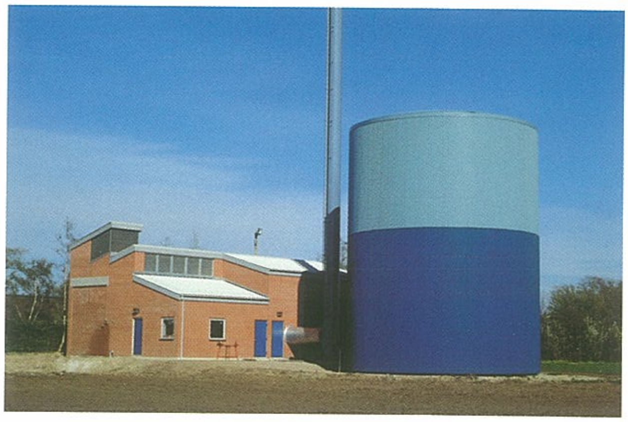
EVERYTHING WORTH KNOWING ABOUT WÄRTSILÄ 25SG GAS ENGINES

WÄRTSILÄ DIESEL

GAS ENGINES IN MUNICIPAL COGENERATION PLANTS

Municipal gas engine cogen plant in Tylstrup, Denmark (1x W12V25SG)



Municipal gas engine cogen plant in Stövring, Denmark (3x W16V25SG)

The Wärtsilä 25SG lean burn spark-ignited gas engine is well suited for cogeneration applications. This has been demonstrated in many plants now in operation and under construction. For district heating applications as well as for industrial applications, the power range is 1–20 MWe.

The power-efficient gas engine as prime mover gives an optimal solution for low cost, energy-efficient and environmentally sound plants wherever gas is available.

This brochure will give some ideas with examples how modern gas engines can be the right choice for communities and industry alike.

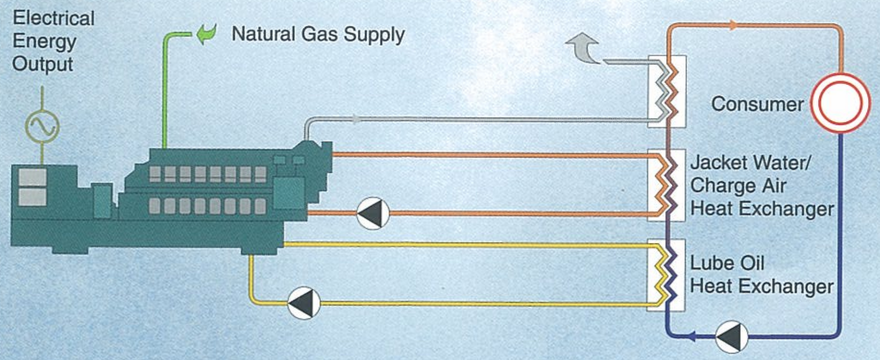
MUNICIPAL ENERGY SUPPLY

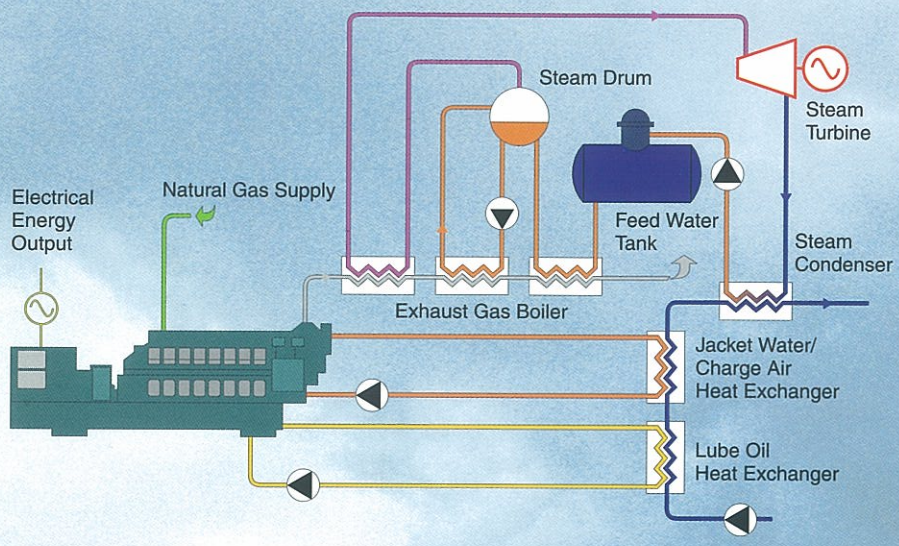
In many places worldwide, the local community is responsible for supplying heat and power to its inhabitants. The Pure Energy Plant (PEP) provides combined heat and power in the most efficient manner possible today.

