



SIEMENS

Where innovative power plant technology is made

The Mülheim plant – pioneering spirit and top expertise since 1927

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Answers for energy.

Mülheim – global expertise center for power plant technology

Pioneering spirit meets innovation

Mülheim an der Ruhr is a special place, not just for Siemens but also for power plant technology. In 1881, August Thyssen opened a small repair workshop for steel and rolling mill machinery here. After being acquired by what was then Siemens-Schuckertwerke in 1927, it became an internationally leading turbine and generator plant.

With an impressive pioneering and innovative spirit, the location has grown into a facility that ensures economic stability and is an important employer in and beyond the region.

Setting records, over and over

Right from the first day, the staff at the Mülheim plant demonstrated impressive innovative strength. They have continued to develop and manufacture turbines and generators that set new records again and again.

- The world's largest half-revolution steam turbine, with an output of up to 1,900 MW, originated in Mülheim.
- The largest generator of the world, at 900 tons and measuring almost 17 meters long, is also made at the Mülheim plant.
- Mülheim helped develop the world's most efficient gas turbine in combined cycle operation, which achieves an efficiency rate of over 60 percent.

Facts and figures



Since 1927 Siemens has developed and manufactured advanced turbines and generators in Mülheim for the worldwide power plant business.

Almost 5,000 employees work at the Mülheim plant, which covers an area of about 435,000 square meters.

- Steam turbines: 1,650 employees
- Generators: 500 employees
- Service: 1,200 employees
- Gas turbine engineering: 400 employees
- Other: 900 employees
- Trainees: 250 employees

(Rounded figures, status as of 4/2011)

As a development center and manufacturing facility, Mülheim plays an important role in the global Siemens Energy manufacturing network.

The location is not just a technology leader, it also leads in training and continuing education. Seven degree programs and ten apprenticeship occupations give talented people a great start in a successful career.

With its extensive range of initiatives, the facility is committed to ongoing quality and productivity improvement.

By implementing internal measures to improve environmental protection, the Mülheim plant flies the flag of greater sustainability.

Products and services at a glance

Mülheim creates innovative top-level solutions for the world market.

Steam turbines

Steam turbines from Mülheim set world standards for quality and reliability. All process steps, from engineering to production to commissioning, are coordinated and directed from here.

Generators

Mülheim is the international leader in the development and production of high-efficiency generators. The facility builds generators in the upper power ranges, starting at 165 megavolt amperes (MVA).

Gas turbines (engineering)

The Mülheim plant develops innovative gas turbines. Four hundred specialists in the fields of development, design, and materials work on the ongoing development of gas turbine technology.

Service

Mülheim is a service center for steam turbines and generators and for power plant modernization. Services are not limited to repairs and part replacements; they also include concepts for the long-term efficient operation of power plants.

Feeder plants

The activities of international suppliers and global joint ventures and holdings are directed and coordinated in Mülheim.

Product integrity

Product integrity offers outstanding operational support for gas and steam turbines and generators. Among other things, Product integrity specialists run performance tests in the field as well as design tests.

A brief history

Siemens-Schuckertwerke acquires the part of the Thyssen machine plant that builds steam turbines and generators from DEMAG.

1927



Construction of the world's first steam turbogenerator utilizing supercritical steam parameters. The turbogenerator, built for the Hül's chemical works, has a steam temperature of 650 °C.

1954

Founding of Kraftwerk Union AG (KWU) by Siemens and AEG-Telefunken to bundle the power plant activities of both companies. The new headquarters are located in Mülheim.

1969

Foundation laid for the Harbor plant, because the growing production volume makes water access necessary.

1970

More development at the site: The Wiesenstrasse plant becomes the Siemens Technopark Mülheim; a concept study for the Harbor plant, with new office and large-component production buildings, is submitted.

2001

The Harbor plant project is completed, and the new office buildings and production facilities are occupied. All new buildings are certified Green Buildings.

2010



The challenge – cleaner fossil power generation

Fossil fuels – the stable basis

The future of power generation will see a diverse mix of energy resources. Renewable sources will play an increasingly important role, but fossil fuels will continue to be the mainstay for securing a reliable worldwide energy supply. Fossil power generation is indispensable for absorbing volatile fluctuations in grid infeed from renewable sources and for meeting a demand for electricity that will continue to rise. As a result, fossil power generation will play a crucial role in meeting growing power requirements in the future.

