Biomass production in a sustainability perspective

Per-Anders Hansson
Department of Energy and Technology, SLU

Optimal **utilisation** of biomass is of course important!

But today I will talk about biomass **production**,

and what we have to do, to make it **sustainable**

(focus on the national perspective)

Per-Anders Hansson
Department of Energy and Technology, SLU

Biomass production (with acceptable yields)

Resources and structures needed:

- Fertile land
- Water
- Plant nutrients
- Energy for machinery operations
- Infrastructure

Per-Anders Hansson
Department of Energy and Technology, SLU

Sustainable production?

- Land (25-30 Mha) (limited but sustainable resource, if correctly handled)
- Water (not a major problem in Sweden)
- Plant nutrients (agriculture)
  - N, from air but a lot of energy is needed, today 100% fossil)
  - P, K, reserves for 200-300 years (P), waste and ash recycling must increase
  - S, may become a problem, but complicated to estimate
- Machinery operations (vehicle fuels needed, today 95% fossil)
- Infrastructure (probably not a major problem in Sweden)

Per-Anders Hansson
Department of Energy and Technology, SLU

Two major problems!

- Mineral nitrogen
- Vehicle fuels

To be sustainable we have to produce mineral nitrogen and vehicle fuels from renewable sources

The link between sustainable energy systems and sustainable food supply systems is very clear

Per-Anders Hansson
Department of Energy and Technology, SLU

Substitute needed

Agriculture (output in food and energy approx 80 TWh)

280 000 m3 diesel etc	2,7 TWh (SCB)
Nitrogen fertilisers	1,8 TWh (Ahlgren)

Forestry (biomass output approx. 250 TWh)

Diesel and gasoline	3,7 TWh SCB
Nitrogen fertilisers	<0.1 TWh

Figures not static, but not necessarily decreasing

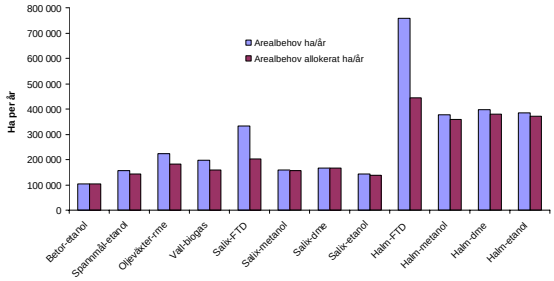
Per-Anders Hansson
Department of Energy and Technology, SLU

Non-fossil vehicle fuels

- G1
  - FAME (RME)
  - Ethanol from sugar and starch (beats, grain etc)
  - Biogas
- G2
  - DME
  - Methanol
  - Fischer Tropsch Diesel (FTD)
  - Ethanol from cellulose (straw, forest residuals etc)
- G3
  - Hydrogen gas
- Electricity

Per-Anders Hansson
Department of Energy and Technology, SLU

Land "use"



Total area used for agriculture 2.6 Mha

Per-Anders Hansson
Department of Energy and Technology, SLU

Need of biomass to produce the yearly demand of vehicle fuels for Swedish agriculture (2,71 TWh).

Fuel	Biomass	Totalt arealbehov för systemet ha/år	Arealbehov efter avdrag för biprodukter ha/år	Percentage of existing area[1]
G1 fuels				
Ethanol	Sugar beat	104 644	102 933	253 %
Ethanol	Wheat	156 630	142 143	39 %
RME	Oil crops	222 832	181 411	207 %[2]
Biogas	Grass	198 630	186 670	16 %
Biogas	Manure			
G2 fuels				
FTD	Salix	331 557	203 044	1 420 %
FTD	Straw	759 146	444 709	45 %
FTD	GROT			79 %[3]
Methanol	Salix	157 437	156 947	1 098 %
Methanol	Straw	377 497	359 351	36 %
Methanol	Grot			64 %[3]
DME	Salix	166 105	165 600	1 158 %
DME	Straw	397 754	379 164	38 %
DME	Grot			67 %[3]
Ethanol	Salix	142 572	138 155	997 %
Ethanol	Straw	383 513	371 612	38 %
Ethanol	Wood chips	11 565	11 207	5 %[4]

[1]Baserat på areal efter avdrag för biprodukter. Procent över 100 anger att dagens arealer är mindre än det framtida behovet
[2]Procent av nuvarande areal oljeväxter (raps och rybs)
[3]Beräknat som % av energin i dagens uttag av grot, 8 TWh
[4]Beräknat som procent av total slutavverkning år 2006

Per-Anders Hansson
Department of Energy and Technology, SLU

Fossile resource use approx 35 MJ/kg N

Per-Anders Hansson
Department of Energy and Technology, SLU

Mineral nitrogen production

Mineral nitrogen is produced from ammonia

Ammonia is presently produced from fossil hydrogen gas and nitrogen gas (Haber-Bosch)

From renewable sources?

Nitrogen gas can be collected from the ambient air, but how can we get fossile free hydrogen?

- Thermal gasification of biomass ("syngas")
- Reforming of biogas methane
- Electrolysis based on el. from renewable sources

Per-Anders Hansson
Department of Energy and Technology, SLU

Land use for biobased N fertiliser production (170 000 tonnes/year)

100 000 ha Salix (in CHP)

or

700 MW installed wind power

or

100 000 ha Straw (4.3 tonne DM/ha, gasification, matured technology)

(preliminary figures)

Per-Anders Hansson
Department of Energy and Technology, SLU

To conclude:

- Biomass can probably be produced in sustainable systems with yields and outputs similar to today (in Sweden)
- Technology for non-fossil vehicle fuel and mineral nitrogen production has to be developed and implemented in near future
- Approx. 10% of the agric. area will be needed for internal supply of energy
- Remaining 90% can be used to supply the society with food and energy carriers

Per-Anders Hansson
Department of Energy and Technology, SLU