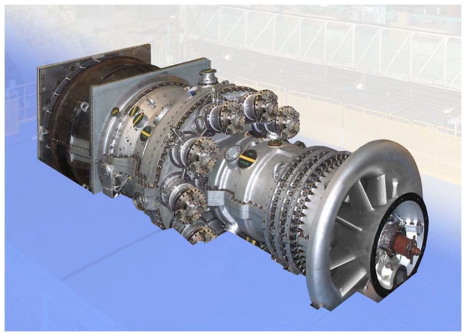
MHPS Middle & Small Capacity Gas Turbines and Web-based Performance Calculation Tool



Mitsubishi Hitachi Power Systems, Ltd.

The lineup of the H-Series middle & small capacity gas turbines of Mitsubishi Hitachi Power Systems, Ltd. (hereinafter, MHPS) is comprised of the 40MW-class H-25 series and the 100 MW to 120MW-class H-100 series, which have been widely used for private power generation for industrial use and the power generation business. Due to its dual-shaft configuration, the application of the H-100 series gas turbine to LNG plants for driving compressors is also under consideration. In this article, the H-25 and H-100 series gas turbines and the web-based Product Selection Assistant Program, which was developed for customers who are considering the application of middle & small capacity gas turbines are introduced.

1. H-25 series gas turbine

The H-25 series gas turbine is a single-shaft gas turbine with a heavy-duty design. **Figure 1** shows a cross-sectional view of the H-25 series gas turbine and a photo of the opened upper-half casing. Since the first unit started operation in 1988, orders for a total of 176 units have been received from both inside and outside of Japan. The customers and plant configurations using the H-25 series gas turbine are shown in **Figure 2**. About half of the customers use the H-25 series gas turbine on site in the oil & gas industries. The H-25 series gas turbines are applied to various plant configurations such as simple cycle, cogeneration and combined cycle. The delivery regions of the H-25 series gas turbine are shown in **Figure 3**. Many units are in service, and the cumulative total operating hours have exceeded 6.3 million hours, which proves their high reliability. The features of the H-25 series gas turbine are as follows.

(1) It has a heavy-duty design, reliable, and suitable for continuous operation.
(2) The adoption of a horizontally-split casing and a multiple-can type combustor offers good maintenance performance and easy on-site replacement of hot components.
(3) The fuel diversification technology enables the use of fuels such as natural gas, light oil, LPG (Liquefied Petroleum Gas), off gas, COG (Coke Oven Gas) and bioethanol.

For the H-25 series gas turbine, since the start of operation of the first unit, improvements such as increased combustion temperature and improved aerodynamic and cooling performances have been continuously implemented. At the beginning of the development, the output was 25MW class, whereas it is now 40MW class. The specifications of the H-25 series gas turbine are indicated in **Table 1**.

