COMBINED HEAT AND POWER (CHP) FROM NATURAL GAS

Valid for North America
<table>
<thead>
<tr>
<th>Page</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>04</td>
<td>MTU Onsite Energy</td>
</tr>
<tr>
<td>06</td>
<td>Overview</td>
</tr>
<tr>
<td>08</td>
<td>Advantages</td>
</tr>
<tr>
<td>10</td>
<td>Applications</td>
</tr>
<tr>
<td>12</td>
<td>Compact systems: Series 400</td>
</tr>
<tr>
<td>14</td>
<td>Split-module systems: Series 4000</td>
</tr>
<tr>
<td>16</td>
<td>System controls</td>
</tr>
<tr>
<td>17</td>
<td>Additional system components</td>
</tr>
<tr>
<td>18</td>
<td>Container units</td>
</tr>
<tr>
<td>20</td>
<td>Project planning</td>
</tr>
<tr>
<td>22</td>
<td>Parts and service</td>
</tr>
</tbody>
</table>
COMBINING OUR RESOURCES TO SUPPLY YOU WITH DEPENDABLE ENERGY: ANYTIME. ANYWHERE.

MTU Onsite Energy is one of the core brands of Rolls-Royce Power Systems AG, which is a world-leading provider of high- and medium-speed diesel and gas engines, complete drive systems, distributed energy systems and fuel injection systems for the most demanding requirements.

MTU Onsite Energy offers complete power system solutions: from mission critical to standby power to continuous power, heating and cooling. We also provide a full line of service products to help you get the most from your equipment.

Customers around the world trust us to provide reliable power for a wide range of applications, such as healthcare, data centers, airports, farms and independent power stations. Our product portfolio covers diesel generator sets up to 3,250 kW, gas-powered cogeneration systems up to 2,500 kW and gas turbines up to 50,000 kW. This product offering is complemented by medium-speed engines for land-based energy solutions up to 9,300 kW as part of the Rolls-Royce Power Systems AG product portfolio.

More than 60 years of power generation systems expertise and over a century of diesel engine engineering experience have enabled us to provide complete solutions all over the globe. And we continue to develop sustainable alternatives, with systems that produce greener energy from climate-neutral, regenerative fuels, such as combined heat and power (CHP) plants fueled by biogas, landfill gas or sewage gas.

MTU Onsite Energy gas engine systems
Developed and manufactured for operation with natural gas, biogas and other specialty gases, MTU Onsite Energy provides three types of systems:

- Gas generator sets for producing power
- Combined heat and power modules (CHP) for generating heat and power
- Combined heat, power and cooling modules (CHPC) for generating heat, power and cooling (in combination with appropriate cooling units)

By converting gas into various combinations of electrical and thermal energy on site, MTU Onsite Energy gas engine systems produce energy exactly where it is needed without any transmission losses.

Natural gas as fuel
Modern energy production focuses mainly on fossil fuels. However, their limited supply--combined with the negative impact of conventional technologies on the environment and our climate--have prompted a shift towards new energy policies.

Gas powered energy systems offer great potential for playing an important role in the energy mix of the future--and our gensets and CHP modules can effectively explore this potential. Covering the 128-2,129 kW range, and based on technological advancements achieved over multiple decades, they combine high performance with low emissions.
Whether you require power, combined heat and power (CHP), or combined heat, power and cooling (CHPC), MTU Onsite Energy gas engine systems fulfill your demands.

**Power**

Deployed for grid-parallel or off-grid operation as needed, our gas generator sets are trusted to provide power around-the-clock in locations where the power supply is unreliable or even nonexistent.

Power stations based on gas engines are a special application of power generation plants. They often fulfill medium- and long-term power needs for projects that must be developed and implemented quickly, frequently under critical conditions.

Aligned with all requirements on-site, we deliver and service highly efficient power station solutions providing 200 MW or more.

**Combined heat and power (CHP)**

Many applications require heat in addition to power. Hospitals, schools, sports facilities, office and administrative buildings, industrial enterprises with heat-intensive manufacturing methods, department stores and shopping centers often generate heat and obtain power from the public grid separately.

