C60 CUMMINS/CAPSTONE CHP WITH REMOTE DISPATCH

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Project Site

Project Organization

Program Manager:	**Rob Brandon, CANMET Energy Technology Centre**
Funding Partners:	**1 - Natural Resources Canada (PERD Program)** **2 - Public Works and Government Services Canada** **3 - Enbridge Gas Distribution**
Demo Site Host:	**Health Canada, Scarborough, Ontario**
Design Spec. Engineer:	**CEM Engineering, St. Catherines, Ontario**
Project Engineer:	**Bryan Halliday, CANMET Energy Technology Centre**
Project Manager:	**Ruhnke Consulting Inc., Pickering, Ontario**

Project Organization (Cont'd)

Principal Suppliers:

1 - Cummins Ontario, Inc. (Mississauga, Ont.)
Capstone 60 Microturbine Generator Set, Copeland Scroll Fuel Gas Booster

2 - Unifin International Inc. (London, Ont.)
MicoGen, 2nd-generation Flue Gas Heat Recovery unit

3 - Full Circle Systems Inc. (Richmond Hill, Ont.)
General Contractor

4 - DTE Energy Technologies (Farmington, MI)
Web-enabled Energy Management System

Project Milestones

Milestone	Plan	Actual
Equipment Delivery	Aug 12/02	Aug 12/02
System Commissioned	Sep 20/02	Oct 09/02

Commissioning delayed 2 weeks due to installation delays.

Placed in Service	Sep 20/02	Nov 27/02

System operation delayed due to:
1) Heat Recovery unit installation error, and
2) delayed Regulatory Authority approval.

Energy Management System	Sep 20/02	Jan 10/03

System monitoring delayed due to delay in issuing monitoring contract.

Summary Performance

Nov 27/02 to Dec 31/03

- **Hours of Operation: 5050 hrs**
- **Net economic performance $3,841.**
- **Average electrical efficiency 23.0%**
- **Average thermal efficiency 38.6%**
- **Total efficiency performance 61.6%**
- **Hours availability (up to Nov 2/03) 80.4%**

Detailed Economic Performance

Nov 27/02 - Dec 31/03

	Net Gas Used (m^3)	Elect. Gen (Kwh)	Net Gas Cost ($)	Net Elect. Credits ($)	Net Energy Credits ($)
Q4-02	3,612	20,800	1,143.70	1,396.79	253.09
Q1-03	21,902	118,600	7,047.27	11,087.30	4,040.03
Q2-03	14,093	80,200	5,349.99	5,895.85	545.86
Q3-03	13,551	42,800	5,956.24	4,305.79	-1,650.45
*Q4-03	3,529	16,800	1,358.72	2,011.28	652.56
TOTAL	56,687	279,200	$20,855.92	$24,697.01	$3,841.09

* Turbine out of service since Nov 02/03.

Detailed Efficiency Performance

Nov 27/02 - Dec 31/03

	Turbine Gas (Kwh)	Thermal Output (Kwh)	Elect. Gen. (Kwh)	Elect. Eff. (%)	Thermal Eff. (%)	Total Eff. (%)	Average kw
Q4-02	86,542	36,680	20,800	24.0	42.4	66.4	58.0
Q1-03	484,912	192,560	118,600	24.5	39.7	64.2	58.0
Q2-03	347,512	150,530	80,200	23.6	43.3	66.4	55.1
Q3-03	216,076	56,170	42,800	19.8	26.0	45.8	54.1
*Q4-03	80,894	33,100	16,800	20.8	40.9	61.7	53.1
TOTAL	1,215,936	469,040	279,200	23.0	38.6	61.5	55.5

Detailed Availability Performance

Nov 27/02 - Nov 02/03

	Available Hrs.		Run Hours		Availability		
	Mo.	PTD	Mo.	PTD	Mo.	PTD	Starts
Q4-02	842.7	842.7	338.7	338.7	40.2	40.2	15
Q1-03	2,148.8	3,027.5	2,071.3	2,410.0	94.8	79.6	9
Q2-03	1,870.6	4,898.1	1,388.1	3,798.1	74.2	77.5	39
Q3-03	972.1	5,870.2	921.8	4,719.9	94.8	80.4	53
Q4-03	Turbine shut down Nov 02/03: internal fault: still out of service.						99
TOTAL	5,870.2	14,638.5	4,719.9	11,266.7		80.4	215

Microturbine Issues

Dec 17/02	**Replace defective communication modem**
Jun 25/03	**Engine changeout - reliability upgrade (double diaphragm coupling retrofit)**
Nov 02/02 to Dec 17/03	**Failed to start** **Replaced:** **Precharge board twice** **Ceramic resistor on BCM** **IGBT and power supply board on ECM** **Replaced 3 - 125 amp fuses @ MCC** **Mean time to repair - 45+ days**
Dec 17/03 to Present	**Need to replace igniter** **Parts not yet received** **Mean time to repair - 30+ days** **Total mean time to repair 75+ days**
Future	**New engine to be installed once unit up and running**