As we enter the new electricity age, one of the challenges will be generating cleaner electricity from fossil sources. The need for fossil energy will continue to grow along with renewable energies. According to present-day expectations, over half of the power in 2030 will still be generated from fossil fuels. At the same time, CO₂ emissions need to be significantly reduced.

More efficiency, less carbon

When it comes to the efficiency of buildings, machines, and entire production plants, intelligent technologies from Siemens set standards worldwide.

The Ulrich Hartmann combined cycle power plant (CCPP) in Irsching, Germany, and the Waigaoqiao III coal-fired power plant in Shanghai, China, are examples of how to obtain a high power output with low emissions. In Waigaoqiao III, steam turbines and generators from Mülheim contribute significantly to reducing the burden on the environment. Compared to the average Chinese coal-fired power plant, Waigaoqiao III cuts carbon emissions by almost two million tons per year.

Thanks to its innovative gas turbine, the Ulrich Hartmann power plant achieves an efficiency of more than 60 percent. Thus, engineering from Mülheim reduces annual CO₂ emissions by 43,000 tons, which corresponds to the annual emissions of some 10,000 cars traveling 20,000 kilometers each.

Setting a good example

At all Siemens locations – and Mülheim is no exception – minimizing our own carbon footprint is a top priority. This applies both to the design of production processes and to the equipping of buildings.

When expanding the Harbor plant location, for example, Siemens invested in a shopfloor and a new office building. Both buildings were consistently designed with energy efficiency and low carbon emissions in mind – also earning them the Green Building certificate, which is awarded only to buildings that consume 25 percent less primary energy than required by law.

In the shopfloor alone, construction measures have resulted in annual CO₂ savings of 426,000 tons. The office building saves another 198,000 tons, for total savings corresponding to the annual carbon emissions of 150,000 cars traveling 20,000 kilometers each.

But Mülheim takes sustainability even further. Ideas are constantly being put forward on how to save energy on a small scale and thus make valuable large-scale contributions to environmental protection. Employee suggestion programs are offered with special emphasis on the environment as well as regular participation in the Siemens Environment Award competition – an internal environ-





mental protection program that the company publicizes worldwide.

Just as important is the plant's collaboration with the city of Mülheim on various environmental initiatives. Over the medium term, the plant will be equipped with a future-oriented energy management system. The goal is to use resources even more responsibly while continuing to improve the carbon footprint.

“Mülheim isn't just a think tank; it's also a factory of the future. The intelligent and efficient use of energy is the future.”

Such use is significantly shaped by technologies and ideas coming out of Mülheim.”

Peter Löscher, CEO of Siemens AG

Steam turbines – working under high pressure

Always in the vanguard of development

Steam turbines from Mülheim have traditionally set the standards in terms of performance, reliability, and long service life. From the moment production began in 1927, the focus was on improving performance and efficiency. Engineers accomplished this by increasing steam pressure, employing new blade geometries that improved the flow of steam, and using new materials. Today Siemens steam turbines achieve an efficiency of more than 46 percent.

Steam sets things in motion

Steam turbines convert heat to mechanical energy. The heat can be generated by fossil fuels such as coal, oil, or gas (steam power plants and combined cycle power plants), or by solar energy (solar-thermal power plants). The heat then is used to generate steam and sets the rotor in motion by producing an angular momentum on the blades. Due to the extreme pressure drop and tremendously high efficiency requirements, this process is distributed over a number of stages comprising blades and vanes. Physically there is a steady drop in vapor pressure and temperature during this process. At the same time,

however, the volume flow increases, so that rotor blades of up to two meters in length can be driven at the turbine end.

After the steam drives the turbine, it enters a condenser, is turned back into water, and is finally recirculated through the system to the boiler.

Quality makes the difference

The outstanding feature of Siemens steam turbines is quality. Throughout the entire manufacturing process, tight process control guarantees consistently high quality and conformity to the required specifications – within the plant itself and on the part of internal and external suppliers. Through every stage of production, turbines are subjected to function, materials, and geometric testing.

Turbine production follows a number of parallel but also sequential steps. It begins with the production of the rotors. Turbine rotors made of high-strength steel are supplied as prefabricated forged parts that are then optimally shaped by means of high-precision lathes. Extreme accuracy is required to within a hundredth of a millimeter.





Production of the casing also requires maximum precision. Although dimensions are in the meter range, the drills, millers, and lathes that are used operate with the same high precision to within a hundredth of a millimeter.

In terms of blade production, the low-pressure blades arrive at Mülheim as semifinished parts and are finally shaped on-site. All other blades are already finished when delivered to Mülheim from the global production network.

