Securing of supply in short and longer term of wood and straw

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Introduction

In Denmark - as well as in the rest of Europe - the importance of biomass as energy source has developed during the last two decades. In the Nordic countries we have seen a rise in utilisation of wood, straw and biogas. Concurrently with this development the trade of biomass has grown and a market has been build up while prices for biofuels has declined by up to 40% in real term prices.

The trade of biofuels is expected to increase in the future in order to meet the overall goal and fulfil the international agreements on climate change and reduction of CO_2.

Basically the object of securing supply of biomass for energy production is the same as for all types of fuel or other commodities: to make supply and demand meet at prices the market are able and willing to pay.

Price and security of supply are of vital importance for users of biomass - such as Energi E2. Based on these criteria biomass would never have been a fuel for electricity production. The market and supply of biomass is small compared to fossil fuels and the price is 2-3 times the price of coal calculated on an energy basis. But legislation, financial support and tax on fossil fuels have made biomass a competitive fuel for production of electricity and heat.

Background

Energi E2:

- Owns and operates 17 power stations / CHP plants in Eastern Denmark
- Share in hydropower plants in Sweden
- Total capacity: 4,100 MW, electricity
  2,900 KJ/sec., heat
- Production: 21.1 TWh electricity
  8.1 TWh, heat

Use of biomass in Denmark

Biomass is an important renewable energy source in the Danish energy system. Wood, straw, municipal solid waste and biogas covers 8% of the gross energy consumption For comparison wind energy only contributed with 1,3% of the gross energy consumption, [1].

Today more than 1.3 million tons of wood and 750,000 tons of straw is used in power plants(incl. Avedoere 2), industries, district heating plants, farms and private households.

According to the Danish energy policy the part of biomass in the energy supply pattern will continue to expand in the future. The future use of biomass is outlined in the national energy strategy plan: "Energy 21" from 1996. In this very ambitious plan utilisation of wood and straw in Denmark should be doubled to 4 million tons (53 PJ) by 2005 and doubled one more time to 9 million tons (105 PJ) by year 2030 [2].

The aim of "Energy 21" is to reduce the national CO2-emission by 20% by year 2005 and by 50% by year 2030 as compared to the 1988 level. Besides the increased use of biomass, wind energy and use of energy crops (such as willow and Miscanthus) are substantial elements in the plan.

The electricity sector is a key element in the efforts to fulfil the goals of "Energy 21". In May this year the Danish Parliament instructed the electricity utilities to use about 1.5 million tons of biomass by year 2005 and gave the necessary financial support for use of biomass in power and heat production.

As seen in figure 1. and table 1. the Danish power companies will have to triple their use of biomass by burning an extra 500,000 tons wood and 530,000 tons straw per year.

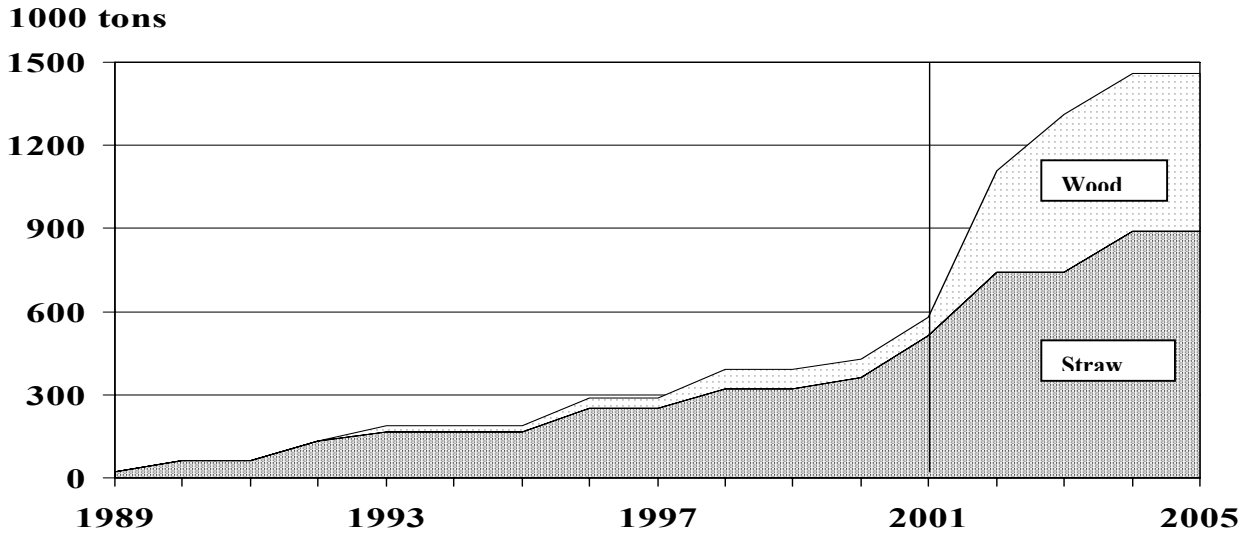

Figure 1. Use of biomass in Danish power plants, 1989 – 2005.

