

**Power systems**  
Reliable and efficient  
power generation

# The ANDRITZ GROUP

The ANDRITZ GROUP is a global leader in supplying customized plants, process technologies, and services for the power generation, pulp and paper, metals, and other specialized industries.

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▲ ANDRITZ headquarters, Graz, Austria

The ANDRITZ GROUP has more than 24,000 employees and over 250 production sites, service centers, and sales companies around the world. Recent focus has been on expanding manufacturing presence in the growth markets of China, India, and South America, and on further developing the well-established sites in Europe and North America.

ANDRITZ is active in power generation and environmental processes. More than 50% of ANDRITZ's revenues comes from technologies and processes that generate energy from sustainable resources. The company is well-equipped to handle complete projects from design to start-up. Much of the company's expertise is in the design of tailor-made solutions and processes. Basic and detail engineering combine the expertise in chemical, mechanical, electrical, and civil disciplines.

ANDRITZ has the financial strength and global experience to deliver fully integrated systems to virtually any location in the world. Specialists provide engineering, procurement, construction supervision, commissioning, and start-up services. When needed, plants can be provided on a turnkey basis.

ANDRITZ experts know how to extract the maximum performance from production equipment over its long lifetime. Using the Overall Production Efficiency (OPE) approach, ANDRITZ works in close cooperation with operations and maintenance personnel to apply the most modern tools for achieving results – including global experts and online diagnostics.

# Fluidized bed technology

## Decades of experience go into every ANDRITZ fluidized bed boiler and gasifier

ANDRITZ is a leading supplier of plants based on bubbling fluidized bed (BFB) and circulating fluidized bed (CFB) technologies for boilers and gasifiers. The different technologies are distinguished by capacity, fuel, and application.



▲ M-real, Hallein, Austria

Excellent mixing and heat transfer make fluidized bed technology ideal for a wide range of applications. A variety of coals and lignites can be combusted, as well as clean biomass (bark, agricultural, forestry, and sawmill residuals) and many other fuels (demolition wood, refuse-derived fuels, peat, various sludges, etc.).

### BFB technology

In a BFB unit, fuels are thoroughly mixed in a dense suspension of fluidized bed material in the lower furnace. BFB systems operate at a moderately low fluidization velocity and under controlled temperature conditions. Thanks to the large heat capacity of the fluidized bed material, which is mostly sand, the combustion conditions are ideal for biomass and recycled fuels with varying moisture contents. In many installations, various fuels are fired simultaneously.

### CFB technology

With CFB technology, the flue gas velocity in the furnace is higher and the bed is expanded and entrained with the flow. The bed material flows with the flue gas through the furnace, after which the material is separated by cyclones and returned to the lower furnace. CFB technology also allows an extremely wide range of fuels to be fired in the same unit. The efficient mixing and relatively low combustion temperatures contribute to low emissions of carbon monoxide, hydrocarbons, and nitric oxides.

### Gasification technology

The fluid dynamics of BFB gasifiers are similar to BFB boilers, but they operate under substoichiometric conditions. Biomass can also be gasified in a CFB reactor to produce a combustible gas that can be utilized for various purposes (e.g. replacement of fossil fuels for the firing of lime kilns in the pulp industry). Gasification technology can also be used for power and heat generation with a low-pressure air-blown BFB gasifier.

### Advantages of ANDRITZ fluidized bed technologies

- Fuel flexibility
- High burn-out and conversion rates
- Inherently low emissions
- Excellent availability with long continuous operating periods
- Operational flexibility with good load following capability
- Minimal maintenance
- Proven design

# EcoFluid BFB boilers

## Generating power from renewable fuel sources

The fuel flexibility of an ANDRITZ EcoFluid boiler is an inherent feature.



▲ Fortum, Pärnu, Estonia

### Flexible solutions

In addition to typical biomass fuels such as wood (chips, bark, forest residues, and sawdust), more recently short-rotation energy crops, sludges, rejects, agricultural wastes, and refuse-derived fuels (RDF) are being introduced as fuel sources. Common characteristics for these fuels are that they are high in volatile matter and have a high variance in moisture content.