MTU Onsite Energy CHP systems provide a significantly more economical alternative. Generally consisting of an engine-generator set and heat exchangers for waste heat utilization, MTU Onsite Energy CHP systems produce both heat and power on site using a single fuel source. The generated power can be used to cover internal demands or fed into the public grid, while the produced thermal energy can be utilized for heating purposes or deployed as process heat. The inclusion of various heat sources—from engine cooling water to exhaust gas—is individually customized for your unique situation to provide you with the greatest benefit.

**Combined heat, power and cooling (CHPC)**

Using an absorption or an adsorption chiller, CHP systems can also create cooling energy, making them even more cost-effective. For example, this functionality could be used for air conditioning in an office building. The supply of cooling energy plays an important role not only for building climate control—it can also be utilized as process cooling in manufacturing, or for food refrigeration or ambient cooling in temperature-sensitive areas (e.g. data centers).
Every MTU Onsite Energy system is designed and implemented based on the unique, combined know-how of MTU and MTU Onsite Energy—with more than 100 years of experience in engine manufacturing and more than 35 years of expertise in complete system development, design, manufacturing and support. As a result, our CHP technology offers convincing advantages.

**Efficiency**
Our CHP plants offer a promising revenue potential when surrounding conditions are favorable. Working closely with you, we’ll conduct a profitability analysis to demonstrate how much profit you can generate by deploying an MTU Onsite Energy CHP system. We’ll also determine your requirements for size and number of gensets.

**Eco-friendliness**
The generation of heat and power with a gas-powered CHP reduces CO$_2$ emission by up to 50% compared to a conventional solution that produces heat and power separately. And our lean-burn engine principle prevents the production of harmful emissions during the combustion process. In many cases emission levels below the limits required by clean air regulations around the world can be achieved even without the use of a catalytic converter.

**Sustainability**
CHP systems extract the heat that accrues during the combustion process via heat exchangers and provide it to the consumer as usable heat, enabling reduced energy usage up to 40 percent compared to conventional power systems.

**Independence**
In areas with nonexistent or unreliable public infrastructure, MTU Onsite Energy systems ensure an independent supply of heat and power.

**Reliability**
Our gas power systems have been proven in many applications and over hundreds of thousands of operating hours. Their high reliability and availability rates are based on a variety of factors that give MTU Onsite Energy the advantage:

- Air-fuel ratio control system guarantees optimum combustion even with variable gas qualities, preventing engine damage.
- Cooling system arrangement enables straightforward integration into existing heating systems.
- Exhaust heat exchanger integration into engine coolant circulation system minimizes the risk of heat exchanger damage.
- Utilization of carefully selected, standardized sub-assemblies achieves maximum operational safety and reliability.
- Low fuel and lubricant consumption combined with long component life for reduced operating costs.
- Continuous analysis of field data by in-house development department for ongoing technological optimizations.
- Extensive service network provides timely support—anytime, anywhere.
- Comprehensive MTU ValueCare parts and service portfolio, with flexible solutions to ensure system reliability and longevity.
MTU Onsite Energy natural gas CHP systems are deployed in numerous applications worldwide.

Building maintenance
Local heat supply is an economically viable alternative to separate heat generation in individual buildings and provides various cost advantages. Investment and maintenance costs are significantly lowered, and additional space is gained since a boiler plant is no longer necessary in each building. The CHP system meets base load heat requirements reliably and economically. Heat storage and an additional peak load boiler enable flexible and adaptable heat generation to the users’ heating profile.

Common applications:
- Housing estates
- Swimming pools
- Hotels
- Schools
- Public buildings
- Leisure centers
- Shopping centers

Industry and commerce
Gas-powered CHP modules from MTU Onsite Energy provide efficient and independent energy for companies with production processes requiring a continuous supply of power, heat or cooling energy. They are also an interesting alternative if a production facilities’ capabilities require extension. Rather than increasing line capacities, you can invest in an independent, distributed energy solution.

