

# MAN 35/44 Gas Variants

For flexibility in an era of renewables

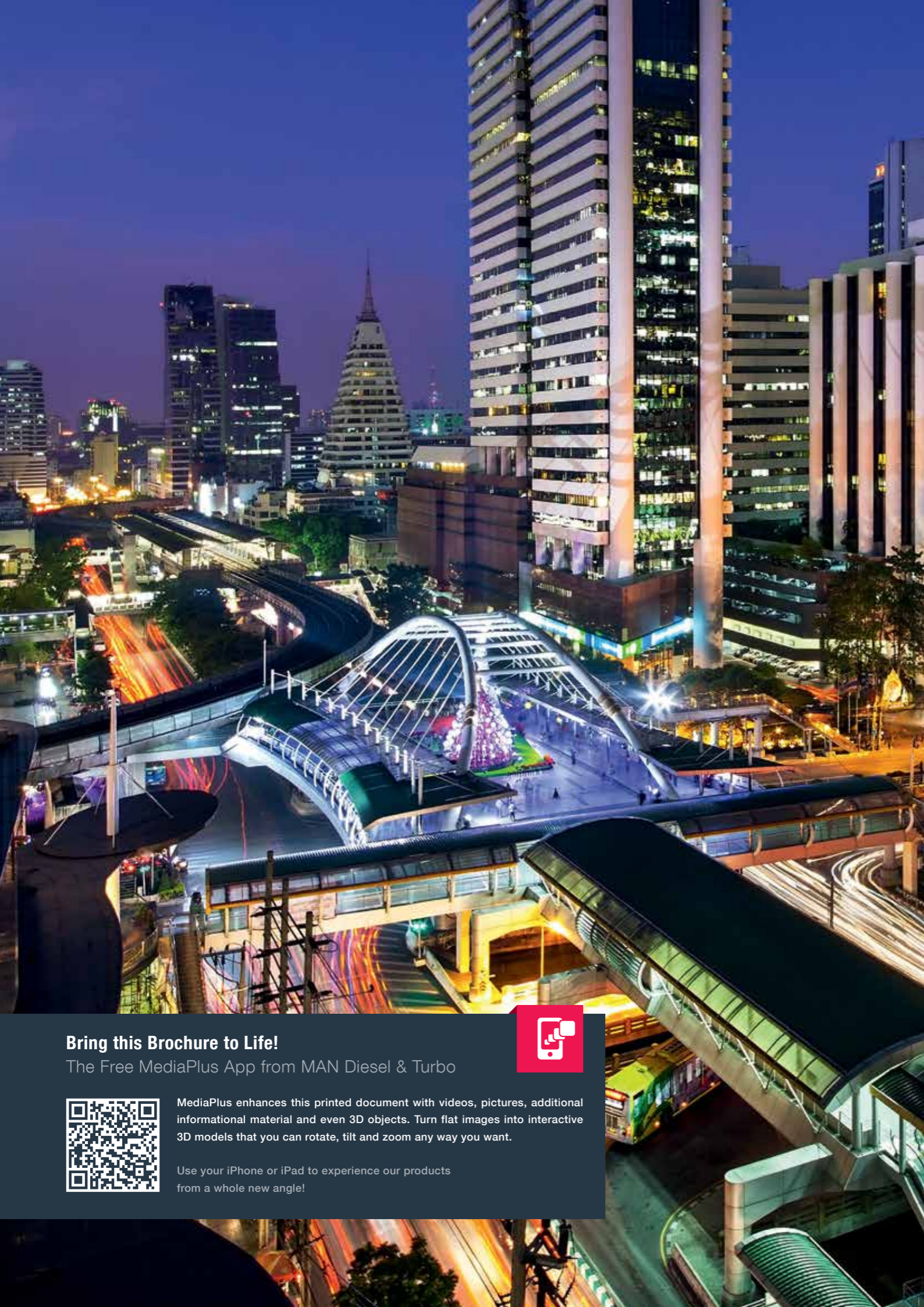


Engineering the Future – since 1758.

**MAN Diesel & Turbo**







## MAN Diesel & Turbo

Powering the world – responsibly

MAN Diesel & Turbo is the world's leading provider of large-bore diesel engines and turbomachinery. Our product portfolio includes two-stroke and four-stroke engines for marine and stationary applications, turbochargers and propellers, as well as gas and steam turbines, compressors and chemical reactors.