A cogeneration plant, with gas engines as the prime movers, produces almost as much power as heat. This means twice as much power compared to a conventional coal-fired power plant at the same heat supply level. The overall efficiency of cogeneration plants is dependent on the return water temperature from the district heating system. The colder the return temperature, the higher the efficiency. In some European countries where 40° C is the norm, a PEP provides total efficiency of some 90%. In countries — such as those in central Europe — with a traditionally higher supply and return temperature, the total efficiency will be around 85%.

COMBINED POWER GENERATION

In order to improve economy and efficiency even further, gas engines have been combined with a standard steam turbine. This increases the level of efficiency from 40% to 44% when Pure Energy Combined cycles (PEC) are used purely for power generation. When PEC cycles are used for cogeneration, the relationship between the power and the heat produced is also improved.





HOT WATER

2 x W12V25SG

Power: 4200 kW_e, Hot water: 5420 kW_{th}

3 x W16V25SG

Power: 8400 kW_e, Hot water: 10860 kW_{th}

Efficiency power: 40%

Hot water: 50%

Total efficiency: 90%

Capacities based on 100% load at ISO conditions, hot water return temp 50°C and supply temp 90°C.

COMBINED CYCLE

4 x W16V25SG and turbo-generator

(4 x 2.8 + 1.2 = 12.4 MW_e)

Heat power: 12.4 MW_{th}

Four heat recovery steam generators and one common steam turbine

Steam: 10 bar/380° C, 2.1 kg/s

Gas: 33 – 40 MJ/m^3n, gas flow ~ 2800 m^3n/h at 4 bar (a)

Emissions at full load: NOx – 0.9 g/kWh_e CO – 1.8 g/kWh_e, NMHC – 0.9 g/kWh_e

Net power efficiency: 43%

Total efficiency 86%

GAS ENGINES IN INDUSTRIAL COGENERATION PLANTS

STEAM AND HOT WATER

The exhaust gas boiler will produce steam suitable for most industry processes. Because of the high exhaust gas temperature (420° C), high-quality steam—saturated and superheated—can easily be produced to match existing industry steam conditions.

DRYING APPLICATIONS

Exhaust gas at a temperature of 420° C is also suitable for drying purposes. When a lower drying temperature is needed, preheated fresh air can easily be mixed with the exhaust gas. If a higher temperature is required, a duct burner can be installed between the gas engine and the exhaust gas boiler.

COOLING APPLICATIONS

Gas engines can also be used in special applications where power, heat and air conditioning are required. Good examples are commercial centres, hospitals, schools and office buildings. Steam from the gas engine's exhaust gas boiler can be used for driving an absorption cooler, producing chilled water (6° C) for an air conditioning system.