These alternative fuels require certain considerations in design as well as in the steam output parameters. ANDRITZ has technical solutions for a broad range of fuels that can be burned in an EcoFluid boiler.

### Scalable and reliable

EcoFluid boilers can be either top- or bottom-supported, depending on the desired capacity and site conditions. Scalability and ease of construction are enhanced since the main boiler components are designed as modules. The arrangement of all heating surfaces is tailored to the customer's requirements. The boilers are conservatively designed with regard to materials of construction, location and spacing of heat surfaces, etc. to ensure high plant availability and low maintenance requirements.

### Fortum Termest A.S. Pärnu, Estonia

#### Fuels

Wood, peat, and natural gas

#### Technical data

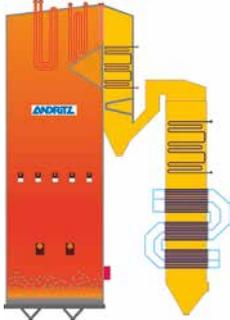
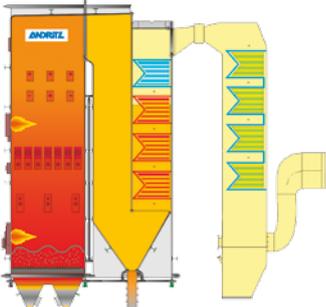
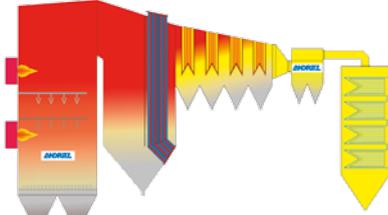
Steam output: 94 t/h (207 klb/hr)

Steam temperature: 525 °C (977 °F)

Steam pressure: 117 bar (1,700 psig)

#### Features

SNCR and bag filter combined with sorbent injection

BFB applications	EcoFluid BC Biomass fuels concept	EcoFluid AC Alternative fuels concept	EcoFluid RC Residues and refuse-derived fuels concept
Type			
Size range	40-420 t/h (88-925 klb/hr)	30-250 t/h (66-550 klb/hr)	30-100 t/h (66-220 klb/hr)
Main fuels	Biomass fuels (bark, chips, sawdust), peat	Rejects, sludges, demolition wood, agricultural residues	RDF, rejects, sludge
Secondary fuels	Sludges, demolition wood, agricultural residues, Coal up to 20%, TDF	Biomass fuels	Biomass fuels, demolition wood, agricultural residues

An important feature of the boiler is the design of the fluidizing nozzle grid, which distributes the primary air and drains inert, coarse material such as rocks and other impurities. These materials can cause disturbances in the bed fluidization if not removed from the furnace. The ANDRITZ fluidizing grid can be designed with a unique water-cooled or air-cooled structure, providing reliable and efficient removal of coarse material from the fluidized bed.

**EcoFluid features**

- Fuel flexibility
- High efficiency
- High availability
- Modular design
- Low emissions

**Efficient air pollution control**

Fluidization air (primary air) supplies part of the total combustion air and creates gasification conditions in the lower furnace. The balance of the air (secondary and tertiary air) is injected higher up in the furnace to complete the combustion process. In combination with an adequate reaction time, this reduces CO emissions to low levels, while the gradual addition of oxygen also ensures minimal formation of NO<sub>x</sub> emissions. Further NO<sub>x</sub> reduction can be achieved by injecting ammonia into the furnace. This system can also be combined with ChlorOut, a patented process (licence

from Vattenfall) that reduces corrosive alkali chlorides as well as NO<sub>x</sub> in flue gases, effectively reducing fouling and corrosion of the superheaters. These measures provide enhanced steam parameters and boiler reliability using more challenging fuels, while keeping operating costs to a minimum.

Particulates are removed from the flue gases in an electrostatic precipitator or fabric filter, depending on customer preference and environmental requirements. Additional emissions control can be achieved via sorbent injection to reduce acid gas emissions (SO<sub>2</sub>, HCl, Hg, and dioxin/furans).



