Biomass Technology

A part of the solution for tomorrow's green energy

B&W babcock & wilcox vølund

VØLUND SYSTEMS

The future is also tomorrow

Our planet is sweating! Today, global warming is a reality that gives rise to extreme weather conditions and natural catastrophes such as Arctic meltdown and rising water levels.

We are living at a time when we cannot simply talk about climate problems in the future. The changes have already occurred – and they are more than just noticeable.

Solutions are no longer simply necessary, they must also be found rapidly! Populations and businesses all over the world are therefore being faced with an increasing number of climate policy demands in such areas as reducing CO_2 emissions in relation to lifestyles and production.

We work for a greener future every day at Babcock & Wilcox Vølund and we are already one of the world's leaders in the field of technological solutions to burning biomass, but we are far from finished.

We will also play an active role in the race for the continued development and optimisation of technology in the future so that it can measure up to the tremendous climate challenge that concerns us all – today, as well as tomorrow.

Welcome to Babcock & Wilcox Vølund!

Biomass

- the greatest source of green energy

Through the ages biomass has always been an obvious choice as a source of energy, and since the early dawn of civilization people from all cultures and regions of the world have used nature's materials for heat, cooking, and production.
Other sources of energy later made an appearance, and coal, oil and gas have predominated in the production of electricity, heat, and fuel for many years. Unfortunately, as most people are aware, the use of fossil fuels has had a major impact on the earth's climate and environment.

CO_2 reduction and recycling

In recent decades, people in most countries have realised in earnest the pressing need to find CO_2-neutral alternatives for energy production, and the focus has once again returned to biomass, which has several advantages in this connection.
Generation of energy from biomass lives up to the increasing global political demand to reduce emissions, but can at the same time also recycle biological waste from many forms of production, thereby solving serious problems with waste – so, with regard to the environment, biomass kills two birds with one stone.

The preferred choice

For many years, biomass has occupied a undisputed first place in the choice of renewable energy sources and outstrips wind, water, and solar energy by several lengths, and consumption in the EU alone has increased by more than 60% over the past ten years. In Denmark, which is one of the EU's pioneers in the field of sustainable energy, 15% of all electricity and district heating is already produced with the help of alternative energy.
In this respect, biomass accounts for as much as 70% of total green energy consumption – consumption that is expected to increase in Denmark, the EU and the rest of the world.

Technology opens doors

An increase in the use of biomass is very much due to the major advances being made in biomass technology. The development of more reliable plants, optimised pre-processing and combustion methods have improved utilisation rates, and research into the possibilities of generating energy from bio-fuels has already yielded results that bode well for the future. Even after several thousand years, biomass still has tremendous, unused potential that modern technology will continue to ensure we all benefit from through a cleaner world.

Table 1 : Evolution of RES (Renewable Energy Systems) Mtoe (Mtoe = million ton oil equivalent)

	1995	2004	Difference
Biomass	44.8	72.3	+ 27.5
Hydro	26.4	26.1	- 0.3
Wind	0.4	5.0	+ 4.6
Solar thermal	0.3	0.7	+ 0.4
Geothermal	2.5	5.4	+ 2.9
PV	0	0.1	+ 0.1
Total	74.4	109.6	+ 35.2

Source: European Biomass Association (2007)

OUR EXPERIENCE WITH BIOMASS

- Babcock & Wilcox Vølund has more than 25 years' experience of biomass technology as well as more than 70 years' technological expertise in the waste-to-energy field.
- Today, Babcock & Wilcox Vølund is one of the world's leading suppliers of equipment and technologies that convert waste and bio-fuels into energy.

Biomass

Technology

Babcock & Wilcox Vølund has developed a series of technologies that improve efficiency in connection with generating energy from biomass. The great interest in CO_2-neutral and climate-friendly energy has engendered a growing demand for biomass technology and the path towards a cleaner world is a positive development that we are delighted to support through in-depth research and high-tech biomass systems.

Our biomass technologies were developed to be incorporated into the many different stages involved in generating energy from biomass. Our systems and components have been adapted to the many different ways of producing biomass energy from country to country all over the world. This means we can supply energy production systems for many different types of biomass fuel where the required energy end-products also differ widely – heat, electricity, syngas, or bio-oil. In addition to a high degree of adaptability, our systems and technologies are also known and recognised as being extremely robust and at the forefront of developments.

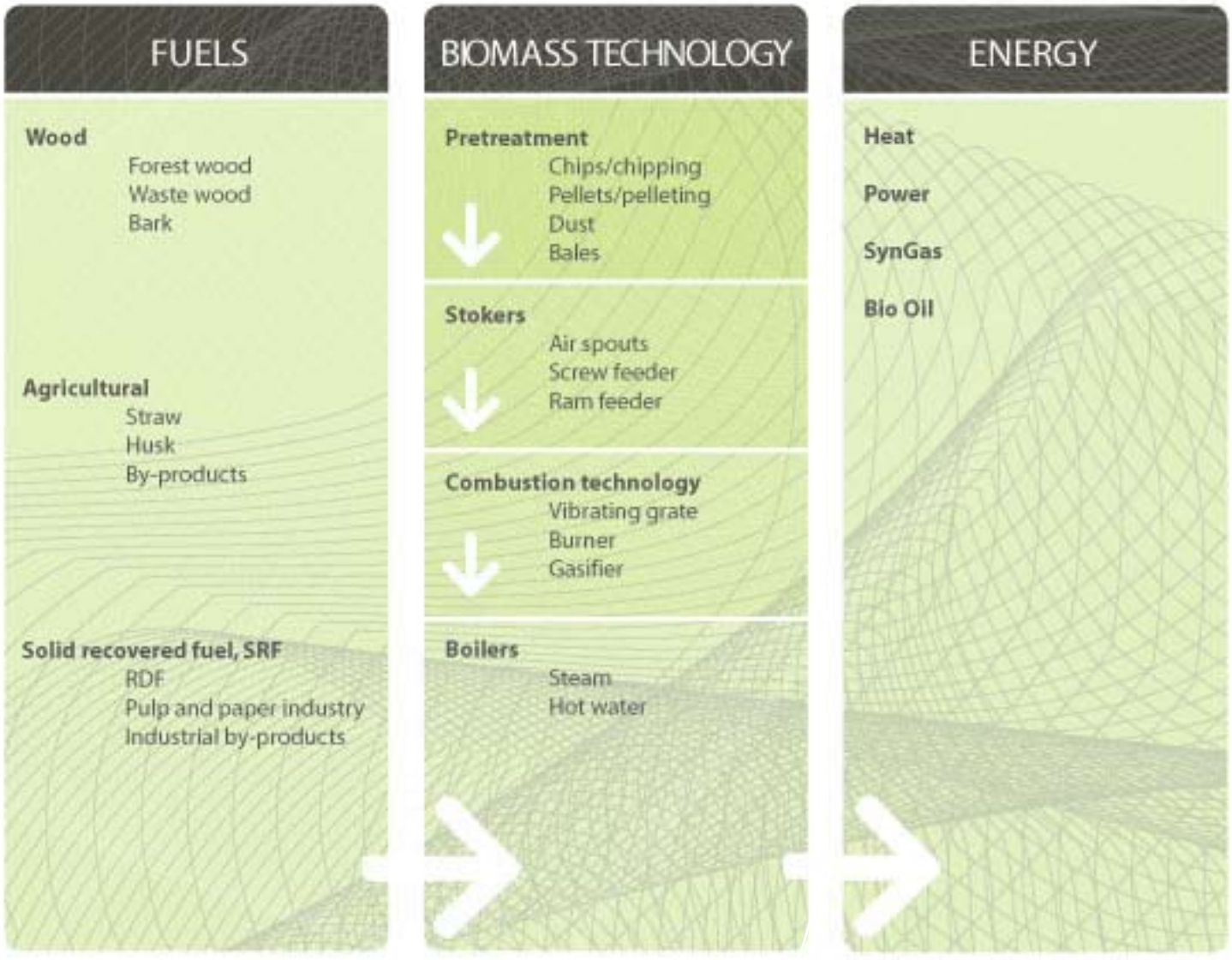
The table on this page provides an overview of energy-generating processes and the next pages of the brochure contain a more detailed presentation of some of our biomass technologies as well as examples of several of our systems that are in operation throughout the world.