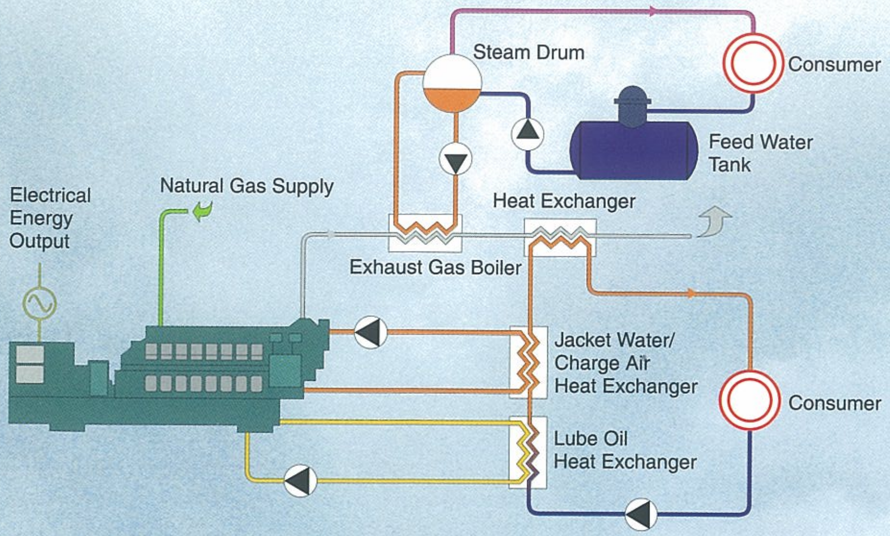
SUPPLEMENTARY FIRING

A duct burner, fed with the same gas that fires the engine, can be placed between the gas engine and the exhaust gas boiler.

Gas engine feed water preheat of a waste-to-energy plant in Alkmaar, the Netherlands (3x W16V25SG)

This way the exhaust gas temperature provides opportunities for higher steam flow and pressure.

Thanks to supplementary firing, gas engines can be installed where high steam conditions are already used for existing steam turbines. With gas engines in base-load mode, the duct burner controls the immediate process steam demand, thereby obtaining higher gas energy utilisation.



STEAM AND HOT WATER

1 x W12V25SG

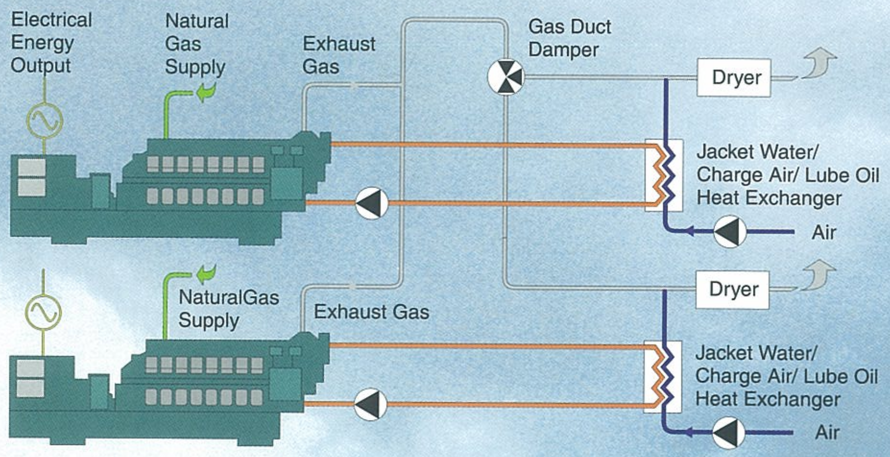
Power: 2100 kW_e, Steam: 1160 kW_{th}
Steam: 1.8 ton/h, Hot water: 1500 kW_{th}

2 x W16V25SG

Power: 5600 kW_e, Steam: 3100 kW_{th}
Steam: 4.8 ton/h, Hot water: 3920 kW_{th}

Plant efficiency
Electric 40%, Hot water 27%
Steam 22%, Loss 11%

Capacities based on 100% load at ISO conditions, steam pressure 7 bar(g), hot water return, temp 50°C and supply temp 90°C



