

COMBINED HEAT AND POWER FROM BIOGAS



COMBINING OUR ENERGIES TO MAKE ENERGY: ECONOMICAL, SUSTAINABLE, CLEAN.

MTU Onsite Energy is one of the core brands of Tognum AG, a world-leading provider of distributed energy systems, diesel engines, fuel injection systems and complete propulsion systems for ships, heavy-duty land and rail vehicles, military vehicles and the oil and gas industry.

Under the umbrella of Tognum AG, MTU Onsite Energy bundles the competencies for distributed energy systems and offers you comprehensive, intelligent and innovative system solutions for diesel and gas technology – for all applications, for the most diverse needs.

Sustainability is one of the most important values MTU Onsite Energy stands for. Today and in the future, our focus is on developing and implementing system solutions for producing energy from climate-neutral, regenerative fuels – such as combined heat and power plants for biogas fuels.

Better energy

Biomass has massive potential as an essential component of the energy mix of the future. Energy plants supplied by MTU Onsite Energy utilize that potential. Our generator sets and cogeneration modules based on gas engines use biogas, sewage gas and landfill gas to produce electricity and heat – ecologically, reliably and extremely efficiently. Government subsidy schemes such as the EEG (Renewable Energy Act) in Germany make investment in a biogas plant even more financially attractive.

Whether for recycling organic waste in the agricultural industry or utilizing sewage and landfill gas, MTU Onsite Energy develops solutions perfectly tailored to fit each customer's specific requirements.



BIOGAS CHP PLANTS: A BEST BUY FROM MTU ONSITE ENERGY GAS POWER SYSTEMS.

Our cogeneration systems benefit from more than 100 years of experience in manufacturing engines from MTU and more than 35 years of experience in design, manufacturing and support of MTU Onsite Energy Gas Power Systems.

The use of biogas and sewage gas is one of the typical applications for MTU Onsite Energy CHP generators and modules based on gas engines. Whether for power generation alone, for cogeneration or trigeneration, whether for governments, farmers, sewage plants or landfill sites: MTU Onsite Energy develops economical and reliable systems solutions specifically configured for individual applications and customer requirements.

The combined heat and power systems of MTU Onsite Energy not only supply energy – they provide better energy.

Our technology offers many advantages:

// Economical

Under current conditions, the use of these systems offers promising revenue potential. A profitability analysis for the specific application demonstrates the customer's profit potential when using an MTU Onsite Energy CHP system. In many countries, e.g. Germany, biogas plants are subsidized by the government as part of the Renewable Energy Law (EEG) and are therefore even more economical.

// Environmentally friendly

One of today's main challenges is to reduce emissions of greenhouse gases. In comparison with conventional power generation, MTU Onsite Energy CHP modules provide a CO₂ reduction of up to 50 %.

// Sustainable

Combined heat and power (CHP) systems make use of a combustion engine to drive a power generator. Heat accrued during the combustion process is transferred via heat exchangers and provided to consumers. The high efficiency of CHP systems enables up to a 40 % reduction in primary energy usage compared to conventional power plants.

// Reliable

MTU Onsite Energy gas power systems have proven their reliability, availability and longevity in many applications and hundreds of thousands of operating hours.

MTU Onsite Energy's advanced control technology ensures a high availability rate for your plant. Thanks to our extensive service network, you will receive speedy support from our experienced service partners. With our MTU **ValueCare** portfolio, we provide comprehensive service solutions which guarantee the efficiency of your plant in the long term.

// Independent

In areas with missing or unreliable public infrastructure, MTU Onsite Energy systems ensure independent power and heat supply.



BIOGAS: THE NATURAL CHOICE.

The principle of a CHP system based on biogas is simple and ingenious: biogas is generated during the fermentation of organic material and collected. It is then used to power cogeneration systems resulting in heat and power that is both economical and saves resources.

The electricity produced can either be used to supply the operator's own requirements or fed into the national power grid (as provided for by the Renewable Energy Act in Germany).

The heat generated by operation of the engine (as part of waste gas, coolant and oil) is used by heat exchangers to maintain the temperature of the fermenters at a constant optimal level for the fermentation process. Additional heat consumers can also be supplied with heat, such as buildings in the same complex or in neighbouring residential areas.

Biogas is created by the digestion or fermentation of organic materials. The basic material is often slurry or solid manure. Regenerative raw materials or waste from the food industry are generally used as co-fermentates. 50 – 70 % of the gas produced this way are composed of the high-quality fuel methane. Carbon dioxide (CO₂), nitrogen and trace gases (such as hydrogen sulfide) are its other constituents.

