Modelling alternative fuel production technologies for the future Danish energy and transport system

Venturini, Giada; Pizarro Alonso, Amalia Rosa; Münster, Marie

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How should we best value residual biomass resources?

The dependence on fossil fuels and lock-in effects in the infrastructure network have for long determined a slow pace in the transition to a transport sector based on sustainable and renewable sources. While biofuels represent a possible alternative, biomass restricted by potential social, technical and environmental effects. Because residual biomass, e.g. straw in Denmark, inherently minimizes these negative impacts, it could lend itself to multiple options, including production of alternative transport fuels.

**Methodology**

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**Optimal scenario**

| OPT                          | Cost-optimal combination of technologies |

**Technological pathways**

- AGR: Anaerobic co-digestion with manure and biowaste
- BGA: Biogas
- CHP: Heat and power
- ETOH: Ethanol 2G
- BTL: Biokerosene
- OPT: Optimal scenario

**Biomass resource potentials in 2050 (PJ)**

- Manure
- Straws
- Woodchip
- Biowaste
- Agriculture sector

**Key Results**

The bottom-up optimization model TIMES-DK covers the Danish energy system, allowing electricity and fuel exports, and it optimizes under the assumption of perfect foresight from 2010 through 2050. No primary imports of biomass are allowed for this study.

- **Objective function**: Minimize the total cost of the energy system in year y and region r
- **Resource bounds**: y \in C, r \in R, y \in Y
- **Fulfilment of service demands**: w_y \geq \mu_{y} y \in S, r \in R, y \in Y
- **Emission targets constraints**: \sum_{y \in Y, r \in R} \mu_{y} = \text{Target}_{y}

**Optimal scenario**

| OPT | Cost-optimal combination of technologies |

**Key Technologies**

- BTL: Biokerosene
- BGA: Anaerobic co-digestion
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**Further work**

- How does plant location affect the final use of straw?
- How do we measure costs and benefits within the agriculture sector?
- What are the policy implications?

**Literature**


**Conclusions**

- The analysis on the optimal use of straw suggests that a combination of technologies (BTL and biogas) is the most cost efficient while using straw for heat and power is the least attractive solution. However, the choice has a sensible impact only on the future configuration of the transport and heat sectors, with minor effects on the rest of the energy system.
- While uncertainty on cost and efficiencies of emerging technologies remains, further sensitivity analyses performed showed no changes in the optimal combination associated with smaller or larger costs of investment and operation for the winning technologies.
- Given the current political debate on the optimal use of this unutilized resource, the analysis offers an objective and comprehensive comparison of the different options.