GE’s 7HA and 9HA plants rated at more than 61% CC efficiency

Air-cooled HA gas turbine platforms are operationally rated at more than 61% net plant efficiency for 50 and 60Hz combined cycle projects.

GE is drawing on its ‘FlexEfficiency’ DNA to introduce a series of air cooled high efficiency gas turbines with firing temperatures of over 2600°F for 50 and 60Hz combined cycle power generation:

The first on the market is a 9HA.01 gas turbine design, rated at 592MW net output and 61.4% net efficiency, currently in production that is to be delivered next year to EDF in France for a single-shaft combined cycle plant project.

Flexibility and performance improvements of 9HA combined cycle plants feature rapid startup, high ramp rates and good part-load efficiency:

Quick start. Full plant load in less than 30 minutes from the start command.

Ramp rate. Up to 60MW per minute ramp rate and turndown to less than 40% plant load while maintaining emissions guarantees and 60% efficiency down to 87% load.

Revenue. Potential for standby capacity fees and spinning reserve at low load operation.

Historically the most effective way to increase combined cycle efficiencies has been to develop advanced gas turbine engine technologies capable of operating at ever higher firing temperatures.

Started with 2000°F
In the 1970s GE introduced its E-class machines which operated at 2000-2300°F firing temperatures capable of achieving close to 50% combined cycle efficiency at the higher temperature range.

This was followed by F-class gas turbines in the mid-1980s capable of 2300-2600°F firing temperature for 55-58% combined cycle efficiency levels. And in 2003 GE introduced 2600°F steam-cooled H-class units equipped with single crystal turbine blades capable of 60% combined cycle efficiency.

GE's latest HA gas turbine product line represents an evolution of steam-cooled H-class technology in the form of a simplified air-cooled HA (H class Air-cooled) gas turbine designed to operate at firing temperatures of 2600-2900°F which at the high end could make 62- 63% combined cycle efficiencies a reality.

Now at 2600-2900°F
Currently GE Power & Water is developing two versions of a 7HA design for the 60Hz market and two versions of the 9HA for 50Hz power generation.

The first 9HA.01, already produced and heading for validation testing, is rated at close to 400MW simple cycle and 1x1 600MW combined cycle. To be joined by a 9HA.02 unit rated at 470MW simple cycle and 1x1 700MW combined cycle.

The 7HA.01 now in production is rated at 275MW simple cycle and 405MW in 1x1 combined cycle. This is to be joined by a 7HA.02 unit rated at 330MW simple cycle and close to 500MW 1x1 combined cycle.

Effectively this enables GE to blanket a power range of 275 to 500MW for 60Hz applications with a single 7HA gas turbine platform and also cover a range of 400 to 700MW for 50Hz applications with a single 9HA gas turbine platform.

> **Launch orders for 9HA and 7HA combined cycle projects** GE Water & Power has orders for 50Hz and 60Hz combined cycle projects in France and Japan – with EDF as the first customer. **EdF Bouchain, France**Electricite de France (EDF) is building a 1x1 9HA.01 combined cycle plant at its Bouchain site in the North of France that currently operates a coal-fired steam plant due to shut down. The 9HA.01 gas turbine is scheduled to ship in 2015. GE and the French state-controlled utility group EDF are jointly developing the project nominally valued at around EUR400 million ($533 million). **Chubu Electric Power, Japan**GE and Toshiba were awarded contracts in 2012 to supply and install six 7HA.01 gas turbines for a combined cycle project being built at Chubu Electric's Nishi-Nagoya thermal power plant in Nagoya City, Japan. GE is scheduled to start shipping units to Toshiba, the EPC contractor, in February 2016. All six gas turbines are expected to be installed and operational by March 2018. **GE and Toshiba MOU**In January 2013 GE and Toshiba signed a memorandum of understanding (MOU) to form a global strategic alliance for the joint development of select 50Hz and 60Hz combined cycle generation projects around the world that could be powered by 7HA and 9HA technology.

50/60Hz markets
Vic Abate, President and CEO Power Generation Products for GE Power & Water, sees strong growth potential in both developing and industrialized regions around the world.

The 9HA and 7HA gas turbines offer high operating efficiencies at full and part-load conditions, low emissions, fast startup, high ramp rates and excellent reliability and availability.