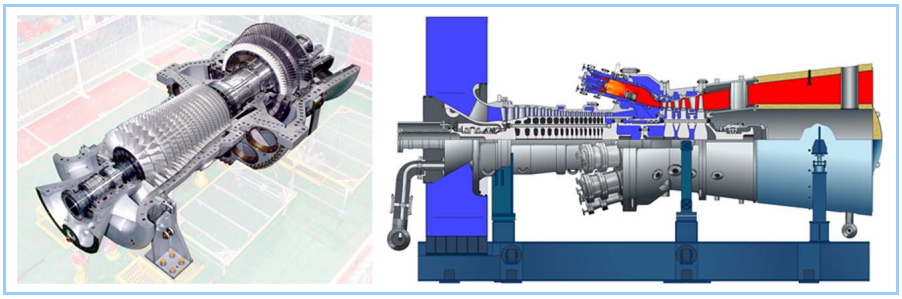


Figure 1 H-25 series gas turbine

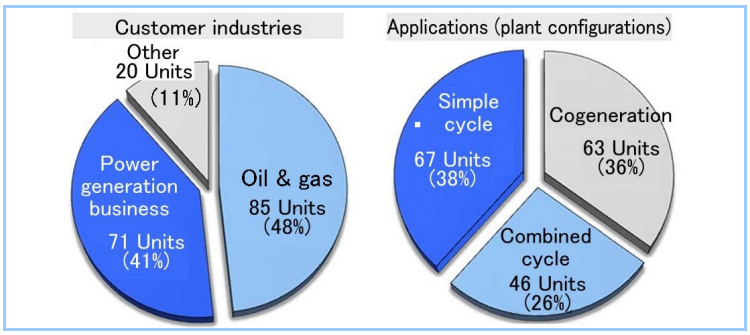


Figure 2 Customer industries and applications (plant configurations) for H-25 series gas turbines

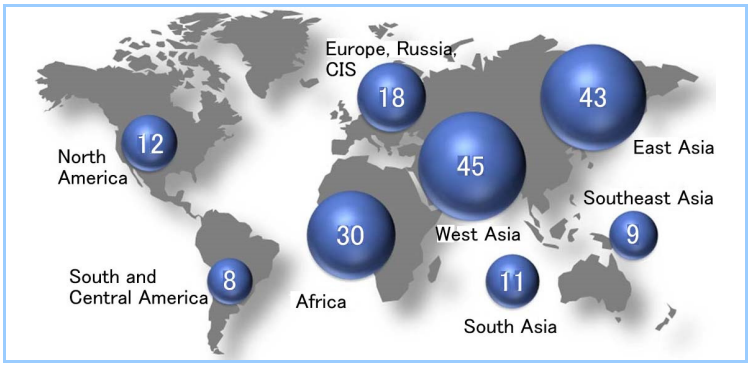


Figure 3 H-25 series gas turbine delivery countries

Table 1 Basic specifications of H-Series gas turbines

Item		H-25	H-100	
		50Hz / 60Hz	50Hz	60Hz
Type		Heavy-duty design, single-shaft	Heavy-duty design, dual-shaft	
Compressor		Axial-flow type, 17 stages		
Combustor		Multiple-can type, 10 cans		
Turbine		Axial-flow type, 3 stages	Axial-flow type, 4 stages (High pressure: 2 stages + Low pressure: 2 stages)	
Output		41030 kW	118200 kW	105780 kW
Efficiency		36.2% LHV	38.3% LHV	38.2% LHV
Rated speed		7280 rpm	4580 / 3000 rpm	4580 / 3600 rpm
1 on 1 combined cycle performance	Output	60100 kW	172600 kW	150000 kW
	Efficiency	54.0% LHV	57.2% LHV	55.1% LHV
2 on 1 combined cycle performance	Output	121400 kW	347800 kW	305700 kW
	Efficiency	54.5% LHV	57.6%	56.1% LHV

2. H-100 series gas turbine

The H-100 series gas turbine is a dual-shaft gas turbine with a heavy-duty design. **Figure 4** shows a cross-sectional view of the H-100 series gas turbine and a photo of the opened upper-half casing. In 2010, the first H-100 series gas turbine for 60Hz areas started operation, and in 2016, the first H-100 series gas turbine for 50Hz areas entered service. Orders for a total of 21 units have been received so far, and the cumulative operating hours have exceeded 360,000 hours. In addition to a heavy-duty design like the H-25 series gas turbine, the H-100 series gas turbine has the following features:

(1) All 21 orders were for combined cycle plants, and the H-100 unit achieves the highest-level of efficiency in the same output class.

(2) By replacing an old gas turbine of the same output class with the H-100 series gas turbine, the efficiency can be increased. (Orders for 20 units were received under the GT replacement project.)

(3) Due to its dual-shaft configuration with separate high-pressure and low-pressure turbines, the H-100 series gas turbine is suitable for driving machinery. The low-pressure turbine has a wide range of speeds (70% to 105%), and the required starting torque is smaller compared with a single-shaft configuration, allowing a smaller-capacity starting device to be used.