MAN solutions can be found in ship propulsion, engine-based power plants and turbomachinery trains for the oil & gas and process industries. We support our global customers with a comprehensive range of after-sales services under the MAN PrimeServ brand.

MAN Diesel & Turbo has always been committed to increasing fuel efficiency and reducing emissions. Today, this commitment ensures that our customers are able to meet increasingly strict emissions regulations and plays a vital role in reducing the environmental impact of global trade and industry.

### Bring this Brochure to Life!

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Use your iPhone or iPad to experience our products from a whole new angle!



## MAN 35/44 Gas Variants. Ultimate Power

100% efficiency

Sustainable energy production is capturing attention across the globe. As countries and companies look for environmentally friendly options for power generation, MAN Diesel & Turbo continues its ongoing mission to meet the changing demands. That's why we develop state-of-the-art power sources that deliver the highest-possible efficiency while producing the lowest-possible emissions.

### Many good motivations

Clean energy production can take on many forms. Solar, wind and hydroelectric power are only a few examples. Combined heat and power generation will also play a leading role in sustainable modern systems in the future. Run on natural gas, these plants are literally a powerhouse of low-emission power generation. MAN Diesel & Turbo makes components that are ideal for the core functions of such systems. For example: the MAN 35/44G – a single-stage turbocharged gas engine with an output of 10.6 MW and an electrical efficiency of 47%. This engine is just a small part of a portfolio that offers first-rate stationary power production.

### Benefits at a glance

- Highly efficient power generation: 10.6 MW
- Low fuel costs: 47% electrical efficiency
- Short power ramp-up time: 100% load within 3 minutes
- Outstanding heat utilization: > 90% in CHP mode
- Excellent load response
- Easy maintenance/high availability
- Ideal for sustainable heating and cooling
- Fully emission-limit compliant

## MAN 35/44 Gas Variants. Clean and Strong

Gas engines for power plants



As the trend toward clean energy production gains momentum, gas engines are attracting attention as an alternative for electrical power generation. The reasons for this are clear. With the right design, these engines are clean, powerful and cost-effective to run.

### Modern and innovative

Thanks to gas engines, power plants and cogeneration facilities can now benefit from clean and efficient power generation in a number of ways. For example, they offer low emissions – lower even than diesel engines. Gas-fired options present a truly economical solution for energy production that's easy on the environment. In a lean-burn gas engine, the mixture of air and gas in the cylinder is lean, with more air in the cylinder than is needed for complete combustion. With leaner combustion, the peak temperature is re-

duced and less NO<sub>x</sub> is produced. MAN Diesel & Turbo has developed the MAN 35/44G for just this type of application. It offers best-in-class power density, and thanks to advanced ignition technology, it also guarantees optimal efficiency. SaCoS<sub>one</sub> ensures reliable engine operation, individually regulating the cylinders and keeping the entire system under control. Best of all, since natural gas is in good supply, fuel is not only cost-effective but also readily available. All the key factors add up to an ideal option for power generation.



# MAN 35/44 Gas Variants. A Great Source of Power

Benefits at a glance

- Highly efficient
- Low fuel costs
- Fast operating
- Short power ramp-up
- Excellent load response
- Easy maintenance
- Low emissions



# MAN 35/44 Gas Variants. Spearhead Solutions

## Empowering energy production

Making fuel go twice as far is exactly what cogeneration and combined cycle facilities are designed to do: one fuel, various energy applications. MAN Diesel & Turbo has perfected the art of making natural gas go a long way, creating energy by developing advanced solutions for power plants and gas engine technology.

The MAN 35/44G exemplifies this type of technology development and is available in three different engine configurations. Whether optimized for power generation, combined cycle (CC) or combined heat and power (CHP), this engine offers fast ramp-up times and operating reserves. Whatever variant fits the requirements, the MAN 35/44G is sure to deliver ultimate performance, increasing the overall output and efficiency of the power plant – with no additional outlay on fuel.

### Combined cycle

Combined cycle processes involve three simple stages to produce power: an engine burns fuel to drive a generator, exhaust heat from the engine is recovered and converted to steam, the steam is then channeled to the generator where it contributes to overall energy production.

As part of its commitment to environmentally friendly power production, MAN Diesel & Turbo has developed a power cycle process for stationary power plants that uses heat from the engine exhaust gases to produce live steam. The steam is expanded in a steam turbine and this produces electrical energy without consuming additional fuel, thus exploiting the strength of the combined cycle.

