RWE Power

WTA TECHNOLOGY

A modern process for treating
and drying lignite

The energy to lead

RWE POWER – ALL THE POWER

RWE Power is Germany's biggest power producer and a leading player in the extraction of energy raw materials. Our core business consists of low-cost, environmentally sound, safe and reliable generation of electricity and heat as well as fossil fuel extraction.

In our business, we rely on a diversified primary energy mix of lignite and hard coal, nuclear power, gas and hydropower to produce electricity in the base, intermediate and peak load ranges.

RWE Power operates in a market characterized by fierce competition. Our aim is to remain a leading national power producer and expand our international position, making a crucial contribution toward shaping future energy supplies.

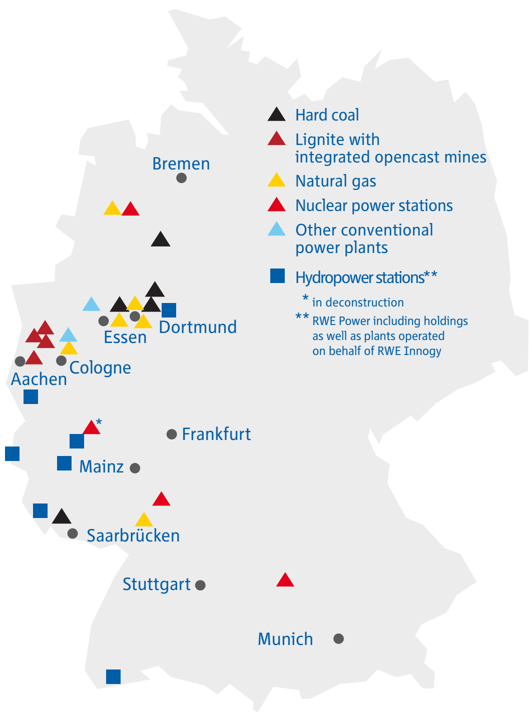
A strategy with this focus, underpinned by efficient cost management, is essential for our success. All the same, we never lose sight of one important aspect of our corporate philosophy: environmental protection. At RWE Power, the responsible use of nature and its resources is more than mere lip service.

Our healthy financial base, plus the competent and committed support of some 17,500 employees under the umbrella of RWE Power enable us to systematically exploit the opportunities offered by a liberalized energy market.

In this respect, our business activities are embedded in a corporate culture that is marked by team spirit and by internal and external transparency.

With an about 30 per cent share in electricity generation, we are no. 1 in Germany, and no. 3 in Europe, with a 9 per cent share. We wish to retain this position in future as well. That is what we are working for – with all our power.

One of the focuses of RWE Power is on the Rhenish lignite-mining area where the Company mines some 100 million tons of lignite every year, most of which is used to generate electricity. Lignite needs no subsidies, offers work and training to many people in the mining area, underpins spending power with the salaries and taxes the Company pays, so that it is an economic asset for the entire region.



GREATER EFFICIENCY, MORE CLIMATE PROTECTION

How can we obtain the greatest benefit possible at the lowest possible cost, while avoiding harmful side effects? This is an issue not only for experts from science and technology.

All of us try to maximize results with minimum outlays of money or effort, for instance. Be it in our daily shopping or in seeking insurance cover or heat insulation for the home. Behind this is the basic principle of good housekeeping: efficiency.

This is also the rule that powers RWE, as the Company presses ahead with the development of new processes and technologies. The objective: energy use must be better, read: more economical and, hence, more climate-sparing. This extends all the way from raw-material extraction to the way the consumer uses the energy. RWE does its crucial bit here at all levels – including in-depth research and development in the area of power-plant engineering.

What matters is that we drive up efficiency in power generation: the more electricity is squeezed out of a given amount of coal, say, the less coal we need per kilowatt hour generated – and the lower the amount of greenhouse gases like CO_2.