▲ Stora Enso, Maxau, Germany

## PowerFluid CFB boilers

Unmatched fuel flexibility – from coal and biomass to alternative fuels and wastes

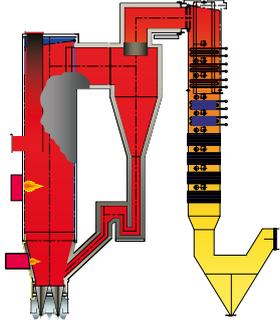
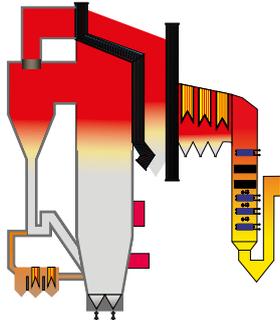
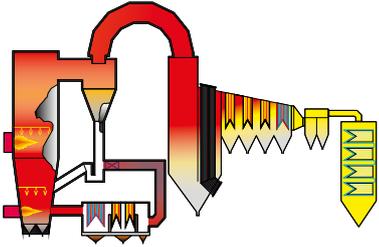
CFB technology is the state-of-the art technology for multi-fuel combustion.

### Freedom of choice: multi-fuel design

This enables the PowerFluid boiler to employ fuels of differing quality and source – giving plant operators the freedom to take advantage of changing market conditions and fuel supplies.

The modular CFB design of an ANDRITZ PowerFluid boiler enables the boiler to utilize conventional and alternative fuels. The core components are standardized to deliver efficient, reliable performance. In addition, many features can be custom-tailored for optimal performance in each installation.

In addition to firing conventional fuels (coal, lignite, and biomass), PowerFluid boilers have proven reliable in firing such fuels as biogenous residues, sludge, and rejects or waste fractions with high calorific value (RDF). These can be fired as the primary fuel or in combination with others.

CFB applications	PowerFluid CC Conventional fuels concept	PowerFluid HC Hybrid fuels concept	PowerFluid RC Residues and refuse-derived fuels concept
Type			
Size range	50-800 t/h (110-1,760 klb/hr)	50-500 t/h (110-1,100 klb/hr)	50-200 t/h (110-440 klb/hr)
Main fuels	Biomass fuels, coal	Biomass fuels, RDF, rejects	RDF, rejects, sludge
Secondary fuels	Sludge	Coal, sludge	Biomass fuels, demolition wood, agricultural residues, coal

**Stora Enso, Maxau, Germany**

**Fuels**  
Wood, rejects, paper-derived sludge, bituminous coal

**Technical data**  
Steam output: 198 t/h (436 klb/hr)  
Steam temperature: 520 °C (970 °F)  
Steam pressure: 95 bar (1,360 psig)

**Features**  
Hybrid fuel concept for the treatment of fuels with higher chlorine content

The large heat capacity and turbulent inter-mixing of the fluidized bed compensate for fluctuations in fuel variations and maintain complete combustion, even with low-grade fuels with high moisture and ash contents.

**Superior environmental performance**  
The removal of nitric oxides (NO<sub>x</sub>) and sulfur oxides (SO<sub>x</sub>) is easily accomplished with CFB combustion. PowerFluid boilers can meet strict emission requirements without adding post-combustion cleaning equipment, such as flue gas desulfurization and selective catalytic reduction systems.

The low temperatures and staged combustion in the furnace prevent thermal NO<sub>x</sub> formation and suppress the oxidation of fuel nitrogen – resulting in low NO<sub>x</sub> formation and high fuel burn-out rates. Low cost limestone, used as a sorbent in the furnace, captures the fuel’s sulfur components in a simple and efficient manner during the combustion process.

- PowerFluid features**
- Multi-fuel combustion
  - Highest fuel flexibility
  - Inherently low emissions
  - High boiler efficiency
  - Proven reliability

# ANDRITZ Carbona CFB gasifiers

## Atmospheric systems for producing fuel gas

The basic fluidization principles are the same for fluidized bed boilers and gasifiers. For this reason, CFB gasification technology can be scaled up to very large sizes compared to most biomass gasification technologies.