Common applications:
- Food processing
- Chemical production
- Traditional plant and systems engineering
- Greenhouses

Safety-critical applications
Our gas engine systems have proven themselves in numerous safety-critical environments where a continuous energy supply is essential.

Common applications:
- Hospitals
- Telecommunication centers
- Data centers

Depending on the local legal requirements, our CHP modules can also take on emergency power generator functions.

NATURAL GAS CHP SYSTEMS: HIGHLY VERSATILE CUSTOMIZED SOLUTIONS.
For more than 35 years, we have been delivering compact systems based on 6- and 12-cylinder Series 400 gas engines, with an output range from 128-358 kWe.

Throughout that time the engines have been continuously advanced and optimized to provide the maximum electrical and thermal efficiency within their output range—topping 90 percent.

Series 400 gas engines are mainly deployed in CHP applications (including thermal use with heat extraction from engine cooling water or waste gas). However, deployment for just power generation is also possible. Optimized components and mature control and monitoring systems guarantee the highest reliability.

In addition to single module systems, several modules or plants can be combined in a multi-module system. Adjustments to the electrical or thermal load profile are achieved by switching in or shutting down individual modules. Another advantage of multi-module systems is their high level of availability.

Advantages of compact CHP modules
MTU Onsite Energy compact modules offer numerous advantages:
- Space-saving
- Supplied ready to connect
- Factory tested with heat recovery
- Available as open or enclosed units
- Easy to maintain
- Standardized

Our Series 400 systems can be integrated into existing buildings or provided as turnkey containerized units.

Many of our systems have completed well over 100,000 hours of service and are still providing reliable power and heat day after day—proving the dependability and longevity of our engine technology.

Description of individual components

1. MTU Module Control (MMC)
   - Contains all functions necessary for controlling the system. All auxiliary drives required for the CHP system can be operated from here. The integrated power circuitry minimizes the need for cabling on site.

2. Generator
   - Optimally tailored to the engine and made by renowned manufacturers, the generator ensures a high level of reliability with the optimal efficiency.

3. Crank-case ventilation
   - Improved ventilation minimizes deposits in intake tract and combustion chamber, guaranteeing continuously high performance levels.

4. Mixture cooler
   - Two-stage with large surface area to improve engine performance and heat utilization.

5. Gas engine
   - Advanced and proven Series 400, optimized for natural gas use. Combustion chambers ensure highest efficiency levels in its performance category.

6. Ignition system
   - Designed for individual cylinders, enabling the most efficient operation levels for all cylinders, even with variable CH4 content. The ignition voltage display provides information about the condition of the spark plugs.

7. Knock detection
   - Cylinder-specific knock detection and regulation protects against abnormal operating conditions and guarantees safe engine operation even with natural gas containing low methane levels.
SERIES 4000: SPLIT-CONFIGURATION CHP SYSTEMS.

Output range 763 – 2,129 kWe

Our split-configuration CHP systems are based on MTU Series 4000 engines, incorporating more than 100 years of engine development and manufacturing experience. With countless hours of operation all around the world, these systems continue proving themselves in the most severe conditions.

Available in 8V, 12V, 16V and 20V configurations, our CHP systems offer the maximum electrical and thermal efficiency—and highest fuel efficiency rates—in the 763 – 2,129 kW output range. Series 4000 gas engines are deployable with or without heat extraction (from engine cooling water and/or exhaust gas). Our split-configuration CHP systems can be integrated into existing buildings or provided as turnkey containerized units.

Split-configuration indicates that motor/generator and heat module (if applicable) are provided as separate components. Optimized components and mature control and monitoring systems guarantee the highest reliability.

Our CHP systems are often designed as multi-module systems, enabling optimal system performance and efficiency in the upper megawatt range. Adjustments to the electrical or thermal load profile are achieved by switching in or shutting down individual modules. Another advantage of multi-module systems is their high levels of availability.

All systems undergo comprehensive factory-tested before being delivered to you.