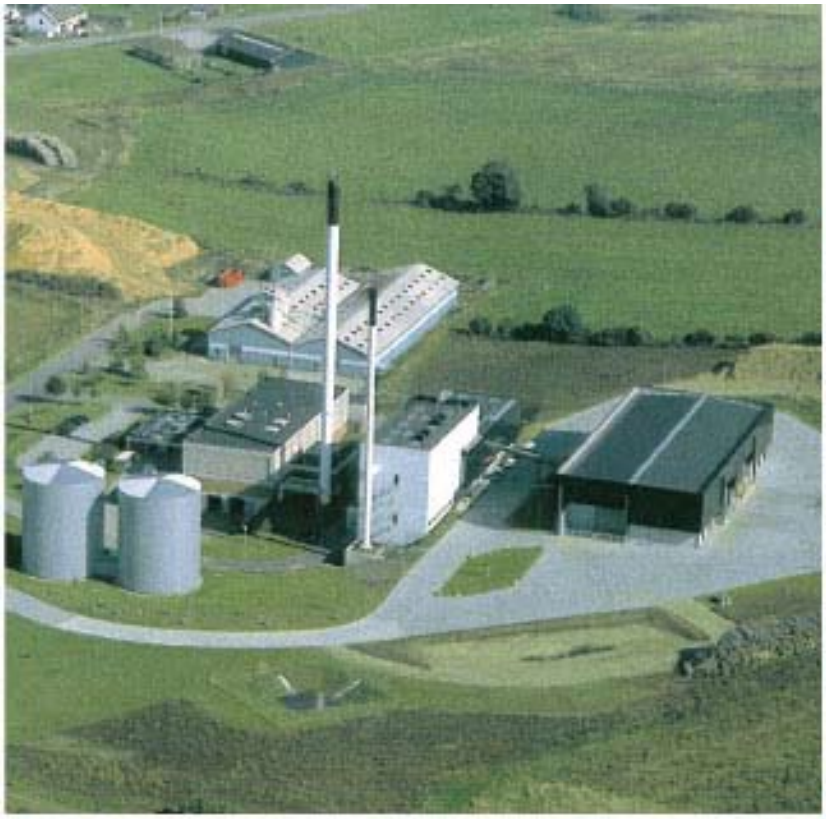
Biomass fuels to energy

Over the years, Babcock & Wilcox Vølund has supplied sound biomass systems and advice of a high scientific standard throughout the world for:

Supplied by Babcock & Wilcox Vølund:
• District heating plants
• Combined heat and power plants
• Industrial energy production

Overview of the fuels, processes, technologies, and end-products covered by our systems.





Assens Combined Heat and Power Plant:

"The technology kept more than it promised"

Switching fuel from coal to biomass has given Assens CHP plant many advantages. In this connection, John Jessen, director of the plant at Assens, emphasises the incredibly robust and far-sighted technology at the plant: "The technology actually gave us a head start in the utilisation of biomass and also paved the way for future opportunities that we hadn't anticipated."

One of Denmark's biggest privately-owned biomass fired combined heating and power plant (CHP) is located at Assens on the island of Funen. Assens CHP plant was originally an ordinary coal fired heating plant, but for several reasons at the beginning of the 1990s the management began to discuss the possibility of modifying and upgrading the plant and turning it into a more environmentally-friendly alternative. There was a choice between natural gas and biomass and, in 1997, a decision was made in favour of biomass when, after thorough consideration, the management agreed to build a wood fired CHP plant. The old, coal fired heating plant (block 1) had already been modified to produce heat with the help of fuels such as wood chips and wood pellets. "This meant we already had knowledge of wood as a biomass fuel and reliable deliveries at hand when we decided to build our new CHP plant (block 2)", explains Director John Jessen. Babcock & Wilcox Vølund won the turnkey contract for the new biomass fired plant at Assens and only 15 months later – in 1999 – the new plant was in operation.

Big output and rapid depreciation

Building the Assens block 2 plant cost a total of DKK 127 million which was expected to be depreciated over 20 years. "But the operation is actually so economically sound that we can repay an additional DKK 3.5 million a year and thereby depreciate it over only 13 years", smiles John Jessen, and goes on to explain "one of the reasons we can depreciate so rapidly is that the technology used at the plant makes it possible to produce an energy output that corresponds to an output normally only seen in far bigger plants. The boiler produces steam at a temperature of 525° Celsius and a pressure of 75 bar, enabling us to achieve an electrical efficiency of 25%. That's not high for a big plant,

but it is quite incredible for a small plant such as ours". And the high electrical efficiency is a real financial benefit, as the price of electricity at present is DKK 600/MW, whereas at DKK 308/MW the price of heat is considerably lower. Today, the biomass fired CHP plant at Assens supplies 98% of the total consumption of electricity and district heating for the approximately 8-9,000 inhabitants of Assens, as well as two smaller villages in the area.

Fuel of varying quality

In addition to providing an efficient end result, the technology used at Assens CHP is so robust that it can handle wood fuel products of highly varying quality. The primary fuel used in the biomass plant is forest wood chips with a humidity of up to 50% – now and again supplemented with bark, sawdust, wood pellets, other wood chips, and untreated waste wood from industry. John Jessen explains that the fuel is often of very poor quality. "This is naturally the case due to its high moisture content, and it often contains large branches or similar. On the other hand, the poor quality means that we can buy the fuel very cheaply which is an advantage because our plant can easily handle it." The wood usually comes from Denmark, but also arrives at Assens by sea from Russia and the Baltic States as wood chips and tree trunks – an impressive sight that has become a real tourist attraction at Assens. The trunks are turned into wood chips at the plant and the fuel that arrives as wood chips is tipped straight into big silos, after which a completely new type of advanced feeding system takes it to the fully automatic plant. "Having to move the fuel only once means a lot," clarifies John Jessen, "anything else would need far too many resources because we consume 150 tonnes of wood products a day."

