Sustainability of grass biomethane according to REDII

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Luke in brief

MISSION
Through research, we create VALUE AND SOLUTIONS for our customers by solving local and global challenges.

RENEWABLE NATURAL RESOURCES
A sustainable future and well-being from circular bioeconomy.

VISION
A sustainable future and well-being from renewable natural resources.

Profits and responsible primary production

Competent personnel and motivating organisation

Adaptive and resilient bioeconomy

Data-driven solutions

Cross-sectoral and interdisciplinary collaboration

Modern research platforms

Climate smart carbon cycle

1288 Employees
46 research professors
622 researchers

We are one of the four Statistical Authorities in Finland.

125 M€
Turnover

73 M€
Budget funding

52 M€
External funding

25 Locations in Finland
HQ in Helsinki

Present in 12 campuses with universities, research institutes and polytechnics

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Biogas research at Luke

SUSTAINABILITY
- The environment
- Economy
- Society

IMPACT ASSESSMENT
- Energy
  - Optional uses to heat/electricity/fuel
  - Enhancement of energy production
  - Enrichment with H₂ to CH₄
- Fertilizer products
  - (post-processing)
  - Circular economy solutions
  - Development of post-processing technologies
  - Usability assessments
  - Precision fertilization
  - Soil carbon management
- New products
  - Novel value-added products
  - Technical development

Raw materials
- Quantity
- Quality
- Spatial distribution and availability

AD process
- Technology options
- Successful operation
- Microbial management

Potential pre-treatment

New feedstocks
- Plant biomass
- Municipal & Industrial Materials

SUPPORT FOR BIOGAS PRODUCERS

SUPPORT FOR POLICYMAKERS AND AUTHORITIES
- Legislation
- Support mechanisms
- Impact assessments
- Policy tools

SUPPORT FOR PRODUCT END-USERS
What is RED II?
Renewable Energy Directive II

- As part of its ‘Clean Energy for all Europeans’ package, the European Commission proposed an update of the Renewable Energy Directive for the period 2021 – 2030 (RED II)
- The RED II compromise raises the overall EU target for Renewable Energy Sources (RES) consumption by 2030 to 32%
  - A minimum of 14% of the energy consumed in road and rail transport
RED II

- The RED II defines sustainability criteria for liquid biofuels used in transport, as well as for solid and gaseous biomass fuels used for power, heating and cooling production.

- Suppliers of bioenergy will have to comply with the criteria in order for the biofuels and bioenergy to account towards the RES target and to be eligible for financial support by public institutions.

- For installations starting in early 2021 or later, the emission reduction compared to fossil fuel requirement for biogas used in:
  - Transport will be 65%
  - Heat, electricity and cooling 70%
  (80% for installations starting in 2026)
Biogas production in Finland
Political ambition in Finland

• In Finland the target is to increase the share of renewable transport fuels to 40% by 2030
  • 50,000 gas driven passenger cars by 2030 (now about 10,000 CH₄-cars)

• Governments biogas program seeks ways to increase biogas production in Finland
Biogas production in Finland

Winquist et al 2019
Biomasses from various sources (t/a)

- Manure: 15,500,000 t (ex storage)
- Grasses: 700,000 t
- Municipal wastewater sludges: 4,700,000 t
- Municipal biowaste: 370,000 t
- Other biodegradable waste: 340,000 t

74% of recyclable phosphorus and 82% of nitrogen is in manure.

+ others, like straw and sludges from forest industry
Biogas potential

• Theoretical biogas potential in Finland about 18-24 TWh
• Techno-economical about 10 TWh
  • In production now about 1 TWh and only part of that in vehicle use
  • Almost 90% of potential from agricultural materials, mostly energy crops and plant side-streams
Why grass?

• Perennial grasses start growing early in the spring when solar radiation is abundant and soil water situation is good
  • In addition, grasses are grown in as perennial green fallows and in buffer zones
• Silage production is closely connected to milk production and the additional biomass generated from more efficient grass production would be available on areas where milk production is high
• Green fallows are located quite evenly around the country in relation to overall field area
Biogas from grass – sustainable?
Emissions from biogas produced from grass

• The life cycle assessment (LCA) was used to calculate the climate impact of grass cultivation as well as emissions from the production of biomethane

• Five scenarios were set, to compare the emissions from different substrates used in biogas plant
Scenarios

1. Grass silage (mineral soil, 62 000 t/a)
2. Grass silage (organic soil, 62 000 t/a)
3. Clover silage (mineral soil, 74 000 t/a)
4. Grass silage + 80% manure (135 000 t/a)
5. Grass silage from green manuring (48 000 t/a)
Emission from process chains

- Grass silage (mineral soil)
- Grass silage (organic soil)
- Clover silage (mineral soil)
- Grass silage + manure
- Grass silage from green manuring

- CO₂ eq/MJ

- Pressuris
- Transport
- Upgrading
- Biogas process
- Silage cultivation
# Emission reduction compared to fossil fuels

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Emission reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass silage (mineral soil)</td>
<td>50</td>
</tr>
<tr>
<td>Grass silage (organic soil)</td>
<td>-13</td>
</tr>
<tr>
<td>Clover silage (mineral soil)</td>
<td>61</td>
</tr>
<tr>
<td>Grass silage + manure*</td>
<td>96</td>
</tr>
<tr>
<td>Grass silage from green manuring</td>
<td>79</td>
</tr>
</tbody>
</table>

* Manure bonus -45 gCO2eq/MJ\textsubscript{manure}
Other benefits

• In principle, expansion of biomethane production from grass leys could lead to improved crop rotations with perennial species amending monocropping or simple rotations
  • The LCA methods for estimating soil CO$_2$ balance are still in the development phase
Manure is valuable resource

• The most important biomass containing nutrients
  • Phosphorus in manure would cover almost all needed phosphorus
  • Covers also remarkable amount of needed nitrogen

• Part of recycling organic material back to soils

www.luke.fi/manurestandards
Biogas production from manure

• When manure is used for biomethane production (in transport), the emission savings compared to fossil fuels can be even 72-202%*

• Treating manure in centralised biogas plants could also be solution for fertiliser production
  • Especially phorphorus concentration in manure rich areas
  • Large scale bring economic benefits

*examples in REDII
Conclusions

• It is recommended to use manure as co-substrate when grass silage is used for biogas production
  • Not only reduces the emissions but helps also the degradation process
• If biogas production increases green manuring and/or crop rotation, the positive effects are larger than only CO₂ emissions
Thank you!

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