DRYING

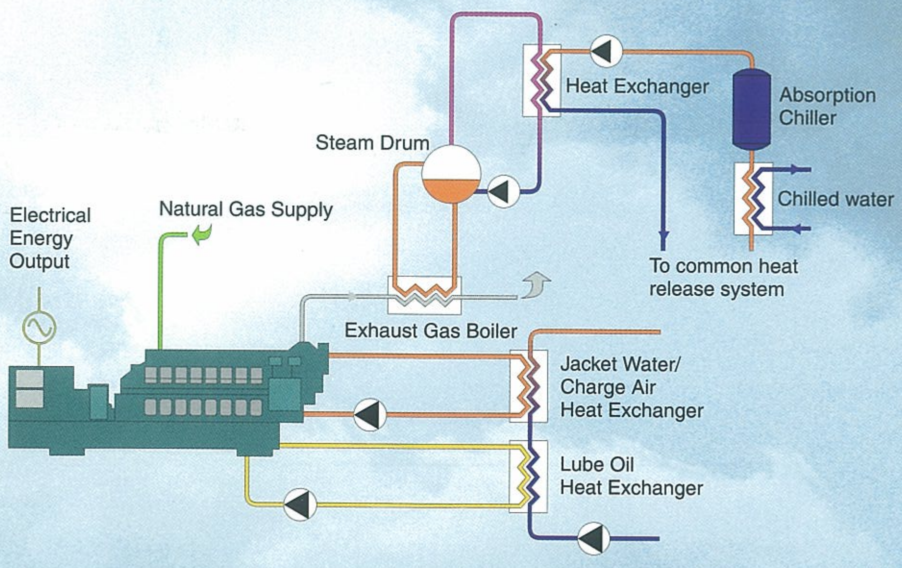
Example: Exhaust gas of two gas engines led to a common duct, split for two dryers and mixed with pre-heated fresh air

Gas engine: 2 x W16V25 SG

Exhaust gas: 420°C, 11.2 kg/s

Radiators: Engine cooling used for air pre-heating from 25°C to 80°C

Dryers: Inlet gas temperature 180°C for direct drying purpose



CHILLED WATER

Example: One steam driven double effect absorption chiller

Gas engine: 1 x W16V25 SG

Boiler: 8 bar(g) sat. steam, 1.8 ton/h

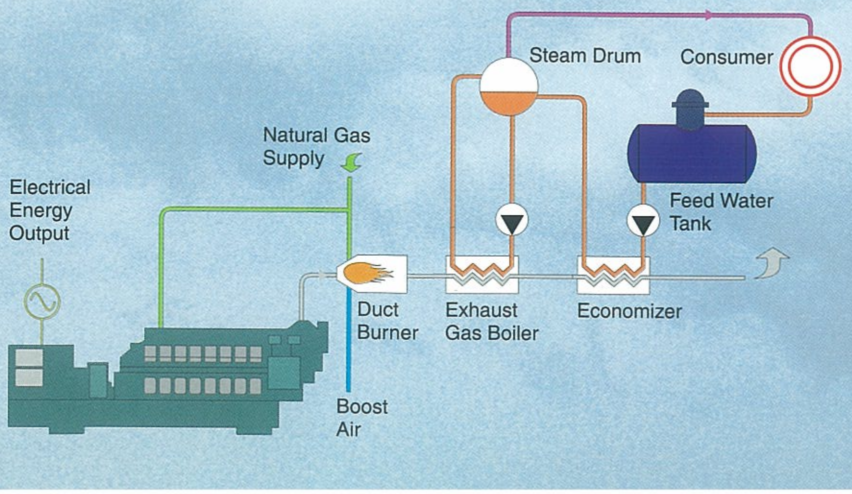
Heating system:
Supply temp 85°C, return temp 45°C

Power: 2800 kW_e, 40%

Heat: 2040 kW_{th}, 28%

Chiller: 1740 kW_{ch}, 24%

Total: 6580 kW, 92%



SUPPLEMENTARY FIRING

Exemple: Natural gas fired duct burner with booster fan

Gas engine: 1 x W16V25 SG

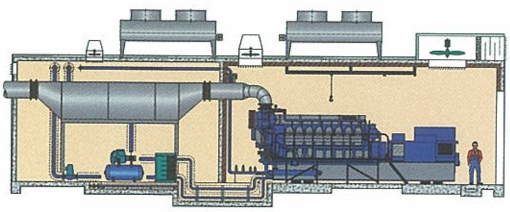
Duct Burner: ~ 340 Nm^3/h, exit burner temp 730°C

Boiler: 8 bar(g) sat. steam, 5.7 ton/h

MODULAR POWER PLANT CONSTRUCTION

Modular built cogen plant in Tyumen, Russia (3x W16V25SG)

Wärtsilä Diesel gas engine power stations are well suited for modular construction and assembly in our factory and for subsequent transportation and erection on-site.



Building a plant in modules makes sense for a number of reasons. Since it enables us to deliver as complete a plant as possible right to the site, it shortens construction time for power plants, particularly those located in sparsely populated areas. Modular construction also allows all connections to be completed, units to be interconnected, and, when possible, even commissioning and start-up of the plant to be accomplished before it is transported to the site. This also provides an opportunity to obtain performance parameter approvals as well.