THE PROJECT

Power plants deliver lots of energy, but also use plenty in doing so. Hundreds of units, like conveyor belts, crushers, motors, fans and pumps, are dependent on heat and electricity for the various process steps. Lowering energy consumption at power stations is one essential key to increasing efficiency.

RWE Power has erected a prototype plant to pre-dry lignite in the Coal Innovation Centre at the Niederaussem power station, creating a crucial prerequisite for a further rise in efficiency in power generation from lignite.

The system works according to the fluidized-bed drying process with internal waste heat utilization (WTA)* as developed by RWE Power. It is upstream of the adjacent power-plant unit K – the first BoA unit which went on stream in 2003 – and replaces up to 30% of the raw lignite otherwise needed. It is trialling the method for the first time in conjunction with an industrial-scale power station. RWE Power is investing some € 50 million in its erection and operation.

* WTA is a process protected by several patents and is a registered trademark of RWE Power AG

DRYING – IMPORTANT FOR ANY LIGNITE USE

Before any industrial use, lignite must be dried. Nature has given lignite up to 60% moisture, which is bound by capillaries, and the stored moisture aggravates lignite combustion. In view of the high moisture content, drying is an energy-intensive process, and that is why energy efficiency is a primary focus here.

WTA technology is an important element in the RWE Power's efforts to further reduce CO_2 emissions in lignite-based electricity generation – higher efficiency means more climate protection.

With the Niederaussem plant, RWE Power intends to show that WTA drying in continuous operations is technically and economically suitable for lignite-based electricity generation. Using the WTA method, the already achieved efficiency of BoA technology could be increased by some 10%. If WTA proves its worth, it can be used in future power-plant new-builds – e.g. in the planned dry-lignite power station (TBK) of RWE Power. Thanks to better fuel utilization and the associated lower fuel needs per kilowatt hour produced, emissions and, hence, CO_2 values, too, can be cut again in the interest of climate protection.

For future advanced lignite-based power plants – irrespective of the technique used, whether with or without CO_2 capture – pre-drying will be the basic precondition for achieving even higher efficiencies.