This will be done by building 2 new big power plants and by rebuilding 4 existing coal- and gas-fired power plants. The first in this range of plants - Avedoere Unit 2 - is under construction and will start production of heat and power in September this year. The other 5 are in the design phase.

Year	**Location**	**Wood** Tons/year	**Straw** Tons/year	**Total** Tons/year
To day:				
Total	10	70,000	360,000	**430,000**
New plants:				
2001	Avedoere		150,000	
2004	ELSAM		150,000	
Rebuilding:				
2002	Amager		130,000 (straw pellets)	
2002	Studstrup		100,000	
2002	Avedoere	300,000 (wood pellets)		
2003	Herning	200,000		
Development	6	500,000	530,000	**1,030,000**

Year	**Number**	**Wood** Tons/year	**Straw** Tons/year	**Total** Tons/year
2005	**16**	**570,000**	**890,000**	**1,460,000**

Table 1. Future plans for biomass-fired power plants in Denmark.

From these figures it can be concluded that:

1. The yearly consumption of biomass will increase by more than 1 million tons.
2. The use of biomass will more than triple from 430,000 tons to 1,460,000 tons per year.
3. There will be an even increase in wood and straw: some 500,000 tons of each.
4. The mix of biomass will change dramatically, from straw being the all-important biofuel to a balance of 60% straw and 40% wood.

Markets for biomass

The size and geographically distribution of the market for biomass is determined by the physical properties of the type of biomass in question, prices on fossil fuels and policy instruments, e.g. tax, subsidises and environmental legislation.

In table 2 the physical properties of straw and different types of wood are compared with coal - a commodity of abundant supply, which has been traded on the world market for more than a century.

		Density kg/m^3	**Moisture**	**Energy-Density** GJ/m^3	**Transport** Type	**Market** Geography
Straw	Big bales	130	13%	1,9	Lorry	Local
Wood	Sawdust	160	20%-50%	1,4-2,5	Lorry	Local
	Chips	300	40%-50%	2,7-3,4	Lorry/ship	Local/regional
	Pellets	650	<10%	11	Lorry/ship	Local/regional/international
Coal	Bulk	1,000	10%-15%	25	Ship	International

Table 2. Physical properties for straw and wood.

The heating value and the energy density are the most important factors for the user of biomass as fuel. This depends on the physical density (kg/m^3) and the heating value (in practise: the moisture content) of the biomass in question. Higher physical density and lower moisture content will result in higher energy density and higher heating value.

As seen in table 2 the energy density for pellets is higher than for wood chips. Consequently the transport costs per energy unit will be lower for pellets than for wood chips.

These facts are important when trying to define the potential geographical market for a certain type of biomass. Likewise when calculating the potential for use of biomass as fuel, increased use of biomass will lead to longer transport distances. For longer distances it is rational - from a financial and environmental point of view - to transport wood pellets and other refined biomass fuels instead of bulky material like wood chips, sawdust or energy crops.

Furthermore the quality of the biomass is important to the user because the chemical composition (chlorine, potassium, heavy metals etc.), ash content and physical dimensions can limit the amount or types of biomass suitable for use as fuel.

Straw

Resources

Straw is a by-product form growing of grain. The yield varies from year to year depending on the weather and is 3 to 5 tons per hectare per year in North Europe. The theoretical amount of resources of straw for energy purposes can be calculated form the yield per hectare and the amount of hectares of grain with deduction of loss and the amount of straw used in agriculture.

A study on the theoretical resources of straw in Denmark has shown a potential surplus of 2.3 million tons.

In order to secure supply of straw it is important to establish precise facts on the amount of straw available on the market at competitive prices. Energi E2 has made a number of market surveys for straw and found

figures quite different from the theoretical calculations, as only 20% to 50% of a potential surplus - were offered to us regardless of the price.

Market type and developments
Straw has a very low energy density and the costs for transportation and handling are high, consequently the market is local and limited. In Denmark the market is divided into a number of geographical areas with deliveries coming from farmers within a short distance from a certain plant - on average 25-35 kilometres. Straw is delivered according to individual, long-time contracts between the user and a number of farmers.

Previously we have seen some tendency of monopoly of supply as farmers have made supplier organisations with exclusive rights of supply to a certain customer. This was enhanced by the fact that other fuels can only partly and with great difficulties substitute straw.

The volume of the market depends on the demand for straw for use in district heating and power plants. Since the oil-crisis in 1973 the market in Denmark has developed from scratch to 600,000 tons per year. The high prices and taxes on oil powered this development. In the coming 4-5 years the demand for straw will almost double as the Danish power plants are forced to use an extra 530,000 tons per year in 4 big scale power plants. This is **not** based on financial calculations but due to a decision in Parliament and pressure from the agricultural sector.

Wood

Resources
Wood for energy purposes is by-products from forestry and waste from sawmills and wood working industries.

In Europe the largest resources of wood are found in the northern and eastern part especially in the area around the Baltic Sea. This forms the background for vast supply of wood in form of logs, firewood, forestry residues, waste wood from sawmills, wood pellets and briquettes.