Generally the modules are arranged so that the engine, boiler with auxiliaries, motor control centre and switch gear room easily fit together. Silencers, radiator and air intake filter are all installed on the roof of the modules.

The projects shown here have all been built in this manner and have been transported from our factory in Trollhättan first by boat, then by truck or train to their final destinations. Delivery time from order to on-site start-up for a three engine power plant can be as short as six months.

COMMISSIONING, OPERATION AND MAINTENANCE

Wärtsilä Diesel undertakes various commitments when providing a new gas engine power plant—*Genset supply, process package supply and turnkey delivery.*

We participate, utilising our own staff, in all phases of a new plant—design, procurement, project management, commissioning, start-up, operation, and maintenance, so that our customers can obtain the *highest availability and the lowest life-cycle investment cost.*

Design and project execution are carried out based on prior plant involvement and *experience gained from installing over 2,000 engines in power plants* around the world.

Commissioning of the plant starts in our factory, where the engines are run and tested to see if they meet the requirements, either as separate engines or as complete modules.

The final start-up of the plant takes place on site, where all systems are operated as a whole unit, demonstrating their performance for final approvals.

To fulfill the client's demand for safe and economical operations, Wärtsilä Diesel offers individualized customer training programs in specially equipped facilities with engines, workshop and class rooms. The second stage of the training takes place on site in conjunction with actual start-up.

Maintenance can be provided by Wärtsilä Diesel through individually tailored agreements that can cover supervision of the first overhaul to continuous operation, including spare parts and consumables .

LEAN BURN COMBUSTION TECHNOLOGY FOR HIGH EFFICIENCY AND LOW EMISSIONS

Gas engines can employ various combustion technologies, such as stoichiometric, lean burn and diesel principles. In figure 1, efficiency and emissions are shown as a function of excess air ratio (lambda-ratio = λ). Stoichiometric combustion technology ($\lambda = 1$) is used primarily in smaller engines, which (as shown) are not very efficient and must be equipped with a catalyst.

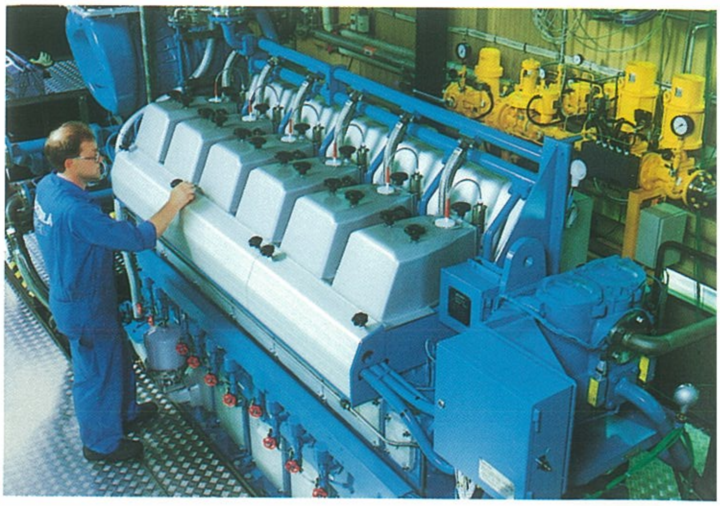
The lean burn gas engine ($\lambda = 2$—2.3) operates in the upper ranges of the combustion window, provides higher efficiency with lower emissions, and requires no external catalyst. With pre-combustion chamber ignition, this engine type can be designed with a wider cylinder size range.

However, the most feasible combustion technology for 1—5 MWe gas engines is the medium-speed engine with direct gas feed and combustion control for each cylinder.

This lean burn combustion method combines high mechanical efficiency with a low weight-to-power ratio and low emissions of NOx, CO and HC.