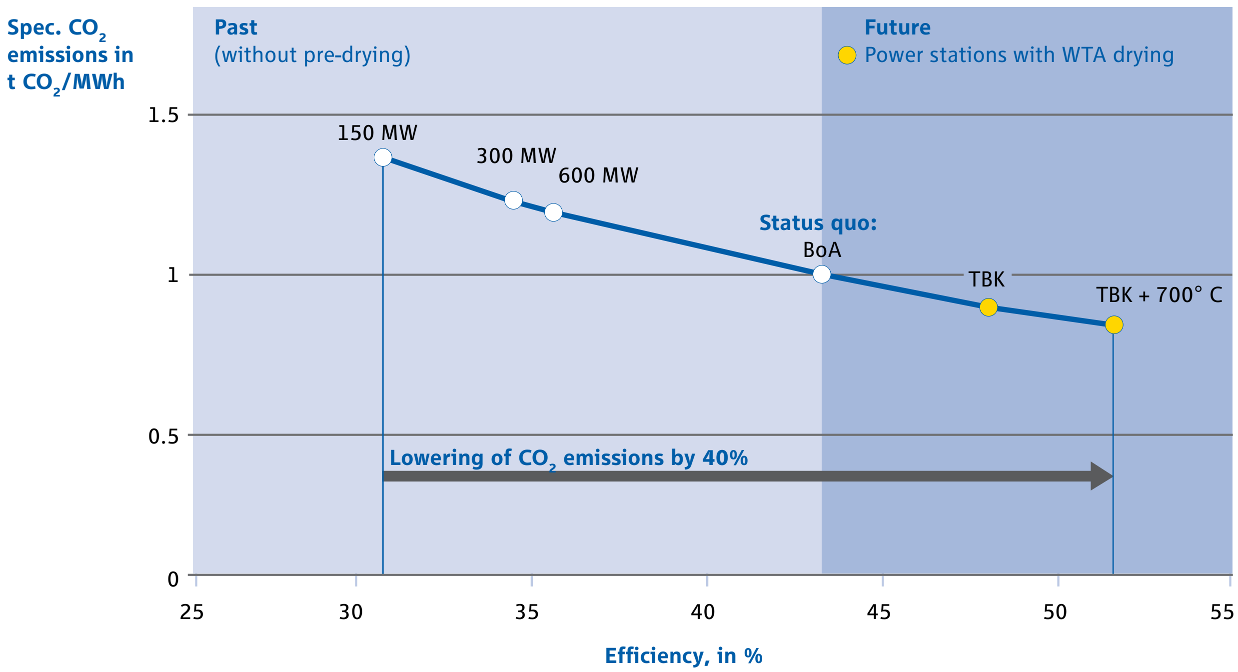
THE REMIT

In conventional lignite stations, the fuel is dried using hot flue gases, which are sucked from the steam generator furnace at a temperature of 900 to 1,000°C and conducted to the beater wheel mills: there, they withdraw much of the lignite's moisture from the lignite while it is being pulverized.

If this combined process is decoupled and separated into drying and milling, the lignite can be dried at a low temperature with greater energy efficiency: this significantly increases the efficiency of the power-plant process as a whole.

Pre-drying of the lignite is absolutely mandatory if electricity is to be produced in an integrated gasification combined-cycle plant or in an oxyfuel process. Here, too, an energy-saving drying method can further increase efficiency.

In so-called low-rank coals with a high moisture and ash content, pre-drying can increase the calorific value to such an extent that it can be used for combustion in conventional steam generators without back-up fuels.



Specific CO_2 emissions depending on efficiency

In order to process the lignite to make gaseous and liquid products as well as high-quality solid fuels, the moisture content must be reduced to 10 to 20 % wt. Being a basic process-technology operation, drying occupies a key position in lignite upgrading as well. Here, too, an energy-efficient drying method improves the energy balance of the overall process.

As a modern method for processing and drying lignite, WTA technology can be used and adapted to all of the above processes. It makes a crucial contribution to optimizing the entire process of utilizing lignite energetically, and to lowering emissions. As the energy input for drying rises with the increase in moisture content, efficiency improvements from WTA technology are not a constant value. The higher the moisture content to be removed, the greater the potential for improving efficiency. The flue-gas emissions (CO_2, SO_2, NOx, and others) associated with power generation are directly proportional to the amount of fuel input and to the power plant's efficiency. The increase in efficiency from WTA technology directly helps lower emissions and further raise the environmental compatibility of power generation.