(4) Quick starts are possible with a starting time of 10 minutes.

The specifications of the H-100 series gas turbine are shown in Table 1. We plan to continuously increase the performance of the H-100 series gas turbine for 300MW-class combined cycle power plants as mid-level capacity and to introduce to the market a dual-fuel combustor, such as one using natural gas and light oil, as well as a natural gas-fired dry type low NOx combustor.

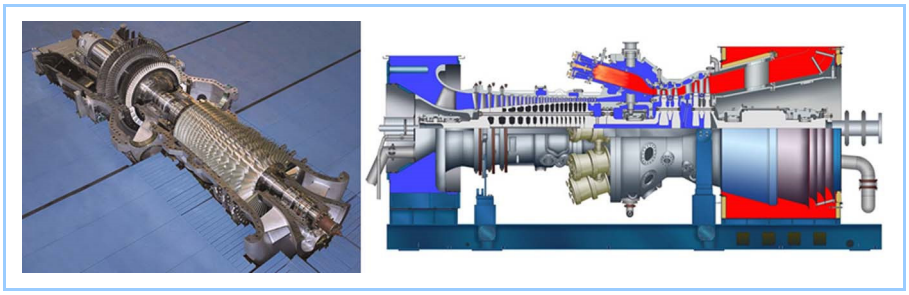


Figure 4 H-100 series gas turbine

3. Web-based Product Selection Assistant Program

MHPS developed and released the web-based Product Selection Assistant Program to support customers considering the introduction of private power generation and entering the power generation business, for the selection of middle & small capacity gas turbines, as well as for the consideration of required site area, delivery period, economic efficiency, etc., in the initial study stage. The Product Selection Assistant Program features A) Easy Product Selection and B) Detailed Production Selection.

(http://www.mhps.com/products/gasturbines/diagnosis/index.html)

A) Easy Product Selection Program

To determine which model of H-Series product would best meet the needs of a customer, the customer answers questions using the web-based tool. With such easy operation, the optimal model is selected and the standard performance, standard plant layout, standard delivery period and typical revenue from sales of electric power are proposed. The customer operates the buttons or bar chart to enter the frequency (50Hz or 60Hz), plant configuration (simple cycle, combined cycle or cogeneration) and demand (required power or required steam output) or fuel flow availability. The operation and execution of the Easy Product Selection Program requires no customer registration. **Figure 5** shows an example of Easy Product Selection results.