Future-oriented technology

The entire CHP plant at Assens is fully automatic and all production is "untouched by human hand". The plant's operation is computer-controlled, which means that it can be carried out with the help of just three man-years. The plant is in operation for 24 hours a day and production can be modified as required – during the winter season, for instance, when consumption is at its highest. Production only comes to a standstill for 14 days once a year to allow technicians to make adjustments and carry out any repairs to the various units that may be necessary. John Jessen is completely satisfied with operation, but also says he was surprised that the technology was as robust as it is. "As I mentioned, it is a great advantage that we can handle fuels of highly varying quality at the plant, but we have also found it's possible to use fuels that are otherwise very difficult to utilize. Among other things, we have tried out what the Germans call "trester" (stones, seeds and skins from fruit), and we have plans to cultivate what we could call an energy forest in the form of willow trees that can be used as fuel, which we have also had good results with. Over and above this, we would also like to burn biogas at the plant, as trials have shown that this is possible", explains John Jessen "in brief – the technology at our plant has given us a head start in the utilisation of biomass because we can use the fuel that happens to be available at a given time and don't have to wait for an advanced technological upgrade to make it possible. All of which means we have a plant that far exceeds our expectations and also opens up some really good perspectives for the future."

Assens Fjernvarme AmbA
- Assens Combined Heat and Power Plant

Facts:

Assens Combined Heat and Power Plant produces electricity and heat and has the capacity to supply broadly speaking all households and industries at Assens. Babcock & Wilcox Vølund was hired to build the plant in October 1997 and, 15 months later, it was in operation.

Fuel:

Primarily forest wood chips and bark with a moisture content of up to 50%, sawdust, wood pellets, wood chips, and untreated waste wood from industry.

Operation:

A crane lifts the fuel into the feeding silo from where it is blown into the furnace by two pneumatic air spouts. Some drying and combustion occurs while it is still suspended in the air above and on the combustion grate itself. The energy from the flue gas is transferred to the boiler and turned into steam, which is sent through a turbine that drives a generator. The steam energy that is not used in the turbine is converted to heat by condensing it with the help of a high and low pressure condenser. The condensers are cooled with district heating water, thereby producing district heating for the town of Assens.

Total output:

Heat: 10.3 MW
Flue gas condenser: 3.5 MW
Electricity: 4.68 MW

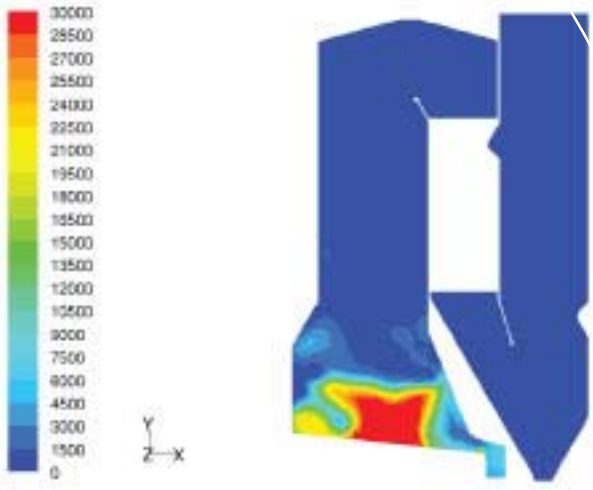
FACTS ABOUT BIOMASS

- The designation biomass fuel covers a wide range of materials that release energy when they are burned. Unlike fossil fuel, biomass fuel is characterised by the fact that it was "recently alive".
- Biomass fuel is CO_2-neutral in the sense that when it burns, it only releases that quantity of CO_2 that the plant itself absorbed as it was growing.

Biomass

The fuel

Processing and burning biomass requires considerable technological expertise and a good deal of detailed knowledge of the individual fuel types. The use of various kinds of biomass fuel varies greatly because the choice of fuel often depends on which type is available in a given geographical area.



Computational Fluid Dynamics (CFD) illustration

Seen globally, the raw materials used include maize, soy beans, palm oil and rape seed oil, or residual products such as waste wood, hay and some types of refuse, and each of these types of fuel has its own characteristics and therefore differs in the way it reacts during pre-processing and combustion.

Some types of biomass contain a great deal of moisture, for instance, some contain large quantities of volatile components, and others again may have special characteristics and structures that must be taken into account.

In order to get the maximum yield from a given type of biomass, it is important for the technology involved to have been adapted to the fuel during all stages of the process. This applies to pre-processing, feeding, combustion, and the subsequent scrubbing of the flue gas. Some plants can even use several types of fuel, which makes even greater demands on the knowledge of fuels and technological flexibility.

At Babcock & Wilcox Vølund, we have developed a number of technologies for burning biomass based on many years' experience with combustion technology and specialised knowledge of biomass fuels. Our plants are characterised by a high degree of adaptability and are easy to upgrade in relation to new developments or the transition to other or more types of fuel.

Analyses
The purpose of Babcock & Wilcox Vølund technology is to ensure at all times the maximum possible yield from biomass fuel. We therefore frequently make use of preceding analyses that make it possible for us to determine the properties of the fuel and to predict and counteract any operating problems.
Our analyses are thorough and based on the latest technology and methods in the field of plant and process optimisation so they provide us with the necessary advance knowledge that makes it possible for us to supply a customised, optimum system every time.

What do we analyse?

1. ANALYSES

Physical
- Calorific value
- Density
- Particle size and distribution
- Ash melting point
- Unburned carbon in the ash

Chemical
- C, H, N, O – element analysis
- Volatile components
- Ash
- H_2O

2. TEST COMBUSTION
- Small scale (cooperation with universities)
- Full scale (Babcock & Wilcox Vølund plants)

3. COMPUTATIONAL FLUID DYNAMICS, CFD

• Simulating the concept:
- Commercial CFD programs have been developed for use in project planning, optimising and diagnostic tests of plants. The CFD programs are advanced calculation tools for computations and three-dimensional turbulent flow with heat and mass transfer.

• Simulating operation:
- The design and optimisation of flue gas recycling (FGR), which at the same time makes it possible to reduce excess air and control flue gas temperature in the furnace. This will result in lower flue gas loss and consequently higher total efficiency and lower NOx emissions.

- Evaluate location, number and design of nozzles for the introduction of secondary combustion air and recycled flue gas to control furnace temperature.

- The design of the post-combustion chamber, e.g. for grates with understoichiometric combustion.

- Diagnostic tests of plants with technical process and combustion problems, e.g. plants with inadequate flow conditions, poor mixing, insufficient combustion – carbon monoxide problems, thermally strained surfaces, and corrosion problems.

Processing and feeding

Babcock & Wilcox Vølund has developed a unique, flexible processing and feeding technology for the three major groups of biomass fuel.

Rotary straw rake

The combustion chamber

This applies to:

- All kinds of straw, grass, stalks, etc. – pressed into bales
- Wood of all kinds
- By-products from food production in particle form

Our processing and feeding systems are characterised by a high degree of operating economy and their adaptability to a very wide range of biomass fuels.