WTA TECHNOLOGY

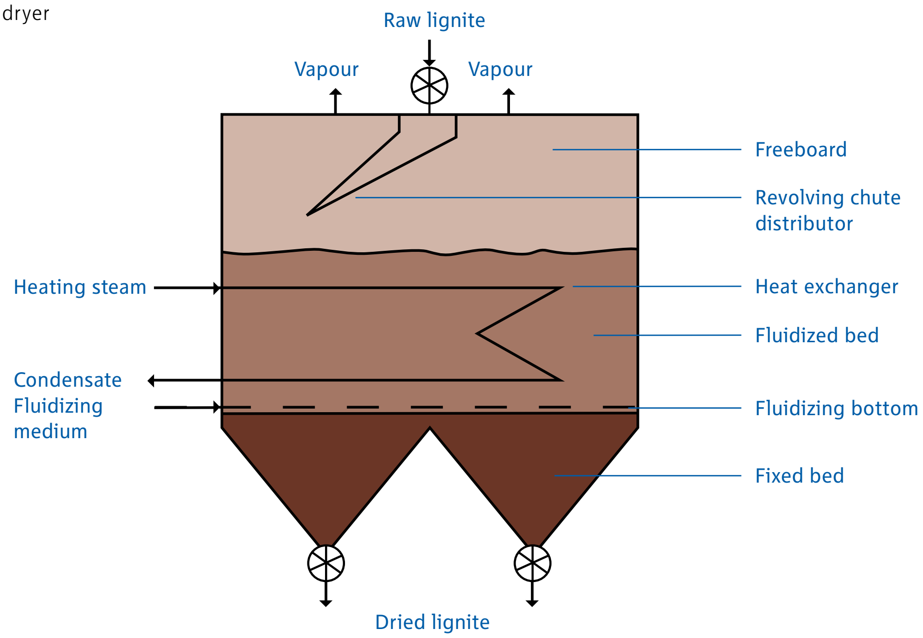
Process fundamentals

WTA technology works according to the principle of a stationary fluidized bed with low expansion. This is a bed of solid particles which is converted into a floating-to-flowing state by an upward flow, usually of air. The energy needed for drying is injected via heat exchangers integrated into the fluidized-bed dryer and heated with steam. Drying is in virtually 100% pure, slightly superheated water vapour. In the process, an equilibrium emerges at a constant pressure between the temperature of the steam concerned and the residual moisture of the dried lignite. With a system pressure of approx. 1.1 bar and a fluidized-bed temperature of 110°C, a residual-moisture content of some 12% emerges in the case of Rhenish lignite. By controlling the fluidized-bed temperature, the moisture content can be adjusted and kept constant at the desired value.

Design of the dryer

The lignite reaches the dryer, which is under slight over-pressure, via a star feeder. A system specially developed for WTA technology installed in the upper section of the dryer distributes the pre-milled raw lignite across the surface of the fluidized bed. The fluidized bed is heated by low-pressure steam or, depending on the process variant, by recompressed vapour: this is the vapour that emerges when drying lignite. The heating-steam pressure is approx.

Design of a WTA dryer



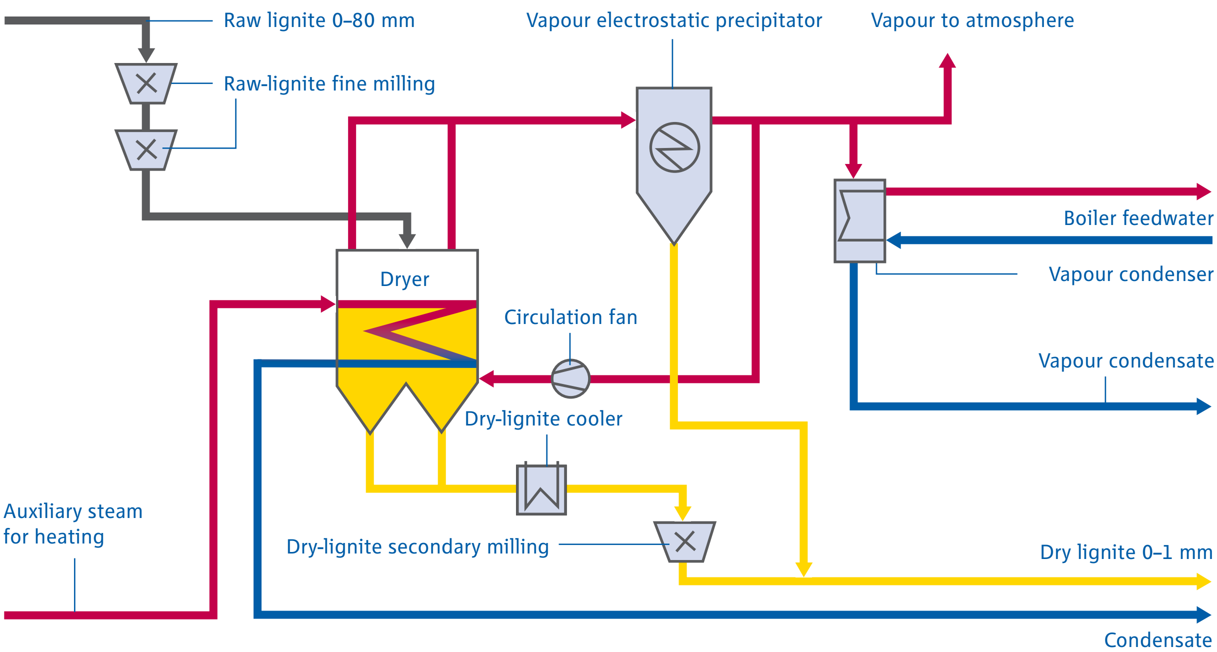
three to four bar. For swirling (fluidization), the system used is adapted to the specific conditions of lignite drying. Below the fluidizing bottom, the dry lignite is discharged from the fixed bed via star feeders. The dryer has a high specific capacity and a particularly compact design.