COMBUSTION CONTROL

In order to maintain stable and complete combustion in the cylinder, an engine control unit (ECU) has been developed for the Wärtsilä lean burn engines. At $\lambda = 2.3$ and the selected gas amount, the gas-air mixture cannot be ignited safely with a spark plug. Therefore, a stoichiometric gas-air mixture is used for igniting the main fuel in the pre-combustion chamber (PCC, see figure 2). This stepwise ignition procedure is controlled individually for each cylinder and continuously adjusted depending on power requirements, temperatures and emissions. The ECU provides opportunities to further increase efficiency and adapt to various gas qualities while still maintaining high efficiency and complete combustion without any knocking or hazardous emission formation (see figure 3).



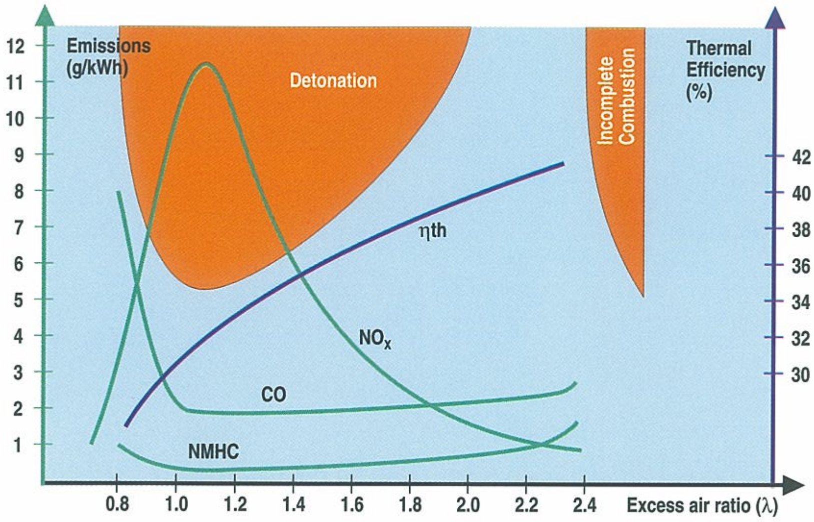


Figure 1.

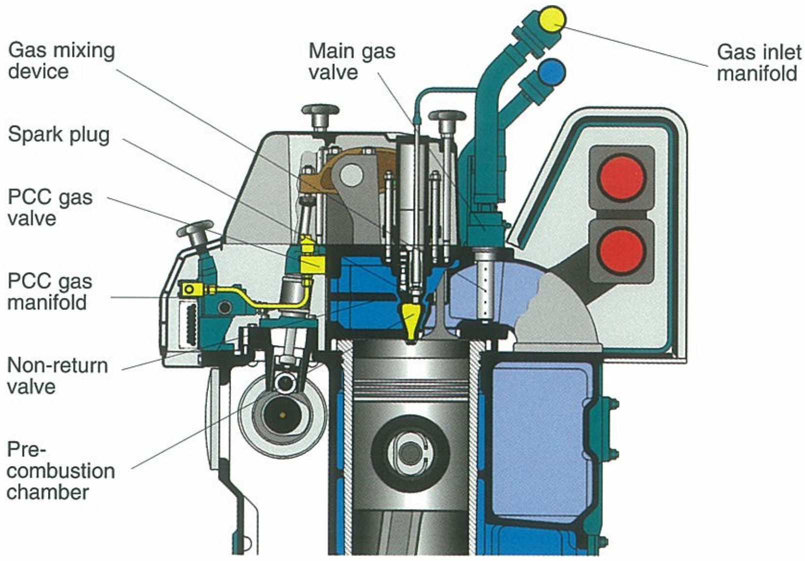


Figure 2.

