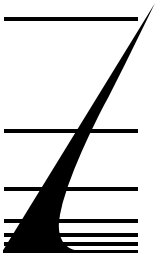
The Market for Microturbine Electrical Power Generation

Product Code #F647

A Special Focused Market Segment Analysis by:



FORECAST INTERNATIONAL

Analysis 2
The Market for Microturbine Electrical Power Generation 2010-2019

Table of Contents

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PROGRAMS

The following reports are included in this section: (**Note:** a single report may cover several programs.)

Calnetix
Capstone MicroTurbines
Ingersoll-Rand Microturbines
Turbec Microturbines

Introduction

Microturbines (very small gas turbine machines) are small combustion turbines approximately the size of a household refrigerator; they currently have outputs of 30 kW to about 250 kW. This type of power generation machine is not as new as some would believe, having evolved from automotive and truck turbochargers, auxiliary power units (APUs) onboard aircraft, and small jet engines.

Some industry followers of the small engine marketplace have split the arena into two segments: "microturbines," machines whose power outputs are in the range between 30 and 250 kW; and "miniturbines," machines whose power outputs are above 250 kW. At present, only Kawasaki (CGT302 at 300 kW) and Niigata (RGT3R at 300 kW) have worked on machines that have a power output of about 250 kW. These two efforts are now in limbo.

Gas turbine machines as a group can be classified by the physical arrangement of their component parts: single-shaft (single-spool) or twin-shaft (twin-spool), simple-cycle or recuperated, inter-cooled, or reheat. These machines generally rotate at speeds in excess of 40,000 rpm. As such, the selection of bearings, or whether the machine's manufacturer selects oil or air, is a function of the machine's use. A single-shaft design is the more common since it is less complex and less expensive to build. A twin-shaft design is needed for mechanical load drive applications where an inverter is not needed to change the frequency of the AC power.

Microturbines, which are Brayton-cycle machines, can also be classified as simple-cycle or recuperated. Recuperated units have a heat exchanger (normally made of sheet metal) that recovers (recuperates) some of the heat from the machine's exhaust flow and transfers it into the entering air flow. The preheated air is then utilized in the combustion process.

Having very low emissions and requiring low maintenance, microturbines are well suited for small-scale cogeneration schemes. The machine's exhaust can be used for hot water heating, absorption cooling, and dehumidifying. The extremely clean exhaust of many microturbines can be used directly in many industrial processes. In some instances, the machine's CO_2 generation can be utilized in greenhouses.

Several manufacturers have very small machines with few parts and relatively good efficiency, largely due to the incorporation of small recuperators that boost combustion efficiency. Some adapt the recuperative cycle further for waste heat recovery, which pushes system efficiency yet higher.

A key point in the promotion of microturbines is their versatility. Their multifuel capability, reliability, and simplicity in design can be exploited in a number of ways.

The machines are being considered for distributed generation baseload use. Electric utilities can expand their ability to offer remote power, in small increments, without having to connect to their main grids.

Because their small size affords them such mobility, microturbines are ideal for providing remote temporary power. They can also be installed permanently at remote sites, providing prime (peak) power for a variety of applications. They can also be run on low-quality gases where available.

Small gas turbines have been used for some time as standby generators. Microturbines are efficient enough to provide peak power as well as standby, particularly in combined cycles.

The costs of microturbine machines, relative to their application and competing piston and diesel engines in the same power class or higher, have long made them uneconomical. As their prices per kilowatt drop, they will find greater acceptance.

At present, a drawback of microturbines is the limited number of times the machines can be cycled on and off. Each startup and shutdown adds Equivalent Operating Hours (EOH) to the machine history, which leads to more frequent maintenance requirements. As a result, it is relatively normal practice to keep the machines running continuously once they are started. That drawback, however, is being addressed, and in the future should not prove to be an obstacle to their increasing acceptance. On a 24/7, 365-day basis, the typical useful life of a currently commercially available machine ranges from 40,000 to 80,000 hours, or up to 10 years with proper overhaul.

Microturbines are viable for energy applications. They are ideally suited to alternate fuels, CHP applications, and remote siting, and their costs, performance, and emissions are competitive in selected applications.

Microturbines have significant expanded market potential with technology advances:

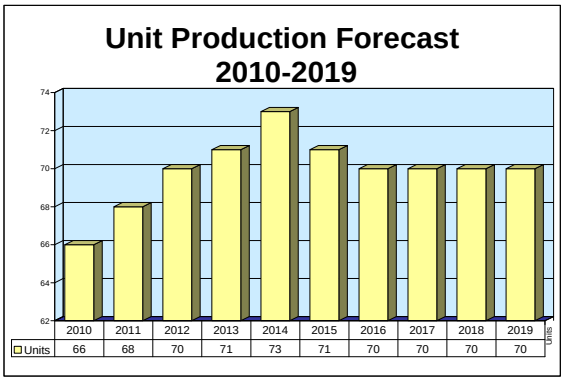
- Competitive efficiency at < 1 MW size
- Potential for low first cost
- Low emissions and broad fuel specification
- Class boundaries of 30 kW to 250 kW

Continued…

Turbec Microturbines

Outlook

- Deregulation of the power utility markets worldwide has opened opportunities for small-power-output machines
- T100 CHP is ideally suited for installation in sports facilities, shopping centers, hotels, offices, universities, hospitals, and apartment housing complexes
- Turbec has signed on six distributors; agricultural applications in Europe may be surprisingly beneficial



Orientation

Description. The T100 is a single-shaft, high-speed microturbine with a four-pole permanent magnet mantled on the same shaft as the compressor/turbine.