A multiplicity of organic materials can be used in a biogas plant. Some systems run entirely on slurry and solid manure, while others exclusively use regenerative raw materials. Frequently, a mixture of materials is used. An increasing number of commercial operations specialises not only in the recycling of slurry but also the disposal of organic waste. Food waste from the hotel and catering industries, wholesale markets, market gardens, etc. is one type of material

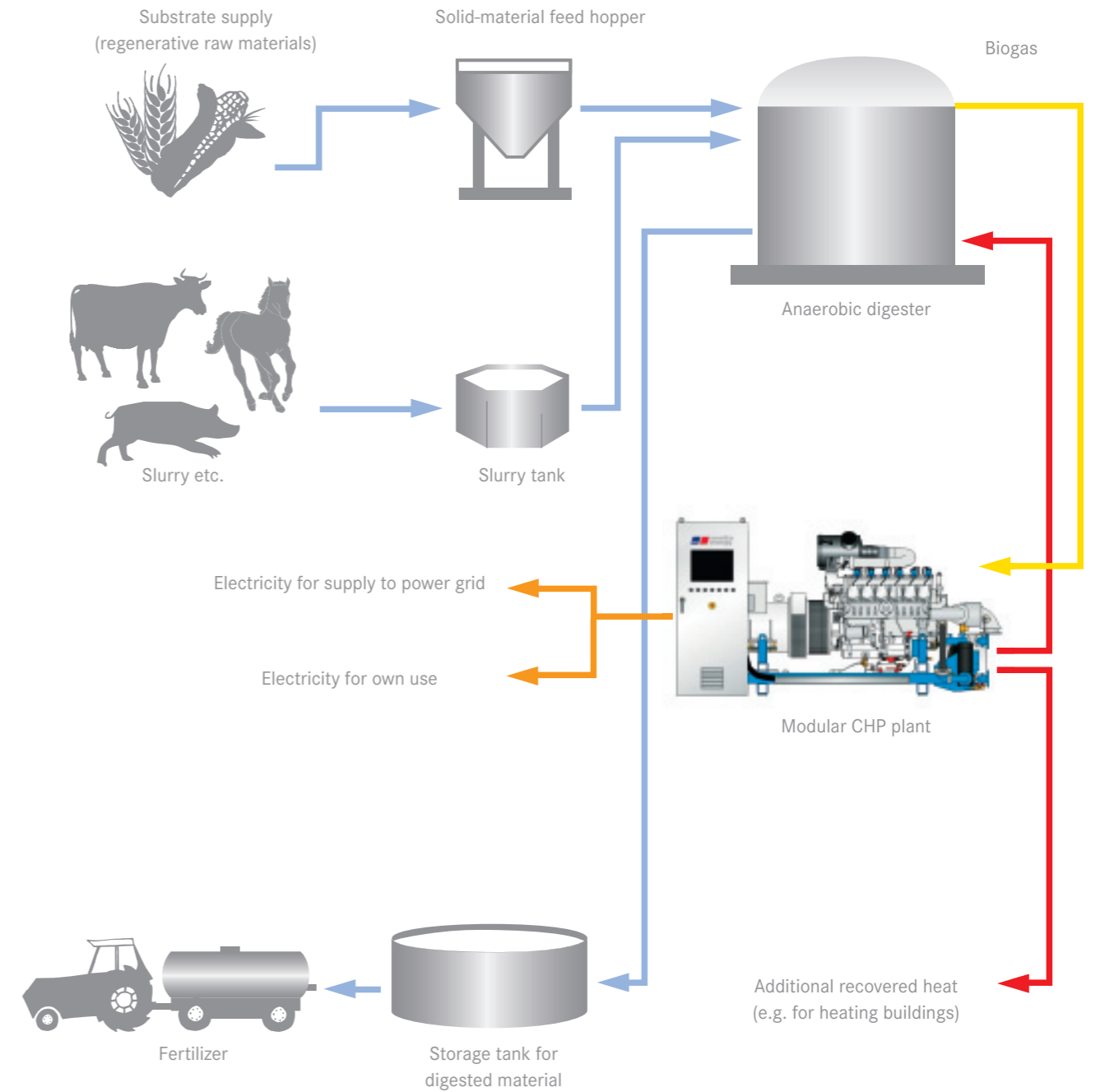
they process and dispose of.

With many years of technological experience and engines that have proven their reliability in the biogas segment, MTU Onsite Energy is able to integrate CHP technology into the overall process and make it profitable.

Details on the available systems and information about our numerous reference installations are available on request.



