



Doosan Lentjes

Circulating Fluidised Bed Boiler Technologies



Doosan Lentjes is a global leader in circulating fluidised bed (CFB) boiler technologies. Our expertise gives you access to advanced, efficient and environmentally sound steam generation solutions for biomass, multi- and conventional fuel applications.

Exploiting the potential of green CFB boiler technology

Rich heritage in CFB boiler technology

Doosan Lentjes, part of the global Doosan Group, has pioneered the development of CFB boiler design for about 40 years. In 1981, we designed, built and commissioned the world's first commercial CFB boiler, featuring the first fluidised bed heat exchanger (FBHE) at a multi fuel-fired industrial power plant located in Germany.

Original Equipment Manufacturer (OEM)

Our predecessor company filed the basic CFB boiler patents for power plant applications in 1976, so we are the Original Equipment Manufacturer (OEM) of the technology. In 2016, Doosan Lentjes proudly invited a number of high-ranking experts from across the CFB environment. The occasion was the 40th anniversary of the filing of these patents.

At this event, Dr. Ludolf Plass, former patent holder, explained why CFB boiler technology is the solution of choice for future fuel challenges:

"Plant operators face demanding future challenges in terms of their used fuel types, as well as, framework conditions, which means power production plants need to be flexible when it comes to efficient combustion of changing fuels – even those with the most difficult properties. CFB plants can reliably deliver on these requirements making them the solution of choice for both efficient and environment-friendly future power and heat generation."

Proven track record

Our track record in the areas of biomass, multi-fuel and conventional designs includes more than 110 boilers with a capacity of up to 300 MW_e each, which have been delivered worldwide. These units reliably generate more than 22 GW_{th} of electricity and steam, reflecting their excellent performance.

Using alternative fuels

CFB boiler processes are able to contribute to meeting the challenges of the global energy transition process. Thanks to the flexibility of the technology, sustainable alternative fuels such as, biomass sewage sludge or refuse derived fuels (RDF) can also be burned efficiently. Thus, the potential of these products is used in a resource-oriented way and supports efforts to become less dependent on fossil fuels.

Global Centre of Competence

As the global Centre of Competence for CFB boiler technology within Doosan Heavy Industries & Construction, we consistently invest in the further development and optimization of our processes. In this way, we want to ensure that we remain at the forefront of our industry and help shape the green future of the CFB boiler technology.

1976

Basic CFB boiler patents for power plant applications were filed

1981

Doosan Lentjes designed, built and commissioned the world's first commercial CFB boiler

Our reliable and price-competitive CFB boilers generate power at more than **110 plants** around the world.

We put extensive efforts in further developing our advanced technologies to shape the green future of CFB boiler solutions



Delivering flexibility and availability on industrial and utility-size circulating fluidised bed (CFB) boilers.

Getting the most from your fuel

Our industrial and utility-size CFB boilers focus on high-efficiency generation of power and heat on an environmentally friendly basis. Understanding that your project success can demand the use of fuels with challenging compositions and properties, we are proud to possess a long and proven track record for the combustion of a wide range of fuels, from the straightforward to the most difficult applications.