Variants of energetic vapour use

One of the advantages of drying lignite in a vapour atmosphere is that the evaporated coal water condenses isothermally, i.e. at a constant temperature, so that it can be used in an energetically efficient manner. RWE has developed two concepts for vapour use to industrial scale:

- Mechanical vapour recompression as open heat-pump process to heat the dryer's heat exchangers with and without integrated lignite pre-heating (see p. 11).
- Vapour condensation for preheating of, e.g., boiler feedwater in the power-plant process, as implemented at Niederaussem (see below).

Process principle: WTA with vapour condensation



The two variants can be integrated into the WTA process. They increase the energy efficiency of the drying process and reduce emissions. The vapour condensate produced can be used as industrial water. Which of the systems for utilizing vapour is employed depends, among other things, on the drying task and on the integration into the overall process.

Raw lignite in different grain sizes

WTA drying was developed for two input grain sizes: the so-called coarse-grain WTA works with lignite in grain sizes 0 to 6 mm, the fine-grain WTA in grain sizes 0 to 2 mm. The coarser variant is used if the downstream process requires dry lignite in a minimum grain size, like gasification in the high-temperature Winkler process or the coking of lignite. For all other processes, the fine-grain variant will usually be the much more attractive option in technical and economic terms. Especially as a pre-drying stage in conventional power stations, the fine-grain WTA process offers advantages, since the dried lignite of max. 1 mm grain size is so fine that it can be used directly as fuel in the steam generator.

For the necessary up-front fine-milling of the run-of-mine lignite, RWE has developed a special process with two milling stages connected in series reducing the raw lignite's grain sizes from approx. 0 to 80 mm to the desired 0 to 2 mm.

The overall process of fine-grain WTA

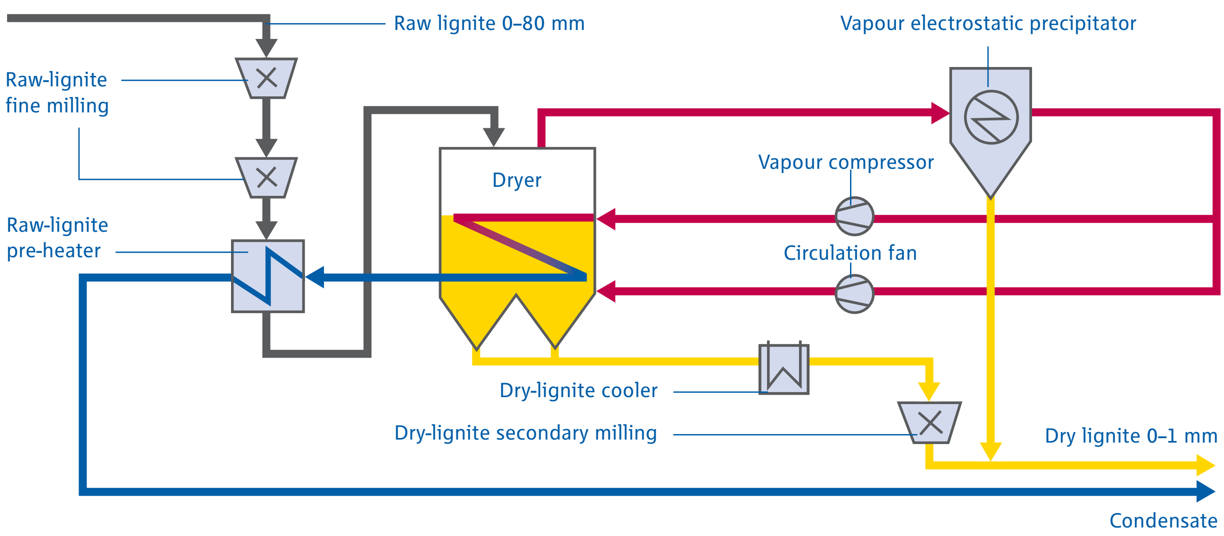
The diagram below shows the overall process in the fine-grain WTA variant with upstream fine-milling and integrated mechanical vapour compression for using the vapour energy in the drying process.