At the Mülheim plant, the various turbine components are assembled into high- and medium-pressure turbines and then undergo function testing. Because of their size, low-pressure turbines are fully assembled and commissioned when they reach the customer site.

Gas and steam – the power team

Combined cycle power plants equipped with the latest Siemens technology achieve unprecedented efficiency levels of more than 60 percent. In this case, the hot exhaust from the gas turbine is used to generate steam for a downstream steam turbine. The Mülheim plant also plays a large role in the further development of this future-oriented technology.



Generators – exciting technology

Werner von Siemens laid the cornerstone

With his discovery of the principle of electrodynamics in 1867, Werner von Siemens laid the cornerstone for generator manufacturing. Generators are responsible for the actual production of power. With the aid of electromagnetic induction, they convert mechanical energy – produced by the rotation of the turbine shaft – into electrical energy that is then fed into the grid.

Siemens offers a comprehensive portfolio of generators from 25 to 2,235 MVA. The company's expertise is based on over 100 years of experience and an installed base of 1,300 generators. Specialists also process service orders

from around the world, such as modernizations and repairs – including third-party products.

In manufacturing, precision counts most

Generators basically comprise a stationary stator that accommodates the stator winding, and the rotor that spins inside it with its integrated rotor winding. The tremendous technological challenge is to combine steel, copper, and insulation materials despite their different expansion properties.



is fully assembled, it is transferred to the testing facility, then packed and shipped to the customer. Assembly and testing specialists accompany the generator to its final destination and commission it there. Depending on their power rating, generators from Mülheim are mainly used in steam, gas, and combined cycle power plants.

Products with world-class performance

Air-cooled generators are especially compact and achieve world-class efficiency levels of up to 98.8 percent. At max. 375 MVA, their power rating is also a peak value.

Hydrogen-cooled generators are also an extremely attractive option due to their performance capability and longevity. Hydrogen ensures reduced friction losses as well as increased performance and efficiency. This product series has a power output of up to 600 MVA with an efficiency level of up to 99 percent.

In addition, Mülheim produces generators with water-cooled stators and hydrogen-cooled rotors that achieve an efficiency of up to 99 percent as well. A special highlight from Mülheim is the world's largest generator – a 4-pole giant with a power output up to 2,235 MVA that weighs 900 tons, is almost 17 meters long, and has a 4.5-meter diameter.

Moreover, the Mülheim factory has its own generator testing facility where all prototype tests are performed as well as the performance verifications required by customers.

In Mülheim, generators are produced for the performance range above 165 MVA. When rotors are manufactured in the Harbor plant, the individual components are combined, balanced, and assembled. If there is a service order, maintenance is performed here. Depending on the area of application, the rotors can weigh over 200 tons. Because they are subjected to extreme centrifugal forces during operation, highest precision is required at assembly. The most important factor is the mechanical strength of the rotor. For the high-voltage insulation on the generator winding, technicians use high-quality glass fiber materials that, in addition to mechanical loads, can also withstand high electrical and thermal loads.

The Harbor plant also produces stators weighing up to 400 tons. In the stator core production area, the middle section of the stator is assembled for the new plant and service department. Each day, robots laminate almost 200,000 stator segments. The stator core is then inserted in the housing using a heavy-duty crane, aligned, and welded. This is the so-called wedding. Once the generator



Gas turbines – in hot pursuit of the highest efficiency

Full power within minutes

There must always be enough power available in the grid to supply short-term consumption peaks. This is where the gas turbine comes into its own. It achieves full power within a short time, thus guaranteeing power supply in any situation.

The gas turbine functions on the same principle as an aircraft engine. Air is sucked in, compressed, and channeled into the combustion chamber at high pressure. Natural gas or light heating oil ensures ignition. The fuel/air mixture is ignited and hot gases are produced at extremely high temperatures and high pressure. These gases drive the turbine rotor, which in turn drives a generator that produces power.

Siemens gas turbines are renowned for their reliability, eco-friendliness, and cost-efficiency. They achieve their maximum efficiency of more than 60 percent in combined cycle power plants in which gas and steam turbines work together.

Mülheim is also jointly responsible for the engineering of large gas turbines used by power supply utilities and independent power producers, by major energy consumers and industrial plants, and by the oil and gas industry. Gas turbines offer low life-cycle costs, meaning a fast return on investments.





Engineering from the Ruhr region

Within the global organization, Mülheim is home to some of the gas turbine engineering activities at Siemens. Material, design, performance figures, service life – each detail of a turbine is considered and integrated into the development process. Siemens has based its designs on the same proven principles since the 1940s: the use of clean fuels, low plant investment, design for high performance, and operation in the base and peak load ranges.