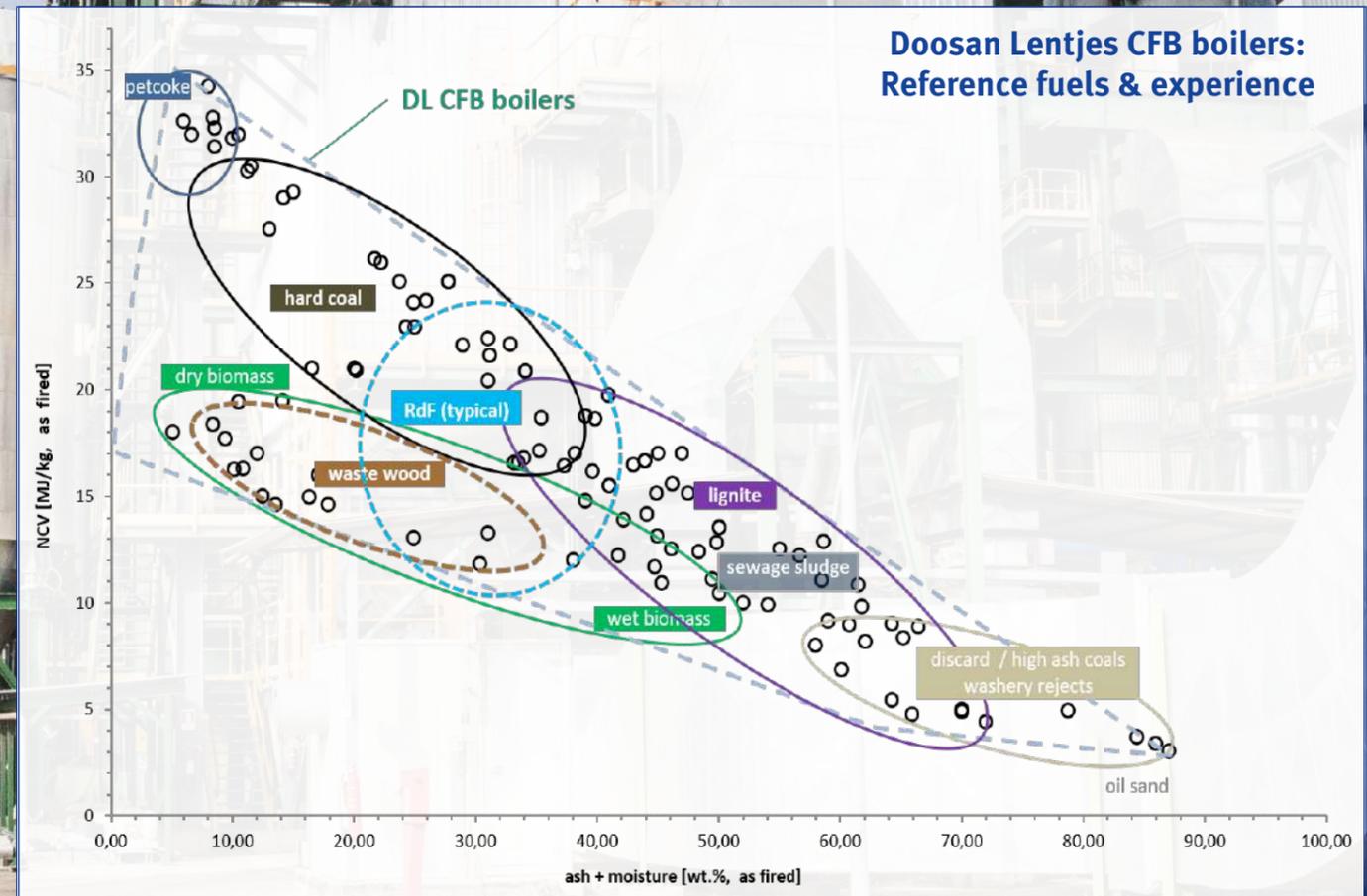
We have developed our CFB boiler technology for the combustion of a broad range of fuels, encompassing, for example:

- Biomass (including agricultural)
- Refuse derived fuels (RDF) / solid recovered fuels (SRF)
- Petroleum coke and refinery by-products
- Paper and sewage sludge
- Paper waste and recycling residues
- All variations of coal / lignite
- Others
- Mixtures of these fuels

The challenges of such fuels lie in their physical properties, which require appropriate handling and feeding, as well as, effective combustion, often limited by their chemical composition including harmful and corrosive compounds. We have bespoke systems to avoid bridging and blockage of handling systems and the combustion of fuels where calorific value, ash properties or corrosive components normally make reliable steam generation impossible. More specifically, our CFB process has been tailored to operate with high solid recirculation rates due to enhanced cyclone efficiency and superior process control with fluidised bed heat exchangers (FBHE) allowing for:

- Efficient ash recirculation with circular cooled cyclones to ensure complete burn out
- Efficient temperature control by controlled cooling of recirculated ash, ensuring optimal desulphurisation, burn out and low NO_x formation, resulting in lowest gaseous emissions
- Controlled flow of recirculated ash through the FBHEs and heat exchange respectively, allows for high load flexibility without the need for support fuel, which is essential for meeting varying grid demands and economic operation

Even with the most difficult, demanding and abrasive fuels, our unique Spiess Valves have been developed as robust and reliable devices to ensure safe control of the ash flow through the FBHE thus allowing greater fuel flexibility.