We possess unique expertise in connection with grates. Over the years we have equipped more than 50 plants throughout the world.

Product example:

Rotary straw rake

Rake in a unique design for preparing and pre-processing bio-fuels. Low energy-consumption loosening of all kinds of straw and stalk bales.

- **Specifications**
- **Materials:**
  - All types of straw, grass, stalks, etc. – pressed in big bales

- **Capacity:**
  - Bales up to a weight of 1000 kg
  - Up to 15 tonnes/h corresponding to approximately 50 MW at 25% humidity

- **Properties:**
  - Slow-speed operation to reduce wear and prevent sparks, thereby reducing the risk of fire
  - Not sensitive to minor foreign bodies
  - High efficiency at low energy consumption
  - Not sensitive to straw bale strings – a string remover is unnecessary

- **Recommended combination:**
  - Heavy duty double screw feeder

Product example:

Hydraulic fuel feeding silo (HF)

Feeding silo with hydraulic feeding cylinders.
Available in two types with the option of adaptation as required.

- **Specifications**
- **Materials:**
  - Wood of all types in pieces – wood chips, wood briquettes, wood pellets
  - By-products from food production – grains, etc.

- **Types:**
  - Fuel feeding from the top – to the combustion grate

- **Capacity:**
  - Both types can be made and supplied to meet capacity requirements

- **Properties:**
  - Suitable for feeding vibrating and step grates
  - Works concurrently as a storage silo
  - Not sensitive to foreign bodies
  - Robust, durable construction
  - Can be adapted with regard to capacity and quantity

Biomass

Combustion grate

Product example:

Vibrating grate (HVB) water-cooled

This water-cooled vibrating grate has proved to be robust and highly efficient through more than ten years of operation. The grate was specially developed for fuels with little or almost no ash content, but also works very well with fuels containing ash. It is distinguished by a very high degree of utility, low maintenance costs, and minimal wear on components.

Unique design for smooth operation

The grate consists of two or four panel walls mounted on leaf springs. These panels are activated in pairs, in counter phase, by a vibrating unit. This is a simple construction with no internal moving parts to ensure smooth operation and long life. The grate can be supplied with specially formed cast steel top plates for firing fuels with a high content of low melting point metals – such as RDF or demolition timber.

Optimal conditions for air flow control

Primary combustion air is injected through holes in the fins of the grate panel. The pattern of these holes can be custom-designed to meet the demand for primary air as determined by the specific fuel. This, combined with the independency of air flow for cooling, gives the optimal conditions for air flow control, staggered combustion and thereby NOx emission control.

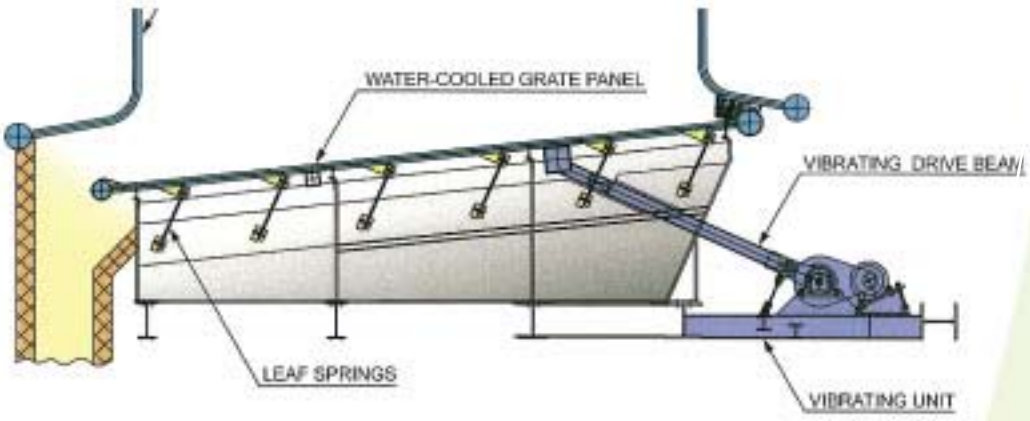
Integrated part of the boiler

As standard, the grate panels are supplied with water from the drum and act like any other evaporating surface in the boiler pressure part. Other high or low pressure cooling cycles can be adopted in order to optimise overall plant performance.

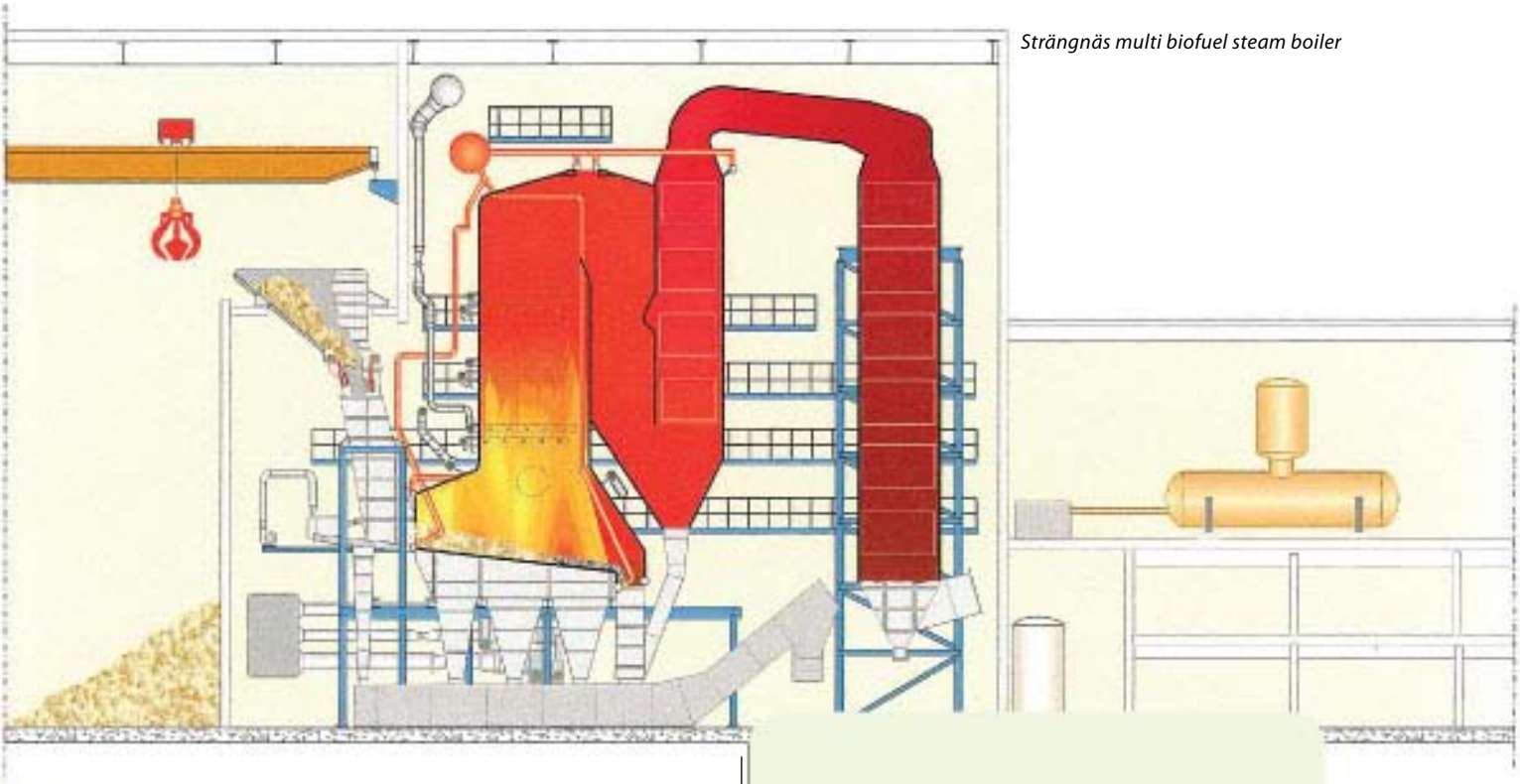
- **Specifications**
- **Materials:**
  - Ideal for burning most types of biomass, RDF and other solid recovery fuels