Biogas plant using regenerative raw materials

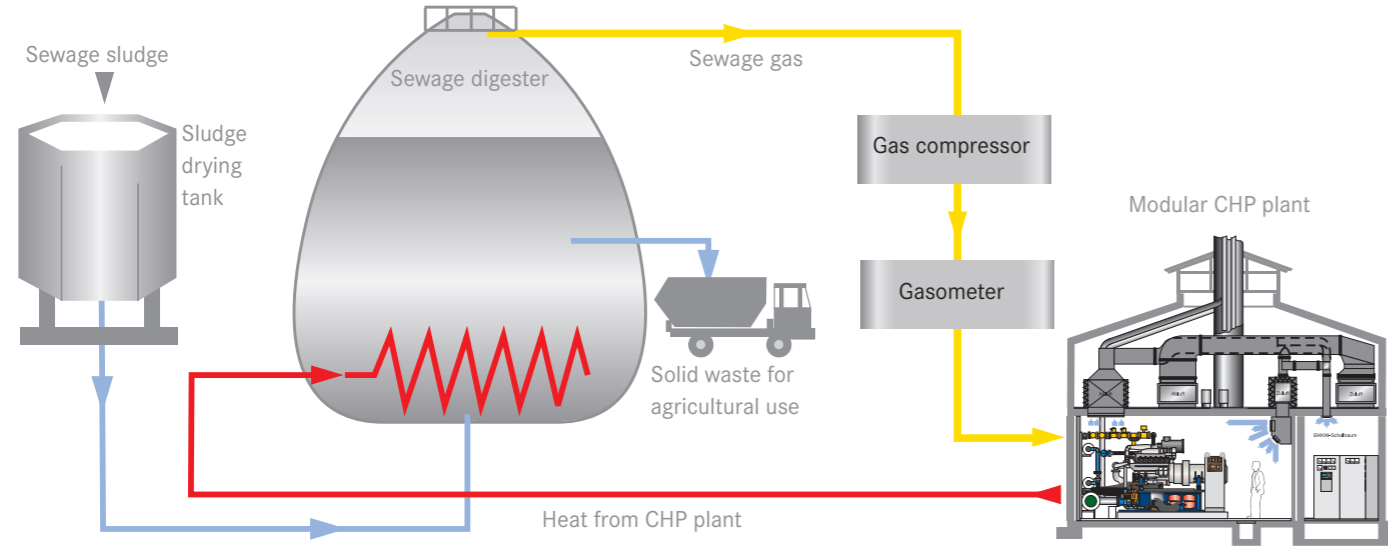


SEWAGE GAS: ENERGY FROM EFFLUENT.

Installing CHP modules in sewage plants is one of the most economical ways to utilize waste energy – sewage gas, much like landfill gas, is available as a “free” fuel on site. The numbers speak for themselves: from 6 m³ of sewage, MTU Onsite Energy systems manage to generate on average 1 kWh of electric power and 1.2 kWh of thermal energy.

The efficiently and ecologically generated electric power can either be used to supply the sewage plant itself, or it can be fed into the electricity grid. In the latter case, compensation according to government subsidy schemes, like the German Renewable Energy Act (EEG), is available in many countries.

During the combustion process, heat is being generated inside the gas engine. This thermal energy can be utilized for heating up the sewage sludge in the digester or for heating the whole facility. In large-scale plants, excessive high-temperature heat may be available that can be used to pasteurize or dry the sewage sludge.



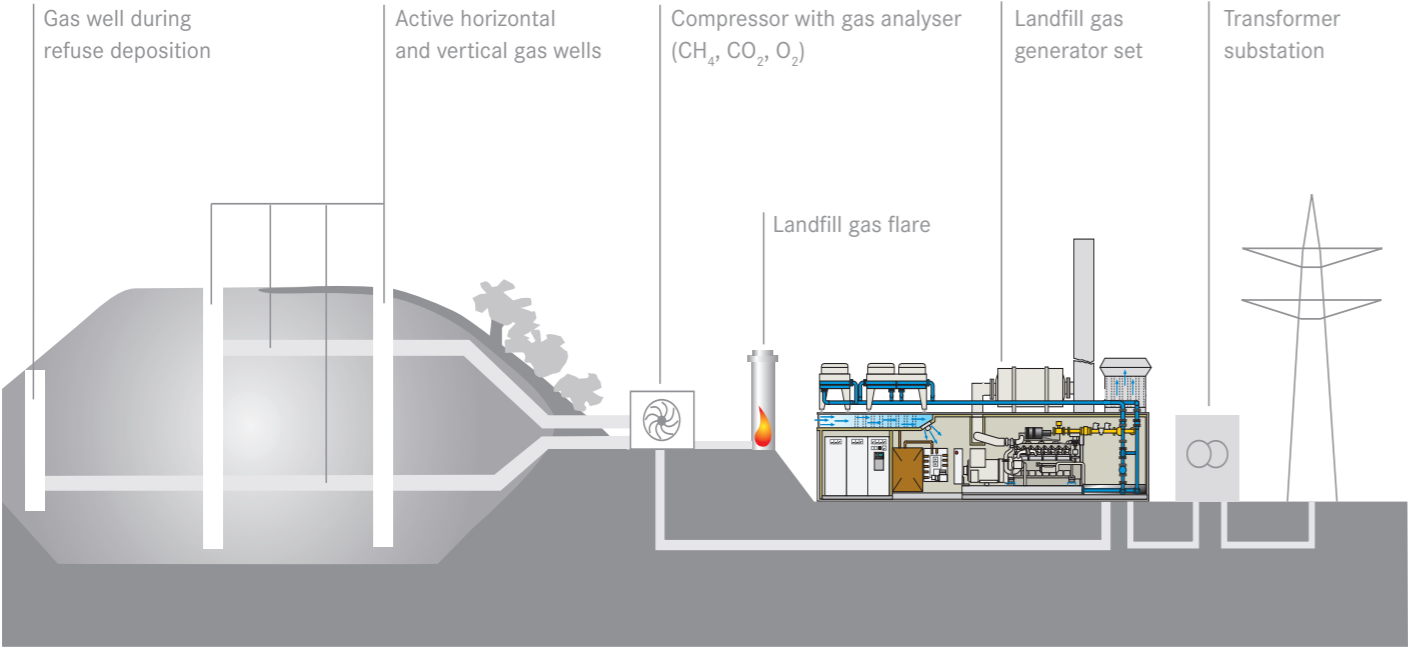
LANDFILL GAS: GAIN FROM GARBAGE.