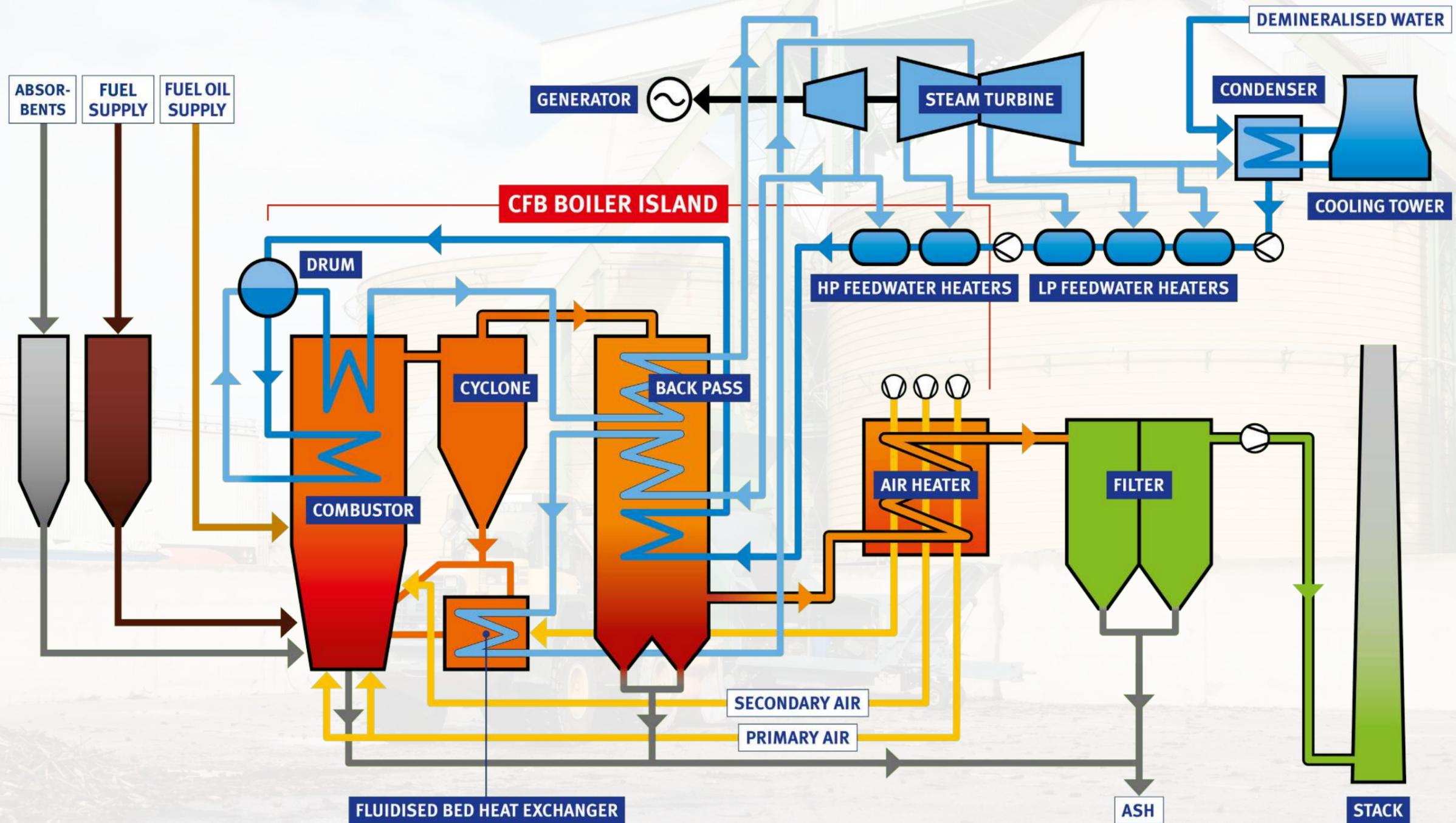


Basic CFB boiler flow sheet

Design
Utility-size circulating fluidised bed boilers

Fuels
Firing or co-firing of all types of biomass, several opportunity fuels and coal types

References
Over 110 units in operation worldwide



Global experience



Honshu Paper, Japan
126 MW_{th}



Twin Oaks, USA
2 x 474 MW_{th}



Berlin, Germany
242 MW_{th}

Over 110
global
references

More than
22 GW_{th}
installed
capacity

Our combustion solutions help you achieve all your economic and environmental objectives.