- **Properties:**
  - Heat release rate up to 2.5 MW/m²
  - Suitable for a wide range of boilers within 10-170 MW
  - Possible to burn fuels with a high moisture content
  - Efficient water cooling results in less wear and ensures long operating life
  - High availability, low maintenance costs and low spare part consumption
  - High flexibility due to multiple water cooling options
  - Air flow through the grate can be optimised for combustion conditions as there is no need for air cooling

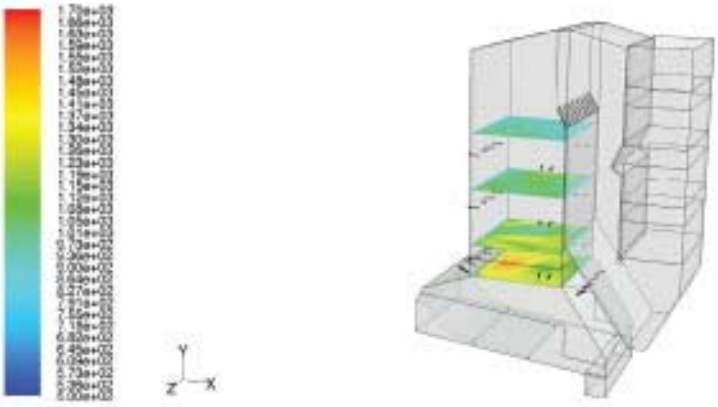
- **Advantages:**
  - Heat input is utilised for steam generation
  - In spite of water cooling, grate temperature is high enough to contribute efficiently to fuel drying and pyrolysis
  - Primary air can be heated to a temperature of more than 300 °C
  - Alternative methods are incorporation as an economiser in the high pressure system or as a feed water preheater in the low pressure system
  - High heat release rate with medium wet fuel
  - Stable combustion with wet fuel
  - Stable combustion at low load



Cross-view of the vibrating grate



Strängnäs multi biofuel steam boiler



Computational Fluid Dynamics illustration

PLANT OPTIMISATION

At Babcock & Wilcox Vølund, we optimise plants exclusively on the basis of thorough analyses.
When we provide advice and analyses in relation to plant optimisation, we always do so with the help of results obtained from the latest technologies on the market. CFD analyses (Computational Fluid Dynamics) offer a good overview of such factors as gas flow, temperatures, particle traces, and concentrations of O_2, CO_2, H_2O and CO in furnaces and boilers. The analyses are very useful tools for our experts who determine where in the process optimisation would be beneficial and what the subsequent strategy should be.

Biomass

Boilers

Babcock & Wilcox Vølund has been developing advanced boilers for biomass and other solid fuels for decades. This long-standing, in-depth knowledge has given us a tremendous lead in designing efficient boilers.

Together with our clients and highly skilled business partners, we have succeeded time after time in creating unique boiler systems in connection with projects involving burning a wide range of biomass fuels. The technology in question includes steam boilers for saturated and superheated steam.

The steam boiler converts flue gas energy into high pressure steam. The arrangement is normally a two or three-pass boiler. The first passes are dominated by radiant heat transfer. In the last pass, convection is the dominant form of heat transfer.

The Vølund Systems™ boiler:
Properties:
• Integrated furnace, post-combustion chamber and boiler
• Boilers with high circulation numbers
• Optimised flue gas flow in the system
• Uniform temperatures and heat loads
• Minimised corrosion risk
• Good burn-out, low CO and TOC in the flue gas
• Optimised and integrated SNCR NOx reduction process
• Hot water or steam/electricity production
• Easy cleaning with sootblowers
• Maximum availability
• Good turndown ratio

Biomass

Gasification

Babcock & Wilcox Vølund has been conducting research into gasification technology since 1988 and today, we regard our technology as state-of-the-art. Gasification technology plays a central role in the development of CO_2-neutral energy supplies and therefore at Babcock & Wilcox Vølund we consider it a major step in the right direction when we integrate gasification technology into several different concepts:

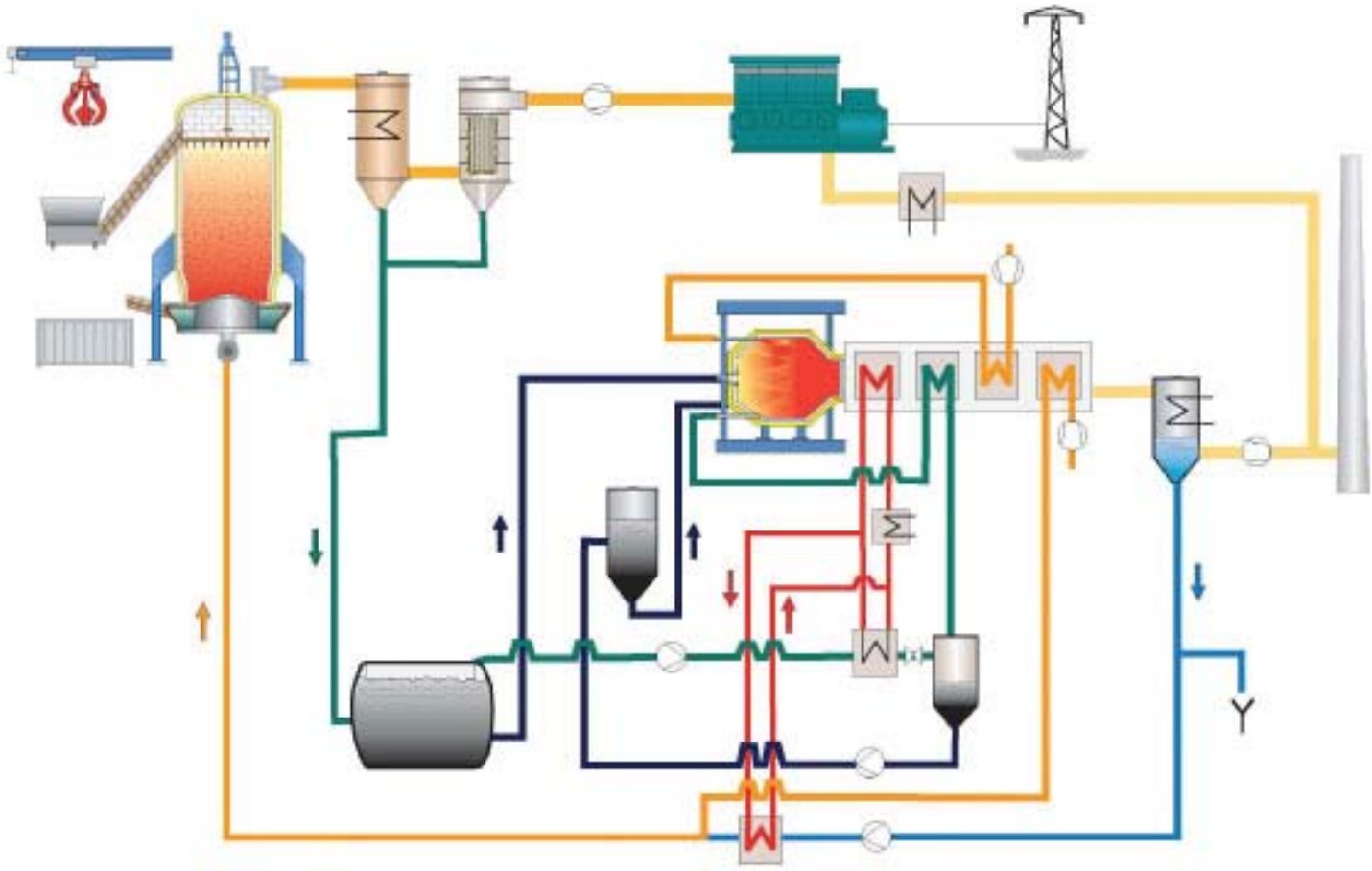
- Combined heat and power plants (CHP) – up to 50 MWth
- District heating plants – up to 50 MWth
- Gasification to supply an external superheater at a waste-to-energy facility (Waste Boost ™)