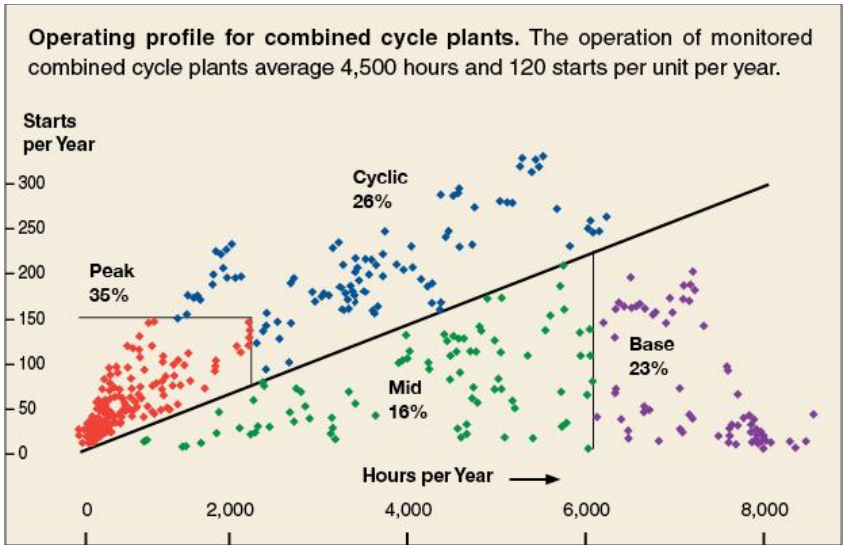
Operational characteristics are increasingly important to all owner operators. Even more important, however, these advanced gas turbine-based plants "offer the most cost-effective conversion of fuel to electricity with the lowest life cycle costs".

Considering that after 20-30 years the fuel cost for a base load combined cycle plant adds up to more than 80% of total plant owning and operating costs, high operating efficiency is vital.

Life cycle cost
"Larger, more efficient units however should also have a low ownership cost" with respect to parts life and O&M costs to ensure lowest life cycle costs, Abate notes.

The 9HA gas turbine models have been developed for the growing gas-fired power generation markets in 50Hz regions, including the U.K., Europe, Africa, Australia, southern cone of South America, Middle East (except for Saudi Arabia), Turkey, India, China, half of Japan, and Russia.

Likewise the 7HA models will serve 60Hz power generation regions like the U.S., Canada, Mexico, Central America, northern part of South America (especially Brazil), Saudi Arabia, half of Japan, and S. Korea.



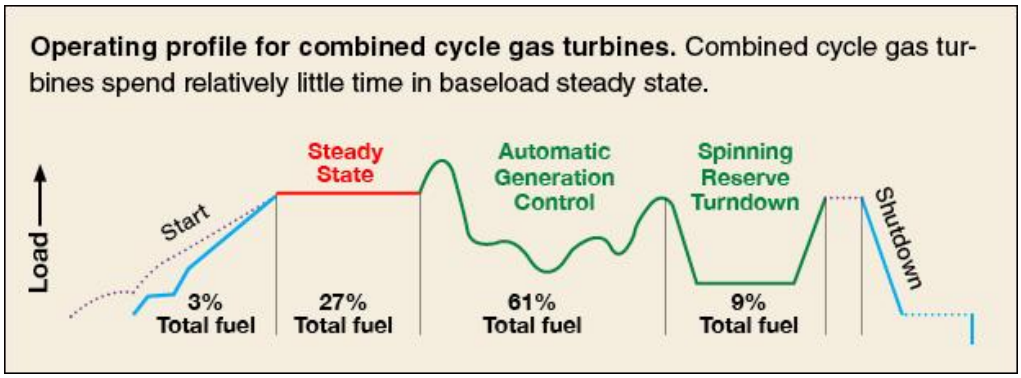
Operating profile for combined cycle plants. The operation of monitored combined cycle plants average 4,500 hours and 120 starts per unit per year.

Growing the market

The HA machines are not really competing with F- and E-class units where such large chunks of power are not suitable. In smaller markets with lesser grid capacity, absorbing large unit sizes is not practical.

In other words, just as the introduction of F-class machines didn't fully displace the smaller E-class units, the HA will not fully displace the "F" and "E" machines in markets where smaller "chunks" of power are still most suitable for local needs.

In the US, for example, the big combined cycle plants are almost all comprised of the latest and biggest machines. In that sort of market the HA definitely is displacing the "F" (which definitely had displaced the "E" in the mid-late 1980s).



Operating profile for combined cycle gas turbines. Combined cycle gas turbines spend relatively little time in baseload steady state.