Cost-effective and clean solutions

Compared to other technologies, such as pulverised coal, our CFB boiler technology is inherently flexible and cost-effective due to the reduced requirement for air quality control systems for SO_x/NO_x emissions control. In addition to this, we have focused on further optimising costs by developing:

- A less expensive, integrated design for minimal boiler footprint
- Standardisation of materials and maximisation of more cost-effective supply chain

We continue to focus on delivering a range of competitive solutions that maximise availability, reliability and efficiency, while minimising emissions, making us the technology provider of choice for plant operators around the world. Our CFB boiler technology also offers cleaner, integrated, best-in-class emission control: More than 90% of the sulphur dioxide (SO_2) released during combustion can be captured by adding limestone to the CFB furnace.

The comparatively low and precisely controlled combustion temperature of 850°C and the staged air supply further prevent the formation of thermal NO_x . This negates or reduces the need for separate external flue gas desulphurisation and denitrification for the full range of fuels, while still complying with strict emission regulations.

People-powered

Because Doosan understands that sustainable business success depends on people performance, it defined its global “2G strategy” meaning that growth of people leads to growth of business and vice versa. We, at Doosan Lentjes, strongly believe in this approach, which is why we put extensive efforts in recruiting, training and developing the very best talents of tomorrow. Together with our well-committed people, we continue to engineer safe and reliable energy generation solutions that shape a sustainable tomorrow for generations to come.

Integrated design

Excellent ecological performance

Reduced carbon footprint





90%
reduction of
the ecological
footprint

More than
25 years of
biomass
experience

Considering
fuel
properties

Doosan Lentjes supplies CFB boiler units that can be fired with 100% biomass. Biomass is a sustainable source of energy, which supports global goals of shaping a fully CO₂-neutral economy. Doosan Lentjes' design range starts at about 25 MW_{th} per unit.