### Combined heat and power

One valuable byproduct of engine-based power plants is waste heat. Once recovered, it can be converted into useful forms of energy. Combined heat and power (CHP) is an excellent example of this and MAN Diesel & Turbo offers various technologies to make it possible. Our engine-based CHP plants are designed to meet end consumers' heating needs and can be used for a wide range of thermal applications.

Not only can the recovered heat be used for steam generation, but it can also be used to heat water which can be channeled back into a heating network. By using an absorption chiller, cooled water can be used to run central air conditioning systems in hospitals, hotels and office blocks. This makes it perfect for cogeneration and trigeneration applications. The benefits of these plants and engines seem endless – from reduced emissions and lower costs to incredible operational flexibility. And the MAN 35/44G is the perfect centerpiece for such a plant.

### Operating reserve

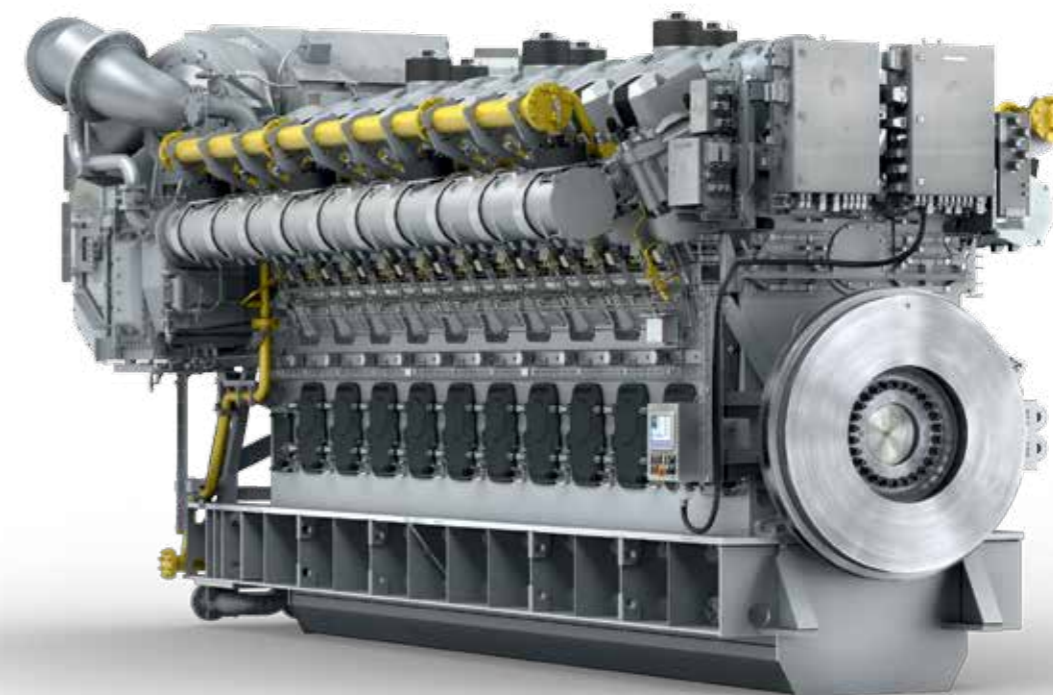
Generating power from fluctuating renewable sources such as wind and solar energy requires highly flexible power plant technologies that provide efficient back-up power on extremely short notice. In addition to offering rapid startups, these solutions must also be extremely efficient when operating under partial load conditions. They also have to be capable of accommodating wide variations in load. In contrast to axial flow machines, MAN gas engine plants are physically suited to these kinds of applications, with efficient operation from anywhere between 20% to 100% of rated load.

Short power ramp-up times are also critical. This is where the MAN 35/44G engine really comes into its own, with a ramp-up time of only three minutes.

### Two-stage turbocharging option

The idea behind two-stage turbocharging is simple: two turbochargers upstream from the engine – a low-pressure and a high-pressure turbocharger arranged in series – boost the charger air pressure substantially and enable an outstanding efficiency increase. Lower fuel consumption and reduced exhaust emissions are the beneficial outcomes of this smart setup, in which the intercooler set between the two turbocharger stages is the main success factor.

