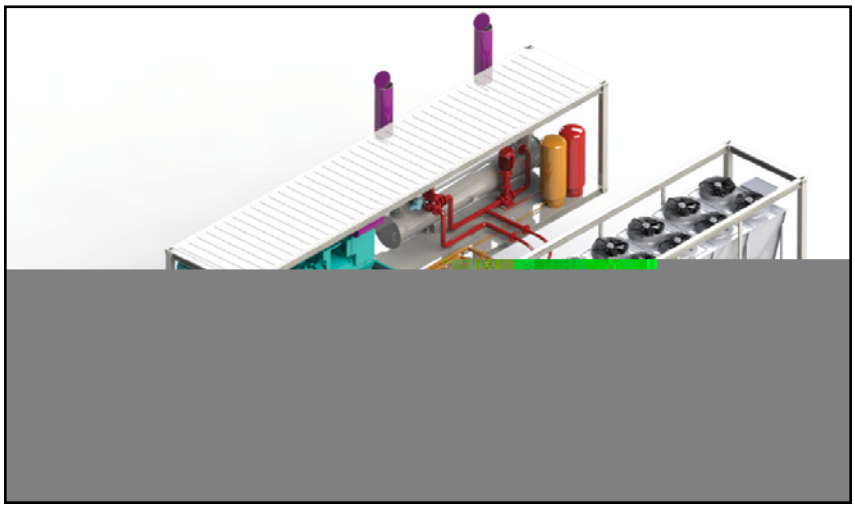

The DOD-funded ORC integration and replacement project that will deploy later this year is comprised of two 40 ft. (12 m) ISO shipping containers.

Utilizing Waste Heat For Power

Advanced engine cooling with economic payback; DOD project demonstrates up to 12% increase in fuel efficiency

Continuous duty gen-sets provide base-load power generation in diverse applications around the globe. However, high fuel costs and engine maintenance are pain points felt by operators. A low-maintenance path to significant fuel savings and lower emissions is what the U.S. Department of Defense (DOD) had in mind when they approached ElectraTherm to integrate the company's Green Machine waste heat to power (WHP) generator with a 1.1 MW Cummins KTA-50 generator.

ElectraTherm specializes in small-scale, distributed power generation from waste heat, utilizing Organic Rankine Cycle (ORC) and proprietary technologies to generate power from low temperature heat ranging from 77° to 116°C. The company's WHP technology converts various sources of heat into power, including internal combustion engines, small geothermal, biomass, concentrated solar and process heat. To date, ElectraTherm said it has deployed 42 units worldwide, with a cumulative 250 000 operating hours and over 97% availability.

ElectraTherm's primary market is waste heat from stationary internal combustion engines. Typical sites for these engines include prime power production in remote areas, island and developing nations, biogas gen-sets including landfill and waste water treatment plants, natural gas compression stations and renewable biofuels. With the typical engine running at about 35% efficiency, there is considerable waste heat between the jacket water and the exhaust that ElectraTherm converts into emissions-free/fuel-free electricity.

ElectraTherm's Green Machine generator operates using a closed-loop ORC, where hot water is the fuel. Hot water from the engine enters a heat exchanger to excite (pressurize) the non-flammable, nontoxic working fluid, driving the twin-screw expander and generator to create electricity. The company said its twin-screw expander is unique in its configuration, lubrication and specifications, but the core technology is based on decades of proven compressor technology.

The twin-screw expander has a rotational speed of 1800 to 4900 r/min, considerably less than turboexpanders, according to ElectraTherm. Unlike high-speed turboexpanders, screw expanders are robust units that tolerate "wet" dual-phase flow.

"This allows a very robust and cost-effective design for the Green Machine that can tolerate perturbations in both temperature and flow with turn down ratios of 6:1 available on demand," said John Fox, CEO of ElectraTherm, Inc. "This is particularly advantageous in low temperature waste heat streams such as engine jacket water. Our Green Machine design is simplified and eliminates lubrication reservoirs, oil coolers, pumps and land filters, creating a simple, robust and efficient system with fewer parasitic loads and maintenance requirements."

The Green Machine acts as the engine's radiator, so the engine-driven radiator fans can actually be disconnected (or eliminated completely for a new installation), allowing more work to be performed by the engine to generate additional electricity. In effect, the engine's waste heat becomes a source of cost savings by displacing the radiator's capital cost and parasitic load.

Between the DOD project and the machines currently running in the field, ElectraTherm said it increases fuel efficiency up to 12%, depending on engine size and configuration, and site conditions while featuring simple installation, mobility and low maintenance.

There are multiple benefits to integrating an ORC heat to power generator with an engine gen-set: the additional electrical output from the conversion of the waste heat to electricity with no additional fuel consumption or emissions, and the reduction or elimination of the parasitic load from the engine cooling fans. In hot climates or seasonally high ambient conditions, which often coincide with peak demand, the engine's derate can be reduced due to the added cooling effect of the ORC, thereby increasing the power output of the engine. "The additional benefits from