

Minto Place Suite Hotel Microturbine Commissioning Experience

SPONSORS

MINTO DEVELOPMENT INC:
ANDREW PRIDE
 ENBRIDGE GAS DISTRIBUTION:
TERRY WHITEHEAD
 ONTARIO POWER GENERATION:
MARK TINKLER
 CANMET ENERGY TECH CENTRE/
 NATURAL RESOURCES CANADA:
ROB BRANDON



INSTALLATION AND COMMISSIONING TEAM

MINTO ENERGY MANAGEMENT:
ROBERT SMITH
 CANMET ENERGY TECH CENTRE/
 NATURAL RESOURCES CANADA:
BRYAN HALLIDAY
SYLVAIN DEROME
RANDY BIGGS
 ENVIRONMENT CANADA:
DAVID E. VILLARROEL
 RUHNKE CONSULTING INC:
WAYNE RUHNKE

Project Schedule

S	M	T	W	TH	F	S
			PLAN	ACTUAL		
			DEC '02	OCT '03		
			FEB '03	AUG '04		
			FEB '03	SEP '04		

	ACTUAL \$	HINDSIGHT \$	50th Install \$
Turbine	24 000	24 000	24 000
CHP Unit - Unfin	10 700	10 700	10 700
Mechanical	12 000	12 000	8 000
Electrical	8 400	6 400	5 600
Civil	3 200	3 200	3 200
Consulting	4 000	4 000	4 000
Project Management	1 600	1 600	1 600
TOTAL	63 900	61 900	57 100

ALL IN US\$

Maintenance Costs

EVERY 8000 HRS:
MATERIALS: ENGINE AIR FILTER,
 INLET FUEL FILTER, IGNITOR AND
 BATTERY.
COST: \$1044

LABOUR/EXPENSES: \$1972
TOTAL COST: \$3016 (\$0.0171/kWh)

AFTER 16000 HRS:
MATERIALS: AS ABOVE PLUS
 ELECTRONIC AIR FILTERS, INLET
 FUEL FILTER, INJECTOR
 ASSEMBLIES, THERMOCOUPLE.
COST: \$3646

LABOUR/EXPENSES: \$2889
TOTAL COST: \$6535 (\$0.037/kWh)

AFTER 24000 HRS:
MATERIALS: SAME AS 8000 HRS
COST: \$1120

LABOUR/EXPENSES: \$2077
TOTAL COST: \$3197 (\$0.018/kWh)

INSTITUTIONAL EXPERIENCE

THE APPROVALS THAT WERE REQUIRED FOR THE PROJECT WERE TSSA, ESA, and HYDRO OTTAWA

NRCAN MADE A SIGNIFICANT CONTRIBUTION TO LESSEN THE OVERHEAD BURDEN WHEN OBTAINING APPROVALS.

HYDRO OTTAWA WAS HELPFUL AT INVESTIGATING THE CAPACITOR SWITCHING ISSUE.

ECONOMIC\$\$

PRICE OF NATURAL GAS: \$0.28 / CUBIC METER
 ELECTRICITY RATE: \$0.0376 / kWh
 OPERATING HOURS (90% AVAILABILITY):
 8000 HRS
 MAINTENANCE COSTS: \$0.0171 / kWh
 (NOTE: TO CALCULATE COSTS A
 \$0.01/kWh MAINTENANCE RATE IS USED)
 OPERATING COSTS: \$0.1431 / kWh

REVENUE	
ELECTRICITY	\$6,610.98
DEMAND SAVINGS	\$4,134.08
THERMAL	\$17,393.06
	\$26,138.07
COST	
FUEL	\$25,174.80
MAINTENANCE	\$1,758.24
	\$26,933.04
NET TOTAL	\$1,205.03

ALL IN US\$ US\$0.8 - CDN\$1

SUPPLIER SUPPORT

CAPSTONE'S STAFF WERE UNABLE TO RESOLVE THE TRIPPING DUE TO UTILITY CAPACITOR SWITCHING. THE TURBINE SOFTWARE STILL ALLOWS OCCASIONAL (1-2 / WEEK) TRIPPING.

AN ELECTRICAL CONSULTANT IS INVESTIGATING A SOLUTION TO THE TRIPPING PROBLEM.

RUHNKE CONSULTING INC WAS A VITAL PARTNER DURING COMMISSIONING.