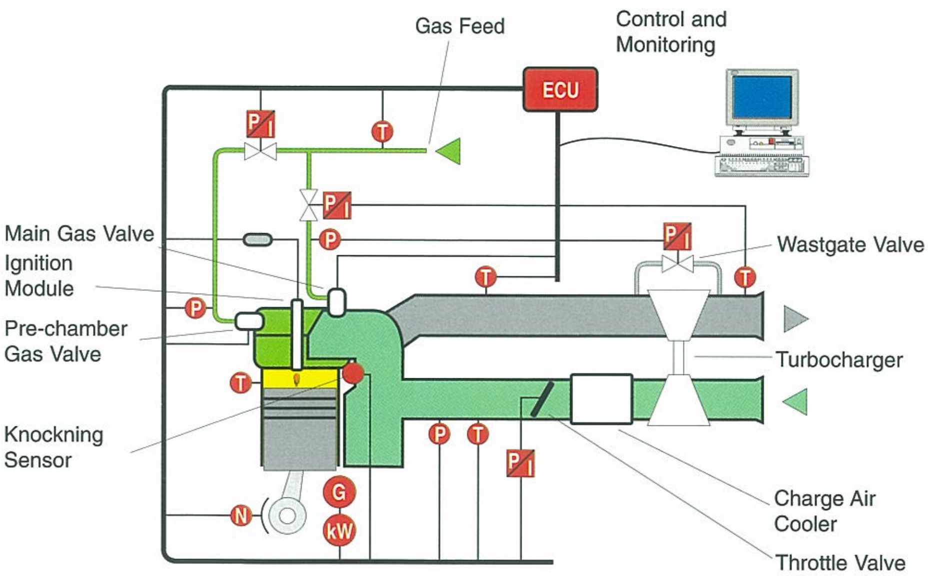
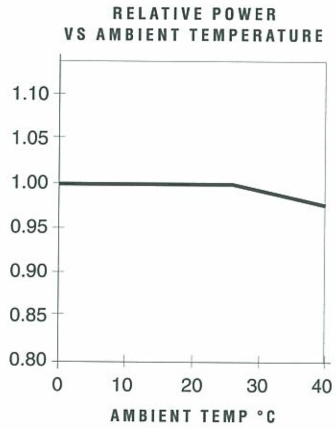
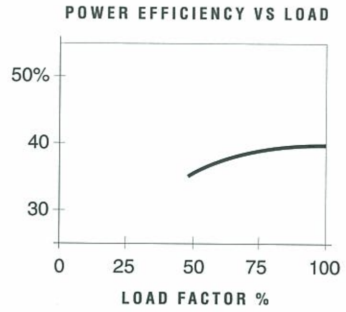


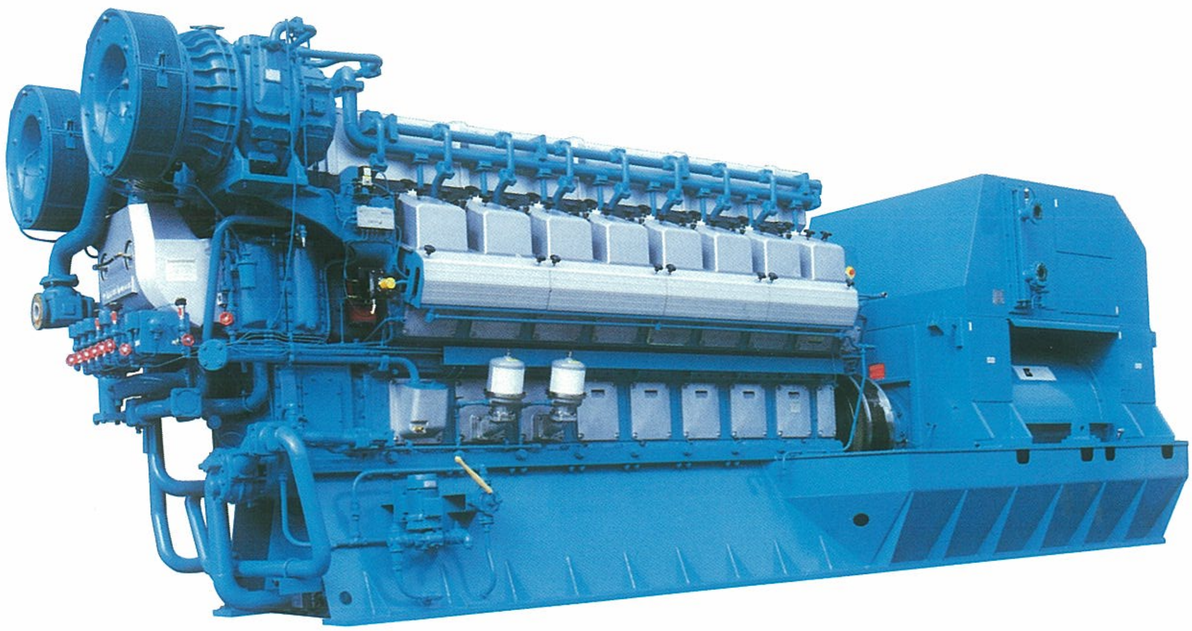
Figure 3.

