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Der Dänische Weg
Chance und technische Herausforderung

- Lars Nikolaisen, B.Sc. (Mech.Eng.)
- Danish Technological Institute.

- Expertengespräch „KWK mit Stroh“
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- e-mail: lars.nikolaisen@teknologisk.dk

Danish Technological Institute

DTI is an independent, non-profit institution.

DTI is approved as a technological service institute by the Danish Ministry of Science, Technology and Innovation

The objective of DTI is to address the needs of the industrial sector and society as a whole through the development and dissemination of technological innovation.

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25 Years of Danish Energy Policy

- **Tripled the biomass share of energy supply since 1980.**
- **Biomass accounted for 11% of the total energy supply in 2005.**
- **The Danish Biomass Agreement 1993:**

1.4 million tons of biomass for use in power plants.

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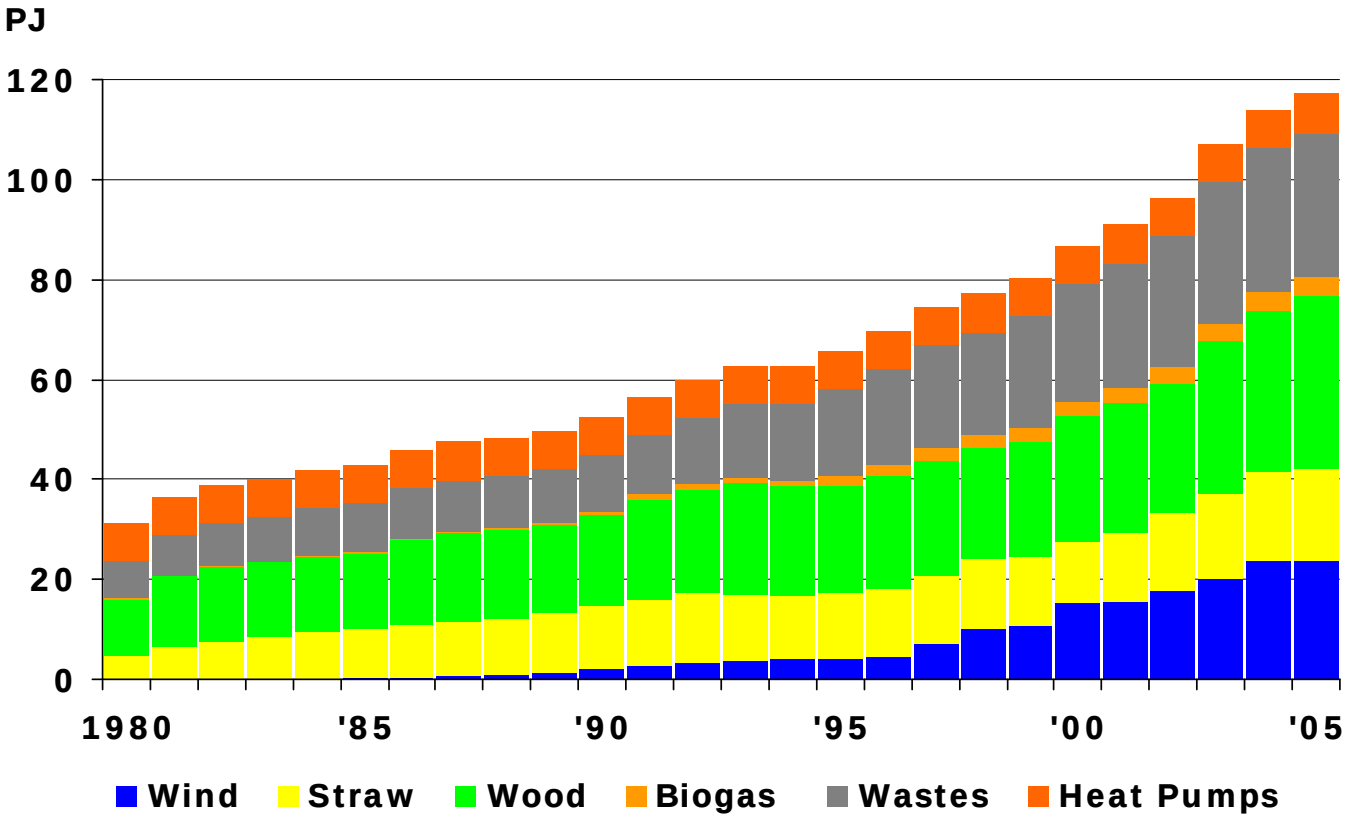
Renewable Energy Consumption 1980-2005



