Sustainable fuels
- Breaking the blend walls

*Innovation in Forest, Fuel & Freight*
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Exceeding the 10% renewable fuel target (Sweden)

- Effective long-term policies & ambitious targets
- Today's short-term policies

Year

2005 2010 2015 2020 2025 2030

%
Biofuels in the Swedish road transport sector

• Low-blend fuels:
  - Ethanol (in petrol)
  - FAME (in diesel)

• High-blend fuels:
  - Ethanol (E85 & E95)
  - FAME (100)
  - Biogas (CBG & LBG)
  - HVO diesel (drop in)
Tall oil-based HVO as drop-in fuel in diesel

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
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<tbody>
<tr>
<td>2005</td>
<td>Idea</td>
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<tr>
<td></td>
<td>Commercial plant</td>
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<tr>
<td>2010</td>
<td>100,000 m³ biodiesel</td>
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<tr>
<td>2015</td>
<td>Forest company</td>
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<td>“Innovation” company</td>
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Photo: Magnus Wikman, SunPine
New feedstock from the forest industry

- Pulp wood
  - Cellulose 45%
  - Lignin 28%
  - Hemicellulose 25%

- Process energy

- Bio oil

- Paper pulp

- Drop-in biofuels

(Ren Fuel 2016)
Improved ethanol production systems

- Grain
- Cellulosic feedstock
- Process energy
- Forest residues
- Ethanol
- Protein feed
- Compressed carbon dioxide

Photo: Agroetanol
Long-haul methane diesel truck using *liquefied* biogas

Methane bus using *compressed* biogas
Development of biogas production systems

*Anaerobic digestion*

of industrial waste, manure, food waste, crops etc.

*Thermal gasification*

of logging residues, forest by-products etc.
Improved FAME production systems (RME)

- Rape seed
- Methanol
- Thermal gasification
- Forest residues

- RME
- Protein feed
- High quality glycerine

Photo: COWI, Perstorp
Balance – Potential *increase* in sustainable domestic supply and demand of biomass in Sweden 2030

(Börjesson 2016)
Sustainability performance

• Meets current Swedish environmental quality objectives (biodiversity, nutrient balances, soil productivity etc.)

• High reduction in greenhouse gas emissions (normally 80-90 %)

• Increased efficiency in resource utilisation (biomass feedstock, land use etc.)

• Reasonable production costs (normally 0.6-0.8 € per litre petrol-equivalent)

(Börjesson, Lundgren, Ahlgren & Nyström 2016)
Conclusions

• The innovations and development in the biofuel field is going fast, especially regarding sustainable forest biomass-based systems

• However, the market expansion is significantly hindered today by the low oil prices in combination with the weak political incentives and targets

• The forest industry is increasingly cooperating with new industry actors, such as oil and chemical industries etc., but the existing “untapped” potential is substantial

• Breaking the blend walls, such as Sweden did for several years ago, is a prerequisite to meet compulsory climate targets, but will also be an effective catalysts for innovations and technology development and an expanded bio-based economy in EU