250 KW LANDFILL GAS FIRED MICROTURBINE DEMONSTRATION PROJECT AT THE BURBANK LANDFILL

Jeffrey L. Pierce, P.E.
Vice President
SCS Energy
Long Beach, California

Introduction

The City of Burbank installed one of the first landfill gas fired microturbine power plants. Commercial operation of the power plant began in November 2001. The power plant experienced operational problems, and it was shut down in 2002. Although not involved in the original installation, the City asked SCS Energy (SCS) to determine what it would take to solve the power plant's problems, and to bring the power plant back into service. SCS Energy recommended that improved landfill gas compression and treatment facilities be installed. Contemporaneously with discussions with the City on replacement of the landfill gas compression and treatment facilities, SCS secured a $450,000 grant from the California Energy Commission to cover part of the cost of undertaking a demonstration project on Ingersoll-Rand's newly developed 250 kW microturbine. The City agreed to be the host site for the demonstration project.

Ultimately, the overall scope of the project became the restoration of the initial 300 kW of Capstone microturbine capacity (10 units x 30 kW), and the addition of 250 kW of Ingersoll-Rand microturbine capacity (1 unit x 250 kW). The presence of two distinctly different types of microturbines at the Burbank Landfill affords a unique opportunity to not only demonstrate the performance of the 250 kW microturbine, but also to directly compare its performance to the 30 kW microturbine.

Start-up of the refurbished and expanded Burbank microturbine power plant was scheduled for February 4, 2005, which was shortly after the deadline for submittal of written papers for this conference. The paper which follows will discuss the project's development and design. It is anticipated that initial performance data will be available by the time of the conference, and the data will be incorporated into the conference presentation.

Pre-Existing Microturbine Power Plant

In August 2001, construction was completed on a 300 kW landfill gas fired microturbine power plant at the Burbank Landfill. Commercial operation of the power plant began in November 2001. The power plant consisted of the following principal components:

- Ten Capstone 30 kW microturbines;
- Ten Copeland scroll-type compressors (each compressor was dedicated to one microturbine);
- Five activated carbon vessels; and
- A deliquescent-type dryer (two vessels).

After a troublesome first year, power plant operation was suspended in late 2002. The plant experienced compressor failures and microturbine failures. The landfill gas clean-up process chain employed at Burbank is typical of the earliest Capstone biogas installations. The approach to moisture removal in this process chain was not robust, and the scroll-type compressor, which was employed, appeared to be ill-suited to the application, at least given the clean-up process chain that was employed.

New Landfill Gas Treatment and Compression Facilities

SCS has designed or installed ten landfill gas fired microturbine power plants, including a 300 kW Capstone-based power plant at the Calabasas Landfill. All of these facilities take an aggressive approach to moisture removal, and use a single compressor more suited by design to landfill gas service. The Calabasas Landfill is located a short distance from the Burbank Landfill. The Calabasas power plant commenced operation in August 2002, and experienced an availability of about 90 percent during its initial year of operation.

Encouraged by the success of the Calabasas facility, and motivated by a desire to place an abandoned facility back in service, the City began to discuss with SCS the possibility of replaced the then existing landfill gas compression and treatment facilities with SCS-supplied facilities. The typical SCS landfill gas compression and treatment facilities consist of the following components:

- Inlet moisture separator;
- Rotary vane type compressor;
- Chilled water heat exchanger (reducing landfill gas temperature to 40° F);
- Coalescing filter;
- Landfill gas reheat heat exchanger (to add 20° F to 40° F above dew point); and
- As an option, the polishing of the moisture-free landfill gas in vessels charged with activated carbon and/or other media.

In general, all of these components are shop-fabricated by SCS and delivered on a single skid.

While SCS and the City were discussing the possibility of engaging SCS to upgrade the City's landfill gas compression and treatment facilities, SCS secured a $450,000 grant from the California Energy Commission (CEC) to partially fund a demonstration project on the then soon to be available Ingersoll-Rand 250 kW microturbine. SCS offered the City the opportunity to serve as the host site for the demonstration project, and the City accepted the offer.