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Taxation and subsidies

- Fossil fuel (oil, coal, natural gas) is taxed heavily
- No taxation on biomass as fuel
- Heavy support for investment in biomass plants
- Subsidies for electricity production on biomass

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Straw production 2005

Straw production 2005	**1000 tons**
Use on farms	1,900
Energy purpose	1,300
Ploughed in	2,300
TOTAL	**5,500**

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Straw for energy 2005

Straw for energy 2005	**1000 tons**
Central power plants	460
CHP plants	250
District heating	260
Industry	0,5
Farms and houses	330
TOTAL	**1,300**

The Biomass Agreement 1993-2009

The Biomass Agreement	1000 tons
Central power plants 2005	460
CHP plants 2005	250
Power plant Amager, pellets	130
Power plant Odense, bales	170
TOTAL	**1,010**

High efficient Baling

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Out door storage of straw 1

Out door storage of straw 2

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District Heating Plants
Fired with straw

- 55 straw fired plants with heat production only
- Low pressure boilers. 6 bar, 120°C
- Average size 3.15 MW.
- Max. size 9 MW, min. size 0.6 MW
- Storage tank for hot water. 400 m^3
- Bale dimension 120 x 130 x 240 cm, 500 kg
- Annual consumption: 260.000 tons of straw
- Mainly owned by heatconsumers in a cooperative

District Heating Plants
Types and emissions

- **TYPES**
- **Plants for scarified or shredded straw**
- **Plants for sliced bales (minor plants)**
- **Plants for cigar firing (Schkölen)**
- **Plants for whole bales**

- **EMISSIONS (Plants > 1 MW)**
- **CO at 10% O_2: 0.05%**
- **Dust: 40 mg/Nm^3**

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CHP and Central Power Plants

- **EFFICIENCY**
- **Condensing Central Power Plant: $\eta_{el,\ net,\ calc.}$ = 40 - 48%**
- **Central Power Plant with district heating: 85 - 90%**
- **CHP plant 85 - 90%.**
- **Straw: $\eta_{el,\ net,\ calc.}$ = 21 – 29%**
- **Wood: $\eta_{el,\ net,\ calc.}$ = 16 – 35%**

- **FUELS**
- **Central Power Plant: Coal or cofired coal/biomass**
- **CHP plant: Biomass. Straw or wood or both**

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Straw firing in Power Plants

	Unit	Stud-strup 4	Ensted	Aved-øre 2	Amager	Odense
El. Power	MW	350	39	585	80	35
Heat output	MJ/s	824	88	570	250	84
Steam press.	Bar	143	210	300	n.a.	n.a.
SH temp.	ºC	540	542	580	n.a.	n.a.

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Straw firing in CHP Plants

	Unit	Rudk bing	Has-lev	Sla-gelse	Mas-nedø	Grenå	Må-bjerg	Maribo
El. power	MW	2.3	5.0	11.7	8.3	18.6	28	9.3
Heat output	MJ/s	7.0	13	28.0	20.8	60.0	67	20.3
Steam pr.	Bar	60	67	67	92	92	67	93
SH temp.	ºC	450	450	450	522	505	520	542
El. eff. calc. calc.	η	21	23	27	26	(18)	27	29
El. eff. ann.	η_a	17	17	22	23	(14)	20	26

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Wood firing in CHP Plants

	Unit	Hjordkær	Assens	Born-holm	Herning
El. power output	MW	0.6	4.7	16	95
Heat output	MJ/s	2.7	10.3	35	174
Steam pressure	Bar	30	77	80	115
SH temp.	ºC	396	525	525	525
El. efficiency, calc.	η	16	27	35	32
El. eff. per annum	η_a	12	n.a.	n.a.	n.a.

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Emission requirements, straw

- **The emission requirements for straw fired CHP- and Power Plants are individual.**

- **Approvals are in the following range:**
- **CO: None to 0.05% at 10% O_2**
- **Dust: 40 – 50 mg/Nm^3**
- **NO_x: None to 400 mg/Nm^3**
- **SO_2: None to 300 mg/Mm^3**

Truck with 24 straw bales
Køge Pelletplant

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Straw crane with 12 bales
Køge Pelletplant

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Straw crane unloading 12 bales Køge Pelletplant

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Market and prices for straw 1

- Two straw markets in Denmark.
- The one is Jylland-Funen to the west
- The other is Zealand to the east.
- The toll-bridge across the Great Belt is a barrier for the straw trade in Denmark
- 2006 price is 48.60 Euro/t delivered to DH plant
- The Zealand market has highest prices.

