Solutions to increase gas turbine capacity

Power station equipment supplier Powerphase describes how its Turbophase system can help address Nigeria's power shortage

Nigeria, , which has a population three times larger than South Africa's, generates just a tenth as much electricity.

Power from private generators costs US$0.35 per kilowatt-hour or more, ten times more than electricity from the grid in most other countries. The World Bank reckons that power shortages trim more than two percentage points from annual growth in GDP on average in Africa; in Nigeria the loss has been almost four percentage points a year.

It was reported that Nigeria's power generation system hit zero megawatts six times in May this year, the highest level since 2009.

According to industry data acquired by a Citizen correspondent, power supply to households and businesses across the country dropped significantly in May as the national grid recorded six total collapses and one partial collapse within the period.

Nigeria has 11,600MW of installed gas turbine generation. What if Nigeria could add incremental power to the existing installations, specifically where natural gas supply is not a challenge?

The 'Turbophase' upgrade

Powerphase, a Company in Florida, USA makes an upgrade that could do just that, allowing Nigeria to get more from the power plants it already has as opposed to investing billions and many years to build new power plants. The upgrade, known as "Turbophase" is fast, flexible and cost-effective.

In late summer 2015, Powerphase installed a Turbophase upgrade on an operational GE 7FA gas turbine in the Middle East. The upgrade was installed in four months in order to meet the customer's summer peak load requirements.

In simple or combined cycle applications the skid-mounted Turbophase system consists of an air compressor driven by a reciprocating engine and a heat recovery system which captures the engine's exhaust heat and adds it to the compressor discharge, enabling the system to match the turbine's compressor discharge temperature.

The Turbophase system "takes advantage of the fact that all gas turbines lose power as ambient temperatures or elevations rise," explained Bob Kraft, Powerphase president and chief executive. The system "adds the air that is naturally missing back into the turbine". The air is injected into one or more of the existing ports, "typically about five per cent air, which results in 10 per cent more turbine power".

"We are the first commercial air injection system available on market," he said, "and for the next 18 to 20 years we expect to be the only one because of our patent portfolio."

Turbophase installations could add 1,200MW to the gas turbine capacity of Nigeria installed in a few months from order. The grid efficiency would increase and carbon emissions per MWh would decrease. Turbophase systems can be offered as capital purchase or under long term PPA.

Sizing up the competition

A Turbophase unit can run 24/7.

"The chiller is running harder at night to do the storage process and only gets auxiliary power during the day. The customer generates about six times the revenue stream with our system compared to a chiller system", said Kraft.

"New aero-derivative gas turbines are also competitive. These units suffer similar output reductions due to high ambient temperatures. Turbophase mitigates, and in some cases eliminates, the need to install new peaking gas turbines by providing an alternative at much better fuel efficiency."

Project specifications

The installation in the Middle East was designed to demonstrate the Turbophase system's performance at high ambient temperatures. The project was operational between mid-July and early October 2015.

"Our product works on every gas turbine on the planet. On B-class machines a system might make 8MW whereas on a J machine it will make 40MW," said Kraft. "On more advanced frames you will see some of the OEMs offering our equipment. This product works nicely with OEM offerings. It could be viewed as a competitive product because OEMs like to upgrade their GTs, however it's such a unique product and we see OEMs moving towards putting it on their engines, either in new or existing offerings, on both mature and advanced fleet GTs."

Hitting targets

The initial 7FA performance test was conducted on July 28, 2015. The Turbophase system achieved its output and heat rate targets of 31.5 MW and five per cent heat rate improvement for a full installation. At the customer's request, a second performance test was conducted in early September and confirmed the results of the first test. In both cases, the upgrade demonstrated that a full installation would produce a five per cent fuel efficiency improvement and 31.5MW power increase on the 7FA gas turbine.

Additionally, the system demonstrated as high as 99.3 per cent availability in ambient conditions up to 55ºC. The fuel efficiency improvement was demonstrated at both baseload and part-load operating conditions.

"A turbine has to be down for six weeks or more if you're installing a new hot gas path or putting on an inlet cooling system," Kraft said. "We have one air pipe that hooks to the GT and outage has been less than one day. So when the plant is down for something else, we tie in and we're done. It's a really simple installation, which leads to unique opportunities in that we can do something like the aircraft business does: power by the hour or PPA." ■