Advantages of split-configuration CHP systems
// Separate heat generation module
// Simple modifications to individual customer requirements
// Optimal adaptation to available space at installation site
// Warm-water generation with various temperature ranges and steam generation with separate waste heat utilization
// Easier transport
// Simplified installation

Series 4000 components

1 Generator
// Precisely customized to the engine and built by renowned manufacturers, ensuring a high level of reliability with the best degree of efficiency.

2 Mixture cooler
// Two-stage with large surface area to improve engine performance and heat utilization.

3 Ignition system
// Designed for individual cylinders, maximizing efficient operation for all cylinders even with variable CH4 content. The ignition voltage display also provides spark plug information.

4 Gas engine
// Advanced and proven Series 4000, optimized for natural gas use. Combustion chambers ensure the highest efficiency levels in its performance category.

5 Knock detection
// Cylinder-specific knock detection and regulation protects against abnormal operating conditions and guarantees safe engine operation even with natural gas of varying composition.

6 Crank-case ventilation
// Minimizes deposits in intake tract and combustion chamber and guarantees continuous high levels of performance.

MTU Module Control (MMC) – Not shown
// Contains all functions necessary for controlling the CHP plant. Provides full access to auxiliary drive operation. Integrated power circuitry minimizes the need for cabling. The MMC is housed separately in the control cabinet and hidden from sight.
MTU MODULE CONTROL:  
SYSTEM MONITORING – ANYTIME.

MTU Onsite Energy provides the complete system package, fully engineered and ready for installation. One of the most important aspects is the control system technology. If the generator set is the heart of the system, then the MTU Module Controller (MMC) is its brain. Our reliable, industrial-computer controlled electronics monitor the overall engine and system to ensure operation.

The most important features are:
- Drive and control via Programmable Logic Controller (PLC)
- Operation and visual display via industrial PC and touch-screen panel with color display
- Visual display of all functional processes and controls
- Optional integration of numerous additional controls and functions (CH4, gas tank, heat production mode, heat storage, mains power usage)
- Ethernet enabled multi-module system networking
- Linkable with master control system
- Wide choice of interface protocols (Ethernet, Profibus DP, Modbus RTU, Modbus TCP/IP, Profinet)
- Database logging of all fault and status messages (up to six months of data can be recorded)
- Optional remote diagnosis via DSL or ISDN
- Optional integration of SMS / E-mail client (notification of faults, daily reporting of all meter readings)

ADDITIONAL SYSTEM COMPONENTS:  
TAILORED TO YOUR NEEDS.

MTU Onsite Energy is your full system partner—we provide a wide range of perfectly developed system components in addition to supplying the actual module or genset itself.

Oxidation catalyst
Tailored to the respective engine, the catalyst ensures adherence to specific emissions standards.

Auxiliary drive control and electrical connections
The integrated MTU Module Control (MMC) offers a range of connections and control options, such as hot water pumps, mixed cooling water pumps, extractor fan control, gas warning system, lubricant system, smoke detector and gas compressor.

Gas safety plan
MTU Onsite Energy has developed a comprehensive gas safety plan for entire systems that guarantees protection against internal and external explosions. Talk to us; our specialists will be happy to advise you.

Grid code
In many countries, the technical specifications for feeding power into the public grid are detailed and exhaustive. The so-called grid codes define the minimum parameters regarding the dimensioning of the generator as well as the control and safety functions a system must fulfill in order to guarantee network stability. Our plants fulfill these standards.
As a system supplier, we offer a wide variety of solutions. In addition to our gas engine systems for use in buildings, we also provide turnkey containerized units. Compact, complete, flexible and autonomous, they are ideally suitable for mobile power generation or applications that do not provide enough space for a complete gas engine system.

When producing power from natural gas, installing the generator set in a container can be a useful alternative to permanently installing a static system in a generator room. Our standardized container generator set is designed to meet the requirements of a variety of applications.

The container includes:
- Generator set
- Switchgear, including control and monitoring system
- All necessary connection and supply systems (ventilation, lubricant supply, heat recovery, etc.)