Properly monitored landfill sites represent economical energy sources. The gas produced by the anaerobic decomposition of organic matter in the deposited refuse has to be captured and removed for environmental reasons. It thus constitutes a virtually free source of energy that can be utilized to generate electricity using the intelligent gas engine systems made by MTU Onsite Energy.

Plants for producing electricity from landfill gas attract government subsidies in Germany under the terms of the Renewable Energy Act (EEG). The electricity generated can be supplied to the national power grid at a fixed compensation rate. There are comparable assistance schemes already in place or in the pipeline in many other countries as well.

Over and above the attractive financial aspects, planned gas recycling also offers a number of other important benefits:

- // The odor nuisance from landfill sites is reduced.
- // Fire and explosion hazards can be prevented.
- // Gas migration is avoided.
- // The landfill site can be recultivated more quickly.



CHP GENSETS AND MODULES: PROVEN, EFFICIENT AND RELIABLE.

MTU Onsite Energy CHP gensets and modules are technologically advanced solutions with a high degree of electrical efficiency. They have proven their reliability, availability and longevity in many applications and hundreds of thousands of operating hours.

- // Our lean-burn engines prevent the production of harmful emissions in the actual combustion process itself. Emission levels below the limits required by the German "TA Luft" clean air regulations and similar standards in other countries are reliably achieved even without the use of a catalytic converter.
- // The MTU Onsite Energy oxygen-content control system guarantees optimum combustion even with variable gas qualities, preventing engine damage. Running the engines on fuels with a variable CH₄ content (frequently a feature of biogas plants) presents no problem.
- // The arrangement of the cooling system enables straightforward integration into existing heating systems.
- // The exhaust heat exchanger is integrated into the engine coolant circulation system, minimizing the risk of heat exchanger damage.
- // By the use of largely standardized and carefully selected subassemblies, maximum operational safety and reliability are achieved. Availability figures of well over 90 % are the norm with MTU Onsite Energy systems.
- // Low fuel and lubricant consumption combined with long component life reduces operating costs.
- // A separate development department constantly analyzes the data from the use of our systems in the field and optimizes the technology on our test benches for a vast diversity of biogas application requirements.

Our CHP modules and gensets for biogas cover the power range from 120 to 2,000 kW_{el}. The decision of the right CHP system depends on various factors. We will provide you with wide-ranging support, all the way from the project idea to its realization.

- // Support in planning your new CHP module.
- // Explanation of how to incorporate the CHP module into your biogas plant.
- // Explanations of the technology behind the engine, system and individual components.
- // Offer creation with budget price for planning phase and fixed price for implementation.
- // Design and planning of peripheral systems.
- // Advice on service solutions as early as the project phase.
- // Help with questions on legal situations (EEG, formaldehyde bonus).

We will gladly provide you with more information by telephone or visit you for a personal meeting on site.



COMPACT CHP PLANTS.

