Exploiting LNG's cold energy potential

Exergy International, an Italian-based engineering company, is leveraging the LNG regasification process' cold energy potential. Technical Editor Ian Cochran reports.

Common technologies used for LNG regasification mainly comprise open-rack vaporisers (using seawater as a thermal source) and submerged combustion vaporisers (with natural gas as a thermal source). Alternatives include intermediate fluid vaporisers and ambient air vaporisers.

However, none of these technologies exploit the cold energy available in LNG, which is around 740 kJ/kg of LNG (-160 deg C to 0 deg C at 80 bara).

Currently, cold energy utilisation accounts for less than 1% of its total potential, although around 2.5 GWe could be produced from its exploitation, which could be further boosted by climate change policies.

Organic Rankine Cycle (ORC) cold energy plants are an efficient technology to recover energy from LNG's regasification and de-carbonise the oil & gas sector, Exergy said, being one of the leading ORC suppliers worldwide with more than 500 MW in its portfolio.

The company said that its R&D department has developed and designed a new solution to this solution - the Cold Energy Plant (CEP).

This is claimed to be an efficient system based on ORC technology, which regasifies LNG and converts the heat absorbed from seawater into electricity by recovering LNG's valuable exergy content.

High efficiency

The CEP system achieves high efficiency, thanks to the use of the proprietary Exergy Radial Outflow Turbine (ROT), combined with the multi-level condensation cycle.

It is a low-maintenance and cost-effective solution that can be efficiently applied in the LNG industry to:

- Increase the energy efficiency of the LNG regasification process.
- Increase operational profitability.
- Increase the sustainability of the LNG regasification process by reducing energy consumption and associated carbon emissions.
- Work in parallel operation with conventional vaporisers for uninterrupted regasification during CEP start-up/shut-down.

Paolo Danesi, Exergy international's Commercial Director told *LNG Journal* that the company's new CEP is a cryogenic cold energy recovery tool.

It can regasify LNG, replacing the use of conventional vaporisers and at the same time, is able to exploit the thermal energy available to produce electricity.

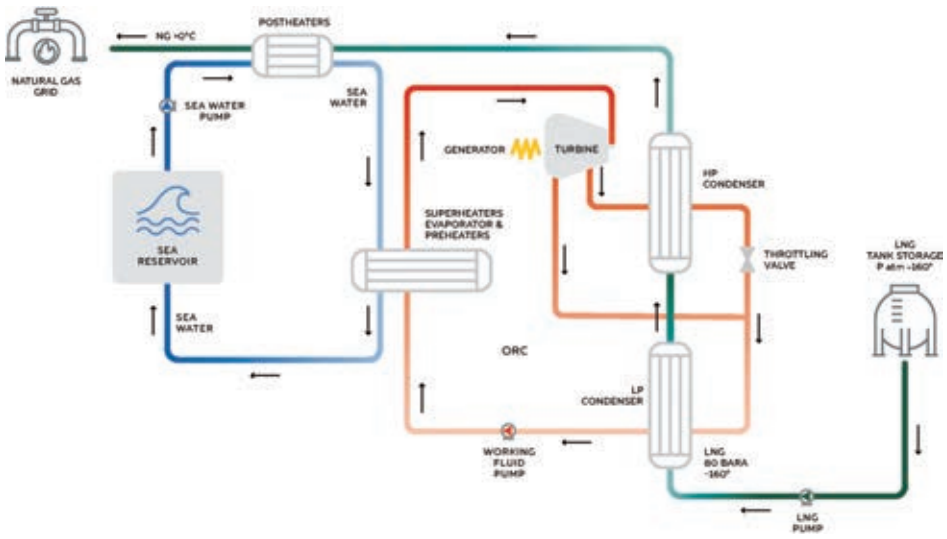
"In fact, a thermal engine can convert any meaningful temperature difference into mechanical energy and then into electrical energy in a turbo-generator," he explained.

Power can be produced in a thermodynamic cycle in which LNG acts as the cold heat sink, and the higher temperature ambient (eg seawater) as a hot resource.

Generated electrical power becomes a valuable "sub-product" of regasification and can be used for internal LNG terminal consumption and as an excess, which is fed into the national grid.