Updraft gasifiers

Updraft gasifiers are known to produce tar (liquid biofuel) and a low-temperature product gas from biomass. At Babcock & Wilcox Vølund, we carry out research to find uses for this tar with the aim of optimising production.

Advantages of updraft gasification technology:

- Low carbon content in ash
- Fast ramping
- High flexibility in turndown ratio
- Avoids pre-treatment of fuel
- Low product gas temperature
- No fuel drying necessary



Process illustration of a gasification plant

FACTS ABOUT BIOMASS

By using our brand new Combined Cycle Gasification technologies, which provide a significant reduction of waste heat, owners of new power plants will be able to achieve an electrical efficiency of approximately 40%

COMBINED HEAT AND POWER PLANT AT HARBOØRE

FACTS:

Babcock & Wilcox Vølund has had Harboøre combined heat and power plant, which is located on the west coast of Jutland, as a reference plant since 1996. The plant was originally built to produce heat and was rebuilt to produce electricity with the help of two Jenbacher gas engines in 2000.

Fuel:
Wood chips

Operation:
Harboøre gasification plant makes use of an updraft gasifier. The fuel is fed in at the top of the gasifier, and heated, moist air is supplied at the bottom. (See page 16).

The gasification process
The gasification process can be divided into the following stages:

- Drying – moisture evaporation
- Pyrolysis – releases pyrolysis gases containing hydrocarbons and tar
- Gasification – partial oxidation/combustion, heterogeneous reaction with CO_2, H_2O and homogeneous water-gas-shift reaction and boudouard reactions
- Combustion – oxidation/combustion of residual carbon
- Ash layer

The gasifier produces a product gas with a calorific value of 6-7 MJ/Nm³ at a low gas temperature (73-76 °C), which makes it useful as fuel for gas engines. The gasifier produces heavy tar with a calorific value of 29-30 MJ/kg – an excellent by-product that is stored and used as auxiliary fuel at peak load periods during the winter.

Plant data and key figures for Harboøre CHP plant (2007)
Figure 1
Thermal input [MWTH] 3.5
Fuel: [-] wood chips
Power production: [MWE] 1
Gasification agent: moist air
Fuel moisture: [% d.wt] 35-55
Plant hours, more than [h] 100,000
Plant hours, annual [h] 8,000
Engine hours, more than [h] 50,000
Power efficiency: [% net] 25-26
Heat efficiency: [% net] 50
Calorific value of tar MJ/kg: 29-30

Technology transfer
The successful technology from the Harboøre plant has been transferred to the other end of the world, to Yamagata in Japan, where a new gasification plant with combined heat and power production began operation in 2007.

Waste Boost ™
One of the challenges of waste-to-energy technologies is that flue gas has a corrosive effect. This effect limits the permissible flue gas temperature in front of the superheater section and thereby limits the steam temperature to 400-425 °C. By combining the waste-to-energy system with a gasifier it is possible to raise steam temperature to 500-600 °C in an external superheater supplied with product gas from a gasifier. The benefit is an extraordinarily high electrical efficiency produced by wood chips and additionally, the risk of corrosion is minimised.

Advantages of the Waste Boost ™ concept:
• Separate ash extraction unit
• Power efficiency on the gasifier fuel – up to 70%
• Auxiliary fuel with heavy tar
• The multi-fuel concept allows the use of contaminated or waste wood as fuel
• Excellent load range and ramping
• Requires only a small area , making it easy to fit in

The Harboøre CHP gasification plant – in operation since 1996

Bioethanol

- with optimised firing technology

Winning bioethanol as an alternative fuel has been criticised for its energy-intensive processing, but new plant technology could lead to a solution.

The development of alternatives to fossil, liquid fuels has been going on for a long time. Cheap fossil fuels will soon be a thing of the past and reserves are dwindling – helped on by the increasing use of cars as a means of transport in big countries such as China and India. Furthermore, powerful political forces are at play to minimise dependency on the oil-producing countries and to reduce CO_2 emissions, also in the transport sector.

The auto industry prepares

The major car manufacturers have already taken account of developments and now make cars that can run on several different types of alternative fuel and the outlook for ethanol-powered cars looks bright. In Sweden, there are already more than 300 petrol plants where fuel containing 85% ethanol can be bought, and one of the EU's climate goals is that bioethanol must constitute 6% of total fuel consumption before 2010. This goal means that the total demand for bioethanol in Europe will increase to about 11.5 billion litres a year.

Criticism of ethanol production

Much of the criticism of bioethanol concerns the very high amount of energy it takes to produce it from biomass – such as wheat, for instance. The energy is used in the distillation process, among other things, and to clean waste water, but a good deal is also used in pre-processing wheat or other cereals and processing the residual product that comprises husk and chaff. But at Babcock & Wilcox Vølund, we have exclusively looked at the problem as a technological challenge.

New firing technology from Babcock & Wilcox Vølund

Thanks to our many years' familiarity with and development of technology for burning straw, for instance, we have accumulated knowledge that provides the basis for a new method of overcoming the challenges of bioethanol production. The method involves burning the residual products and thereby winning energy that can be led back to ethanol production. The plant will be capable of burning 20 tonnes an hour and with the help of its residual products, it will be possible to cover as much as 80% of the energy consumption at the ethanol factory – including 20 MW of electricity.

