Overall biomass strategy, current projects and future directions
European Biomass Power Generation Conference
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Agenda

Introduction DONG Energy

Conversion from coal to biomass

New Bio Solutions
DONG Energy is an integrated utility and present throughout the value chain

**Primary positions**
- **E&P**
  - Geographical focus
  - Central plants
  - Waste-fired plants
  - Gas-fired plants

- **Thermal Power**
  - Central plants

- **Wind Power**
  - Offshore wind
  - Onshore wind
  - Hydro
  - Wind farms under construction/planned

- **Energy Markets**
  - Electricity and natural gas customers
  - Gas storage capacity

- **S&D**
  - Electricity and gas sales
  - Gas distribution
  - Electricity distribution
  - Gas storage

**Total revenue 2011: 7,630 mEUR**

**Total EBITDA 2011: 1,848 mEUR**

**Number of employees 2011: 6.098 FTE**

**Current market position**
- **Strong ownership in a growing gas portfolio**
- **Leading thermal producer in Nord Pool and market leader in Danish district heating**
- **Growing wind portfolio with market leading position in offshore wind**
- **Power / gas infrastructure. Power / gas trading. Retail positions in several countries**
- **Leading in sales of electricity and natural gas in Denmark and present in several other countries**

Source: DONG Energy
More biomass and offshore wind generation of electricity
Meeting the carbon challenge

638 g CO₂/kWh

Additional renewable production
Offshore Wind MW

Green conversion of fossil production

* Consumption at Severn, UK and Enecogen, NL power stations
Source: DONG Energy
Disclaimer: The information and data herein has been obtained from vendors and public sources believed to be reliable and is presented in good faith and for general information only.
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Green conversion of DONG Energy's capacity reduces dependency on coal and contributes CO2 target

Development in DONG Energy portfolio in DK

- Fossil Fuel (coal, gas, oil)
- Waste
- Multi fuel (biomass, gas/coal)
- Planned conversion to biomass multi fuel

More biomass and reduced use of coal

- 2006: ~6 mt coal, ~1 mt biomass
- 2010: ~4 mt coal, ~1.3 mt biomass
- 2016*: ~1.8 mt coal, ~2.6 mt biomass

Total DONG Energy CO₂ emissions in DK

<table>
<thead>
<tr>
<th>Year</th>
<th>CO₂ Emissions</th>
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<tbody>
<tr>
<td>2006</td>
<td>18 mt CO₂</td>
</tr>
<tr>
<td>2010</td>
<td>11 mt CO₂</td>
</tr>
<tr>
<td>2016*</td>
<td>5 mt CO₂</td>
</tr>
</tbody>
</table>

* Dependent on final investment decision and market price development

Source: DONG Energy
Overview of DONG Energy's biomass conversion plans

<table>
<thead>
<tr>
<th>Location</th>
<th>Characteristics</th>
<th>Biomass Conversion Actions</th>
</tr>
</thead>
</table>
| Avedøre  | Unit 1 from 1990 and unit 2 from 2001  
- Multi-fuel unit enabled to fire gas, oil, straw and pellets  
- Also enabled to fire coal but no permit  
- 810MW power / 915MJ/s district heat | - New closed transportation system  
- Additional crane  
- Additional crusher |
| Studstrup| Build as conventional coal in 1984, but converted to CHP straw co-firing unit  
- 350MW power / 455 MJ/s district heat | - New closed transportation system  
- New wood pellet silo  
- Modification of crusher  
- Bio-ash silo |
| Skærbæk | Gas-fired CHP unit from 1997  
- 392 MW Power / 444 MJ/s district heat | - Conversion to wood pellets require additional incentives |

Source: DONG Energy
The case of Avedøre Power Station

**Electricity to 1,3 million homes**
**District heating to 200,000 homes in central Copenhagen**

**Fact Sheet**
- Situated south of Copenhagen
- Power station units from 1990 and 2001
- Overall production capacity of 810MW electricity and 915 MJ/S of heat
- Multi-fuel power plant
- Unit 2 utilises 94% of fuel energy and has an electrical efficiency of 49%
- It is thereby one of the most efficient power generation units in the world

**Avedøre fuel mix 2010 (heat & power)**
Total ~35PJ

- Coal: 32%
- Wood pellets: 33%
- Other: 0%
- Fuel Oil: 6%
- Straw: 2%
- Natural Gas: 27%

**Avedøre wood pellet consumption**
'000 Tons of Wood Pellets
- 2010: ~651
- 2020*: ~1150

*Forecast based on estimated back-pressure consumption and final investment decision of biomass conversion
Source: DONG Energy.
Heat and power consumption from biomass and waste in EU is expected to double by 2020