POSTERS CREATED BY DAVID VILLARROEL



UTILITY GATEWAY SYSTEMS

UGS PROVIDES A REAL TIME INTERNET BASED ENERGY MONITORING, MANAGEMENT AND REPORTING SYSTEM.

THIS SYSTEM PROVIDES A USER FRIENDLY GRAPHIC WEBSITE TO MONITOR ENERGY PRICES AND UNIT PERFORMANCE. DATA IS GATHERED WITH EXISTING ONSITE METERS AND RECORDED IN EASY TO READ TABLES. DAILY, MONTHLY, AND YEARLY INFORMATION IS ACCESSIBLE FOR AN OPERATOR OR MANAGER'S USE.

THE COST OF NRCAN'S 3 YEAR CONTRACT WITH UGS IS \$14,000.

GENERAL EXPERIENCE

AREAS THAT NEED IMPROVEMENT FOR FUTURE PROJECTS:

- A RESOLUTION OF REMAINING GAS AND ELECTRICAL CODE ISSUES IN ONTARIO
- INSTALLATION OF A THREE WAY VALVE TO LIMIT HEAT EXCHANGER CORROSION
- INTEGRATION WITH HOTEL CONTROL SYSTEMS, AND COORDINATION WITH HOTEL STAFF.

R&D AREAS TO LOOK AT INCLUDE:

- PRE-HEATING OF INCOMING WATER TO REDUCE CORROSION EFFECTS
- A COMPLETE HOTEL CHP PACKAGE SPECIFIC FOR DHW SYSTEMS

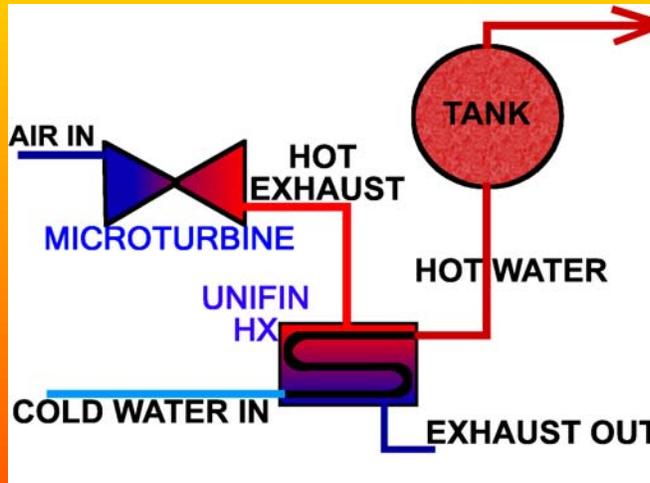


Natural Resources
 Canada

Ressources naturelles
 Canada

Canada

Minto Place Suite Hotel Microturbine Thermal Experience



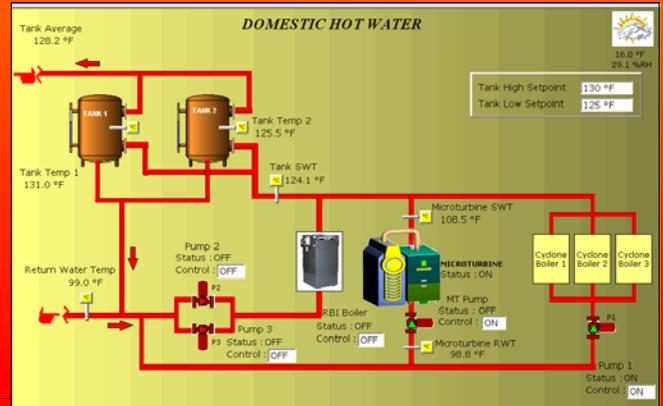
DHW use



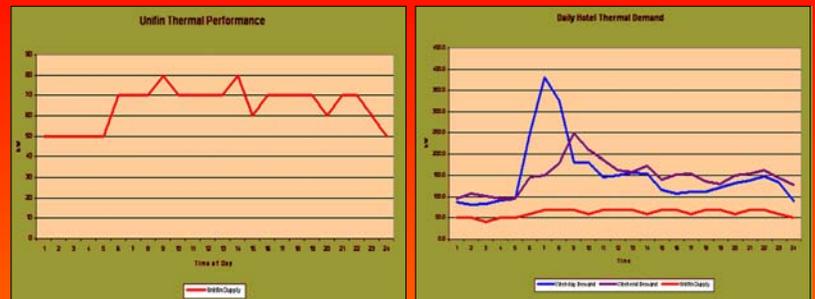
UNIFIN INFO

Max Thermal Output: **75 kW**
 Thermal Efficiency: **59 %**
 Co-generation Efficiency: **80 %**

