Turbine applications today and in the future

Industry Portrait

Who we are…

We are globally operating companies for energy technologies with a strong European basis. The European gas and steam turbine manufacturers provide high-tech solutions for power generation as well as oil and gas and industrial processing industries in a highly competitive global market. The industry employs more than 70,000 people across Europe, generating an annual business volume of around 25 billion euros. Each year, the European gas and steam turbine industry invests more than 6 billion euros for purchases in Europe. Tens of thousands of small and medium sized enterprises are among our suppliers. As one of the most competitive industry sectors, we have proven that manufacturing in Europe is still profitable. Turbines of the highest technology and quality standards are the basis for our success in worldwide markets.
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Introduction

Gas and steam turbines are core components of Europe’s energy generation. Today, almost 70% of Europe’s energy is generated with the support of gas and steam turbines.

Gas and steam turbines provide technology solutions to different global energy needs and policy priorities, as they are not bound to a specific type of fuel. This brochure presents an easy-to-read overview on turbine technology and their applications.

It also explains the changing roles turbines fulfill in a decarbonising energy system, while the past was characterised by central base-load power plants using large turbines for generating electricity, the new European energy mix will consist of a much bigger variety of energy sources, most of them low-carbon, and a more decentralised structure. Still, many of these primary energy sources will drive turbines to generate electricity, a fact most people are not aware of.

Now, the sun, the heat of the earth or waste heat from industry help producing the steam that drives the steam turbine, which in the past was generated by burning coal. Also, biogas, methane and biogas from agricultural waste or sewage will be increasingly used as input for gas turbines. The future applications include many renewable energy sources, but also the fast gas-fired power plants that quickly start up to fill the gap, when there is not enough wind and sun, as well as the extremely efficient cogeneration plants, providing electricity and heating for households or industry at the same time.

We hope you will agree that, after reading this brochure, the European gas and steam turbine industry offers “solutions for a sustainable energy mix”!
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www.euturbines.eu

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What do these things have in common?
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Turbine Technology

A gas turbine, also called combustion turbine, is a type of internal combustion engine. Its components are:

- **Compressor**: The incoming air is compressed and pressurised. This air is fed into the combustion chamber.
- **Combustion Chamber**: Gas or liquid fuel is injected and ignited into the combustion chamber, generating a high-temperature-pressure gas stream that expands.
- **Turbine Blades**: The expanding gas is converted into mechanical energy causing the blades in the turbine to spin. The rotating blades drive a generator to produce electrical energy.

A steam turbine converts the heat energy contained in high-pressure and high-temperature steam into mechanical energy. Its components are:

- **Rotor**: An impeller with mounted blades extracts the energy from steam and transfers this energy to the shaft.
- **Turbine Blades**: A set of stationary blades with increasing size are connected to the rotor shaft, while moving blades are connected to the casing. The blades are turned by the steam passing through them.
- **Casing**: The casing function is to dissipate the steam and to ensure proper sealing.

Turbines convert the kinetic energy of a moving fluid into mechanical energy through the rotation of a bladed rotor. This energy then drives a generator that produces electrical energy.

Gas and Steam Turbines

Gas turbine

Steam turbine

Did you know?

- The temperatures in the combustion chamber can reach up to 2,000 °C. Therefore, turbine blades consist of highly sophisticated materials, including ceramic layers.
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Gas and Steam Turbines

Solutions for a sustainable energy mix

Turbines in power generation – generating electricity with steam

Solar

Harnessing solar energy to create steam through a central receiver, parabolic trough or linear fresnel reflectors.

Geothermal

Using the heat from the earth. Energy is accessed by drilling water or steam wells in a process similar to drilling for oil.

Biomass, Biogas and Biofuel

Generating steam with crops, manure, waste or biofuels.

Nuclear

Using a nuclear reactor as the heat source.

Carbon Capture and Storage (CCS)

CCS is a technology that can capture up to 90% of the carbon dioxide (CO2) emissions prevented from the use of fossil fuels in electricity generation and industrial processes, preventing the CO2 from entering the atmosphere.

Coal

Burning thermal coal. Combined with CCS, it allows generating carbon-free electricity.

Waste heat – an additional source of steam

Heat can be recovered from hot streams, such as hot flue gases, steam from cooling towers or heat from industry processes. With the use of a heat recovery steam generator, a steam turbine can produce electricity, increasing the energy efficiency of any process releasing waste heat.