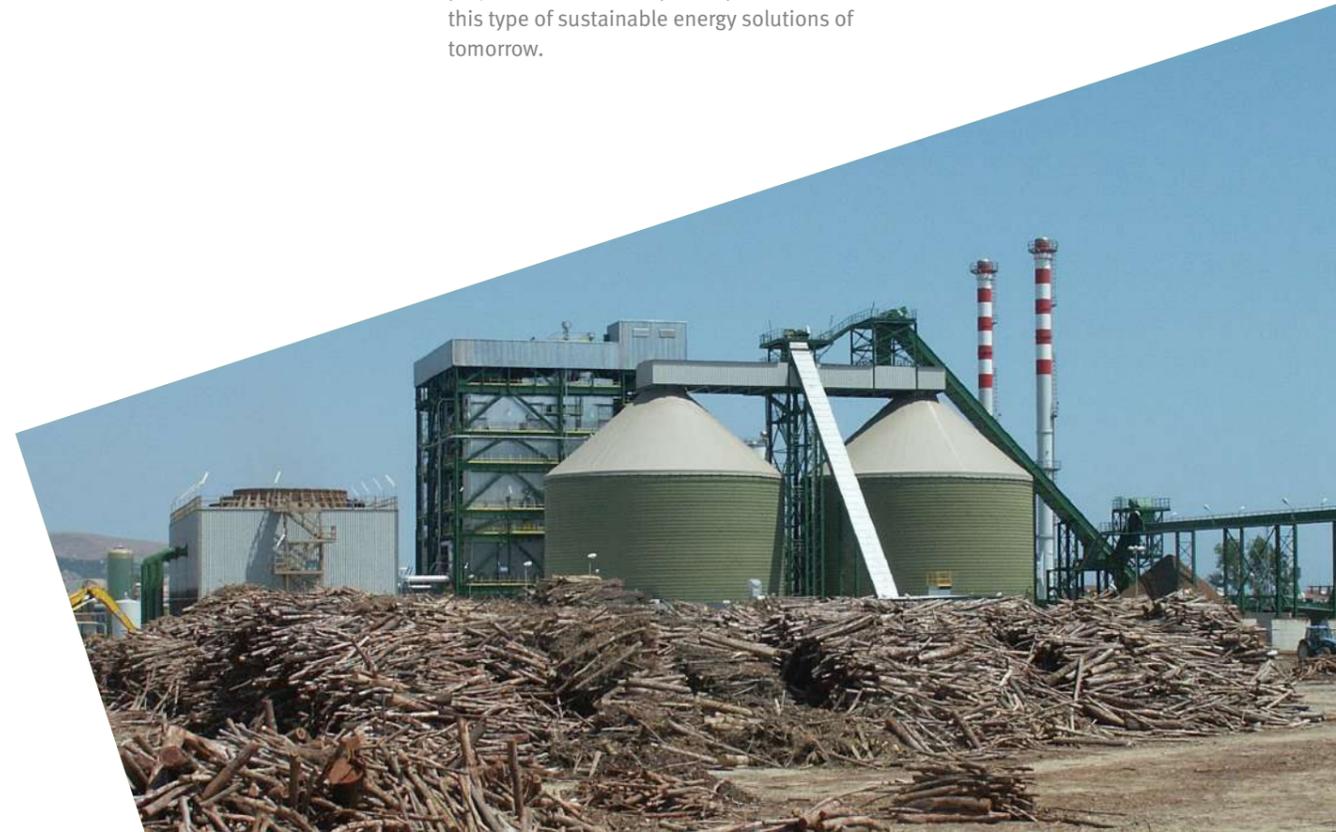
Experts across biomass fuels

Green energy concepts

The combustion of biomass as an ecologically acceptable energy source helps to implement sustainable energy concepts shaping a greener and cleaner planet for generations to come. This practically CO₂-neutral fuel reduces the ecological footprint by 10 to 15 times compared to electricity generated from coal while delivering on efficiency targets. Both are critical factors to ensure a reliable power supply in the long-term and comply with even the most stringent environmental standards.

Individual design adaption

At Doosan Lentjes, we understand that there are different types of biomass ranging from clean, relatively safe wood and forest residues to highly corrosive demolition wood and high alkali agricultural products. Depending on its respective characteristics, we know that each type of biomass requires the CFB boiler design to be individually adapted. This is why we provide tailor-made solutions that can flexibly meet the most demanding combustion requirements of your individual biomass range. With more than 25 years of global biomass experience including new build and conversion projects, we are a competent partner for this type of sustainable energy solutions of tomorrow.



Selected biomass references

Sodegaura, Japan

New build

Fuels:

Biomass wood pellets

Technical data:

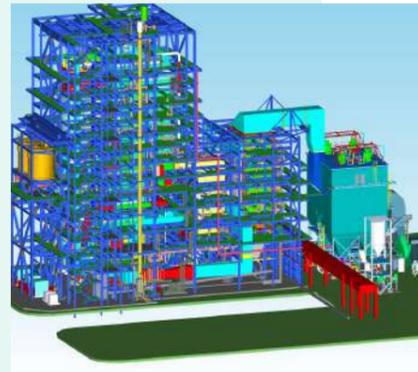
Electrical capacity: 75 MW_e

Thermal capacity: 180 MW_{th}

Live steam: 224 t/h (BMCR); 560 / 560 °C; 170 / 40 bar

Doosan Lentjes was awarded the contract to provide key CFB boiler technology for a new fully biomass-fired high efficient power plant located in Sodegaura, Japan. The delivery includes engineering and procurement of the boiler island including the major boiler and flue gas cleaning (FGC) equipment.

The modern CFB boiler supplied by Doosan Lentjes operates with high steam conditions, an efficient reheat system, and a state-of-the-art FGC system. The new plant allows the generation of 75 MW_e CO₂-neutral power in compliance with the strict Japanese emission regulations. With a gross efficiency of more than 42%, the plant is able to switch from primarily used wood pellets to alternative palm kernel shells. The Sodegaura project supports Japan in their efforts to move towards a cleaner energy strategy.



Strongoli, Italy

New build

Fuels:

Italian and imported biomass

Technical data:

Electrical capacity: 2 x 23 MW_e

Thermal capacity: 2 x 68 MW_{th}

Live steam: 81 t/h; 515°C; 95 bar

Doosan Lentjes was awarded the contract by Biomasse Italia to design and construct two biomass-fired boilers on a turnkey basis for the Strongoli power station located in Calabria, Italy. Both biomass boilers feed one single turbine. The scope of work included basic and detail engineering, as well as, the supply of the CFB boilers inclusive of auxiliaries.

The project supported Italy in its efforts to achieve a CO₂ neutral energy generation which is a critical part in implementing Kyoto requirements that had been internationally agreed in 1997.

Multi-fuel applications allow a flexible incineration of various combustibles, including opportunity fuels like waste, petroleum, agricultural or by-products. The energetic use of these residues allows the share of fossil fuels in the energy mix to be reduced. Thus, multi-fuel units are beneficial to an improved environmental balance of power plants. Doosan Lentjes supplies tailor-made designs from 20 MW_e upwards to industrial sizes.