With its additional power potential, two-stage turbocharging increases the power density of an engine and thus allows more compact plant designs. By adding other benefits like faster starts, stops, and ramp-ups, it improves the operational flexibility of each power plant – and this is crucial in times of fluctuating energy supplies from renewable sources and regulated energy markets.





# Built around Your Needs

The MAN Diesel & Turbo gas engine portfolio



MAN V35/44G

MAN V35/44G TS

MAN V51/60G

MAN V51/60G TS

MAN Diesel & Turbo offers the most comprehensive choice of gas engines available in the market. The portfolio ranges from 7 to 20.7 Megawatts and covers the full operational spectrum – including engine combined cycle solutions. No matter which challenge faced in energy generation, MAN Diesel & Turbo has the perfect engine and power solution to tackle it. Even for gas engine-operated power plants with power outputs of up to 250 Megawatts for grid connected power or captive power applications, we are ideally positioned to serve the demand. Energy wherever you need it.

## MAN Diesel & Turbo gas engines

### Engine type

MAN 18V51/60G TS	18,900* - 20,700*
MAN 18V51/60G	18,900* - 20,700*
MAN 14V51/60G	14,700*
MAN 20V35/44G TS	11,800/12,400
MAN 20V35/44G	10,200/10,600
MAN 12V35/44G TS	7,080/7,440

Output in kW<sub>m</sub> 6,000 8,000 10,000 12,000 14,000 16,000 18,000 20,000 22,000 24,000

Scheme: kW<sub>m</sub> at 60Hz / kW<sub>m</sub> at 50Hz  
Example: 7,080kW<sub>m</sub> at 60Hz / 7,440kW<sub>m</sub> at 50Hz

\* kW<sub>m</sub> at 60Hz = kW<sub>m</sub> at 50Hz





## Good for the Environment

### Natural gas – the friendly fossil fuel

Although not a renewable resource, natural gas is a promising alternative to coal and oil. Natural gas is said to burn “clean”, producing less carbon dioxide and other pollutants than comparable fuel sources. As a result, natural gas is taking a leading role in the energy industry, especially in combination with renewable sources – a good reason for MAN Diesel & Turbo to develop the technologies that can make the most of this precious resource.

#### High score for low emissions

Energy providers have a lot to consider when selecting power plant technologies. They must keep a close eye on emissions produced during the generation process and also remain flexible enough to match output to consumer demand. Plants that rely on gas engines score well in this respect thanks to their exceptional efficiency and use of natural gas.

The impact of carbon emissions on the environment has put this pollutant under particular scrutiny. Government bodies across the globe are defining limits for carbon emissions, and, as a result, only the most efficient technologies will remain competitive. MAN Diesel & Turbo has developed solutions to generate “clean” energy while adhering to legislation.



## Good for Business

Gas engines – highly cost-effective



Many companies worry about the costs of corporate responsibility. What they fail to realize is that looking after the environment can also go hand in hand with substantial savings in company resources and finances. Modern technologies like those developed by MAN Diesel & Turbo are ideal for running sustainable facilities while keeping costs down.

### Key factors

Investing in power plant technology takes careful consideration – how the electricity is produced, fuel supplies, local conditions and related costs. Fuel is often the greatest cost factor for power plants run on fossil fuel. It often accounts for up to 80 percent of the plant's operating costs. What's more, some countries subsidize certain production types, as is the case for CHP in many OECD member states.

### Calculating costs

To fully understand the total cost of ownership (TCO), it is important to analyze long-term electrical energy production. This involves looking at the cost per MWh over the entire lifetime of a project. The aim is to keep TCO down and this is often directly related to high

efficiency and low emissions. Other important parts of the equation are output levels versus consumption and reduced maintenance costs. These are all areas that can be addressed directly by using solutions made by MAN Diesel & Turbo.