Like all MTU Onsite Energy systems, the standard container gensets are fully capable of automatic and continuous operation.

We offer two types of containers:
- Power Containers generate only electrical energy and are ideal for remote locations or areas with unreliable power supply. They are often deployed in Power Stations.
- Combined heat and power (CHP) units generate electrical and thermal energy, e.g. for operators whose processes require heat in addition to power.

Advantages of container units:
- Technically mature, proven and eco-friendly gas engine technology for maximum efficiency and reliability
- Completely autonomous design does not require an additional building
- Flexible unit assembly system based on standardized modules and synchronized components
- Readily available, compact, turnkey plug and play solutions
- Optimal support thanks to our global service network
- Quality certified under ISO 9001 and DIN EN ISO 14001

CONTAINERIZED SOLUTIONS: COMPACT, FLEXIBLE, AUTONOMOUS.
Full support for your individual CHP system
Choosing the best CHP system for your needs depends on several factors. That’s why we provide comprehensive support, all the way from project conception to realization.

// Planning support
// Application and integration expertise
// Comprehensive technological explanation
// Proposal development with budget for planning phase and fixed price for implementation
// Design and planning of peripheral systems
// Guidance regarding service solutions as early as the project phase
// Help with questions regarding emissions regulations

CHP PROJECT PLANNING:
INDIVIDUAL ADVICE FOR INDIVIDUAL SOLUTIONS.

Convincingly economical
Our CHP plants offer a promising revenue potential when surrounding conditions are favorable. Working closely with you, we’ll conduct a profitability analysis to demonstrate how much profit you can generate by deploying an MTU Onsite Energy CHP system. We’ll also determine your requirements for size and number of gensets.

We will gladly provide you with more information by telephone or visit you for a personal meeting.
Purchasing an MTU Onsite Energy gas power system pays off in many ways. In addition to enhanced performance, efficiency and reliability, we offer a full range of superior service and maintenance support through MTU ValueCare—our portfolio of value-enhancing products and services designed for peak performance and maximum uptime. Support is always nearby—anytime and anywhere. For your convenience, MTU ValueCare is available worldwide through our MTU Onsite Energy service network.

MTU ValueCare includes three product lines:

**ValueService**
Our full line of maintenance and repair solutions to help you protect your investment and get the most out of your equipment. MTU Onsite Energy provides you with all the tools, with support customized to your needs.

Service Agreements make it easy to plan the cost of maintenance throughout your system’s lifecycle, with professional maintenance performed by MTU Onsite Energy-certified technicians, using only genuine new or remanufactured spare parts. The details, terms and periods of each package are customized to meet your individual needs, ensuring cost certainty and maximum availability.

Remote Diagnostics is a powerful solution that links you directly to a record of your generator set’s activity through a secure Internet connection. Through early fault identification, you can act quickly to prevent damage, save on service and repairs, identify spares needed and increase engine efficiency.

Technical documentation provides complete, clear information on the installation and commissioning, operation and maintenance your MTU Onsite Energy gas engine systems, helping you maximize its performance and value.

**ValueSpares**
Only MTU Onsite Energy can guarantee genuine quality, with ValueSpares parts, filters, oils and coolants designed to work seamlessly with your equipment for maximum performance and longevity.

**ValueExchange**
Remanufactured MTU products deliver the same high standards of performance, service life and quality as new MTU products, along with identical warranty coverage—at a fraction of the cost. And with design and model-related updates made during the remanufacturing process, they also feature similar technological advancements.

Local support. Worldwide.
Whenever and wherever you need expert support, MTU Onsite Energy specialists are available through our global service network. This continuous and long-term care ensures high availability, dependability and efficiency throughout the lifecycle of your engines and systems. To find your local MTU Onsite Energy distributor, visit www.cogen.mtuonsiteenergy.com.

**ValueTraining**
Training is a great way to get maximum efficiency from your equipment. From timely preventive maintenance to minor repairs and simple error corrections, our customized training programs are designed to make your service personnel proficient with MTU Onsite Energy engines and systems—maximizing your return on investment.