The gas turbine team has grown continually, and so have its multifaceted tasks. Today the team has 400 engineers and technicians in the areas of development, design, and materials. Decades of expertise in engineering come together in Mülheim. This experience is complemented by

a broad customer knowledge base and the experience gained from the millions of operating hours of the worldwide Siemens gas turbine fleet. This is the foundation for the never-ending refinement of Siemens gas turbine technology.

All information is evaluated and used for the research and development of new materials, components, and entire systems. Employees use the latest computer technology, which enables them to design and simulate gas turbines in a way that is very similar to turbines in actual operation.

The gas turbines are manufactured by the Siemens global production network in Berlin, Charlotte (North Carolina, USA), Saint Petersburg (Russia), and Shanghai (China).

Service – so that high-tech remains high-performance

Longer life and better efficiency

Continuous, dependable, environment-friendly electricity generation in efficient power plants is what almost 1,200 employees in the Energy Service Division at Mülheim focus on every day. The term “service” encompasses many things. It is not just limited to repairs and part replacements. It also includes concepts for the long-term efficient operation of power plants.

Continual service – in other words, the expansion, modernization, and upgrading of components – ensures that older power plants keep up with technological advances and can achieve high performance and efficiency levels even after years of operation. The benefit for operators is enormous, because at a relatively low cost they can give their existing power plant a new lease on life.

Every day, power plant components arrive in Mülheim to be upgraded to the latest state of the art, including components by other manufacturers. The focus of the Mülheim service operation is on the modernization of steam turbines and generators. That means the replacement of generator components as well as rotors, blades, and interior housings with the latest technologies. The core customer benefits are higher efficiency combined with lower specific CO₂ emissions and an increased operating life.

Mülheim’s Field Service is also in very high demand. Field Service is responsible for the proper assembly of steam turbines and generators, and for commissioning steam turbines around the globe. Diagnostic procedures and innovative technologies in the fields of nondestructive testing and in situ machining make an important contribution to preventive maintenance and increased availability.

Knowledge and experience count

The qualified analysis of existing components and the development of improvements requires comprehensive expertise and market knowledge. Therefore, the Mülheim Service Division staff work closely with their colleagues in manufacturing and construction as well as in marketing and sales. As a result, the customer always benefits from the collective expertise of the location.

Siemens customers know more

The services provided also include customer training and continuing education. The Power Academy gives customers from around the world a deeper understanding of how their systems work. To ensure that attendees derive maximum benefit from the seminars, instructors always make sure that the training incorporates the right mix of theory and practice. In this way, the Power Academy contributes not only to safe and reliable plant operation, but also to greater customer satisfaction.





Budapest, Hungary



Charlotte, USA



Global manufacturing network – networking excellence



Top quality for global markets

In the Siemens global manufacturing network, the vision of merging the best has been daily practice for years. The network is organized so that partner companies in and outside of Siemens can work on their own tasks with the greatest possible cost efficiency. All partner companies adhere to strict quality specifications that are defined down to the smallest components. The result: innovative technologies and the best possible quality at competitive prices for customers around the world.

A defining role

Mülheim is an important partner in the Siemens global manufacturing network. The plant has worldwide product oversight and system leadership for steam turbine production. Mülheim directs all engineering, purchasing, and assembly operations and sets the quality and delivery specifications. Production takes place in Mülheim as well as at sister plants in Budapest (Hungary), Cilegon (Indonesia), and Newcastle (England).

In generator production, Mülheim is part of a production facility network that includes colleagues with system responsibilities in Orlando (Florida, USA) as well as a production plant in Charlotte (North Carolina, USA) and network plants in Fort Payne (Alabama, USA) and Erfurt (Germany). Mülheim also oversees service for Europe, Asia, Africa, and Australia.

In terms of gas turbine production, the Mülheim plant is jointly responsible for engineering within the facility network. Approximately 400 specialists develop the turbines that are manufactured in Berlin and Charlotte for world markets.

Orlando, USA



Cilegon, Indonesia



The employees – creative, expert, committed

The basis of our success

With their creativity, knowledge, and commitment, Siemens employees have played a major role in making the Mülheim location what it is today. Their confidence and pride in what has been achieved here over the decades is evident throughout the entire facility. A strong team spirit creates the basis for continued success.