The technology is already in use

The new Belgian bioethanol producer – Biowanze – has already made use of Babcock & Wilcox Vølund's new system. Biomass is burned on a water-cooled vibrating grate and steam is produced with the help of special boiler technology that can handle the low melting point of the fuel in an optimum manner. It is expected that the technology will be in great demand in the coming years as about 50 new ethanol projects are already in the pipeline in Europe alone.

FACTS

The Biowanze SA ethanol factory was founded in 2006 and is owned by the German company CropEnergies AG. When it reaches full production at the end of 2008, the factory, which is located near the Belgian town of Wanze, is expected to produce 758,000 litres of alcohol a day.

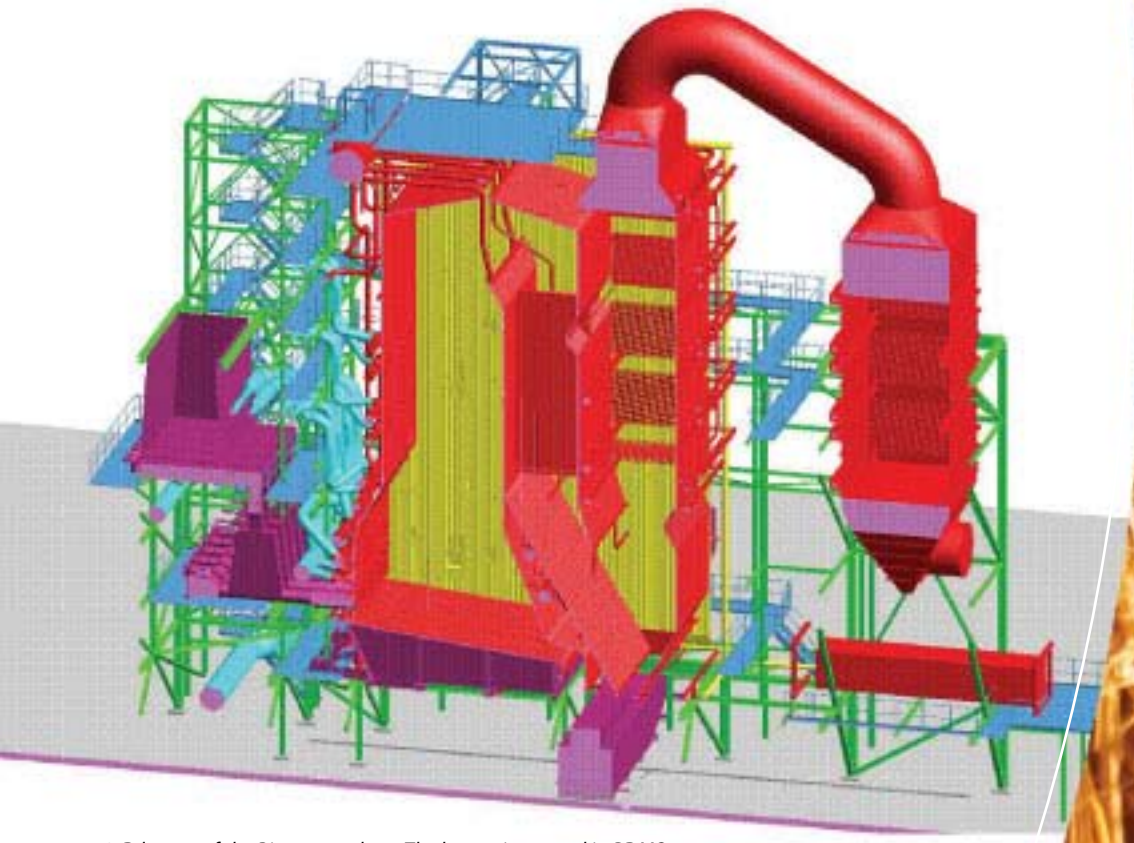
Specifications

Fuel: wheat husk

Steam: 100 t/h at 520 °C/92 bar

Supplied by Babcock & Wilcox Vølund:

- Feeding silo
- Vibrating grate
- Boiler
- External n-gas superheater
- Dry flue gas cleaning
- Instruments
- Construction
- Commissioning



3-D layout of the Biowanze plant. The layout is created in PDMS, Plant Design Management System

Multi-fuel

- tomorrow's plants will be ultra-flexible

The biomass plants of the future must be based on a much higher degree of flexibility. Compiling and integrating various combustion technologies will mean that many types of biomass can be used in the same plant, making them less dependent on a single type of fuel.

New technology for Strängnäs Energi AB

Babcock & Wilcox Vølund recently supplied Strängnäs Energi AB in Sweden with a completely new type of multi-biofuel boiler. The Strängnäs plant is a new combined heat and power plant, which is able to burn several different kinds of biomass fuel. The primary fuel used in production will be virgin wood and waste wood, but it will also be possible to use RDF based on wood, paper, plastic and peat to produce energy at the plant.

Strängnäs Energi is being built to operate on the basis of two different set-ups – one for waste and one for RDF/wood. The boiler was specially developed to handle both types of feedstock. Different types of fuel lead to different risks of corrosion, but it is possible to counteract this by regulating steam data during operation and hereby achieve optimum electrical efficiency.

Today, there are a large number of plants, each of which uses different types of biomass to produce energy. Some exclusively use straw, others wood chips, and still others have taken a step further and now fire with multi-fuel – a mixture of various kinds of biomass, including some types of refuse derived fuels (RDF).