The skid supplied to Burbank is designed to deliver 0 to 400 scfm of dehydrated landfill gas at pressures varying from 70 psig to 110 psig. At Burbank, three parallel compressors were installed on the skid, rather than one, because of the size of the installation, to facilitate turndown, and to add redundancy to the installation. At Burbank, SCS located two polishing vessels in series, off of the skid. The polishing vessels are currently dedicated to the Capstone microturbines. Capstone requires removal of siloxane to limits of detection. One of the purposes of the 250 kW microturbine demonstration project was to evaluate the sensitivity of the 250 kW microturbine to siloxane. The polishing vessels contain a total of 2,000 pounds of activated carbon. SCS uses generically available media rather than rely on a proprietary media. The types of media employed are selected by SCS on a site-specific basis.

SCS has thirteen of its biogas compression and treatment skids operating on landfill gas and digester gas. The applications support not only microturbines but also fuel cells and a reciprocating engine.

SCADA System

At Burbank, like all of SCS's microturbine power plants, SCS provided a customized supervision, control and data acquisition (SCADA) system. The SCADA system links the individual microturbines, the fuel skid and the flare station into a common control system. The SCADA system permits control and monitoring from an on-site touchscreen, or from any remote computer, which has high speed or dial-up internet access. The SCADA system has configurable trending and data logging capability. SCS Energy uses WonderWare software in developing its SCADA systems, including:

- InTouch Window Viewer;
- INSQL;
- Active Factory;
- SCADALARM; and
- Modbus IOSERVER.

Anticipated Performance of the 250 kW Microturbine

Table 1 compares the expected performance and cost of the 250 kW microturbine to the specification sheet performance of the two microturbines now in landfill gas service.

Table 1
Anticipated Performance of the 250 kW Microturbine
Versus Other Microturbines

	I-R 250 kW	I-R 70 kW	Capstone 30 kW
Output at 59° F (kW)	250	70	30
Output at 100° F (kW)	195	60	23.5
Heat rate at 59° F (Btu/kWh)	12,645	13,080	14,410
List price ($)	271,000	81,000	32,000
List price ($/kW)	1084	1157	1067

Heat rate is HHV and without on-board fuel gas booster.

Potential Advantages of the 250 kW Microturbine

The application of a larger microturbine, where power requirements and landfill gas availability can support a higher capacity, could offer the following benefits:

- Reduced capital cost for the microturbine itself: As can be seen on Table 1, however, it appears as if Ingersoll-Rand has based pricing of the 250 kW microturbine on market cost rather than production cost. The cost per kW has not decreased with the improved economy of scale;
- Reduced maintenance cost: Ingersoll-Rand has, in fact, offered a $20,000 per year maintenance cost contract for the 250 kW microturbine, as compared to $10,000 per year for the 70 kW microturbine;
- Reduced Balance of Plant Installation Costs: A reduction in the number of microturbines to reach a given capacity will reduce piping, wiring and foundation costs; and
- Improved Efficiency: The heat rate of the 250 kW microturbine is expected to be about 3.3 percent better than the 70 kW microturbine and about 12.2 percent better than the 30 kW microturbine. It should be noted, however, that efficiency is a secondary concern on most landfill gas fired applications.

Performance Test

One of the more important elements of the CEC funded portion of this project is a formal performance test on the 250 kW microturbine. A twelve-month performance test will be undertaken using a Formal Performance Test Plan. SCS and CEC have jointly developed the Performance Test Plan. Key parameters to be evaluated during the twelve-month performance test include:

- Gross output as a function of ambient air temperature: The 250 kW microturbine is rated at 250 kW at 59° F. The first question is - will it produce 250 kW when fired on landfill gas? A microturbine's output declines as ambient air temperature increases. The second question is - how much will gross output decrease with increases in temperature?;
- Heat rate as a function of ambient air temperature: The specification sheet heat rate of 12,645 Btu/kWh is based on 59° F. The first question is - what is the actual heat rate at 59° F? The second question is - how much does it increase with increases in temperature?;
- Tolerance to landfill gas methane levels below 40 percent;
- Air emissions;
- Availability: Percent uptime versus downtime is a critical consideration in project economics; and
- Impact of landfill gas impurities, particularly siloxane, on performance: The evaluation will be accomplished through periodic inspection of the components most likely impacted by the impurities.

A full report on the results of the test program will be offered at a subsequent conference.