Ideas become reality

Innovations are the visible result of a passion for new thinking. At the Mülheim plant, this passion has been present for decades. Siemens promotes it with initiatives such as the 3i program (ideas, impulses, initiatives), which rewards improvement initiatives by individual employees or teams.

Over 5,000 3i suggestions are submitted every year at Mülheim, of which about half are implemented. They cover the entire value-creation chain, and lead to cost reductions, better lead times, better workplace ergonomics, and other improvements.

Just one example shows how valuable creative 3i suggestions can be: cameras were installed on the large turning machines, making it possible to turn the entire casing without the need for a second person on the carousel. This has speeded up processing while also decreasing the risk of injury.

Safe and sound

The Mülheim plant pays great attention to work safety. Today's low accident rates are the result of years of true commitment.

Over the years, the latest safety devices have been installed on machines, better tools taken into use, and protective clothing introduced.

Safety on the way to work is another important focus. The plant holds safety workshops on a regular basis, including defensive driving courses in a very close and successful cooperation with the local police.

Health – nothing to sneeze at

From the first day of production, there has been a workplace physician service at Mülheim. Since then, the facility management has been committed to promoting employee health, too. Examples of the company's preventive medicine programs are seminars for quitting smoking, spinal health trainings, and presentations on healthy nutrition.

Since 1965, the SV Siemens sports club has provided ways for employees to stay fit. This popular company club offers healthy exercise as well as great fellowship, and with over 20 sports it offers variety as well. In addition to soccer, employees can pursue activities like jujitsu, triathlon, and sport motorcycling.





Professional education and training – actively shaping the future

Education creates opportunity

Power plant technology is highly complex and requires a solid grounding in specialist knowledge. This is why the systematic transfer of knowledge is very important in this field. At Mülheim, almost 250 trainees are undergoing career training in:

- Industrial machining
- Metal machining
- Technical product design
- Machine and drive electronics
- Materials testing
- Warehouse logistics
- Mechatronics
- Industrial business administration
- Office communication
- Mechanical design

All courses are open to both men and women.



Particularly dedicated trainees with good grades have the opportunity to go on to gain qualifications as government-certified technicians in mechanical engineering, or to get master's degrees in energy systems technology with a focus on turbine machines. Special product training is also offered, as are two-year specialties in the fields of metal machining and machine and drive electronics.

An additional motivator is the chance to spend some time abroad: One-third of the trainees and students get the opportunity to acquire valuable international work experience. Twenty-five of them spend three weeks at a Siemens location outside the country in their second year of training. In the third year, another ten trainees get the chance to spend seven weeks outside the country.

Students pass their practical phases and – the right qualifications provided – spend an entire semester abroad.

Cooperative education with strong partners

In Mülheim, the classic dual-education combination of hands-on training and classroom instruction is complemented by cooperative training. This links the work training to a specialist degree. In the technical field, it leads to an engineering degree, while trainees in business subjects graduate with a Bachelor of International Management degree. Siemens Professional Education at the Mülheim location cooperates with three well-known area universities – the Hochschule Ruhr West (HRW) in Mülheim, the Fachhochschule Gelsenkirchen (FH Ge), and the Hochschule für Oekonomie & Management (FOM) in Essen.

The following cooperative education degree programs are available:

- Master of Engineering
- Bachelor of Mechanical Engineering
- Bachelor of Electrical Engineering
- Bachelor of Science in Mechanical Engineering
- Bachelor of Science in Electrical Engineering
- Bachelor of International Management

Additionally, in cooperation with Fachhochschule Gelsenkirchen, the plant offers a master's program with a turbo-machine module.

All students at Mülheim get the opportunity to spend at least three months abroad.

Training creates value added

Systematic continuing education makes a major contribution to boosting the personal and professional qualifications of all staff. Customers also benefit from a high level of qualification.

Intensive seminars on products and processes are offered for employees in all areas. The training portfolio ranges from basic courses to special theoretical and practical training for Field Service technicians to the optimization of internal and business processes. There are also language courses, work safety seminars, moderator training, and continued education programs for technician, bachelor's, and master's degrees.

For the Mülheim location, these training and continuing education offerings are an important part of preparing for the future. By passing along and deepening employee knowledge, they multiply the most valuable resource any company can have: the skills of its people.

Published by and copyright © 2011:
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Order No. E50001-G210-A173-X-4A00
Printed in Germany
Dispo 34802, c4bs No. 7449, 7446,
7478, 7816
fb 3751 WÜ 431941 WS 10113.0

Printed on elementary chlorine-free
bleached paper.

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