratio of sulphur (reed) results in high values for AP and PM
Results, first operation run - application scenario (chopped reed)

• Results are within about +/- 25% of the arithmetic average in each category

• Difference because of varying structure of the supply chains ⇒ A-C and B-C - extra storage hall

• Differences because of harvesting technology and if transport takes place before or after chopping
Supply chains - chopped reed
Best scenarios chopped reed compared to wood chips

- Harvesting reed - no state of the art techniques, lower energy amount for harvesting wood
- Wood chips have a much higher bulk density than reed ⇒ important for transportation; not so storage (volume)
- Combustion ⇒ much higher PM and sulphur emissions were measured for burning reed
Best scenario chopped reed compared to fossil

- Reed has the lowest overall specific GWP
- High ratio of sulphur (reed) ⇒ AP
- PM are much higher for the oil-fired scenario ⇒ caused by particles, sulphur dioxide and nitrogen oxides
Conclusion

- Using reed as a renewable fuel makes sense ⇒ regional resource
- Harvesting reed is more complex than harvesting wood ⇒ higher emissions (chopped material scenarios)
- Transportation – less burdens when transporting chopped material than bales or bundles
- Supply chains reed scenarios: chopped material ⇒ lowest GWP 100
- Compared to wood, reed has lower GWP 100
- Compared to wood, reed has higher AP and PM
  ⇒ is caused by its higher sulphur content ⇒ sulphur dioxide
- Compared to fossil fuels ⇒ much lower values in the impact category GWP 100
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