EU-27 final energy consumption from renewables in 2020

<table>
<thead>
<tr>
<th>TWh</th>
<th>Growth in energy from biomass</th>
<th>Growth in other renewable energy</th>
<th>2020 scenario</th>
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<tr>
<td></td>
<td>800</td>
<td>100</td>
<td>1.650</td>
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<td></td>
<td>310</td>
<td>90</td>
<td>380</td>
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<td>2007</td>
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<td>850</td>
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<td>30</td>
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<td>2020 scenario</td>
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<td>Hydro</td>
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<td>3.030</td>
<td>850</td>
<td>Wind</td>
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<td>Solar, geothermal, tidal and wave</td>
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<td></td>
<td>Biofuel for transport</td>
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<td>Biomass and waste</td>
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</table>

1) Average of two scenarios: "EC proposal with RES trading" and "EC proposal with CDM and RES trading"

Source: Capros et al. (2008): "Model-based Analysis of the 2008 EU policy Package on Climate Change and Renewables"
European consumption of wood pellets will to a large extent be supplied by North America in the future.
Industry develops own sustainability criteria through Initiative Wood Pellet Buyers (IWPB)

**Participants**
- DRAX
- RWE/Essent
- Electrabel (GDF Suez)
- Laborelec (GDF Suez)
- DONG Energy
- EON UK
- Vattenfall

**Purpose of IWPB**
- Members of IWPB consumes more than 70% of industrial wood pellets in Europe (7-10 mt)
- Improve framework for trading wood pellets
  - a) Standard contracts
  - b) Common specifications for wood pellets
  - c) Principles for sustainability
- Work for mandatory sustainability criteria for solid biomass in the EU

**IWPB sustainability principles**
- Significant savings on GHG balance compared to Fossil Fuel
- Avoid reductions in Carbon Stock
- Protect areas with high biodiversity value
- Soil quality is to be maintained or improved
- Conservation or improvement of water quality
- Air quality should be maintained or improved
- Should not endanger production of food and local biomass applications
- Contribute to local prosperity and to the welfare of employees and local population


Source: DONG Energy
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New Bio Solutions
New technologies needed to contribute to solving the global energy need

Global trends and needs

Increased urbanisation
- Almost 60% of the world's population is expected to live in urban areas by 2025\(^1\)
- Major need for green solutions coping with this density of population and harnessing the household waste

Fight for resources
- Global reserves of vital resources such as oil and phosphorus are rapidly exhausted
- Political setting of priorities and geo-political battle regarding access to vital resources are enhanced\(^1\)

Global increase of population
- Global population is expected to increase from today's 6.8 bn to 8.0 bn in 2025\(^1\)
- Global growth leads to increased demand for food and materials\(^2\)

2. Source: IMF Economic Outlook
Green growth with intelligent use of biomass

- Smaller power plants on biofuels
- With combustion

- Multifuel on central plants
- Biogas

- 2. generation biomass (biofuels)

- 3. generation biomass (products for chemical industries)

Source: DONG Energy New Bio Solutions
New Bio Solutions – High value energy from biomass

2. generation bioethanol production based on agricultural waste products (straw)

Enzyme based separation of household waste to flexible and efficient energy production

Low temperature gasification of low value biomass (straw) to production of high value energy products

Source: DONG Energy New Bio Solutions
Maabjerg Energy Concept integrates RE-technologies and exploits synergies

- Maabjerg Energy Concept creates value of all products by integrating:
  - 2G bioethanol
  - Waste incineration and handling
  - Biogas
  - Heat and power production
- Project participants are local energy distribution companies, DONG Energy and Novozymes
- Project is working closely together with local farmers on delivery of manure and straw

Source: DONG Energy New Bio Solutions
Conclusions

1. Biomass to energy plays important role in current EU energy mix and share to increase in the future
2. DONG Energy conversion from coal to biomass to increase production of reliable and clean energy
3. A key issue is sourcing of sustainable biomass
4. Strategic objective of New Bio Solutions to develop world class utilization of low value biomass and waste through bio-refining

Source: DONG Energy
Appendix
Avedøre Power Station: Multi-fueling the future

Source: DONG Energy.
District Heating in Copenhagen

District heating system and suppliers in Copenhagen

**Origin of heat supply (2010)**
- Total ~39PJ
- Peaking plants: 10%
- Waste: 23%
- Other heat and power: 29%
- AVV plant: 38%

**CO₂ targets of Copenhagen**
- 20% reduction in CO₂ emissions by 2015
- CO₂-neutral Copenhagen by 2025

Source: Varmeplan Hovedstaden, DONG Energy