WP5

Biomass and the Energy Transition

Part WSL (Swiss Federal Institute for Forest, Snow and Landscape Research)

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Introduction

WSL activities

- Oriented towards resources and their sustainable use
- Focus on fuel wood from forests and manure

Phase I
Basis: domestic potentials for bioenergy

Phase II
In-depth potential analyses

Mobilisation of biomass for energy purposes - model-based analyses

Contributions to the holistic evaluation of the energetic use of biomass

Conclusions and outlook
Spatial distribution of biomass and hotspots of its occurrence linked to socio economic aspects

**All biomass**, sustainable potential per area

**Hotspot:**
High population density. Many enterprises, high income. Liberal, not very religious. Just barely for the energy strategy.

**Not significant:**
High agricultural and wood bioenergy potentials. Politically somewhere in between the hot- and coldpots.

**Coldspot:**
Low population density. Religious. Few enterprises, small income. In favor of the energy strategy.

Biomass potentials today and in the future

Theoretical Potential

Sustainable Potential


Control possibilities of wood fuel from forests over time

Sustainable potentials by management scenarios
Graph scheint mir unscharf
Vanessa Burg; 01.09.2020
Control possibilities of wood fuel from forests over time

Sustainable potentials by management scenarios

The costs of supply for the use of wood fuel from forests

Ecological potentials by supply costs, scenario moderate stock reduction, 2017-26

One cent more per kWh would increase the potential by one million m³/year more wood fuel from forests!

Mobilisation of biomass


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The effect of subsidies for the use of wood fuel from forests

Protection forest against natural hazards share 50%, in the Alps up to 90%

Without subsidies for protection forests (according to market prices): 20.8 PJ/year

With subsidies for protection forests: 25.9 PJ/year

-> + 25%

(Scenario «moderate stock reduction» and Wood market «less energy wood friendly, 2017 -2026)
Mobilisation of biomass

Farmers willingness to use their manure for digestion

Development of an Agent-Based-Model to simulate the behaviour of farmers towards anaerobic digestion

- Individual or collective action: build biogas facility
  - Willingness to build
  - Incentives
  - Resources, neighbourhood

- Individual action: provide manure to biogas facility
  - Willingness to provide resources
  - Social network
    - Word-of-mouth
    - Adoption of technology

Allows quantification of farmers' reactions to incentives resulting from changes in the system and policy measures

Results in general:
- Energy revenues are decisive
- Little willingness to cooperate
- Consequently fewer large plants


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Greenhouse gas emissions from different manure management

% manure digested: (6%) (65%) (100%)


* (3% of the remaining Kyoto target and 0.8% of the Paris agreement)

** (7% of the remaining Kyoto target and 1.6% of the Paris agreement)
Economic and ecological aspects of the transport of fuel wood from forests and manure

7 forest wood and 5 manure transport chains are identified and analyzed.

Cost is the main barrier to transport.

Maximum transport distances range from several km for firewood and slurry to several hundreds of km for woodchips and solid manure.

Vivienne Schnorf, Evelina Trutnevyte, Gillianne Bowman, Vanessa Burg: Biomass transport for energy: Costs, energy and CO₂ balance of forest wood and manure transport chains in Switzerland. submitted
Food-Energy Nexus - Examples of sustainable use of manure

- Total greenhouse potential area based on manure within 1 x 1 km² grid is 109 ha.
- Symbiosis between biogas facilities and greenhouses could reduce environmental impacts of greenhouse production.
- Strengthen local food production and shorten the food supply chain.

Land requirements and energy balance of the most important biomass supply chains

To compare:
- Crude oil (1000 W/m²)
- Nuclear (70-1600 W/m²)


Holistic evaluation

<table>
<thead>
<tr>
<th>Power density</th>
<th>Total sustainable secondary energy potential: 26 PJ/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude oil (1000 W/m²)</td>
<td>Area already used: 14 km²</td>
</tr>
<tr>
<td>Nuclear (70-1600 W/m²)</td>
<td>Area additionally required: 17 km²</td>
</tr>
</tbody>
</table>

The use of available biomass for energy requires little area
Land requirements and energy balance of the most important biomass supply chains

**Anaerobic digestion**
e.g. Manure: power density up to 104 W/m²

- Total area: 14.5 km²
- Additional: 13.1 km²
- Already used: 1.4 km²

**Incineration**
e.g. Forest wood fuel: power density up to 267 W/m²

- Total area: 4.3 km²
- Additional: 1.3 km²
- Already used: 3.0 km²

- Area already used: 14 km²
- Area additionally required: 17 km²

The use of available biomass for energy requires little area

To compare:
- Crude oil (1000 W/m2)
- Nuclear (70-1600 W/m2)


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Contribution of biomass to energy transition - case study Aargau

Energy Transition in the Swiss Canton of Aargau

2035 Scenarios

- No biomass
- Heat
- Mobility
- Storage

Best case:
- 13% Bioenergy
- 74% Renewable energy
- 26% Gap


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Conclusions

- Identification of many challenges and opportunities of bioenergy by
  - integral analysis of all biomasses
  - spatio-temporal view
  - holistic, cycle-oriented view
  - using the interdisciplinary network in research and practice

- Biomass has to play an important role as a wildcard in the energy transition and a climate-smart resource policy
Outlook

Further development of resource-oriented bioenergy research

- Biogas plants as the hub for a circular economy
- Acceptance and market penetration of bioenergy: the development of biomass heating systems in Switzerland
- Ecosystem service - oriented recording of wood from landscape maintenance (biodiversity and energy)
- Contribution of bioenergy to mobility
Thank you for your attention!