The evaporated coal water (vapour) is cleaned in an electrostatic precipitator and re-compressed in a compressor to approx. four bar, so that the water vapour can be used to heat the heat exchanger installed in the dryer. The sensible heat of the vapour condensate is used to pre-heat the raw lignite to approx. 65 to 70°C. The energy from the vapour goes far to cover the dryer's energy needs, therefore. Some of the cleaned vapour is recirculated to the dryer for fluidization of the raw lignite.

The dry lignite is cooled and – where required – milled again, using a mill integrated into the WTA plant, to a grain size of 0 to 1 mm, so that it can be used directly for combustion in the power plant.

As mentioned, the vapour coming from the dryer can also be used to preheat the boiler feedwater in a power station's water-steam cycle. Likewise feasible is a low-cost variant without use of the vapour, such as can be deployed, e.g., to improve the calorific value of moisture- and ash-rich lignites.

Process principle: WTA with vapour compression



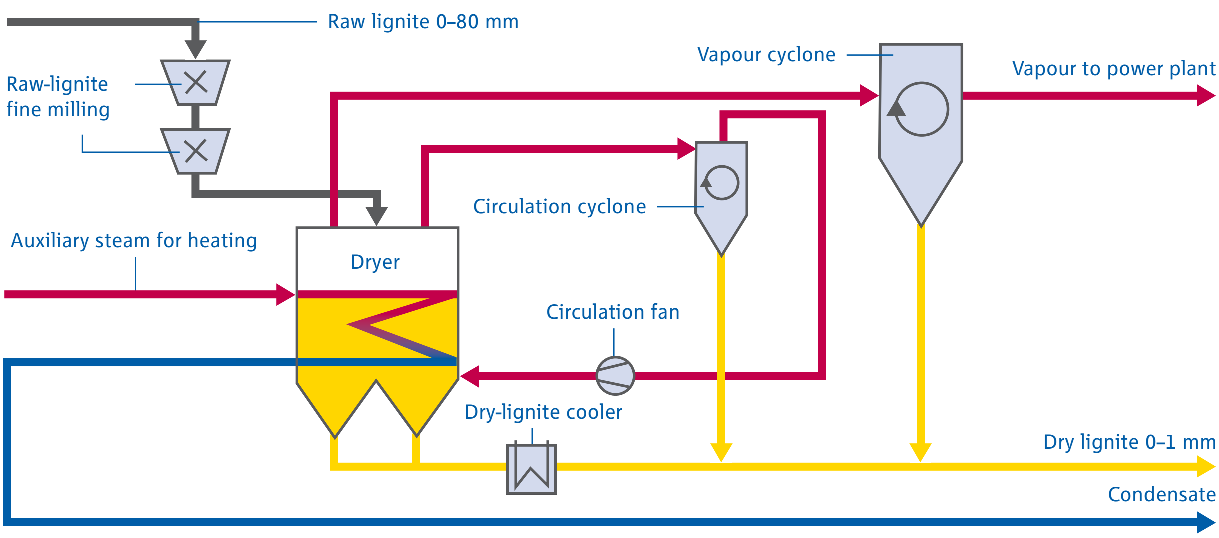
A look into the dryer of the WTA prototype plant at Niederaussem