Concentrated solar power plants can integrate thermal storage systems, making them more flexible than photovoltaics.

Gas and Steam Turbines

Solutions for a sustainable energy mix

Did you know?

The steam temperature of advanced power plants can reach up to 630 °C. With steam pressures of about 410 bar, the state of aggregation is far beyond the super critical point.

Did you know?

Concentrated solar power plants can integrate thermal storage systems, making them more flexible than photovoltaics.
Turbines in power generation – generating electricity with gas

Open Cycle Power Plant (OCGT) – The flexible solution

The central component of a OCGT is the gas turbine, driving electrical power generation in a stand-alone configuration.

- Quick: low start-up times – even in cold start
- Flexible: adapting and reacting to demand requirements
- Simple: limited to three highly efficient components

Due to their flexibility, gas turbines can perfectly complement the variability of other energy sources, delivering flexible, fast and efficient electricity when needed, and so, ensure security of supply and the stability of the grid.

Combined Cycle Power Plant (CCGT) – The efficient solution

Designed for maximum efficiency, a gas turbine and a steam turbine are used in conjunction.

- Efficient: using the waste heat of the process
- Flexible: adapting and reacting to demand requirements
- Cogeneration: Reaching even higher efficiency levels

In cogeneration, the heat generated by gas turbines is used for district heating or industrial applications with a high demand for process heat or cooling. By this, the overall combined efficiency reaches levels up to 90%.

Open Cycle Power Plant (OCGT) and Closed Cycle Power Plant (CCGT) in a nutshell

Properties | OCGT-Plant | CCGT-Plant
--- | --- | ---
Start-up time (hot start) | ~ 9 min | ~ 30 – 140 min
Load following capability – Power-up | 20 – 35%/min | 10 – 15%/min
Minimum load | 50% | 30 – 50% of max

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Did you know?

A modern heavy duty gas turbine is able to cover the electricity demand of a city with 2.2 million people.

A CCU can produce up to 30% more electricity from the same volume of fuel compared to a single gas turbine. By simply using the waste heat in a steam turbine.
Turbines in the sustainable energy mix

Europe’s energy needs of the past were almost exclusively served by central coal, nuclear and gas-fired power plants with gas and steam turbines being their central component. Now, as we move to a more decentralised energy system, the power generation landscape changes – and connected with this, the applications for turbines. The future system comprises less central large central power plants, and more decentralised solutions with a high share of energy generated by renewable energy sources. Additionally, a fleet of flexible thermal power plants will ensure the stability of the electricity grid and security of supply. Turbines, which are improving continuously, will be the core component of many of these solutions using heat to drive a generator or a mechanical drive. The near aspect: the load will come from many different sources.

Turbines for energy storage and waste heat

Storing energy is key for the future energy system. There are more solutions other than batteries – and some are cheaper, better developed... and are turbines!
- Excess energy — may it come from large wind parks or other power plants — can be transformed into hydrogen or methane through electrolysis, stored and when needed, burned completely carbon-free in gas turbines.
- Cogeneration plants: One of the most efficient technology solutions, using the heat for district heating or industrial processes.
- Coal-fired power plants with CCS/U: Capturing the carbon emissions and storing or using them will allow countries with large coal resources to generate carbon-free electricity from coal.

Turbines ensuring energy supply

We all know it: sometimes the wind does not blow as predicted... We need thermal power solutions.
- Flexible gas back-up power plants: The natural ally to variable renewables, delivering very fast, on-demand energy.
- Concentrated solar plants: One of the most efficient technology solutions, using the heat for district heating or industrial processes.
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Turbines for renewables

There are other renewable energy technologies other than wind turbines and solar panels — and most of these solutions work with turbines. They generate hot steam, which is driving a steam turbine connected to a generator.
- Biomascharmen and biofuels plants: All of them can contribute increasing the share of already renewable energy by driving a turbine.
- Concentrated solar power (CSP) plants: Sunlight can be used not only by photovoltaics. CSP plants have an integrated heat storage solution — and a steam turbine.
- Geothermal plants: How to use the heat of the earth? With the help of steam turbines!

Turbines for energy storage and waste heat

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Did you know?
- Amderdias are gas turbines that are applied in jet-engine technology. They are especially optimized for user-size applications.
- No CO2 is emitted when gas turbines burn hydrogen or methane — which can be generated from excess energy in the form wind and sun.