Series 400

Output range 100–400 kW_{el}

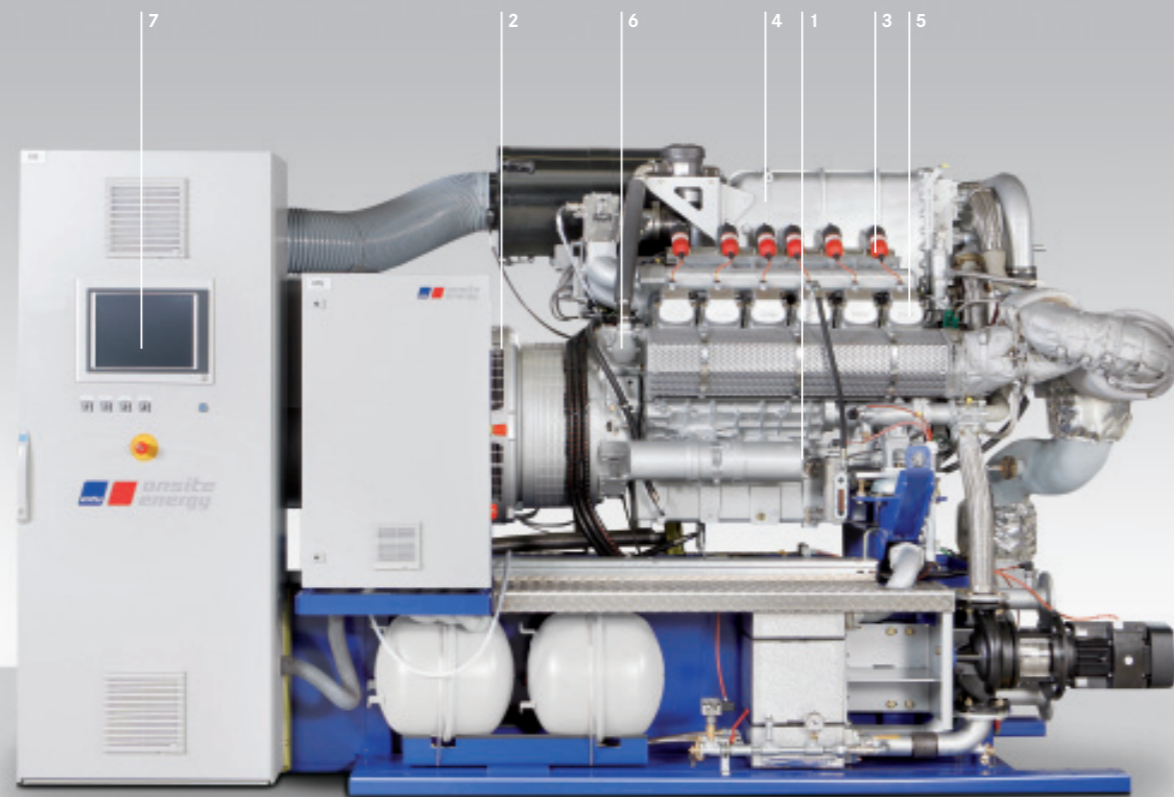
MTU Onsite Energy has an advanced product program. At its heart are our reliable gas engines developed in-house. Many of our systems have already completed well over 100,000 hours of service and still continue to reliably supply heat and electricity day after day – conclusive proof of the dependability of our engine technology. We generally design CHP plants as multi-module systems so that overall plant outputs of as much as 5 MW_{el} can be achieved with optimum efficiency. Adjustment to the electrical or thermal load profile is achieved by switching in or shutting down individual modules. Another advantage of multi-module systems is their high level of availability.

Our compact module technology is based on the economical principle of optimizing both output and benefit. Over 2,700 CHP modules in use worldwide are proof of that. Compact modules not only offer high levels of electrical and thermal efficiency with a fuel-efficiency level of up to 90 % and beyond, but also many other benefits.

Advantages of MTU Onsite Energy compact modules:

- // Space-saving
- // Supplied ready to connect
- // Factory tested
- // Available as uncovered or enclosed units
- // Easy to maintain

When planning distributed energy plants using CHP modules, the question of additional use as a grid backup or emergency power generator often arises. With synchronous generator and starter battery, our modules are fundamentally suitable for emergency power generation.



Description of individual components

1 Gas engine

// Advanced and proven gas engine from the Series 400, optimized for biogas use. Combustion chambers ensure the highest level of efficiency in this performance category.

2 Generator

// Optimally tailored to the engine and made by renowned manufacturers, the generator ensures a high level of reliability at the perfect degree of efficiency.

3 Ignition system

// Ignition systems for individual cylinders allow for the most efficient level of operation for all cylinders, even with variable CH₄ content. The ignition voltage display gives customers information about the state of the spark plugs.

4 Mixture cooler

// The two-stage mixture cooler with large surface area improves engine performance and heat utilization.

5 Knock detection

// Cylinder-specific knock detection and regulation protects the engine from abnormal operating conditions and guarantees safe operation even with biogas, which contains high levels of methane.

6 Crank-case ventilation

// Improved crank-case ventilation minimizes deposits in intake tract and combustion chamber and guarantees a continuously high level of performance.

7 MTU Module Control (MMC)

// The MTU Module Control (MMC) contains all the important functions necessary for controlling the plant. All the auxiliary drives required for the CHP plant can be operated from here. The integrated power circuitry minimizes the need for cabling on site. The MMC is housed separately in the control cabinet and is therefore hidden from sight.

SPLIT-CONFIGURATION CHP PLANTS.

Series 4000

Output range 770–2,000 kW_{el}

Energy modules and generator sets for outputs up to 2,200 kW_{el} per unit complete the MTU Onsite Energy range of natural gas CHP plants.

For plants with a large supply of substrate, it is worth investing in a CHP genset from the Series 4000. The high level of performance produced by such a genset or module has a positive effect on profitability. In contrast to a combination of several smaller systems, the Series 4000 requires a lower investment sum per kilowatt of performance. Larger plants also mean lower individual service and maintenance costs.