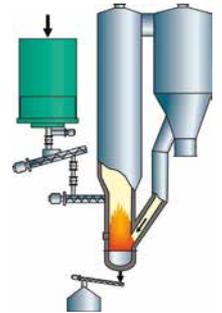


▲ Metsä Fibre Joutseno mill, Finland

A CFB gasifier is fuel-flexible and can process a great variety of low-grade fuels – wood-based biomass, other biomass with sufficient gasification properties, and certain waste-derived rejects from industrial processes.

### CFB gasifier

Type



**Size range** 10-150 MW<sub>fuel</sub>  
(40-600 MMBtu/hr HHV)

**Main fuels** Biomass, waste materials, peat, certain agricultural waste

**Installations** Five plants installed;  
latest 65 MW<sub>fuel</sub>  
(270 MMBtu/hr HHV)  
plant started up in 2015

#### Carbona CFB gasifier features

- Suitable for different types of biomass
- Efficient fuel gas generation
- Total replacement of fossil fuels

ANDRITZ Carbona CFB gasifiers have been in operation since the 1980s. The technology has been upgraded over the years to satisfy today's demands for reliability, safety, and efficiency.

ANDRITZ Carbona CFB gasifiers produce combustible fuel gases in a capacity range of 10-150 MW<sub>fuel</sub> (40-600 MMBtu/hr HHV) for kilns (lime reburning kilns in pulp mills) and for the power industry. The lime kiln gasification system can replace 100% of lime kiln oil/gas consumption by utilizing biomass fuels available at the mills.



▲ Gas duct and burner in the lime kiln



▲ Bark is used as fuel at Metsä Fibre, Joutseno, Finland

Coal-fired power boilers can be converted, at least partially, to use gasifier gas from biomass. Using the existing power generation capacity to reduce CO<sub>2</sub> emissions is an economically viable way to burn local biomass.

ANDRITZ delivers high-quality, proven gasifiers for lime kilns and boilers, including the auxiliary systems and biomass fuel handling.

**Metsä Fibre, Joutseno, Finland**

**Fuels**

Wood residues and bark

**Technical data**

48 MW (200 MMBtu/hr HHV) wood biomass

**Features**

Delivery includes fuel handling, drying, gasification, and gas combustion systems

Replaces fossil fuels 100%



▲ CFB gasifier to replace boiler fossil fuels

# ANDRITZ Carbona BFB gasifiers

## Pressurized systems, air- or oxygen-blown

ANDRITZ Carbona pressurized gasification technology was originally developed for coal gasification by the Gas Technology Institute in the USA. Since this early development, ANDRITZ has modified the technology for biomass use.



▲ Skive, Denmark

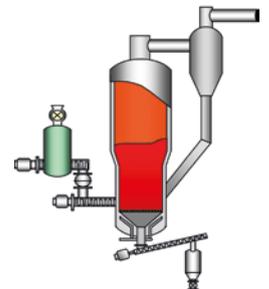
With years of experience in gasification technology, ANDRITZ experts can choose from a range of fluidized bed gasifiers for specific applications.

ANDRITZ has developed air-blown and oxygen-blown BFB gasifiers using two large pilot plants. In addition, a commercial gasification plant in Denmark has logged significant operating hours to develop the gasifier and gas clean-up system. The gas clean-up is particularly important for removing the most harmful elements, either by filtering the partially cooled gas or by using reactive catalysts in order to avoid tar problems. Catalysts are also utilized for changing gas composition, depending on the application.

The main application for pressurized air-blown BFB gasification would be to fuel a Combined and Heat Power (CHP) plant with gas engines like the one in Skive, Denmark.

