



SUSTAINABLE TECHNOLOGY

YOUR COMPETITIVE EDGE

COMPREHENSIVE SERVICES

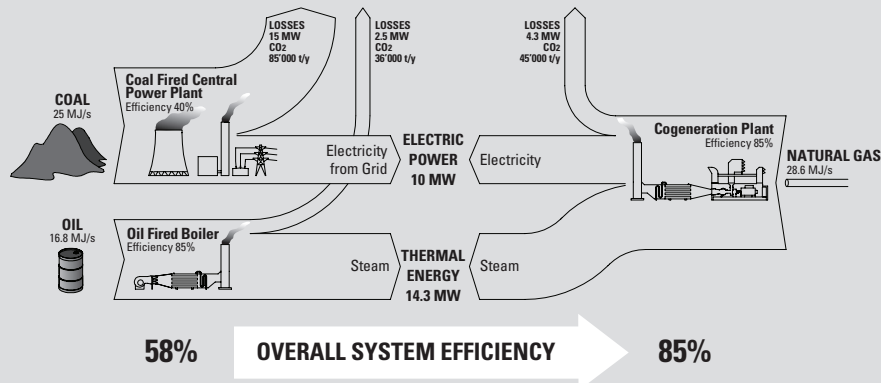
GAS TURBINE COGENERATION SOLUTIONS

Turbomach

A Caterpillar Company

COGENERATION IS THE MOST EFFICIENT WAY TO GENERATE ENERGY FROM FOSSIL FUELS

Cogeneration, also known as Combined Heat and Power (CHP), is a process that enables the simultaneous generation of electrical and thermal power from a single fuel source. Cogeneration can be illustrated by the addition of a waste heat recovery boiler to a gas turbine generator set in order to recover the high quality heat from the gas turbine's exhaust for steam and/or hot water production.



Applying the cogeneration technique, allows the production of electricity at an efficiency rate above 85%, which is significantly higher than any large central power plant efficiency. Since cogeneration installations are primarily decentralised, they provide other significant advantages in addition to being highly efficient:

- secure local energy supply
- contribution to global environmental improvement
- development of local competence in energy efficiency
- reduction in energy costs
- high power density
- reduced reliability on the grid

These advantages go a long way in solving the power generation challenges that are facing countries and communities worldwide. Increased electricity demand, ageing equipment, and stringent environmental standards are driving companies towards alternatives to the central power station. Cogeneration is a solution to these challenges and is attractive to a variety of industry stakeholders.

INDUSTRIES USING COGENERATION

- Pulp and Paper
- Food and Beverage Processing
- Pharmaceuticals
- Universities and Hospitals
- Refineries
- Utilities
- Industrial Manufacturing





A paper company in Spain is increasing the sustainability of its production process using a 22 MWe gas turbine generator set.

WE HAVE THE SOLUTION

Gas Turbines are crucial to cogeneration deployment. Medium scale (1 to 25 MWe) industrial gas turbines, which have few rotating parts, are well appraised for their robustness, fuel flexibility, and the ability to absorb or reject sudden load demands. Such a design generates multiple benefits in terms of maintainability and operability, including no lubricating oil consumption, lower downtime - therefore increased availability, and the potential to easily replace the complete engine when an overhaul is required or at the end of the turbine's life. Their ability to generate high quality heat allows gas turbines to set extremely high CHP efficiency rates from district heating/cooling to heat intensive industrial processes.

MATCHING THERMAL NEEDS

Gas turbines can convert up to 60% of fuel energy into high temperature, clean exhaust gases suitable for a wide range of applications including direct drying or direct chilling, and superheated steam generation combined with hot water production. Since gas turbine exhaust gases contain a significant portion of oxygen, post-firing systems can be easily fitted in order to adjust heat production according to process requirements.

COPING WITH GRID POWER FLUCTUATIONS

In places where grid power is not available or is unstable, gas turbine generator sets are ideal to support the continuous operations of your plant. Turbomach gas turbine packages can accept or reject loads rated up to 80% of nominal which makes them ideal for starting-up and supporting industrial operations.

SECURING POWER SUPPLY

Industrial gas turbines are designed to ensure continuous operation in remote locations such as an offshore oil rig or a natural gas transmission line. As such, the key to their success resides in the combination of a simple design, a rugged combustion system that provides fuel flexibility and low emissions as well as the availability of a replacement turbine fleet that ensures minimum downtime during overhaul, while offering "as-new" performance levels.