Explaining the difference between conventional ORC systems, such as the one recently installed in Thailand's PTT LNG project, the conventional system is characterised by a single level of condensation and the use of propane, R13, R22 or R23 as a working fluid.

This single condensation plant configuration is characterised by a condensation curve, which does not match the LNG vaporisation and strongly limits the turbine expansion, thus the ORC plant power production.



Cold energy recovery plant cycle

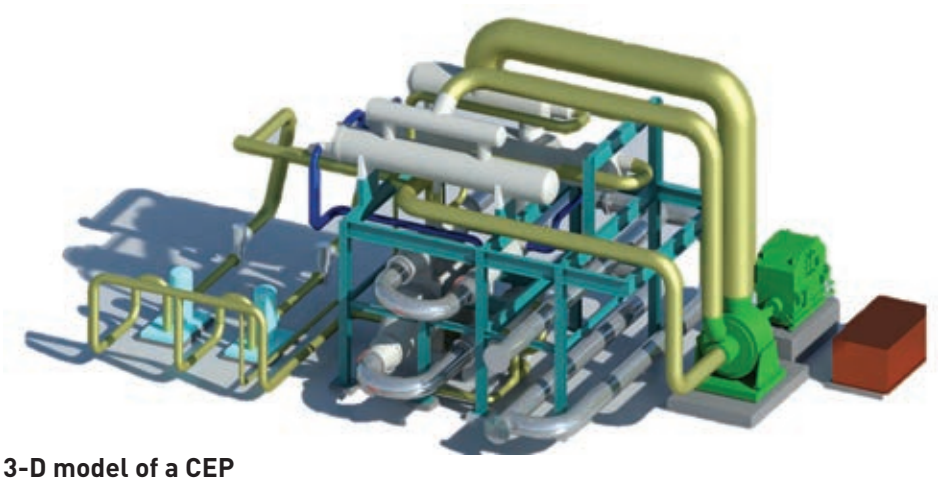
To overcome the single level ORC performance limitation, Exergy developed and patented the multi-level condensation ORC CEP, with the aim of utilising the LNG heat sink, at its maximum, along the vaporisation curve, thus increasing the cycle efficiency and maximising the electrical power production at the regasification rate necessary.

The main ORC cold energy plant equipment includes - pre-heaters, evaporator and superheater (exchanging heat with seawater), ROT turbine and generator, high pressure (HP) and low pressure (LP) condensers (exchanging heat and achieving the regasification of LNG), single feed pump, condensate throttling valve at HP condenser outlet (ORC side), and an LNG post-heater designed to heat up the LNG from the HP condenser outlet with seawater.

Its primary aim is to guarantee the natural gas temperature is always higher than the minimum required by the natural gas distribution network.

Danesi also explained that the company had started to market CEP to developers of new, expansion or enhancement regasification projects.

"These are good opportunities to integrate sustainable technology for regasification and clean power generation," he concluded. ■



3-D model of a CEP

Exergy – a potted history

Exergy was founded in 2009 with the launch of ROT, following years of research and testing. Its development came from a gap seen in the ORC market for a turbine that could utilise lower quality heat sources.

In 2011, Exergy became a subsidiary of the Italian Maccaferri Industrial Group, sitting within SECI SpA Holding.

A year later, Exergy installed the world's first ROT in a geothermal site for Enel Green Power's Tuscany Bagnore III plant, which today, remains the first and only geothermal binary plant for commercial operations in Italy.

Between 2013 and 2018, Exergy won key Turkish contracts becoming a market leader in supplying geothermal binary power plant equipment and consolidated its knowhow by upscaling and improving its technology.

On the 25th of September 2019, the company was acquired by the Chinese TICA Group, a leader in HVAC and thermal energy systems.

Currently, Exergy has supplied equipment to 62 power plants with a total capacity of more than 500 MWe and owns the second largest geothermal fleet worldwide.

Among its most valuable references is Energy Development Corp (EDC), who awarded Exergy the first geothermal brine recovery project in the Philippines and recently ordered a new 28 MWe unit, an LNG waste heat recovery project developed between 2018/2019 in partnership with GE-Baker Hughes, for Samsung Engineering on behalf of Thai state-owned oil and gas company, PTT LNG. ■