MAIN TECHNICAL ENGINE DATA



	W12 and W16V25SG
Output range (shaft)	1980—2960 kW
Bore:	250 mm
Stroke:	300 mm
Speed:	900—1000 rpm
Mean effective pressure:	15 bar
Cylinder output:	165—185 kW
Mean piston speed:	9.0—10.0 m/s
Compression ratio:	11:1
Fuel specification:	Natural gas



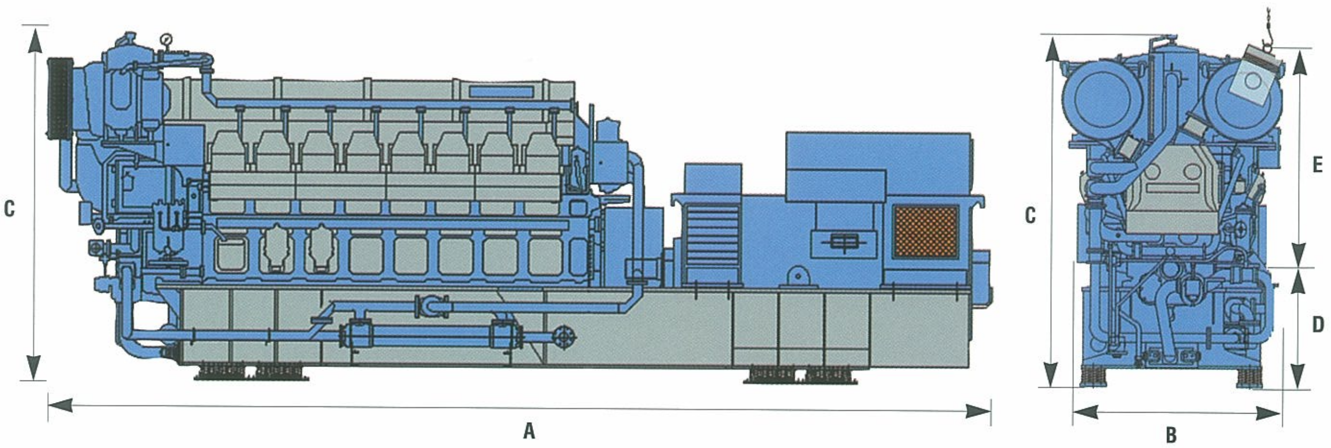


Integrated Generating Sets. To ensure quick and easy installation, a standard generating set includes all ancillary systems and modules.

RATED POWER, WEIGHTS AND DIMENSIONS

Technical Data	Unit	W12V25SG	W16V25SG
Power output base load	kW	2100	2800
Heat rate base load	kJ/kWh	9000	9000
Efficiency	%	40	40
Shaft speed	rpm	1000	1000
Frequency	Hz	50	50
Power output base load	kW	1900	2530
Heat rate base load	kJ/kWh	9000	9000
Efficiency	%	40	40
Shaft speed	rpm	900	900
Frequency	Hz	60	60

Generator output according to ISO standards with a Methane Index = 100
NO_x and CO emissions according to TA-Luft standard



PRINCIPAL GENSET DIMENSIONS AND WEIGHTS IN MILLIMETRES AND TONS

Engine type	A	B	C	D	E	Engine weight	Genset weight
W12V25SG	7850	1960	3350	925	2140	17.6	33
W16V25SG	8750	2110	3350	925	2140	22.1	43

The Wärtsilä Diesel Group is the world's largest manufacturer of medium speed diesel engines and gas engines and a major supplier of high speed diesel engines. The Group has production facilities in five European countries and assembly facilities in India, Spain and the United States of America, supported by a network of sales and service companies around the world. It designs and manufactures engines to satisfy customers' needs for economical and reliable power systems through custom-built units based on engines of over 300 kW.

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POWER FOR A CHANGING WORLD

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