HEATING AND COOLING	INDUSTRIAL	COMBINED CYCLE
		
SECTORS SERVED Hospitals Universities Commercial Buildings Airports Municipalities	SECTORS SERVED Refineries Chemical Plants Coking Plants Food and Beverages Pulp and Paper Ceramic Industry Biomass Waste Treatment Printing Industry	SECTORS SERVED Independent Power Producers Utilities Industrial Parks Automotive Industries Pulp & Paper Refineries
TYPICAL NEEDS Hot/Chilled water Trigeneration		TYPICAL NEEDS Flexible Heat and Power
BENEFITS Small Footprint High Availability Low Emissions Best-In-Class Efficiency	TYPICAL NEEDS Steam Thermal Oil Direct/Indirect Drying	BENEFITS High Availability Flexibility Low Emissions Best-In-Class Efficiency
	BENEFITS Low Emissions Best-In-Class Efficiency High Availability Clean Gases in Drying	

EXAMPLE OF CHP PROJECTS							
COUNTRY	CHINA	GERMANY	INDIA	NIGERIA	RUSSIA	SPAIN	UK
SECTOR	Chemical Manufacturing	University	Fertilizer	Brewery	District Heating	Paper Mill	Hospital
REQUIREMENT	Power Steam	Power Steam Hot water Combined Cycle	Power Steam	Power Steam	Power Steam Hot water Combined Cycle	Power Steam	Power Steam Hot water Chilled water
PROJECT MWe	16.24	13.0	14.6	5.0	63.0	21.0	4.5
GAS TURBINE TYPE	<i>Taurus</i> 60 4 Units	<i>Taurus</i> 60 2 Units	<i>Taurus</i> 70 2 Units	<i>Taurus</i> 60 1 Unit	<i>Titan</i> 130 3 Units	<i>Titan</i> 250 1 Unit	<i>Mercury</i> 50 1 Unit
FUEL	Coke Oven Gas (Diesel backup)	Natural Gas (Diesel backup)	Natural Gas	Natural Gas (Diesel backup)	Natural Gas	Natural Gas	Natural Gas
PLANT EFFICIENCY	68%	80%	84%	80%	77%	78%	81%
KEY BENEFITS	Economic use of previously flared gas. Reducing yearly CO ₂ emissions by over 100'000 tonnes.	Flexible heat generation. 18% CO ₂ reduction. Energy efficiency incentives.	Continuous power and steam supply.	Continuous power and steam supply.	Cost effective and reliable energy supply.	16% CO ₂ reduction. Low NOx emissions. Access to incentives.	15% CO ₂ reduction. Uninterruptable power supply. Access to incentives.



WE HAVE THE SOLUTION

Wherever the location, whatever the application, Turbomach understands that customer's might require complete, integrated power plants to support their core activities. Turbomach's extensive experience in plant engineering and support services through a wide range of applications allows us to be a customer's preferred single point of contact from project definition to plant operation.

GENERATING RELIABLE HEAT AND POWER

Gas turbine generator sets are compact, self-contained, and have low vibration levels that allow for easy installation in existing facilities or boiler rooms, while their low emissions levels make them suitable for deployment in urban areas.

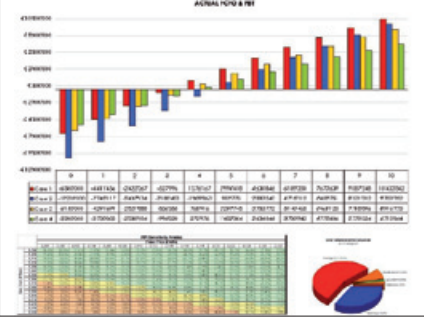
REDUCING YOUR ENVIRONMENTAL FOOTPRINT

Gas turbines provide best-in-class energy efficiency for industrial processes, thanks to their unmatched high quality heat generation capability. *Solar* industrial gas turbines benefit from the latest developments in emission reduction using *SoLoNOx*TM dry low emissions combustion technology which allows them to set benchmarks in terms of NOx and CO emissions, while cancelling unburned hydrocarbon emissions.