Fuel prices 1990 - 2006

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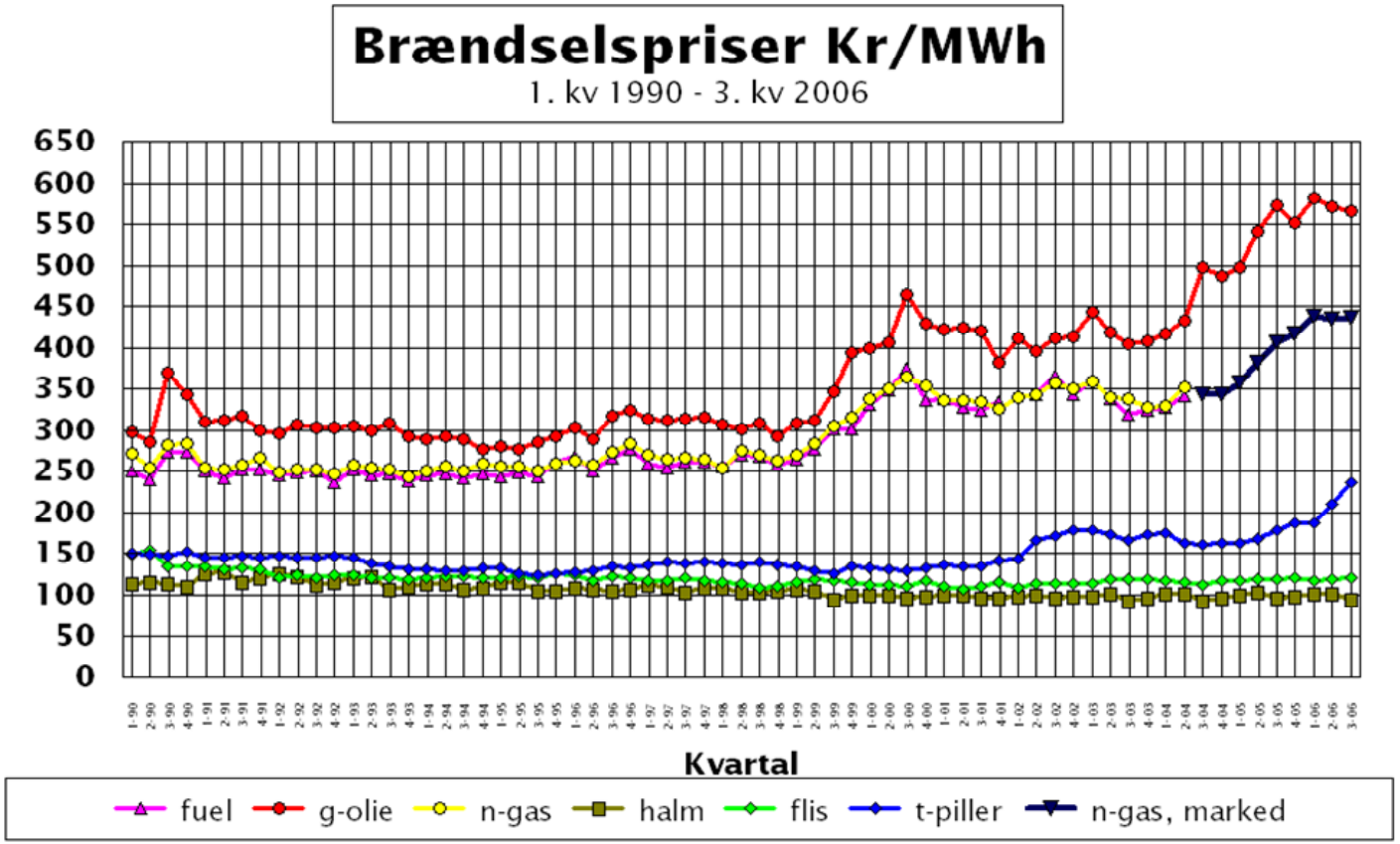

Market and prices for straw 2

- Stable or decreasing prices makes it less attractive for farmers
- All straw for energy is big bales 120x130x240 cm
- There is no commercial straw pellet production
- The Danish straw market is a local market.
- There is no import or export.
- No regional influence on Danish straw prices.

The next 5 – 10 years

- The new market for biofuels for the transport sector will challenge the traditional supply chain for biomass. Straw could be used for biofuels.
- The booming European market for biomass will increase prices, mainly for wood.
- Straw pellets will turn straw from the local market to the regional and international market.
- Straw pellets will challenge wood pellets of lower quality.
- Straw is a very large resource in Europe.

Thank you for your attention

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