Generate power using microturbine project

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Microturbine technology has evolved from early systems of 30 kW to 70 kW to today’s systems, which can have individual ratings of 200 kW to 250 kW. Packages up to 1 MW are now available that can be assembled into multipac units for projects of 5 MW to 10 MW. These modern units are packaged with integrated digital protection, synchronization, and controls; they produce high combined heat and power efficiencies; and they are capable of using multiple fuels.

Microturbines are a relatively new technology for the generation of electric power. So, not surprisingly, questions are often raised by potential customers, engineering firms, original equipment manufacturers, and government agencies about how microturbines perform and how they differ from other more traditional forms of electric power generation. This article addresses those questions, describes the major features of microturbines, and gives examples of how they are used in real-world applications (Figure 1).

Microturbines are a simple form of gas turbine, usually featuring a radial compressor and turbine rotors and often using just one stage of each. They typically recover exhaust energy to preheat compressed inlet air, thereby increasing electrical efficiency compared with a simple-cycle machine. The air-to-air heat exchanger is termed a “recuperator,” and the entire system is typically called a recuperated cycle.

Figure 2 shows a cutaway view of a Capstone 65-kW microturbine illustrating how these major components are arranged in a commercial product. The assembly is often called a “turbogenerator,” as it includes all the microturbine components plus the generator. The single shaft of turbine, compressor, and generator rotates at high speed—96,000 rpm in the case of the Capstone C65 turbogenerator. Generator output is therefore high-frequency AC, which must be conditioned using power electronics to provide a useable 50 or 60 Hertz electrical output.

Microturbines provide high electrical efficiency compared with traditional gas turbines in the same size class. The recuperator that recycles a portion of the exhaust energy back into the energy conversion process produces the efficiency advantage. Figure 3 illustrates the competitive offerings of several microturbine manufacturers plus selected larger gas turbines. Note that microturbines offer the highest electrical efficiency, up to about 5 MW, which is the size of the first traditional gas turbine offered in a recuperated model (Solar Tubines’ Mercury 50).

However, efficiencies in the high 20% to low 30% range are usually not sufficient to provide an attractive economic return on investment in commercial applications where conventional fuel is purchased and the resulting cost of generation must be compared with utility purchased power. The strength of the microturbine option lies with combined heat and power (CHP) or combined cooling, heat, and power (CCHP), where the clean exhaust heat can be recovered and productively used.

The primary value of any microturbine for most business customers is its ability to reduce the cost of energy. In addition to using standard financial analysis methods to evaluate a project, microturbines are often eligible for federal incentives when operating on a renewable fuel and a federal 10% investment tax credit that may be taken as an upfront grant. Many states also have rebate and incentive programs to stimulate the purchase of clean, efficient generation solutions.

Although an attractive payback on investment is usually necessary to generate serious customer interest, several market drivers help determine how rapidly microturbine technology is adopted, as explained below.

Microturbines Meet Low Emissions Limits. An increasing number of regulators around the world are adopting ultra-low-emissions levels similar to those of the California Air Resources Board (CARB). This means that other generation alternatives, such as reciprocating engine generators, often must add selective catalytic reduction systems. Several microturbine manufacturers meet the CARB requirements without active exhaust after-treatment, providing significant cost advantages to owners.

One of the benefits of microturbine technology is its capacity to achieve extremely low exhaust emissions levels. Continuous lean premix combustion provides low levels of oxides of nitrogen (NOx), carbon monoxide, and unburned hydrocarbons (often measured as volatile organic compounds).

As a useful point of comparison, natural gas–fired reciprocating engines produce NOx at a rate about half of the average utility-scale power generation system. The 65-kW Capstone C65 (whose heat rate is about 11,800 Btu/kWh LHV) produces NOx at a rate of approximately 9 ppmvd, a fraction of rate of a large natural gas–fired reciprocating generator set.

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Web: https://www.kary.com.pl/contact-us/
Email: energystorage2000@gmail.com
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