Sponsor. The T100 was privately developed by the prime contractor. It traces its origins back to the 1992 Volvo EEC concept vehicle and its gas turbine engine.

Power Class. The approximate electrical output of the Turbec T100 CHP unit is 100 kWe (±3).

Status. In production.

Total Produced. At the start of 2010, at least 291 T100 CHP machines had been manufactured.

Application. The sole application to date is electrical generation, especially small-scale distributed generation schemes. Applications include combined heat and power (CHP) installations.

Price Range. Estimated at $75,000-$77,000 in U.S. dollars for the 2010 calendar year.

Competition. At about 100 kW, the T100 faces its most serious competition from the Elliott Energy Systems TA-100 CHP system.

Contractors

Prime

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Geveke Power Systems	http://www.microturbine.nl, Ketelweg 20, Papendrecht, 3356 LE Netherlands, Tel: + 31 78 6420 420, Fax: + 31 78 6517 122, Email: sven.fransen@gmo.geveke.com, Dealer/Distributor

Turbec Microturbines

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Turbec SpA	http://www.turbec.com, Via Statale, 20/A, Corporeno (FE), 440 40 Italy, Tel: + 39 0516835273, Fax: + 39 0516830348, Prime

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Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

The T100 CHP unit is divided into five main components: the gas turbine and recuperator, the electrical system, the exhaust gas heat exchanger, the supervision and control system, and the gas compressor. The machine uses a turbine mounted on the same shaft as the compressor and high-speed generator rotor.

It has a minimum/maximum fuel requirement pressure (without fuel gas compressor) of 0.02/1.0 bar(g), and a minimum/maximum temperature of 0°C/60°C.

Design Features

Intake. Radial air intake.

Compressor. Single-stage centrifugal compressor. Pressure is 4.5 bar(a) (65 psia).

Combustor. A single, lean pre-mix low-emissions combustor. Pressure ratio is about 4.5:1.

Turbine. A single radial turbine. Pressure is approximately 4.5 bar(a) (65 psia). Turbine inlet temperature (TIT) is about 1,742°F (950°C). Nominal turbine speed is 70,000 rpm.

Exhaust Gas Heat Exchanger. The heat exchanger is the gas-water counter-current flow type. The thermal energy from the exhaust gases is transferred to the hot water system by the heat exchanger.

Supervision/Control System. The Turbec T100 has an automatic control system, called the Power Module Controller (PMC). The PMC uses values from sensors monitoring the machine's heat demand, gas pressure, oil temperature, and vibrations. In the case of critical distortion, the system automatically shuts down and records the fault code to the PMC.

Approximate dimensions are as follows:

	Metric Units	U.S. Units
Dimensions		
Length	2,770 mm	109.1 in
Width	900 mm	35.4 in
Height	1,810 mm	71.2 in
Weight		
T100 P	2,250-2,750 kg	4,960-6,026 lb
T100 PH	2,770-3,100 kg	6,106-6,834 lb

Performance. The Turbec T100 CHP unit has the following performance parameters (nominal) (ISO conditions; frequency is 50 Hz – 60-Hz alternative):

	ELECTRICAL GENERATION	
	Metric Units	U.S. Units
Performance Data		
Net Electrical Output	100 kW (± 3 kW)	134 shp (± 4 shp)
Net Electrical Efficiency	33% (± 1%)	33% (± 1%)
Net Total Efficiency	80%	80%
Fuel Consumption	333 kW	1,136,000 Btu/hr
Net Thermal Output (hot water)	155 kW	570,000 Btu/hr
Exhaust Gas Flow	0.80 kg/sec	6,350 lb/hr
Exhaust Gas Temperature	270°C	518°F

	ELECTRICAL GENERATION	
	Metric Units	**U.S. Units**
Hot Water Installation (Power/Heat)		
Thermal Output (Hot Water)(a)	155 kW (± 5)	207 shp (± 6)
Total Efficiency(a)	77% (± 1)	77% (± 1)
Minimum Water Inlet Temperature	50°C	122°F
Maximum Water Outlet Temperature	150°C	302°F
Maximum Water Pressure	25 bar(g)	362 psi(g)
Exhaust Gas Temperature(a)	90°C	194°F

(a) At 70-90°C (158-194°F).