TEMP TABLE	INLET	OUTLET
WATER	16 - 55 C 60 - 131 F	23 - 57 C 73 - 134 F
FLUE GAS	288 C 550 F	25 - 60 C 77 - 140 F



Minto's DHW System



FLUE GAS CORROSION



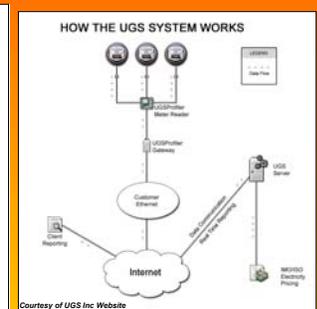
THE INLET WATER TEMPERATURE ENTERING THE UNIFIN IS COLD AND THE OUTLET FLUE GAS TEMPERATURE IS LOW. WE CONSIDER THIS TO BE A POTENTIAL LONGTERM CORROSION HAZARD INSIDE THE HEAT EXCHANGER. AN ACID DEW POINT OF **30 C (87 F)** (AMBIENT CONDITIONS OF 26 C (80 F) AND 50% RH) COULD BE REACHED LEADING TO CORROSION.

OUR SOLUTION WAS TO ADD A THREE WAY VALVE TO REGULATE THE TEMPERATURE OF THE INLET WATER TO **40 C (105 F)** TO ELIMINATE ANY CONDENSATION. THIS REDUCES THE THERMAL EFFICIENCY BY **2 - 3 %**, BUT SAVES REPLACING THE HEAT EXCHANGER.

UGS SCREENSHOTS

Data of October 2004

Utility ID	Meter Date	Peak kW(15 Min)	Peak kW(1 Hr)	kWh	Cost (\$)
MO0000-1	10/01/2004	23.64	24.00	291.32	14.27
MO0000-1	10/02/2004	24.00	24.00	480.84	25.54
MO0000-1	10/03/2004	24.32	24.40	489.45	25.54
MO0000-1	10/04/2004	24.32	24.40	489.18	24.10
MO0000-1	10/05/2004	24.64	24.96	492.92	22.81
MO0000-1	10/06/2004	23.94	24.00	517.78	26.53
MO0000-1	10/07/2004	24.00	24.00	516.36	26.26
MO0000-1	10/08/2004	23.68	24.00	524.56	27.54
MO0000-1	10/09/2004	23.04	23.04	501.24	24.25
MO0000-1	10/10/2004	23.52	23.52	513.20	21.15
MO0000-1	10/11/2004	23.52	23.52	514.36	21.33
MO0000-1	10/12/2004	23.20	23.52	503.40	24.49
MO0000-1	10/13/2004	23.20	23.52	505.08	25.82
MO0000-1	10/14/2004	23.04	23.04	498.24	22.77
MO0000-1	10/15/2004	23.04	23.04	501.04	24.38
MO0000-1	10/16/2004	22.88	23.04	501.12	25.52
MO0000-1	10/17/2004	23.36	23.52	509.88	25.82
MO0000-1	10/18/2004	24.00	24.00	523.56	26.63
MO0000-1	10/19/2004	24.16	24.48	483.32	26.69
MO0000-1	10/20/2004	24.16	24.48	524.80	26.45
MO0000-1	10/21/2004	24.00	24.48	524.76	26.48
MO0000-1	10/22/2004	24.32	24.48	525.12	26.62
MO0000-1	10/23/2004	24.64	24.48	524.12	26.49
MO0000-1	10/24/2004	24.64	24.48	524.12	26.49
MO0000-1	10/25/2004	24.64	24.48	524.12	26.49