Flexible multi-fuel applications

Exploiting the potential of opportunity fuels

The use of fossil fuels is increasingly being rejected because of its negative impact on the environment. There is thus a clear global trend towards a fuel switch to make heat and power generation more sustainable. Fuels, such as, solid recovered fuels (SRF) and refuse derived fuels (RDF), biomass, paper sludge, sewage sludge or waste coal, petroleum and refinery by-products represent valuable alternatives. Not only do these fuels have an energetic potential that can be harnessed to ensure an efficient use of available resources. At the same time, feeding these products into incineration for energy recovery allows a reduction in the landfill space required for their disposal. This is another important contribution to climate protection, because landfills release methane, a harmful greenhouse gas that is 25 times more potent than CO₂.

CFB boilers for the combustion of multi-fuels

However, opportunity fuels are usually characterised by difficult physical properties such as a high ash or moisture content. Furthermore, the requirements resulting from multi-fuel compositions and properties are additionally demanding. Doosan Lentjes CFB boiler technology is able to meet these requirements through precise control of the combustion process and efficient ash handling, which ensures complete burnout of the fuel.

Adapting the boiler to your fuel specifications

Depending on your individual fuel compositions, we offer boiler solutions for the combustion of up to 100% RDF/SRF. Alternatively, the CFB boiler can also be designed to co-incinerate waste fuels such as biomass, paper or sewage sludge or waste coal and mixtures thereof.

Using resources efficiently

Being less dependent on fossil fuels

Full RDF/SRF incineration or co-firing



Selected multi-fuel references

Berlin, Germany

New build

Fuels:

Hard coal, lignite, biomass

Technical data:

Thermal capacity: 242 MW_{th}
Live steam: 326 / 269 t/h; 540 / 540°C; 196 / 42 bar

Doosan Lentjes was awarded the contract by BEWAG to provide a CFB firing system for the 100 MW_e combined heat and power (CHP) plant located in Berlin, Germany.

Thanks to the flexibility of CFB technology, the plant, which was originally designed for the combustion of fossil fuels, is now capable of reliably burning biomass fuels such as wood. For its efficiency and low emissions, the power station already received the International Power Plant Award in the past.



Premnitz, Germany

New build

Fuels:

Rejects from carpet recycling, RDF

Technical data:

Thermal capacity: 54 MW_{th}
Live steam: 60 t/h; 535°C; 97 bar

Doosan Lentjes received an order to supply a CFB boiler for a power plant in Premnitz, Germany. While the plant originally incinerated rejects from carpet recycling, today mainly RDF is being burned, which shows the flexibility of the technology. An integrated emission control system ensures compliance with the 17. BImSchV.



Lenzing, Austria

New build

Fuels:

RDF, wood waste, sewage sludge, rejects, coal

Technical data:

Thermal capacity: 110 MW_{th}
Live steam: 124 t/h; 500°C; 83 bar

Doosan Lentjes was contracted to provide a CFB boiler plant including an integrated flue gas cleaning system for a power plant located in Lenzing, Austria. The boiler was designed to operate on 100% RDF, but is flexible to also burn wood waste, sewage sludge, rejects and coal.

Besides full biomass and multi-fuel applications, we also offer CFB solutions for the combustion of conventional fuels. Our plant designs range from 100 to 300 MW_e per unit. Furthermore, we have developed capacities for ultra-supercritical boilers with electrical outputs of up to 600 MW per unit. Co-combustion of biomass to improve the ecological footprint of the power plant is possible.

Conventional fuel applications and biomass co-firing

(U)SC-CFB technologies

Together with our colleagues at Doosan Heavy Industries & Construction, we have developed advanced, market-ready CFB boiler technology for supercritical (SC) and ultra-supercritical (USC) steam conditions with output of up to 600 MW_e per unit. In contrast to subcritical natural circulation cycles, USC steam conditions achieve net efficiencies of up to 45%. In response to global aspirations to save resources and minimize the environmental impact of power generation facilities, this helps to optimise the use of coal.

Simultaneously, emissions and the requirements for consumables used for air pollution control equipment such as limestone are reduced, while keeping the inherent fuel flexibility of the CFB combustion process.