By improvements in production and logistics of wood fuel it might be possible to minimise costs and overcome bottlenecks and barriers in the supply chain. This might expand the amount of profitable resources available as a higher percentage of the potential resources could find a market at competitive prices.

Market type and developments
For many years there have been a well established and mature international market for logs, sawn timber and pulpwood whereas wood for energy use has only been traded within the same geographical area in which it was used. Driven by high prices and taxes on fossil fuels, vast supply of forestry residues and the possibilities of cost-effective sea shipment a market for wood for energy use has developed between countries in northern Europe [3].

During the last decade we have seen an expanding market in the Baltic Sea Region with increased trade of wood chips, logs and fire wood e.g. from the Baltic States to Sweden, Finland and Denmark. Still only a short number of countries are involved and the trade is carried out in limited amount.

With growing demand transatlantic trade of high-density wood fuel - such as wood pellets - has in some cases been financial feasible and we have seen imports hereof from North America to power plants in Sweden.

The Kyoto commitments on reduction of greenhouse gases and an expected common energy policy of the European Union might increase significantly the use and trade of biomass-based fuels.

The supply of wood for energy use is actually significantly greater than the demand and we might see newcomers in the market, e.g. from the central/eastern part of Europe and from Russia. In this way the geographical marketplace for wood might develop and it might be able to meet an increased demand in the future at stable - or even slightly declining prices. A parallel can be drawn between the actual situation and previous developments on the market for biomass in Denmark and Sweden. In Denmark prices for wood and straw dropped 25% to 40% in real term prises from 1990 to 2001 [4]. In Sweden the market price for wood

fuel had fallen in the 10 years from 1984 to 1994 while the demand for wood increased by up to 20% annually [5].

The role of energy crops so far

Mostly study:

Energi E2 /ELSAM:

- 1995: Assessment of energy crops
- 1995 - 2000: Cultivation tests: willow, Miscanthus, triticale
- 1995 - 1999: Design study: gasification plant, willow
  Supply and storage: test, calculations, design study
- 1998 -2000: Combustion test at Masnedoe: willow, Miscanthus, olive pulp etc. Lars D. Fenger

1995 Assessment:

- Reduction of cost
  - Plantation
  - Growing
  - Harvest
  - Logistic / storage: harvest until use
- Quality of energy crops as fuel in power plants
  - Chemical composition: Chlorine, potassium
- Productions cost, negative gross profit

These findings and conclusions are still valid.

Conclusions

Straw is traded on local markets, which might differ from country to country dependent on the type, size, character and development in the agricultural sector. It must be analysed on this background.

Straw has a potential for energy use in areas with grain growing and a demand for space heating. The potential resources might be huge, but only a small part of the surplus is available on the market at competitive prices.

Use of straw for energy can develop in a local area provided that it is funded or taxes are introduced on fossil fuels:

* In power plants straw is not a competitive fuel on a free or deregulated market for electricity. It can only take place if the price on electricity is heavily subsidised.
* On farms and in district heating plants use of straw might be able to develop due to tax and high prices on fossil fuels.

Wood fuel trade is foreseen to increase in Europe in the future. The potential resources are big and there is room for expansion of supply and trade at competitive prices.

Bottlenecks and barriers in this development have to be identified and ways must be found to overcome obstacles. Analyses of the supply chains, new international standards for solid biofuels and a common energy policy in EU can be helpful elements in this process.

We might see a change in types of wood being traded and a more diversified market can develop. Some part of the market - such as domestic users and single family households - might prefer wood pellets because it is a dry and homogenous fuel while other - e.g. power plants and industry having big boilers - will be more flexible and able to use low-priced waste wood and bark.

Energy crops might have a part to play in the game, but only if they are able to compete on price, quality and security of supply. The demand side of the market for biomass will change in the years to come - when the use of biomass in power plants changes:

- The volume in 2005 = 2001 * 3.3
- From almost 100% straw
- To 60% straw / 40% wood

Energy crops will have to compete with: straw, wood-chips and wood-pellets.

Willow might substitute wood chips, especially in West Denmark, Herning power plant, 200,000 tons/year (Only 8,000 tons/year in East Denmark, the rest is wood pellets).

Miscanthus might substitute straw and/or wood-chips, depending on the method of harvest:
- Straw when baled: West and East Denmark, 890,000 tons/year
- Wood chips when chipped: West Denmark., 200,000 tons/year

This is due to the design and nature of the specific power plants in the two parts of Denmark.

The practical use of energy crops in power plants depends on:
- **Price:**
  - straw from local farmers
  - wood-chips from local forest and/or import, international market price NW Europe / Baltic region
  - wood-pellets international market price NW Europe / Baltic region
- **Quality:** low in chlorine and potassium
- **Security of supply:** harvest, storage and logistic

Only time will show whether the energy crops are able (and the producers willing) to take part in the market and the supply.

References

1. Danish Energy Agency, *Energy in Denmark* (Copenhagen, 1998).

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5. B. Hillring, "Price trends in the Swedish wood-fuel market", *Biomass and Bioenergy*, vol. 12, no. 1 (1997): 41-51.