50Hz power

For the 50Hz market Abate says GE is bidding on a lot of 1x1 combined cycle plant configurations for power generation. Many of the projects, he notes, are for combined heat and power production and petrochemical cogeneration facilities.

60Hz power
His group is currently bidding on 2x1 and 3x1 combined cycle 60Hz projects for 7HA.02 units that have commercial operating dates 6 or 7 years out into the future.

Nearer term, he notes, utilities looking to replace old coal plants are backfilling with high efficiency gas-fired combined cycles based on 7HA.01 units.

Meanwhile there is still strong demand for F-class and even E-class gas turbine plants for fast track projects into Iraq, Libya, Africa and the Middle East.

Design and performance
For more information on 9HA and 7HA power plant design features and performance, you can download a variety of interesting technical briefs and fact sheets by going to the company's website at gepower.com/efficiency.

GTW will also be coming out with a more detailed article in the next issue of the magazine.

7HA combined cycle plants. First 7HA.01 combined cycle plant is expected to become operational in 2018. Power plant output and efficiency performance ratings are based on GE plant design with 1.2 inch condenser pressure.

Design Parameter	1x1 7HA.01	2x1 7HA.01	1x1 7HA.02	2x1 7HA.02
Net plant output	405 MW	813 MW	486 MW	976 MW
Net heat rate (LHV)	5580 Btu/kWh	5570 Btu/kWh	5580 Btu/kWh	5570 Btu/kWh
	5892 kJ/kWh	5878 kJ/kWh	5892 kJ/kWh	5878 kJ/kWh
Net efficiency	61.1%	61.2%	61.1%	61.2%
Gas turbine power	273.4 MW	546.8 MW	328.1 MW	656.2 MW
Steam turbine power	136.8 MW	276.0 MW	164.1 MW	331.2 MW

Air-cooled 7HA gas turbines. Production unit #1 is scheduled for full load engine testing and validation in 2015. The next six production units will be shipped to Japan starting in February 2016 for a 60Hz combined cycle power station.

Design parameter	7HA.01 unit	7HA.02 unit
ISO base load output	*275 MW	*330 MW
Heat rate (per kWh)	8694 kJ (8240 Btu)	8694 kJ (8240 Btu)
Net efficiency	41.4%	41.4%
Pressure ratio	21.5 to 1	21.5 to 1
Exhaust flow (per sec)	575 kg (1269 lb)	826 kg (1522 lb)
Exhaust temperature	619°C (1145°F)	619°C (1145°F)
Approximate weight	600 tons	660 tons
Approximate size	82 x 15 x 23 feet	90 x 17 x 20 feet

*Note: Power ratings are net of inlet and exhaust losses and auxiliary load.

9HA combined cycle plants. First 9HA.01 combined cycle plant is expected to become operational in 2016. Power plant output and efficiency performance ratings are based on GE optimized plant design with 1.2 inch condenser pressure.

Design Parameter	1x1 9HA.01	2x1 9HA.01	1x1 9HA.02	2x1 9HA.02
Net plant output	592 MW	1181 MW	701 MW	1398 MW
Net heat rate (LHV)	5862 kJ/kWh	5878 kJ/kWh	5862 kJ/kWh	5878 kJ/kWh
	5560 Btu/kWh	5570 Btu/kWh	5560 Btu/kWh	5570 Btu/kWh
Net efficiency	61.4%	61.2%	61.4%	61.2%
Gas turbine power	394.5 MW	789.4 MW	467.0 MW	934.5 MW
Steam turbine power	205.2 MW	405.9 MW	242.9 MW	480.6 MW

Air-cooled 9HA gas turbines. Production unit #1 has been instrumented for full load engine testing and validation starting third quarter of 2014. Unit #2 now in production will be shipped to EDF Bouchain in 2015 for installation and commercial operation during 2016.

Design parameter	9HA.01 unit	9HA.02 unit
ISO base load output	*397,000 kW	*470,000 kW
Heat rate (per kWh)	8673 kJ (8220 Btu)	8673 kJ (8220 Btu)
Net efficiency	41.5%	41.5%
Pressure ratio	21.8 to 1	21.8 to 1
Exhaust flow (per sec)	826 kg (1822 lb)	978 kg (2157 lb)
Exhaust temperature	619°C (1146°F)	619°C (1146°F)
Approximate weight	950 tons	1050 tons
Approximate size	30 x 6 x 6 meters	33 x 6 x 6 meters
	100 x 19 x 19 feet	109 x 20 x 21 feet

*Note: Power ratings are net of inlet and exhaust losses and auxiliary load.

Source: Gas Turbine World