### BFB gasifier

Type



<b>Size range</b>	20-50 MW <sub>fuel</sub> (80-200 MMBtu/hr HHV)
<b>Main fuels</b>	Woody biomass
<b>Installations</b>	One system operating since 2008



▲ Three gas engines, Skive, Denmark

**I/S Skive Fjernvarme  
Skive, Denmark**

**Fuels**

Wood pellets and chips

**Technical data**

6 MW<sub>e</sub> and 12 MW (41 MMBtu/hr)  
district heat

Low-pressure BFB Gasifier

Three combustion engines

Option: gas combustion in two district  
heating boilers

**Features**

Unique catalytic tar reforming system

Large turndown ratio

Entire plant CE-approved

**Low-pressure system for combined  
heat and power applications**

In low-pressure (air-blown) systems, the ANDRITZ Carbona gasifier can provide clean gas for engines or boilers. Typically, these applications are in the 20-50 MW<sub>fuel</sub> (80-200 MMBtu/hr HHV) range.

The first demonstration plant in a combined heat and power (CHP) application was commissioned in Skive, Denmark, in 2008. The gas product from the BFB gasifier fuels three gas engines. The main components of the Skive installation are the fluidized bed ANDRITZ Carbona gasifier in connection with a catalytic gas clean-up system and the engine power plant with heat recovery.

This system is best suited for power generation of 5-15 MW<sub>e</sub>. The electrical energy efficiency of the process is around 30%. The total energy efficiency of the plant is high when used in the CHP mode.

**BFB gasifier features**

- Multi-fuel design
- Highly efficient power and heat generation
- Produces fuel gas and synthesis gas

# PowerBlast boilers

## Combustion of process gases with low emissions

Against a background of stricter emission requirements and the desire to reduce operating costs, certain industrial facilities require reliable solutions for the disposal of process gases.



▲ Voestalpine, Linz, Austria

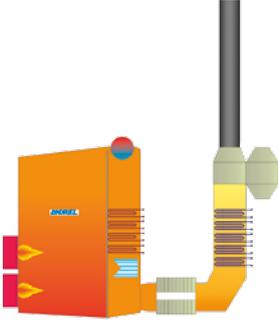
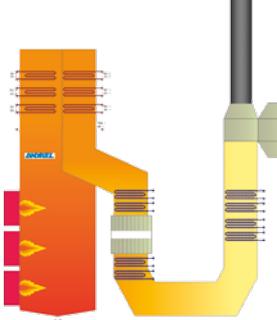
### PowerBlast features

- Fuel flexibility
- High efficiency
- High availability
- Low emissions

### Customized solutions

ANDRITZ PowerBlast gas boilers use these process gases to generate energy in an environmentally friendly process. PowerBlast boilers are customized for the combustion of blast furnace gas, coke oven gas, and LD converter gas. There are standardized designs for single-drum concepts, and the El Paso concept for larger units.

The PowerBlast boiler offers an efficient solution for converting waste gas into electric power and heat. The high-pressure steam can be fed to a turbine for electricity generation. After partial expansion, the exhaust steam can be used as process steam or for district heating.

Applications	PowerBlast Single-drum concept	PowerBlast El Paso concept
Type		
Size range	< 350 t/h (< 770 klb/hr)	< 600 t/h (< 1,320 klb/hr)
Main fuels	Process gases	Process gases
Reheat	No	Yes



▲ Erection of superheater and reheater tube bundles

**Voestalpine Unit 07, Linz, Austria**

**Fuels**

Blast furnace gas, coke oven gas, natural gas, and light fuel oil

**Technical data**

Steam output: 460/422 t/h  
(1,012/928 klb/hr)

Steam temperature: 543/562 °C  
(1,010/1,040 °F)

Steam pressure: 142/35.5 bar  
(2,060/510 psig)

**Features**

High-pressure system with reheat

PowerBlast boilers are flexible by design in handling a wide range of process gases with different heating values and compositions. Advanced multi-burner technology helps the boilers achieve extremely low emissions. The El Paso concept can incorporate a reheat system to attain the highest efficiencies.

As a result of ANDRITZ's years of experience with blast furnace gas firing in combination with modern engineering tools and design methods, customers can benefit from know-how at the highest technological standard.

# ANDRITZ power plant services

## Full support for the life of your plant

ANDRITZ provides analytical services for all engineering and operational disciplines in power plants.