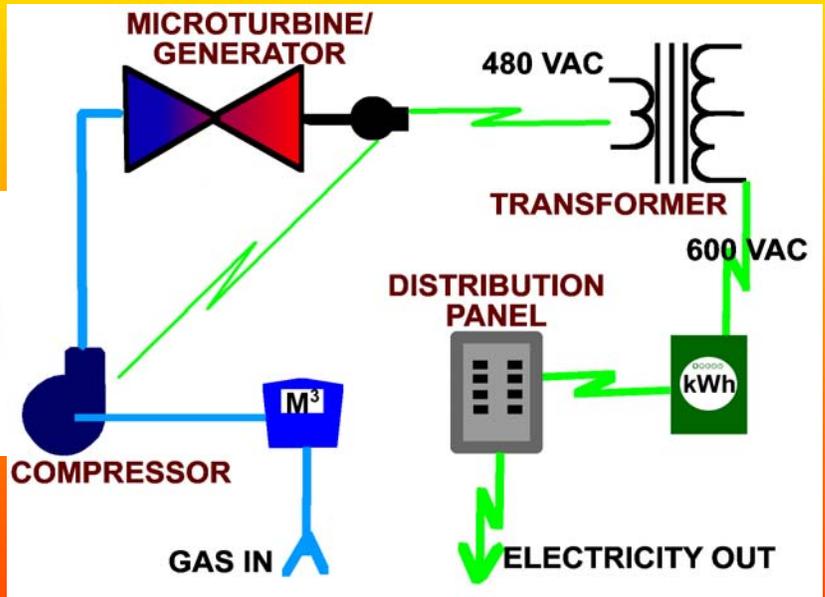
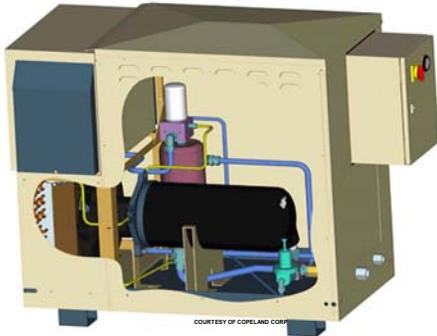
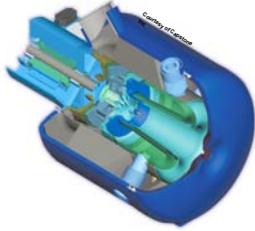


UGS MONTHLY REPORT

Account Number: 020001

Month	Gas m ³	TEWh	kWh	Peak kW	SRF T	Benefits	Electrical eff.	Thermal eff.	Total eff.
January	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0
April	4163.175	958	8123.999	18.72	527.312	8.1429	8.8188	16.1817	16.1817
May	2180.43	440	3878.56	13.52	416.672	8.6759	8.6098	8.8057	8.8057
June	8.38375	1.70	54.12	13.44	1.8654	4.6189	5.37	5.385	5.385
July	3.1725	288	94.96081	18.56	4.6293	8.0978	4.8206	4.1264	4.1264
August	2971.721	1728	8617.793	23.52	624.8812	8.1419	8.2363	8.3162	8.3162
September	2548.587	12570	4888.68	24	-317.2318	8.1381	8.3617	8.4318	8.4318
October	6824.262	42958	15597.28	24.56	-282.7893	8.2189	8.5893	8.8862	8.8862
November	4783.886	18950	11165.88	24.56	164.3789	7.3762	8.2387	7.446	7.446
December	5781.848	34770	11776.72	25.44	-347.8258	1.482	8.4787	1.9687	1.9687

Minto Place Suite Hotel Microturbine Electrical Experience



MICROTURBINE INFO

Capstone C30 Model
 Max Output: **24.5 kW_e**
 Efficiency: **20 %**

Parasitic Losses:

- Compressor: **3 kW**
- Transformer: **0.5 kW**

Derating due to ambient air temp: **2 kW**



PHANTOM POWER (TRANSFORMER LOSSES)

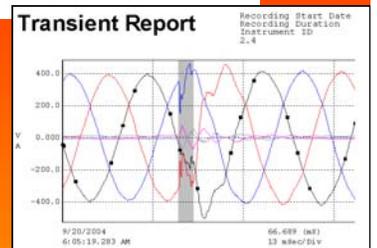
EVER SINCE THE MICROTURBINE WAS INSTALLED, AN UNKNOWN ELECTRICAL LOAD WAS PRESENT IN OUR RECORDINGS. THIS LOAD EVEN OCCURRED WHEN THE MACHINE WAS SHUT DOWN. A READING OF **0.16 kW** AT NO LOAD AND **0.51 kW** AT FULL LOAD WAS MEASURED. THESE WERE THE LOSSES OF THE TRANSFORMER.