Biomass co-firing

The boiler of a new plant, regardless of the steam parameters, can be designed for the co-firing of sustainable biomass. Existing plants can also be retrofitted so that co-combustion of biomass is possible. This helps to improve the CO₂ balance of the electricity and heat production process.

High-efficient
SC and USC
boilers

Outputs of up
to 600 MW_e
per unit

Biomass co-
firing



Selected conventional references

Twin Oaks, USA

Highest CFB plant availability

Fuels:

Lignite (test operation on pet coke)

Technical data:

Electrical capacity: 2 x 175 MW_e

Thermal capacity: 2 x 474 MW_{th}

Live steam (per unit): 499t/h; 540 / 540 / 540°C; 138 / 29 bar

Doosan Lentjes was awarded the contract by Texas New Mexico Power Commission to provide CFB boiler technology, including extended basic engineering and supply of special equipment for the Texas-based power plant.

Thanks to its flexible design, the boiler can reliably burn other fuels, demonstrated through long-term test operation on pet coke while simultaneously delivering on the most stringent environmental targets. Both the excellent environmental performance and efficiency of the plant were the reasons why the power station won the International Power Plant Award, granted by the renowned magazine Power International.

Twin Oaks is participating in the NRECA program comparing the performance of US-based power plants. In doing so, Twin Oaks has achieved outstanding results in terms of availability since the plant commissioning.



Starobeshevo, Ukraine

Long-running, outstanding performance

Fuels:

Anthracite, anthracite sludge

Technical data:

Electrical capacity: 1 x 210 MW_e

Thermal capacity: 1 x 616 MW_{th}

Live steam (per unit): 670 / 538 t/h; 545 / 542°C; 134 / 25 bar



Donbasenergo awarded **Doosan Lentjes** the contract to provide the circulating fluidised bed (CFB) boiler island, including design, supply, construction and commissioning for the Starobeshevo anthracite-fired power station, located in the Ukraine.

The boiler applies the economic, bottom supported integrated design, incorporating water-cooled fluidised bed heat exchangers and seal pots. This optimised plant arrangement helps to substantially reduce space requirements which is a critical success factor to optimise investment costs.



**Doosan Headquarters,
Changwon, Korea**



**Doosan Vina,
Vietnam**



**Doosan Chennai,
India**

Covering the entire EPC value chain

Part of a strong global corporation

As a fully integrated part of the global, Korea-based Doosan Group, we are in a position to deliver complete process solutions or full turnkey projects from one single source. This makes us a reliable one-stop partner for even the most challenging energy generation requirements.

With Doosan's global network, we combine international market know-how with German state-of-the-art engineering – a winning combination for providing innovative solutions for customers the world over.

As a member of Doosan, we benefit from international sourcing and manufacturing capabilities. High quality workshops under the full control of Doosan in Changwon/Korea, Chennai/India and Vina/Vietnam provide best practice procurement of goods and services while maintaining and ensuring compliance with laws, regulatory guidelines and internal control procedures. Procurement hubs in Beijing and Shanghai/China underline our efforts to deliver cost optimised solutions.

Drawing on these extensive in-house capabilities, we are in a position to cover the entire EPC value chain:

- Project management
- Design and engineering
- Manufacturing
- Procurement and logistics
- Construction and commissioning
- Quality, health, safety and environment

Flexible EPC partnering approach

Among extensive in-house EPC capabilities, we can also cooperate with internationally experienced and competent general contractors enabling us to flexibly meet different customer requirements on various global markets. Our vast experience in fruitfully collaborating with global EPCs helps us ensure a successful project execution that reliably meets price, quality and time targets.



CFB in 360° at Doosan Lentjes

Visit our homepage and take a virtual journey through our CFB facilities around the world – a great opportunity for you to experience our reference plants in an impressive 360° environment and convince yourself of our capabilities! To start the tours, please type the address below in your internet browser and open the Virtual Doosan World.

www.doosanlentjes.com

Doosan Lentjes

Doosan Lentjes is a global supplier of processes and technologies for steam and power generation from both sustainable and conventional fuels. Our specific areas of expertise include key technologies for energy recovery from waste, sewage sludge incineration, circulating fluidised bed boilers and flue gas cleaning systems. For more than 90 years, we have been pioneering innovative energy solutions and convert millions of tons of waste into valuable energy every year.

Doosan Lentjes is part of a powerful combination of companies united under the Doosan Group to deliver complementary technologies, skills and value to customers the world over.



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