SUPPORTING INDEPENDENT POWER PLANTS

With low lifecycle costs and high flexibility in heat and power generation, gas turbine cogeneration plants, whether in simple cycle or in combined cycle configurations, are the most effective systems to provide 24/7 heating, cooling and power to your consumers.

FEASIBILITY STUDIES



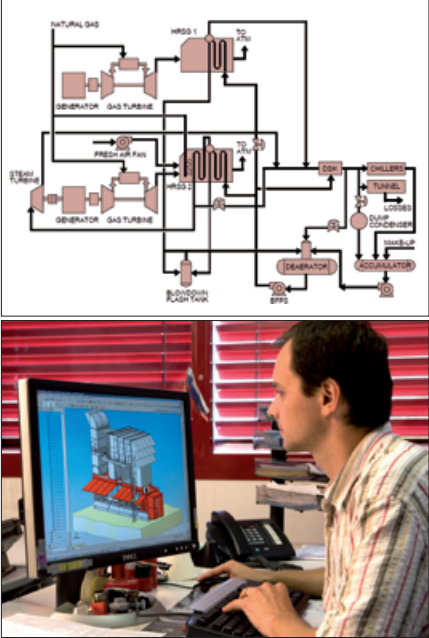
Technology Selection

Technical and Financial Assessment

Thermal Dynamic Optimization

Customization

PROCESS & BASIC DESIGN



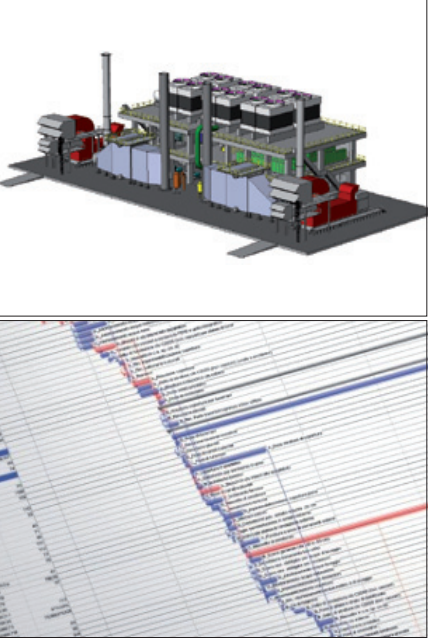
Basic Concept

Modular Design

Basic Design

Facility Integration Planning

PROJECT MANAGEMENT



Detail Design

Scheduling

Procurement and Expediting

Logistics



PROJECT EXECUTION

- Defined roles and responsibilities
- High safety standards
- Maximum minimum on-site civil works
- Quick and easy transportation, installation, and connection
- Professional and highly-trained personnel

CUSTOMER SERVICES

Turbomach Customer Services offers a wide range of products and services to optimize operation, ensure maximum durability, and extend the life of your turbomachinery. Foremost in this suite of support options is our comprehensive technologically based system known as **InSight System™**.



InSight System is the people, processes, and technology deployed to deliver high value machinery management solutions, and directly support our approach to equipment health management for customers worldwide.

The system includes advanced diagnostics in support of condition monitoring, remote troubleshooting, alert notifications, availability and reliability tracking, and equipment operational summary reports to provide predictive recommendations to minimize downtime. This technology also allows for collaborative, remote technical support by a designated Fleet Manager and Global Support Network to enhance decision-making.

PROJECT EXECUTION



Workshop Assembly and Testing

Installation and Supervision

Commissioning

Performance Testing

OPERATION & MAINTENANCE



Remote Monitoring and Diagnostics

Preventive Maintenance

Long-Term Service Agreements

Turbine Overhauls

LONG - TERM SUPPORT



Control System Upgrades

Turbine Upgrades

Refurbishments

Training Support

COMPREHENSIVE SERVICES

WE HAVE THE SOLUTION

A worldwide leader in gas turbine cogeneration systems:

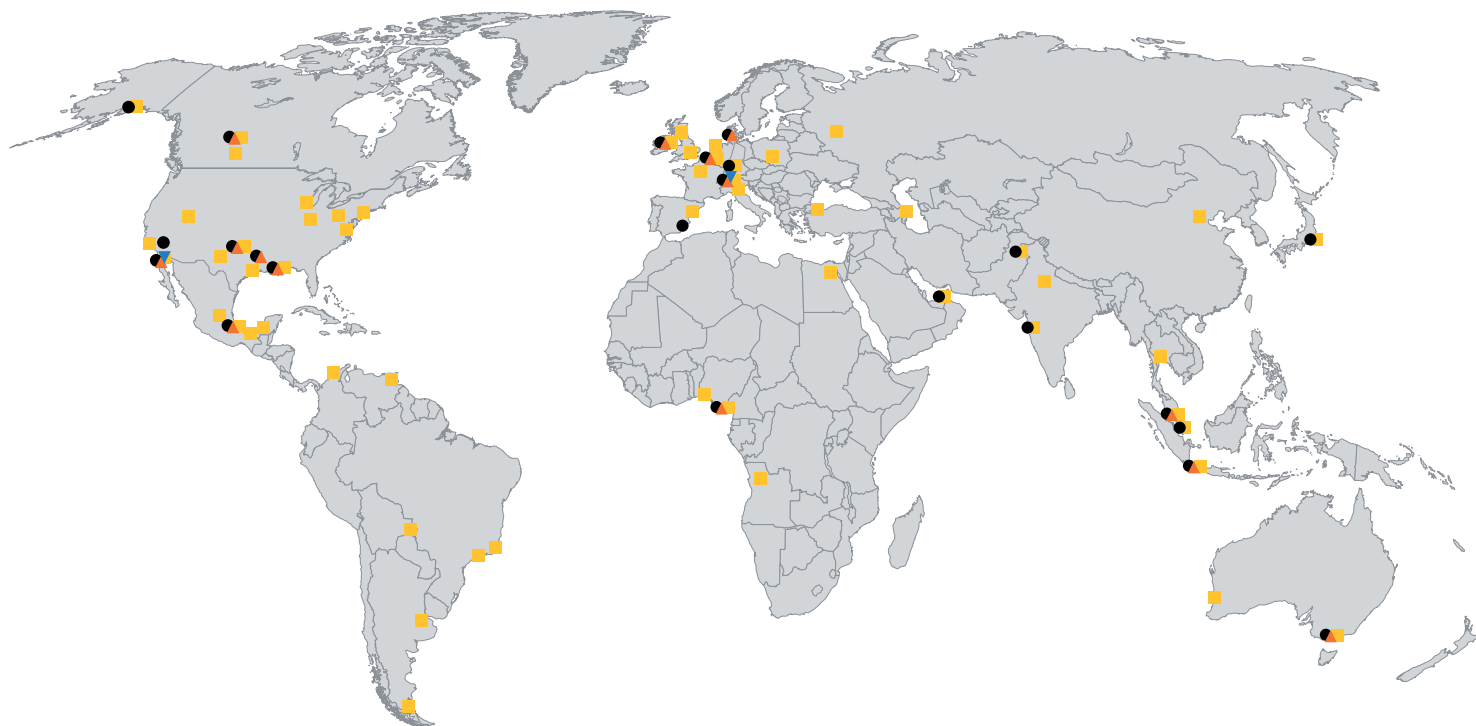
- **EFFICIENT AND RELIABLE GAS TURBINE GENERATOR SETS**
- **THE MOST COMPREHENSIVE PORTFOLIO OF INDUSTRIAL GAS TURBINE APPLICATIONS**
- **OVER 40 YEARS OF EXPERIENCE IN COGENERATION**
- **WORLDWIDE SUPPORT STRUCTURE**
- **TRAINING SOLUTIONS FOR YOUR BUSINESS NEEDS**

With over 40 years of experience, Turbomach is established as a major player in the power generation market. We have nearly 1,000 gas turbine generator sets installed in over 50 countries. Turbomach promotes a partnership relationship with customers. We understand that our growth depends on helping you to succeed in your business.

ABOUT US

Turbomach is a fully integrated part of Solar Turbines, a leading manufacturer of mid-range industrial gas turbines and a subsidiary of Caterpillar Inc. With over 60 years of experience Solar has an installed base of more than 14'000 units produced in 98 countries around the world. The Solar Turbines family has more than 7'000 employees worldwide, 400 of whom are located at Turbomach in Switzerland.

- ▼ Manufacturing, Administrative and Engineering Facility
- ▲ Repair and Overhaul Facility
- Spare-parts Warehouse
- Field Office



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