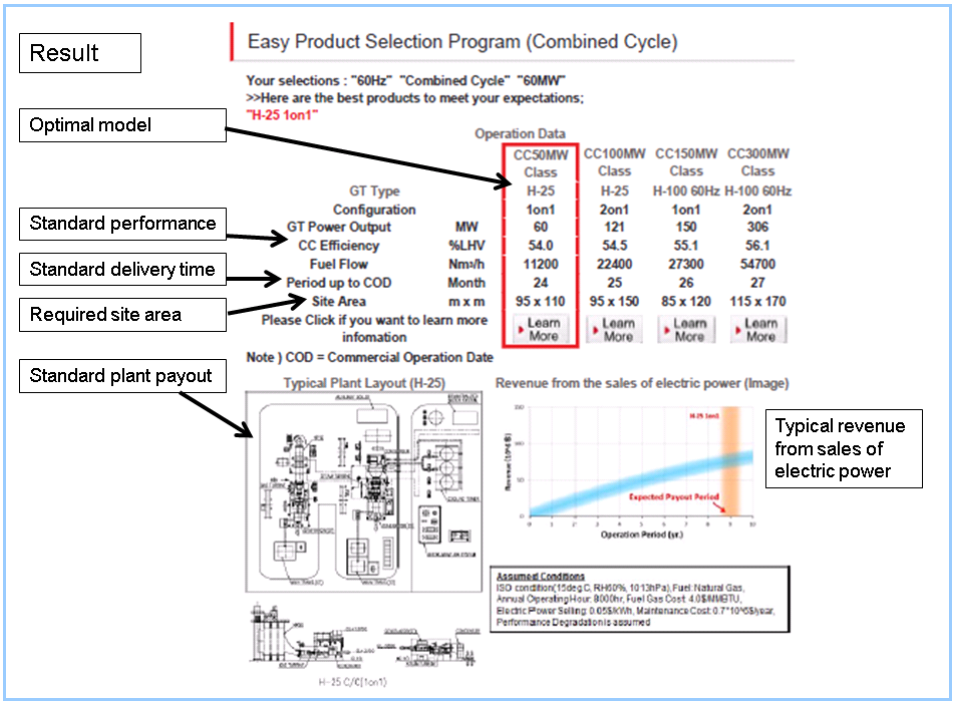


Figure 5 Screen of Easy Product Selection Program (Example)

B) Detailed Production Selection Program

When the customer enters the environmental conditions (atmospheric temperature, relative humidity and altitude), unit fuel price, unit price of sales of electric power, annual operating time, investment, interest, etc., in addition to the entry (selection) in the Easy Product Selection Program, the plant performance and profitability under the environmental conditions are calculated. **Figure 6** illustrates an example of the Detailed Production Selection results. The Detailed Production Selection program is intended for customers who are considering a specific plan for a power generation plant and it requires prior registration for the operation and execution of the program so that subsequent support can be provided.

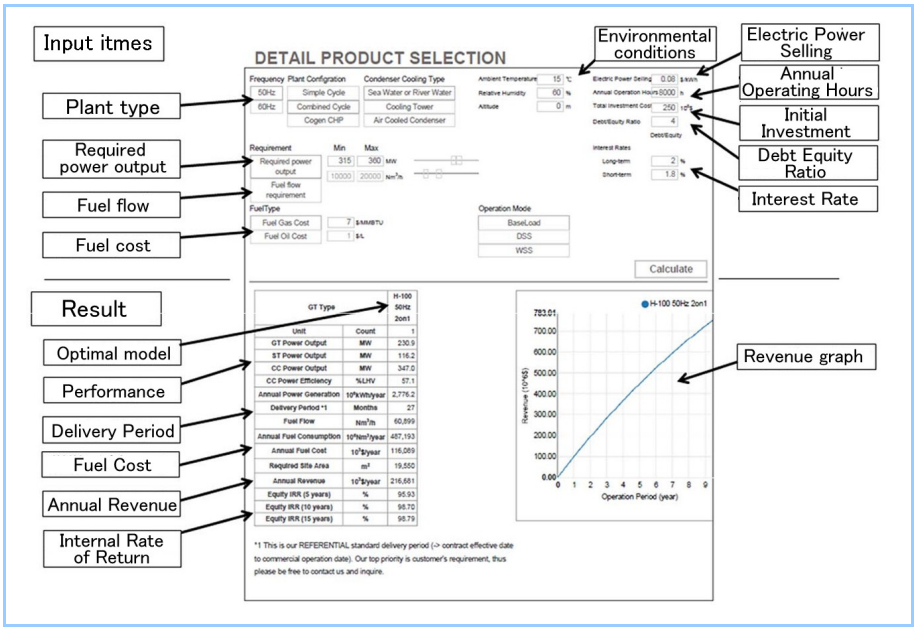


Figure 6 Screen of Detailed Production Selection Program (Example)

4. Future development

We have received more than 200 orders for H-Series gas turbine units so far, and the performance and reliability of H-Series gas turbines are highly evaluated by our customers. We are expected to meet customer demands through further improvements of performance and reliability. On the other hand, for a customer's initial consideration of the application of an H-Series gas turbine, we provide the web-based Product Selection Assistant Program for continuous customer support.