Cogeneration: the smart move for process heat users

Leandro Magro, manager for steam turbines at Zest WEG, argues that cogeneration for plants that already have boilers producing steam for process heat is the smartest move towards electricity cost savings. The addition of a TGM WEG turbine generator system to a steam process plant offers energy security, lower utility bills and the potential to sell excess power to local municipalities.

According to Magro, traditional coal power plants are built around steam, but when considering the current price of renewables such as wind turbines and solar PV, along with the environmental consequences of carbon emissions, building steam-based coal power plants to generate electricity doesn't often make sense anymore.

But for companies that already have boilers to produce the process heat they need, such as sugar, chemical, food, oilseeds processing and paper plants, the addition of a steam turbine generator that can produce some or all of the electricity they need can be a huge benefit. "This is the niche application for our Zest WEG steam turbine business," he tells MechChem Africa.

Opportunities for cogeneration mostly involve industries that use steam for heating, drying, moisture control and sterilisation, for example. "In the paper industry steam is used in the cooking process, to control the pulp moisture content and then to dry the paper. At sugar mills, there is a high demand for steam in the evaporators, where the sugar juice is boiled off to make sugar crystals," Magro explains.

These industries use boilers to produce the process steam they need. But the pressures and temperatures of the steam coming out of these boilers has to be reduced to match the specific process requirements. In numerous cases, this is achieved by passing the steam through a pressure reducing station, which consists of pressure reducing valves and water injection systems that are set up to deliver the steam pressure and temperature needed by the process.

"In terms of energy use, this is very inefficient," Magro explains. "Each stage of the process may need different pressures and temperatures, for evaporation, sterilisation or drying processes, for example, and each time the pressure and temperature is reduced, some of the thermal energy of the steam is lost."

To condition the steam to meet process requirements in a more efficient way, Magro suggests installing one of TGM WEG’s steam turbine generator solutions, which can recover the thermal energy (enthalpy) of the steam that is not required in the process, by converting it, first into mechanical energy through the turbine, and then into electricity through a generator spinning on the turbine shaft. "Cogeneration is also called combined heat and power, since these systems are constantly delivering the process heat (via steam), while converting any surplus heat (enthalpy) into electrical energy via the steam turbine generator set. Plant operators continue to get the heat needed for their process, while also generating some ‘free’ electricity for their internal needs or, when generating excesses, for export to an external grid.

"The basic principle is simple: whenever an enthalpy drop is required to reduce process steam pressure and temperature, there is an opportunity to extract this enthalpy via a suitably sized turbine generator set, and to convert it into electricity," he explains.

"Our TGM WEG cogeneration solutions help plant operators to better benefit the steam they are already producing - and even with small pressure drops, we can cost effectively produce ac power. Saw mills across Africa, for example, have a lot of waste biomasses at their disposal, and they already operate steam boilers to condition their wood products. We see potential to install steam turbine generator systems that can help these plants to generate their own electricity and, in many cases, to export excesses to power-hungry local towns," he informs MechChem Africa.

"At Zest WEG, our integrated solutions offering includes entire cogeneration systems that sit between the boilers and the process steam flange, including the associated electrical network of controllers, transformers, switchgear and transmission lines to enable the electricity generated to be safely and efficiently used," he adds.

The benefit for process heat users is that an easily installed TGM WEG system add-on can transform any operating steam supply line into an ultra-efficient cogeneration heat and power plant. "A carefully sized turbine generator set can control the enthalpy delivered to the process very accurately, by channelling the amount of steam and enthalpy through the turbine exhaust or controlled extraction pathways. Depending on the steam availability, a condensing extraction steam turbine plus a steam condensing system can be added to recirculate boiler feed water. We can also convert most of the available enthalpy into electric power at times when no process steam is required," he says.

TGM WEG has more than 11 GWh of turbine generators installed around the world. In Africa, Zest WEG has already installed 130 MWh of TGM WEG cogeneration systems, in countries including South Africa, Zimbabwe, Angola and Algeria.

"The TGM WEG steam turbine generator range embraces a power range from 50 kW to 150 MW and ‘cogeneration can benefit all industrial segments that use process steam, from small to large operations. Even smaller plants such as food processing plants that make deep fried foods or use sterilisation processes will find that systems in the lower end of the range are viable, particular in the 500 kW to 5.0 MW range.’"

From a payback perspective, Magro says the investment in a steam turbine generator system is typically between R5 000 and R15 000 per kWh installed at plants that already have a boiler producing process steam. "If working for 8 000 hours per year, which is typical, and if assuming a cost saving of only R3/kWh from the utility, a typical system can generate electricity cost savings of R8 000 per kWh installed per year, giving a payback time on the initial investment of between 7.5 and 15 months. This is surprisingly short and makes for an excellent business case," argues Magro, particularly where grid electricity prices are becoming increasingly difficult to afford. As well as promoting higher energy and production efficiencies, the energy security benefits of adopting cogeneration are invaluable, resulting in more reliable power that is less susceptible to grid-wide fluctuation or outages. Plants become much less dependent on diesel-driven gensets in emergency situations and overall plant reliability is likely to improve.

"From a jobs perspective, there are also benefits, because operating a small power plant inside a process plant offers direct employment opportunities and supply chain expansions, which promote localisation.

Adding a cogeneration steam turbine generation system to an existing process steam circuit also benefits the environment, since it results in the most efficient possible conversion of the fuel being burned into useful power, maximising efficiency and minimising plant CO₂ emissions.

"So for anyone already producing process steam, it makes total sense to add a cogeneration system to convert the excess heat into electricity," Magro concludes.