Capacity and plant engineering

The WTA process is marked by high specific capacity and low heating steam pressure. Per dryer unit, therefore, very high drying output can be achieved. Thanks to the space-saving design and the integrated fine-milling system for the raw and dry lignite, the overall plant, too, remains relatively compact. The WTA prototype plant at the Coal Innovation Centre is the world's largest lignite-drying system. It inputs 210 t/h of raw lignite and obtains water evaporation of 100 t/h. As an alternative to the design in Niederaussem, all components of the main lignite flow can also be installed above one another in a steel structure.

Advantages of WTA technology

- High energy efficiency thanks to drying at low temperature, and energetic use of the evaporated coal water (through vapour condensation or mechanical vapour compression).
- Very safe in both normal operations and in powering up/down thanks to drying in an inert atmosphere. This avoids explosive coal dust-air mixtures from the outset.
- High drying capacity per dryer unit.
- Compact design due to integrated raw-lignite fine-milling system and – where required – secondary dried lignite milling as well.
- Utilizing the energetic vapour avoids significant steam and dust emissions. The vapour condensate is a water source that can be used by industry.
- Flexible adaptation of the plant engineering to the needs of the drying task at hand.
- Increase in power plant efficiency by four to six percentage points, depending on the drying variant and the moisture of the raw lignite.



Process principle: WTA as low-cost variant

KNOW-HOW AND SERVICE RANGE

WTA technology is a proprietary RWE Power development specially geared to industrial-scale deployment in the lignite sector. To meet the special requirements of lignite processing and drying, innovative process- and plant-technology solutions have been developed for which 18 patents have been filed or issued to date. The evaluation of plant operations using domestic and foreign coals enables RWE to continuously further develop and optimize the process.

On the basis of its comprehensive know-how gained in developing, planning, building, commissioning and operating its own plants, RWE can offer an extensive range of services:

- feasibility studies, incl establishing investment costs;
- bench-scale testing (processing, drying, fluidization behaviour);
- laboratory analyses;
- licensing WTA technology;
- industrial-scale processing and drying trials at the Frechen WTA-2 plant as basis for the dimensioning of licensed systems;
- basic and detail engineering;
- support during commissioning.

WTA-2 fine-grain drying in the Frechen upgrading operations

ERECTED AND PLANNED WTA PLANTS

- **WTA 1 Frechen**
  Coarse-grain drying with integrated vapour compression and lignite preheating
  Raw-lignite throughput approx. 53 t/h
  Dry-lignite production approx. 28 t/h

- **WTA 1 Niederaussem**
  Coarse-grain drying with integrated vapour compression
  Raw-lignite throughput approx. 170 t/h
  Dry-lignite production approx. 90 t/h

- **WTA 2 Frechen**
  Fine-grain drying with partial vapour condensation
  Raw-lignite throughput approx. 27 t/h
  Dry-lignite production approx. 14 t/h

- **WTA 2 Niederaussem**
  Fine-grain drying with vapour condensation
  Raw-lignite throughput approx. 210 t/h
  Dry-lignite production approx. 110 t/h

- **WTA Hazelwood (Australia/planned)**
  Fine-grain drying without vapour utilization
  Raw-lignite throughput approx. 140 t/h
  Dry-lignite production approx. 70 t/h

The systems WTA 2 Frechen and WTA 2 Niederaussem were planned, built and commissioned by RWE Power itself as general planner. For the other plants, RWE Power provided the basic engineering and some of the detail engineering.

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Aktiengesellschaft

Essen ▪ Cologne
www.rwe.com/rwepower

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