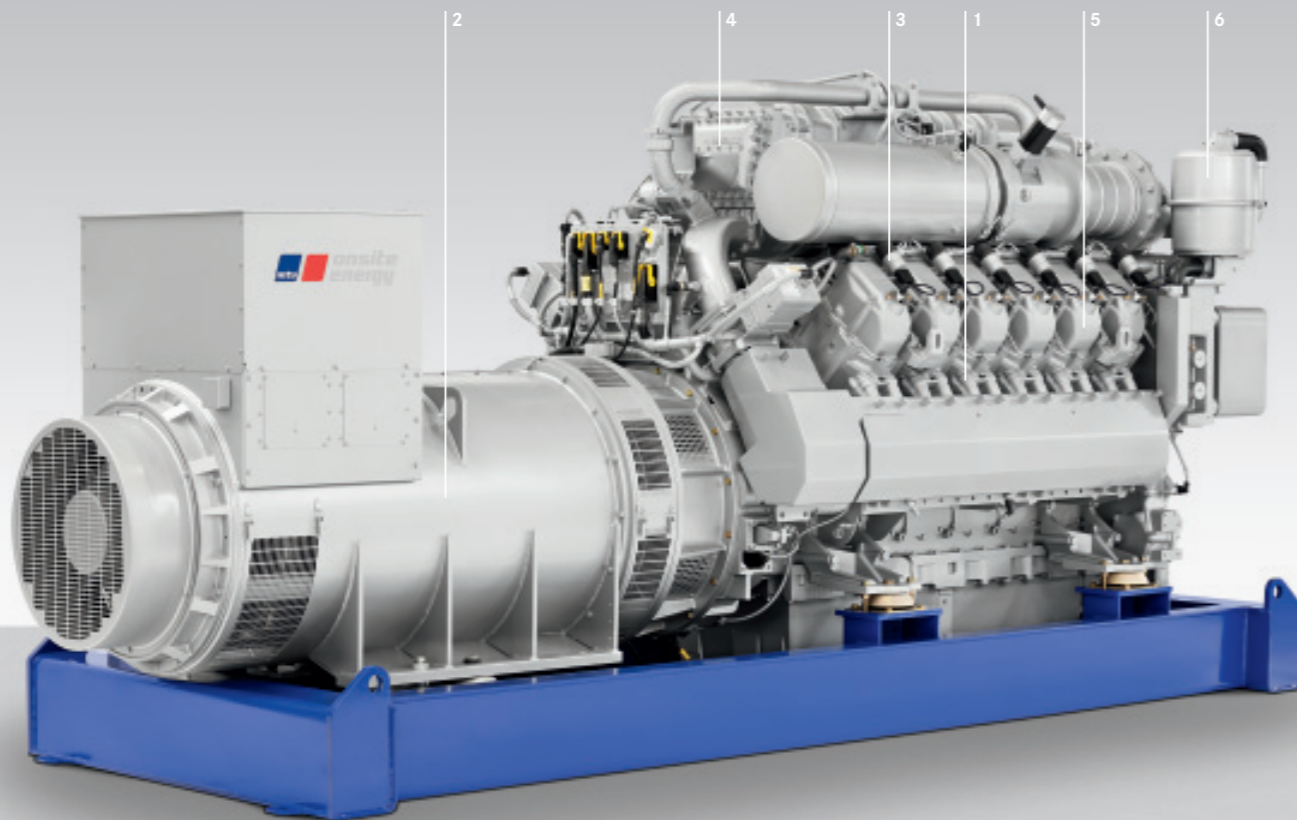
These systems are supplied as split-configuration installations rather than as compact modules. This means that the engine-and-generator set and the heat module are made as separate units.

With the sizes that are required for the high outputs involved, our split configuration offers greater benefits for the operator.

Advantages of MTU Onsite Energy split-configuration modules:

- // Separation of the heat generation module
- // Individual modification to customers' requirement profile
- // Optimal adaptation to the space available at the installation site
- // Easily transportable
- // Simplified installation

Like the compact modules, the engine-and-generator sets are comprehensively factory tested before delivery to the client.



Description of individual components

1 Gas engine

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2 Generator

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3 Ignition system

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GENERATING ENERGY WHEREVER YOU NEED IT: CONTAINER SOLUTIONS TO GO.

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 containerized turnkey units. Compact, complete, flexible and autonomous, they are ideally suitable for the power generation at changing locations or for applications that do not provide enough space for the insertion of a complete gas engine system.

When producing electricity from biogas, installing the generator set in a container can be a useful alternative to the more usual option of permanently installing a static plant in a generator room. Our standardized container genset is designed to meet the requirements of a variety of applications.

The container includes:

- // The generator set
- // The switchgear including control and monitoring system
- // All necessary connection and supply systems (ventilation, lubricant supply, heat recovery, etc.)