Balance of System Issues

Unifin Heat Exchange

Oct 20-Nov 19/02	**Both software and hardware needed to be modified to stop cycling from recovery to bypass**
Nov 19/02	**Keypad changed due to excessive moisture**
Jun 23/03	**Repainted all exterior panels due to accelerated rusting**
Aug 13/03	**Replaced defective keypad and power supply**
Dec 12/03	**Removed defective display power supply. Keypad and power supply to be mounted in weatherproof box on exterior front panel. Still waiting for installation.**

Balance of System Issues (cont'd)

Manifold Breeching Insulation

Jun 27/03	**Added two inches additional insulation from microturbine to Unifin Head Exchanger**
	Found some initial insulation missing.

Copeland Compressor

Nov 29-Dec 17/02	**Replaced defective power supply and contactor. Mean time to repair - 18 days.**
Apr 14-22/03	**Replaced defective power supply. Mean time to repair - 8 days.**
Apr 22-29/03	**Replaced defective Uni drive. Mean time to repair - 7 days**

Thermal Load Issues

Dec 13/03	**Poor thermal output - 91.3 kw**
	Unifin confirmed unit working normally according to performance program output (120 kw)
	Increased water flow
Aug 13/03	**Poor performance (13.9% thermal efficiency)**
	Reduced water temperature at request of Building Manager (45/60° C)
	0 - 10 kw output
	High efficiency summer boilers were running
Oct 01/03	**Increased water temperature to 70/85° C**
	110-120 kw output

Issues for Improvement

Improve System Reliability (PTD Availability 80%)

Microturbine	**Capstone provided two engine upgrades:**
	1st no marked improvement
	2nd still to be installed
Unifin Heat Exchanger	**Locate keypad and power supply to exterior of unit (3 failures)**
	Paint unit to withstand outdoor environment without rusting.
Copeland Compressor	**improve reliability of power supply.**

Improve System Efficiency

Microturbine	**PTD electrical efficiency 23.0%** **Electrical efficiency decreased after engine change** **Investigate ways to improve**
Unifin Heat Exchanger	**PTD thermal efficiency 38.6%**
	At site initiate more efficient thermal load use in summer period

Issues for Improvement

Improve Mean Time to Repair

Capstone technical support is excellent

Improve supplier parts inventory and shipping

(Major turbine fault - Nov 02/03 still not repaired MTTR 75 days and counting.)

Relationship with Site Operator

Relationship has been excellent. However not pleased with extended outage from Nov. 2/03 to present during prime heating season and high electricity costs.

Principal Conclusion

Improve Overall Efficiency of Unit

	PTD	Target
Electrical Efficiency	**23.0%**	**26.0%**
Thermal Efficiency	**38.6%**	**50.0%**
Total	**61.6%**	**76.0%**

Steps taken to increase water temp. settings @ heat exchanger

Expect upcoming engine change out to improve Electrical Efficiency

Net Economic Benefit	**$3841.**	***$24,484.**

***If 76% Eff. run PTD, the net benefit increase would be $20,643.**

Anticipate further net benefit with Economic Dispatch

Data System

- **Provided by DTE Energy Technologies, Farmington, MI**
- **Jan 09/03 system commissioned into service**
- **Near real time data available through web browser interface on internet**
- **DTE provides; monitoring, cost reporting and economic dispatch services**
- **Points monitored - turbine 19, other 13 for a total of 32 points**
- **As Ontario is a deregulated electricity market, DTE picks up five minute feeds from IMO**
- **Economic dispatch uses real time IMO feed, building gas and thermal meters as primary inputs. Many other secondary criteria are also used.**
- **Economic dispatch is programmed to monitor and dispatch on an hour by hour basis.**

Data System (cont'd)

Monitoring

Data availability is good, however, data gaps exist due to their outages and data needs to be filled in.

Mar 10/03	**Replaced defective mediation box at site**
Jun 19/03	**Replaced site hardware to accommodate economic dispatch**

Dispatching

Economic dispatch was developed, but used site to test it as we proceeded.

Programmed Operations

Nov 27/02-Jun 08/03	**Continuous (24/7)**
Jun 09/03-Oct 14/03	**Five days/week, Mon-Fri, 6:00-18:00hr**
Oct 14/03-Present	**Automatic economic dispatch**

Data System (cont'd)

Cost Reporting

The reporting system is still in the testing stages.

Testing compounded by deregulated electricity market and software module received from DTE supplier.

Web-enabled Monitoring