### Perfectly profitable

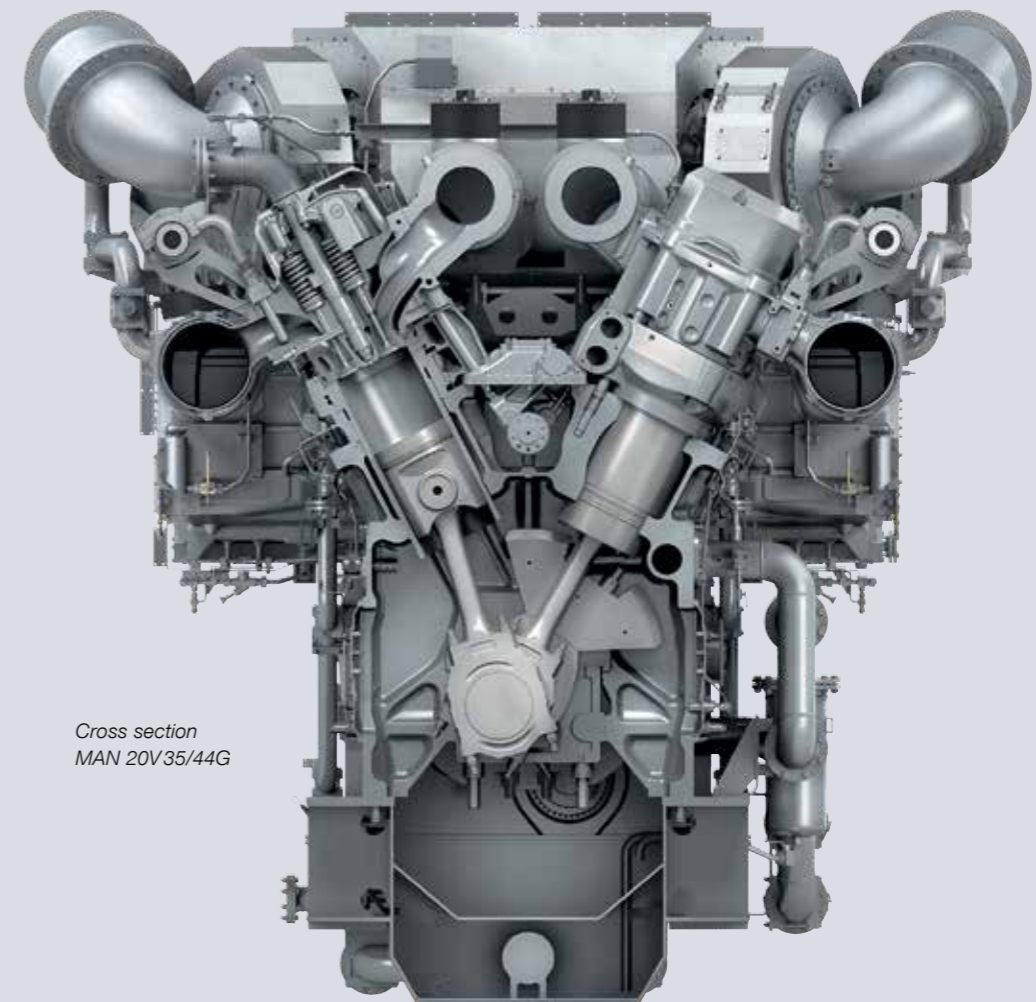
Determining project profitability is an important part of a cost-benefit analysis. This involves examining factors like the internal rate of return (IRR) and operating profits. Beyond delivering the technology itself, MAN Diesel & Turbo offers assistance and advice during the early stages of a project. This can start with sourcing suitable financing and continue throughout the operation of the plant.