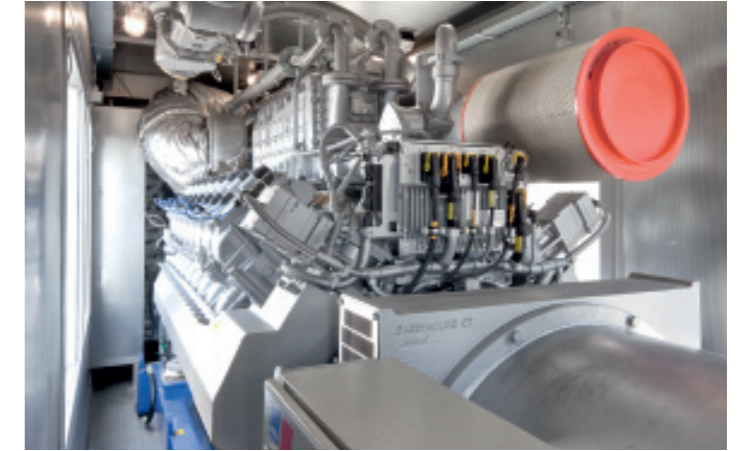
Like all MTU Onsite Energy systems, the standard container gensets are capable of fully automatic and continuous operation. The plants start up on their own whenever there is an adequate quantity of gas available with a minimum methane content, and shut down again automatically when the gas supply is insufficient.

We offer two types of containers for different requirements:

- // Power Containers generate only electrical energy and are ideal for remote locations or areas with unreliable power supply.
- // Combined heat and power units (CHP) generate electrical and thermal energy, e.g. for operators whose processes require heat in addition to power.

Your advantages:

- // Technically mature, proven and eco-friendly gas engine technology for maximum efficiency and reliability
- // Completely autonomous overall design that does not require any additional buildings
- // Flexible unit assembly system based on standardized modules and synchronized components
- // Quickly available, compact turnkey plug & play solutions
- // Optimal support thanks to a worldwide service network
- // Quality certified under ISO 9001 and DIN EN ISO 14001



MTU ONSITE ENERGY: YOUR SYSTEM SUPPLIER.

MTU Onsite Energy offers a range of system components that are perfectly tailored to its gensets and modules.

Gas preparation

Depending on the quality of the biogas, various measures may be required before it can be used. These ensure optimal combustion in the engine and also enable the use of an oxidation catalyst in order to comply with formaldehyde limits (and receive additional incentives). All necessary matching components such as gas cleaning, drying, cooling or reheating systems are available in addition to the gensets or modules.

Oxidization catalyst

Tailored to the respective engine, this can help guarantee adherence to specific emissions standards. For example, it can help plants adhere to the conditions required for the formaldehyde bonus of 1 ct/kWh as defined by the German Renewable Energy Law (EEG).

Auxiliary drive control and electrical connections

The 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 concept

MTU Onsite Energy has developed a comprehensive gas safety concept for entire systems. The concept guarantees protection against internal and external explosions and has been tested by the TÜV. Talk to us – our specialists will be happy to advise you.