Reliable supplies

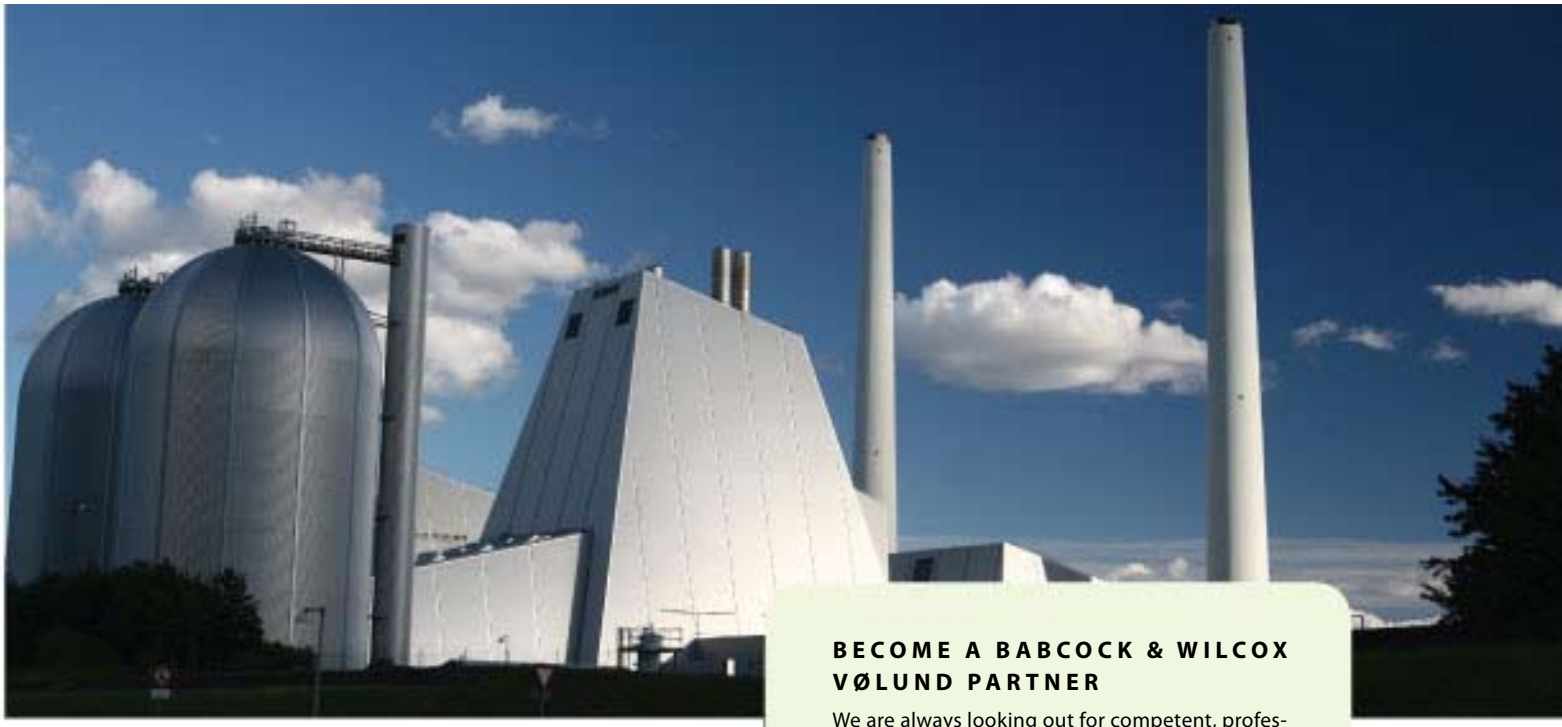
The advantage of the multi-fuel solution is that it provides more opportunities to use the biomass that is available locally and become less dependent on seasonal fuels such as straw. Instead of having to store biomass fuel or collect it from other areas, these plants can interchange fuels and maintain steady production throughout the year. The solution also offers additional savings on transport and fuel storage.

Technology and synergy

Firing with multi-fuel requires advanced technological innovation. The challenge lies in the widely differing characteristics of biomass fuel – biomass ashes, for instance, do not melt at the same temperature, different types of fuel do not burn in the same way (burning straw can create problems with fouling, for instance - blockages/clinker formation) and they do not produce the same emissions. Multi-fuel technology must at one and the same time be able to handle the various methods of combustion and also ensure an optimum, thoroughly reliable result for each type of fuel (cf. WasteBoost ™ concept, page 17).

Energy production in the future

In spite of the challenges, multi-fuel technology offers such advantages that future efforts will be devoted to an increasing integration of combustion methods at the individual plants. Furthermore, the production of various types of energy will also be brought together. This development means that the plants of the future will be far better equipped to meet and adapt to supply and demand.



Avedøre CHP plant, Denmark – the world's largest straw-fired supercritical boiler

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We are always looking out for competent, professional partners who can develop, construct, and sell combined heating and power plant projects. Read more on our web site www.volund.dk

Babcock & Wilcox Vølund

Clients and partners

Babcock & Wilcox Vølund supplies technological biomass systems to clients with widely differing needs and wishes and we are known throughout the world for our thoroughgoing approach to problems, broad perspective, and uncompromising attitude to results.

Optimum solutions – every time

Developments in the biomass field are rapid so we encounter new challenges every day. Our clients are constantly faced with new technological problems that it is our task to solve in an optimum manner. We have built up a solid foundation of know-how through the many projects we have performed and this makes it possible for us to develop and adapt tasks and products individually, as well as to upgrade with the latest technology on an ongoing basis. The list of clients we have developed new technology for is long and includes such Danish power plants as Avedøre CHP plant, Assens CHP plant, Harboøre CHP plant and companies such as Junckers Industrier.

Global partnerships

Babcock & Wilcox Vølund has an extensive network of partners all over the world that we often collaborate with to develop new systems.

Our global partners for biomass technologies include:

- JFE Environmental Solutions. Co. - Japan
- Enco Systems SDN BHD - Malaysia
- Halla Energy & Environment – Korea
- Fortune Engineering & Trading Co. Ltd. - Taiwan
- Relax Umwelttechnik GmbH – Germany

Examples of systems:

AVEDØRE CHP PLANT

FACTS

Avedøre combined heating and power plant produces heat and electricity for the grid in Zealand, Denmark. The plant comprises two blocks – Avedøre 1, where coal is primarily used, and Avedøre 2, where energy is produced from biomass. The Avedøre plant can utilise up to 94% of the energy in the fuels used there and, with an electricity efficiency of 49%, is one of the most efficient straw-fired CHPs in the world.

Feedstock:
Primarily straw and one-year old plants.

Operation:
The straw is separated with the help of a straw screeder in order to decrease its density. Screw feeders lead the biomass over to a water-cooled vibrating grate where it is exposed to powerful thermal radiation, releasing 80% of its energy through a pyrolysis process. The remaining carbons burn out on the grate itself.

JUNCKERS INDUSTRIER A/S

FACTS

Each year, Junckers Industrier A/S produces high-quality parquet flooring and furniture from more than 500,000 meter-tonnes of wood. Production results in large quantities of waste wood, of which a considerable amount is used as fuel in Junckers' own CHP plant to supply the company with energy.

Feedstock:
Primarily waste wood (sawdust, shavings, slip and wood chips).

Operation:
The natural circulation boiler (designed by Babcock & Wilcox Vølund) ensures incineration of the varied biomass (as well as natural gas and biogas) with an efficiency of 90%. Among other things, the equipment comprises two dust burners located in the furnace at different levels to make sure dust particles are burned, as well as three pneumatic air nozzles from bigger pieces of feedstock at the front of the boiler.

Yamagata gasification plant, Japan – winner of the Gold Award for the best renewable energy power plant of the year (Power-Gen 2008)

Babcock & Wilcox Vølund is one of the world's leading suppliers of equipment and technologies designed to convert waste and bio-fuels into thermal energy.

Founded in 1898 with headquarters in Esbjerg, Denmark, the company is owned 100% by Babcock & Wilcox Power Generation Group, Inc., Barberton, Ohio, USA.

Our companies currently employ over 10,000 people world-wide of whom over 340 are employed by Babcock & Wilcox Vølund.

HEAD OFFICE
Babcock & Wilcox Vølund A/S
Falkevej 2
DK-6705 Esbjerg Ø
Denmark

BRANCH OFFICE
Babcock & Wilcox Vølund A/S
Odinsvej 19
DK-2600 Glostrup
Denmark

Tel: +45 76 14 34 00
Fax: +45 76 14 36 00

www.volund.dk