## Technical Data

### Definitions



Cross section  
MAN 20V35/44G

#### Cooling

Cylinder cooling: Fresh water  
Charge air cooler (two-stage): Fresh water

#### Starting method

Compressed air

#### Reference conditions according ISO 3046-1: 2002

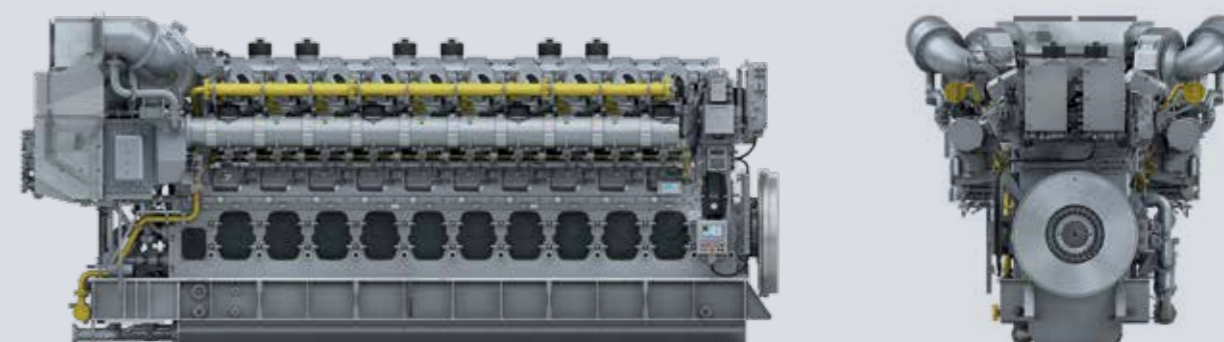
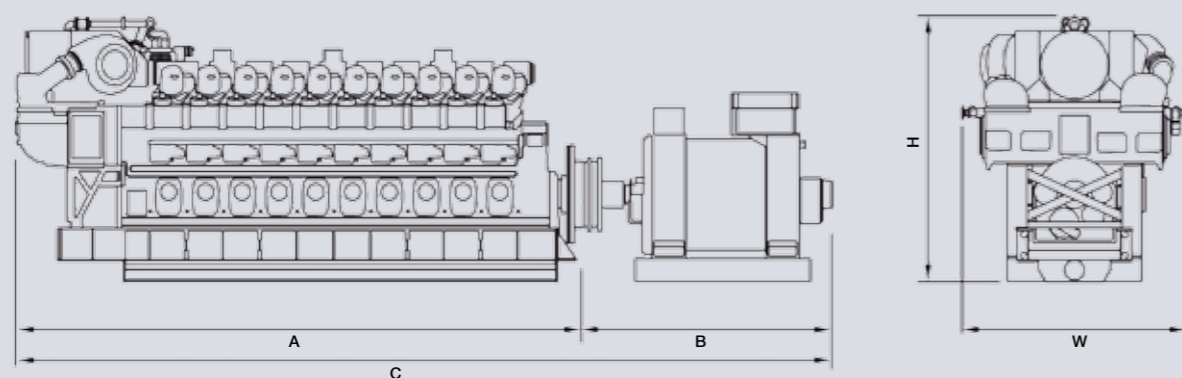
The stated consumption figures refer to:

- Ambient air pressure: 1,000 mbar
- Relative humidity: 30%
- Ambient air temperature: +25°C (77°F)
- Charge air temperature: According to engine type, corresponding to 25°C cooling water temperature before charge air cooler



# Technical Data

## Output, dimensions and weight



### MAN 35/44G GenSet

	A	B	C	W	H	GenSet
Number of cylinders	(mm)	(mm)	(mm)	(mm)	(mm)	dry mass (t)
20V	9,564	4,592	14,156	4,448	4,500	145

The dimensions and weights are given for guidance only.

### MAN 35/44G GenSet output (kW<sub>e</sub>)

Bore 350 mm, stroke 440 mm			20V
Engine speed	rpm	750	720
Frequency	Hz	50	60
Electrical GenSet power	kW <sub>e</sub>	10,335	9,945

### Electr. GenSet heat rate at 100% load and efficiency

Optimized for power generation (TA Luft)	7,436 kJ/kWh <sub>e</sub>	7,436 kJ/kWh <sub>e</sub>
Electrical Efficiency	48.4%	48.4%
Optimized for combined cycle (TA Luft)	7,554 kJ/kWh <sub>e</sub>	7,554 kJ/kWh <sub>e</sub>
Electrical Efficiency	47.7%	47.7%
Optimized for combined heat and power (TA Luft)	7,508 kJ/kWh <sub>e</sub>	7,508 kJ/kWh <sub>e</sub>
Electrical Efficiency	47.9%	47.9%

Nominal generator efficiency: 97.7%, Methane no. ≥ 80; without pumps; 5% tolerance