With service and manufacturing centers around the world, ANDRITZ is well-positioned to offer full support before, during, and after the installation of its products. The goal is to achieve the highest overall production efficiency (OPE) of a power plant by increasing safety, availability, efficiency, and throughput over the entire life-cycle. ANDRITZ has analytical tools and expert assistance to help each customer decide on the most cost-effective course of action – whether it is simple tuning, repair, replacement, optimization, or upgrade.

To complement its service capabilities, ANDRITZ manufactures and stocks a range of replacements parts. Specialists can assist in shutdown planning, on-site coordination, supervision, and the actual shutdown work.

ANDRITZ experts can be called upon to monitor and advise customers regarding the operation of power plants and flue gas treatment systems. Regardless of which services are needed, plant operators can rely on ANDRITZ's in-depth knowledge, years of experience, and competitive pricing to deliver results.



▲ ANDRITZ offers full support, on-site or remotely, to monitor and assist its customers.

### Field service and consultation

- Inspection
- Maintenance
- Annual outage and scheduled maintenance
- Long-term service agreement (LTSA)
- Plant operation
- Measurement and analysis
- Plant condition assessment
- Online monitoring
- Training
- Service product development
- Life cycle calculation
- Process studies
- Process tuning
- Circulation studies

### Rebuilds and upgrades

- Performance improvement
- Retrofits
- Plant upgrades
- Firing system upgrades
- Pressure part refurbishment/replacement
- Emission reduction
- Co-firing of biomass
- Over-fire air systems of grate-fired boilers

### Spare and wear parts

- Replacement 1:1
- Spare parts
- Wear parts

### Overall production efficiency (OPE) agreements

# References

Some of the latest references:



## E.ON, Blackburn Meadows, UK – EcoFluid BFB boiler

Steam conditions: 119 t/h (262 klb/hr),  
490 °C, (914 °F), 85 bar (1,233 psig)  
Fuel: Wood waste  
Start-up year: 2013



## Iggesund Workington, UK – EcoFluid BFB boiler

Steam conditions: 195 t/h (4000 klb/hr),  
540 °C (1004 °F), 102 bar (1,480 psig)  
Fuel: Forest residues, recycled sawmill chips, bark,  
sludge, sawdust  
Start-up year: 2013



## Bollnäs Energi, Sweden – EcoFluid BFB boiler

Steam conditions: 39 t/h (86 klb/hr),  
420 °C (788 °F), 40 bar (580 psig)  
Fuel: RDF, forestry wood, wood waste  
Start-up year: 2011



## Hämeenkyrön Voima, Finland – EcoFluid BFB boiler

Steam conditions: 105/115 t/h (232/253 klb/hr),  
510 °C (950 °F), 85 bar (1,230 psig)  
Fuel: Forest residues, bark, sawdust, peat, natural  
gas for start-up  
Start-up year: 2012



## Fortum Värme, Värtaverket, Sweden – PowerFluid CFB boiler

Steam conditions: 467 t/h (1,030 klb/hr),  
562 °C (1043 °F), 143 bar (2,074 psig)  
Fuel: Forestry wood, bark, peat, wood pellets,  
wood dust, bituminous coal  
Start-up year: 2016



## Propower, Eisenhüttenstadt, Germany – PowerFluid CFB boiler

Steam conditions: 176 t/h (388 klb/hr),  
470 °C, (878 °F), 70 bar (1,015 psig)  
Fuel: RDF, rejects, sludge, coal, LFO  
Start-up year: 2011



## Stora Enso, Maxau, Germany – PowerFluid CFB boiler

Steam conditions: 198 t/h (437 klb/hr),  
520 °C (968 °F), 95 bar (1,378 psig)  
Fuel: Coal, bark, rejects  
Start-up year: 2010



## Adularya, Yunus Emre, Turkey – PowerFluid CFB boiler

Steam conditions: 440/414 t/h (970/913 klb/hr),  
543 °C (1009 °F), 139/37 bar (2,016/537 psig)  
Fuel: Lignite  
Start-up year: 2016



## Zhanjiang, China – Carbona CFB gasifier

65 MW (270 MMBTU/hr HHV) CFB Carbona gasifier  
for lime kiln  
Start-up year: 2015

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