Solutions for a sustainable energy mix

Gas and Steam Turbines

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Energy solutions for industrial applications

Turbines also provide solutions in areas other than electricity generation. These “mechanical applications” contribute to make industrial processes more energy efficient and, by this, help reducing carbon emissions globally.

Recovering waste gases and waste heat in industrial production processes, often waste gases or waste heat are generated. They do not have to be blown away and can often be used with the help of turbines. Flue gases of the metallurgical industry can be burned in special turbines and the waste heat of a paper factory can be used to drive steam turbines and, by this, reduce the need for external energy supply.

Providing heat and cooling
From chemical plants to ice cream factories, many industries need heat or cold to run their processes. Turbines can be used to provide all at the same time (heating, cooling and electrical power). This is called cogeneration, or, if all three options are provided, trigeneration.

Compressing air and pumping fluids
Pneumatic tools are used in many industrial processes. They are powered by compressed air which is generated by compressors and stored. These compressors can be driven by turbines. Pumps driven by turbines are used in municipal or waste water utilities or flood control. The turbines used are often aeroderivates.

Did you know?
Turbines are often used as a compressor drive in LNG-plants. They ensure variable speed operation, full pressure start-up and predictability of the plant.

Did you know?
The latest large turbines have the weight of a fully loaded Boeing 747 and deliver an equivalent of over 500.000 hp, the power of more than 500 Formula One cars.

Supporting the oil and gas sector
Industrial turbines are used in many areas of the oil and gas sector. They provide power to oil fields and platforms,commens gas and help transporting it in the pipelines.

Getting the salt out of the water
Turning salty sea water into fresh potable water is important for many countries around the world. This is mainly done with the support of turbines providing electricity and steam for the desalination process.

… and even driving ships
Gas turbines are used on large naval or cruise ships to support the diesel engines, allowing higher speeds and lower emissions. Steam turbines are running on nuclear ships or special vessels like ice breakers or LNG carriers.

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District heating
For private and commercial buildings, one of the most efficient ways to generate energy is the combined production of electrical power and heat with turbines, reaching overall efficiencies up to 90%. These solutions can go from large central power plants to small district solutions.

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European high-tech for global challenges

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Providing solutions for global energy needs

Energy needs around the world differ widely. While parts of Europe face overcapacities in generation and focus on the sector’s decarbonisation, for many other countries around the world, access to affordable energy and electrification of rural areas are still the main challenges.

The European turbine industry transfers the European know-how about clean and efficient high-tech power plants into efficient and affordable solutions for all parts of the world and, by this, contributes to decarbonising the global energy sector. The application of this best available technology from Europe will contribute to decades of emissions reductions worldwide.

Providing growth and jobs in Europe

The European gas and steam turbine industry is providing directly 70,000 highly qualified jobs in Europe. In addition to these engineers, maintenance experts and skilled workers in production, a strong network of European suppliers, as well as research and academia employ additional staff, depending heavily from the success of this industry. Facing a strong global competition, the key factors for success of Europe’s industry and the European economy will be a framework that ensures constant innovation, the stability of the network and free access to the markets worldwide.

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Conclusion

What do the sun, wood pellets and hot water have in common?
They can all be used to drive a turbine and generate electricity!

What do cogeneration and district heating have in common?
They employ turbines to first use waste heat and then transport it to a given area!

How can salt be filtered from water or a large cruise reach highest speed?
With the support of turbines!

How is natural gas converted and transported?
Gas is compressed and carried in pipelines thanks to turbines!

How can the stability of the grid be ensured when the sun does not shine or the wind does not blow?
Through the flexibility provided by fast-reacting turbines!

How does industry increase its energy efficiency?
Sectors such as chemicals, paper and steel can save heat or gases with the help of turbines!

Gas and steam turbines are not a technology of the past. On the contrary, these complex machines continuously adapt and evolve to meet and deliver new requirements in energy systems with an increasing share of renewable energy sources, the pressure to decarbonise our economy and the need to increase energy efficiency demands.

Turbines: European high-tech solutions now and in the future!

About EUTurbines

EUTurbines is the only association of European gas and steam turbine manufacturers.

EUTurbines advocates an economic and legislative environment for European turbine manufacturers to develop and grow R&I and manufacturing in Europe.

EUTurbines promotes the role of the turbine-based power generation in a sustainable, decarbonised European and global energy mix and contributes to the political and regulatory discussions by continuous exchanges with the European institutions and other stakeholders.

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