UGS SCREENSHOTS

Utility ID	Meter Date	Time (Hours)	kWh	Price (\$/kWh)	Cost (\$)
MC0001-1	05/09/2005	01	15.76	0.0468	0.73
MC0001-1	05/09/2005	12	15.76	0.0467	0.69
MC0001-2	05/09/2005	23	15.81	0.0374	0.60
MC0001-1	05/09/2005	34	15.76	0.0312	0.60
MC0001-1	05/09/2005	45	15.76	0.0244	0.59
MC0001-1	05/09/2005	56	24.15	0.0360	0.80
MC0001-1	05/09/2005	67	24.15	0.0296	0.80
MC0001-1	05/09/2005	78	24.12	0.0288	0.81
MC0001-1	05/09/2005	89	24.28	0.0281	0.86
MC0001-1	05/09/2005	99	24.18	0.0239	0.87
MC0001-1	05/09/2005	109	24.24	0.0432	1.14
MC0001-1	05/09/2005	119	24.09	0.0444	1.12
MC0001-2	05/09/2005	129	24.01	0.0467	1.13
MC0001-1	05/09/2005	139	24.09	0.0523	1.27
MC0001-1	05/09/2005	149	24.04	0.0496	1.19
MC0001-1	05/09/2005	159	23.95	0.0426	1.01
MC0001-1	05/09/2005	169	24.00	0.0427	1.01
MC0001-1	05/09/2005	179	24.00	0.0391	0.94
MC0001-1	05/09/2005	189	23.96	0.0391	0.94
MC0001-1	05/09/2005	199	24.00	0.0323	0.77
MC0001-1	05/09/2005	209	23.96	0.0314	0.75
MC0001-1	05/09/2005	219	23.96	0.0328	0.77
MC0001-1	05/09/2005	229	23.91	0.0467	1.10
MC0001-1	05/09/2005	239	15.89	0.0475	0.69
Total cost:					\$23.77

Utility ID	Meter Date	Time (Hours)	kWh	Price (\$/kWh)	Cost (\$)
MC0001-2	05/09/2005	01	8.89	0.2500	2.21
MC0001-2	05/09/2005	12	8.79	0.2500	2.19
MC0001-2	05/09/2005	23	8.79	0.2500	2.19
MC0001-2	05/09/2005	34	8.79	0.2500	2.19
MC0001-2	05/09/2005	45	8.79	0.2500	2.19
MC0001-2	05/09/2005	56	12.04	0.2500	4.21
MC0001-2	05/09/2005	67	12.15	0.2500	4.25
MC0001-2	05/09/2005	78	12.04	0.2500	4.21
MC0001-2	05/09/2005	89	12.15	0.2500	4.25
MC0001-2	05/09/2005	99	12.15	0.2500	4.25
MC0001-2	05/09/2005	109	12.15	0.2500	4.25
MC0001-2	05/09/2005	119	12.04	0.2500	4.21
MC0001-2	05/09/2005	129	12.15	0.2500	4.25
MC0001-2	05/09/2005	139	12.04	0.2500	4.21
MC0001-2	05/09/2005	149	12.15	0.2500	4.25
MC0001-2	05/09/2005	159	12.04	0.2500	4.21
MC0001-2	05/09/2005	169	12.15	0.2500	4.25
MC0001-2	05/09/2005	179	12.15	0.2500	4.25
MC0001-2	05/09/2005	189	12.15	0.2500	4.25
MC0001-2	05/09/2005	199	12.04	0.2500	4.21
MC0001-2	05/09/2005	209	12.15	0.2500	4.25
MC0001-2	05/09/2005	219	12.15	0.2500	4.25
MC0001-2	05/09/2005	229	12.04	0.2500	4.21
MC0001-2	05/09/2005	239	8.80	0.2500	2.19
Total cost:					\$24.78

Utility Capacitor Switching Transients



HYDRO OTTAWA'S CAPACITOR SWITCHING OCCURS AROUND 5 - 6 AM EVERYDAY, SENDING A TRANSIENT THROUGHOUT ITS NETWORK. MOST OF THE TIME THE MICROTURBINE'S INTERNAL SOFTWARE, AFTER BEING ADJUSTED, CATCHES AND CORRECTS THE TRANSIENT, THOUGH IT STILL TRIPS APPROXIMATELY 1 - 2 TIMES PER WEEK. THE FAULT CODES DISPLAY **SSL 4 - 6** INDICATING A GRID FAULT, THUS CAUSING A SHUT DOWN OF THE MICROTURBINE. TOO MANY SHUT DOWNS AND START-UPS CAUSE UNNECESSARY WEAR AND TEAR ON THE MACHINE.

THIS TRANSIENT PROBLEM CAN BE RESOLVED BY ADDING A CHOKE INDUCTANCE AT THE INPUT OF THE TRANSFORMER.