

# Straw to energy technologies in Denmark

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# Straw to energy technologies in Denmark

- History – why?, when?....and how?
- Farm scale boilers
- District heating with straw
- Power production and CHP
- Straw in Biogas plants
- Other technologies...and a look into the crystal ball

# History – why straw to energy?

- Straw is an abundant resource in Denmark (app 6 mill tons/year ...2 mill tons surplus)
- Ban on burning of straw in the field in 1992
- Competitive fuel price

...and why not?

- Is straw – and other biomass – too valuable a resource to "just" burn?



# Straw as a resource

- Very efficient collection, storage, transport etc
- Reducing costs and optimizing quality





# Farm scale boilers

- Technologies improved drastically since 1970's
- Efficiency improved from app 40% to +80%
- Emissions reduced (example: CO more than 50%)



# Farm scale boilers

- Larger boilers, typically 0,4-1MW
- Larger bales, (round) midi or big bales
- Automatic feed in and ash removal





# District heating with straw

- 50-60 plants in operation
- 0,5-12 MW
- Political (fiscal) framework is important
- Efficient utilization of local resources
- Future part of integrated systems





# District heating with straw

- Efficient utilization of local resources





# Power plants and CHP

- Danish Biomass Action Plan 1993
- "Difficult fuel" (corrosion, utilization of ash)
- Different combustion principles:
  - Straw boiler
  - Straw boiler (<500C) + wood chip boiler superheater
  - Fluid bed
  - Co-firing with coal



# Straw in biogas production

- App. 10 biogas plants in DK is co-digesting straw and animal manure/slurry
- Expected to increase





# Why straw in biogas plants?

- There is a need for measures to increase gas production in new biogas plants.
- Straw is an abundant and reliable resource for biogas production
- Deep litter and poor quality straw is especially interesting, as alternative use is limited (...and price is low)
- Larger proportion of the carbon and nutrients are recirculated to the field with the digestate (compared to ash from combustion)

# Straw in biogas production

- Plant design must be adapted to receive and process large amounts of straw:
  - Longer retention time
  - Pretreatment/mixing/feed-in equipment
  - Stirring in digester must be looked after





# Other technologies

## Straw to biofuels (Ethanol)

- Pilot plant (30.000 tons/year) in operation from 2009-2014
- No commercial draw for the technology

## Gasification - pyrolysis

- Several pilot scale plants, but none in operation at the moment (...on straw).
- Challenges with gas cleaning and quality of biochar
- However, pyrolysis is "hot" as a possible way of carbon storage in the soil (biochar)

# Is straw too valuable to burn??? - straw in biorefineries

## Cascade utilization

High value products? (wax)

Fibres (bottles, building materials)

Feed

Fuels (Ethanol)

Residues to biogas





# Conclusions

- Since 1970(ish) straw has played a significant role in Danish energy supply
- Danish farmers and manufacturers has optimized production and handling of high quality straw
- Also, boilers and other energy equipment has been improved drastically, raising efficiency to more than 80%
- Political framework may boost development
- For the next decade(s), (surplus) straw may still be combusted
- New technologies for "more clever" utilization are developing

# Thanks for your attention

Read more:

[Straw to energy](#)



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