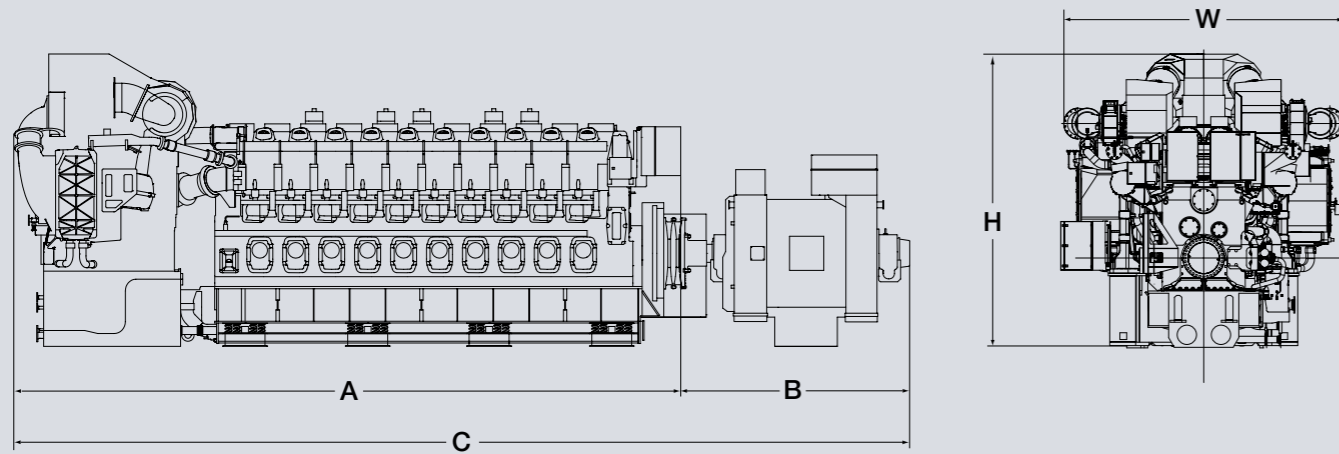
Lube oil consumption	kg/h	3.7	3.7
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Specific lube oil consumption 0.35 g/kWh, tolerance: +20%



# Technical Data

## Output, dimensions and weight



### MAN 35/44G TS GenSet

	A	B	C	W	H	GenSet
Number of cylinders	(mm)	(mm)	(mm)	(mm)	(mm)	dry mass (t)
12V	9,028	4,330	13,358	4,925	5,200	144
20V	11,549	4,137	15,686	4,925	5,200	200

The dimensions and weights are given for guidance only.

### MAN 35/44G TS GenSet output (kW<sub>e</sub>)

Bore 350 mm, stroke 440 mm		12V	20V
Engine speed	rpm	750 / 720	750 / 720
Frequency	Hz	50 / 60	50 / 60
Electrical GenSet power	kW <sub>e</sub>	7,254 / 6,903	12,090 / 11,505

### Electr. GenSet heat rate at 100% load and efficiency

Optimized for power generation (TA Luft)	7,284 kJ/kWh <sub>e</sub>	7,284 kJ/kWh <sub>e</sub>
Electrical Efficiency	49.4%	49.4%
Optimized for combined cycle (TA Luft)	7,506 kJ/kWh <sub>e</sub>	7,506 kJ/kWh <sub>e</sub>
Electrical Efficiency	48.0%	48.0%
Optimized for combined heat and power (TA Luft)	7,647 kJ/kWh <sub>e</sub>	7,647 kJ/kWh <sub>e</sub>
Electrical Efficiency	47.1%	47.1%

Nominal generator efficiency: 97.7%, Methane no. ≥ 80; without pumps; 5% tolerance

Lube oil consumption	kg/h	2.5 - 2.6	4.2 - 4.4
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Specific lube oil consumption 0.35 g/kWh, tolerance: +20%



## World-Class Service

Marine propulsion, gensets, and stationary plants



### The PrimeServ offering

The MAN Diesel & Turbo Group offers worldwide, round-the-clock service, 365 days a year. In addition to MAN Diesel & Turbo's service headquarters in Augsburg, Copenhagen, Frederikshavn, Saint-Nazaire, Hamburg and Stockport, service centers on all continents provide comprehensive and continuous support.

MAN Diesel & Turbo engines are renowned for their quality and durability. We are a global organization with a strong local presence, delivering exceptional field service management, tailor-made solutions, and first-class technical support.

PrimeServ provides advice and assistance to customers throughout the product life cycle, from delivery to resale. With our far-reaching network of service centers, we respond rapidly to customer needs. Furthermore, we offer outstanding service and unrivalled technical expertise. Plus, we only use genuine spare parts – safeguarding the longevity of your engine.

### PrimeServ's aim is to provide:

- Prompt delivery of high-demand OEM spare parts within 24 hours
- Fast, reliable and competent customer support
- Individually tailored O&M contracts
- Ongoing training and qualification of operators and maintenance staff
- Global service, 24 hours a day, 365 days a year
- Diagnosis and troubleshooting with our high-performance Online Service





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