Other performance data include the following:

Volumetric Exhaust Gas Emissions at 15% O2(b)	
NOx	< 15 ppmv NOx (= 32 mg/MJ fuel)
CO	< 15 ppmv CO (= 18 mg/MJ fuel)
Noise Level	70 dBA @ 1 m (3.28 ft)
Electrical Data	
Voltage Output	400/230 V AC, 3 phases
Frequency Output	50 Hz (60 Hz)

(b) At 100% load and 15°C air inlet temperature.

Variants/Upgrades

No variants or upgrades of the Turbec T100 are reported to be in development. Turbec has hinted that other versions may be available at a later date.

Program Review

Background. On April 1, 2005, Turbec was reorganized, and the business was legally transferred from Turbec AB to Turbec SpA. Turbec's production facility is located in Porto Recanati (MC), Italy, while its research, development, and aftermarket support activities continue to be based in Malmö. Turbec SpA has dealers/distributors in Denmark, France, Ireland, Italy, the Netherlands, and the U.K.

The Turbec T100 CHP unit is powered by a small gas turbine, with the unit developing about 100 kW; Turbec offers the T100 CHP for combined heat and power (CHP) applications. Fueled by natural gas, it produces both electricity and heat.

The T100 CHP can be used to provide power generation or hot air, as a water heat bypass exchanger, and for load following. Also, it can serve as an additional relay protection system or as a BMS remote system.

The machine can be modulated down to 50 percent (50 kW) of rated output and lose only a few percentage points of electrical efficiency.

Early Installations. A T100 CHP was installed in the Klitte and Lund greenhouse in Mörarp, Sweden. The machine provides all of the power needs of the greenhouse and a significant portion of its CO_2 needs.

Maintenance. The T100 power module has a simple yet rugged design. Turbec estimates the life of the unit's main components to be as follows:

Gas Turbine Engine	> 60,000 hours
Recuperator	> 60,000 hours
Combustor	> 30,000 hours
Selected Other Parts	< 30,000 hours

Turbec Microturbines

Contracts/Orders & Options

Contractor	Award (millions)	Date/Description
Turbec AB (now Turbec SpA)	N/A	Feb 2002 – 30 T100 CHP microturbine systems for an undisclosed European utility. Delivered in 2002.
Turbec AB (now Turbec SpA)	N/A	Feb 2002 – 10 T100 CHP microturbine systems for use by NewEnCo Ltd, U.K.

Timetable

Month	Year	Major Development
	1998	Turbec AB founded
Apr	2000	T100 CHP units become commercially available
Dec	2000	Turbec relocates to new facility in Malmö
Feb	2001	Product information updated
Sep	2001	T100 CHP microturbine unit installed in greenhouse in Sweden
Feb	2002	Turbec signs NewEnCo of the U.K. as U.K. distributor; NewEnCo signs deal for 10 T100 CHP microturbine systems; Turbec signs deal with European utility for 30 T100 CHP microturbine systems for delivery in 2002
Mar	2003	First T100 installed at Kandenko Company's headquarters in Tokyo
Apr	2003	Geveke Power Systems and Turbec sign agreement
Apr	2005	Turbec AB reorganized into Turbec SpA; corporate headquarters relocated to Italy
Aug	2008	Turbine installed in Malmo operating on chicken farm waste
Thru	2019	Continued production of Turbec T100 CHP unit

Worldwide Distribution/Inventories

At the start of 2010, at least 291 Turbec T100 CHP systems had been manufactured and installed. The majority are located in **Japan**, **Sweden**, and the **U.K.**

Forecast Rationale

The Turbec AB T100 CHP is one of the first microturbine-based systems for CHP and distributed power generation to be designed and produced by a manufacturer in Europe. It appears that its use is not only intended for the European marketplace, but also for sale abroad, with the U.S. and Canada seen as possible customers in the near term. The Turbec T100, a purpose-built CHP package, is ideally suited to European requirements for distributed generation with its high electrical efficiency and heat recovery capability.

With the T100 CHP microturbine producing 105 kW in electrical output and almost 170 kW of heat, a single unit can supply residential buildings with electricity and heat. Its size is also suitable for sports facilities, shopping centers, hotels, offices, universities, hospitals, and apartment housing complexes.

In mid-2003, Geveke delivered its first Turbec T100 to a customer, providing hands-on experience in installation of the T100, in addition to technical training on the machine.

With the distributed generation arena set to grow markedly in the next decade, we are projecting that, from 2010-2019, Turbec will build 699 T100 microturbine-based packages. We believe that in the short term, distributors and dealers will install many if not all of those units primarily in Europe.

In Forecast International's most recent overview of the microturbine arena for electrical generation, Turbec SpA's projected production quantity positioned it fourth of four manufacturers; this does not mean that the company is in any danger of foundering on the shoals, however. Turbec seems to be holding its own in a competitive arena and carving out a niche in farm waste biogas, which, surprisingly, may prove to be a springboard into North American markets.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program		**High Confidence**				**Good Confidence**			**Speculative**			
	Thru 2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
Turbec SpA												
T100 CHP System <> MW < 0.2 <> Industrial Power Generation												
	291	66	68	70	71	73	71	70	70	70	70	699
Total	291	66	68	70	71	73	71	70	70	70	70	699

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