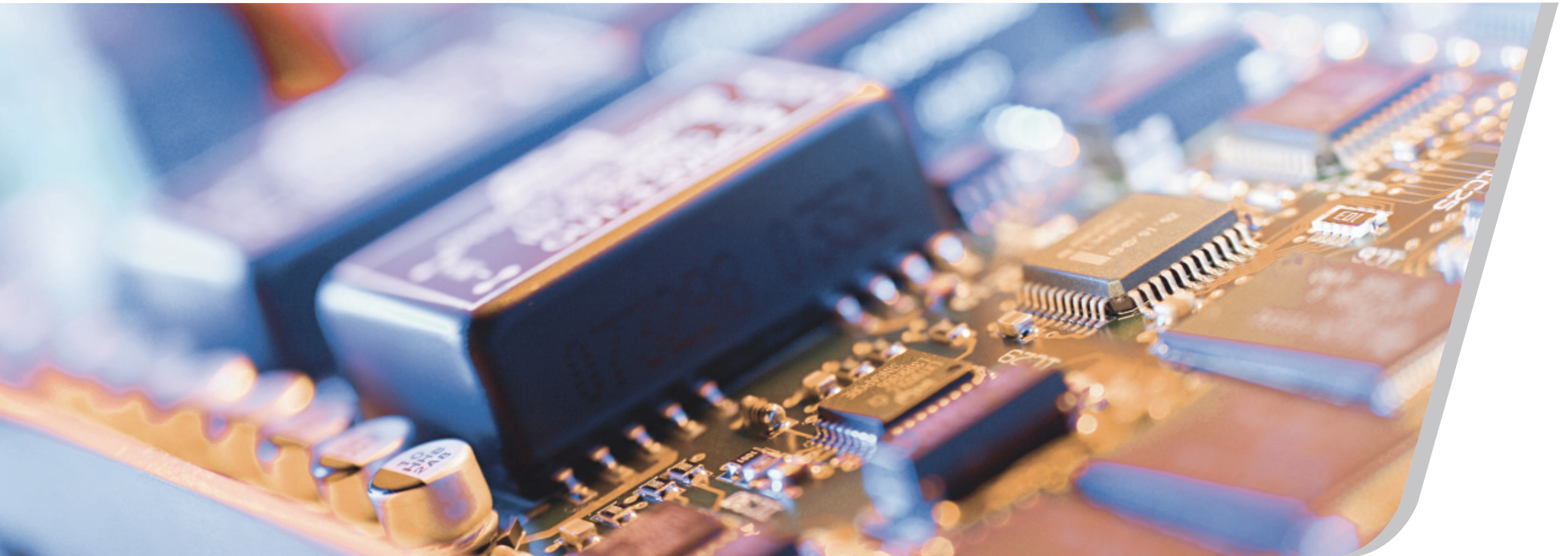


CHP MODULE CONTROLLER: THE BRAINS OF THE SYSTEM.

MTU Onsite Energy is your system partner. This means that as well as supplying the actual module or genset, we offer you a complete system engineering package for your installation. One of the most important aspects is the control system technology, which comes standard when you buy from us. If the generator set is the “heart” of the system, then the module controller is its “brain”. Our industrial-computer controlled and reliable electronics monitor the engine and the overall system to ensure optimum operation.

- // Control via RPS
- // Operation and visual display by means of industrial PC and touch-screen panel with colour display
- // Visual display of all functional processes and controls
- // Numerous additional controls and functions can be integrated (CH₄, gas tank, heat production mode, heat storage, mains power usage)
- // Networking of multi-module plants via Ethernet
- // Can be linked to master control systems

- // Wide choice of interface protocols (Ethernet, Profibus DP, 3964R, Modbus RTU)
- // Logging of all fault and status messages in a database, (up to six months of data can be recorded)
- // Optional remote diagnosis via ISDN
- // Optional integration of SMS / E-mail client (notification of faults, daily reporting of all meter readings)



MTU VALUECARE: SUPERIOR SERVICE FOR LONG SYSTEM LIFE AND TOP PERFORMANCE.

Purchasing a gas power system from MTU Onsite Energy pays off in many ways: not just by its performance and reliability, but also because of the security you will get from our superior service – MTU **ValueCare**.

MTU Onsite Energy has more than 30 years of experience in the field of gas-fueled distributed energy plants. We use that experience to provide advice and support for our clients – to whatever extent the client wishes. It starts with technical assistance during the project planning phase, extends to general contractor services and delivery of a turnkey installation and logically culminates in individually tailored servicing and maintenance programs. In this way, we can guarantee the availability of your installation and the reliable and economical operation you demand.

The demands on complete systems for electricity and heat production are high. We are committed to offering the best services and maintenance solutions. With that as our goal, we offer you a portfolio of services that goes above and beyond the technology itself – MTU **ValueCare**.

MTU **ValueCare** is perfectly developed for your MTU Onsite Energy cogeneration systems, helping to maximize their availability and efficiency.

The three main product lines of MTU **ValueCare** are:

ValueService

Our service program **ValueService** encompasses solutions for maintenance, training, documentation and repairs, which MTU Onsite Energy tailors specifically to its CHP plants and to meet your needs.

// With our individually tailored service contracts, repair contracts, maintenance contracts and inspection contracts for any system, you can save costs over the whole life cycle of the unit, increase the availability rate and avoid individual repairs.

// Our training courses for gas power systems are held by highly-qualified and experienced instructors. Courses are conducted in our training centers or at your facility. MTU Onsite Energy training programs make operating staff proficient with MTU Onsite Energy engines and systems.

// With our diagnostic solution Remote Services you'll have direct access to the activity of your cogeneration systems – no matter where you are. You can receive predefined operational reports by E-mail or SMS to ensure that you are always well informed. Remote Services also provides the ideal basis for operational decisions and guarantees optimal utilization.

ValueSpares

Our genuine MTU spare parts and top-quality consumables are perfectly tailored to your CHP plant and ensure the continued peak performance of your MTU Onsite Energy cogeneration systems.

ValueExchange

Our **ValueExchange** program incorporates a basic overhaul of the engine as well as the refurbishment of components and parts. Remanufactured engines and parts have the same appearance, the same life expectancy and the same performance of new products. They meet the same performance requirements and enjoy warranties similar or identical to equivalent new goods. Our **ValueExchange** program is a cost-effective alternative to new engines and parts.



YOUR PARTNER FOR THE LONG TERM.



Our commitment to you doesn't end with the commissioning of your MTU Onsite Energy cogeneration systems. As a service partner, we will remain at your side for as long as you continue to use our product. The long-term, optimized management of your gas power system by MTU Onsite Energy guarantees high availability and reliability, and along with that, the efficiency you need.

Benefits of our product line:

- // MTU service on location, around the world
- // Experienced specialists from the CHP segment will support you in drawing up measurements for your plant, project outlines and profitability calculations for your area of application
- // System provider services – from design of peripheral systems to delivery and installation
- // General contractor services extending to maximum specifications if required
- // Quick and reliable spare parts supply



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