Capstone MicroTurbines for CHP

Blue Mountain Ski Resort, Collingwood, Ontario, Canada

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Authorized Distributor

Blue Mountain Case Study

- Summary
- Design
- Performance
- Economics
- Lessons Learned
- Approvals
- Canadian & Ontario Market

Blue Mountain Summary

- 30kW Capstone Microturbine & Unifin Heat Exchanger (HX), expandable to 120kWe.
- Turbine outside, HX and stand alone monitoring system inside
- Phase I: Heat for DHW & Laundry - 30kW.
- Phase II: Pool(s), hot tubs, glycol loop - 60kW
- Phase III: Other DHW
- Project Managers: On Power Systems
- Project

	Plan vs.	Actual Dates
– Equipment Delivery	Jan 2003	Jan 2003
–System Commissioned	Feb 2003	June 2003
–Re-Commissioned (due to approval)		October 2003
–Monitoring	Feb 2003	June 2003

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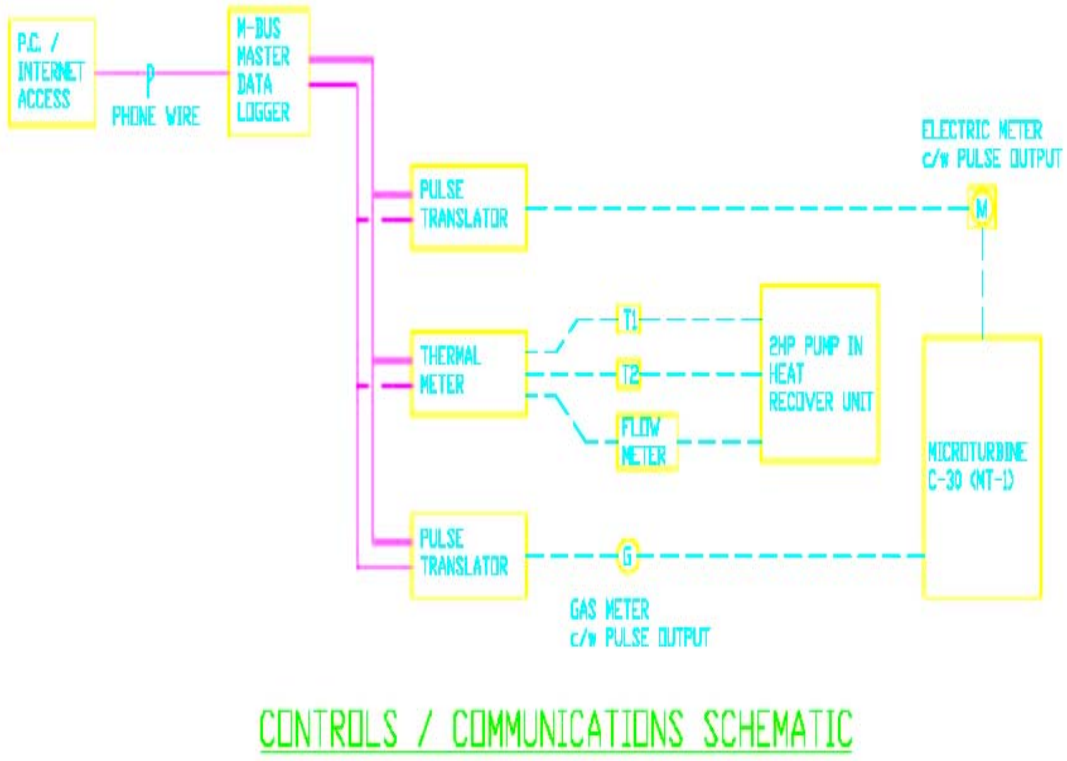
Design & installation

Power Control & Interconnection



CONTROLS / COMMUNICATIONS SCHEMATIC

Performance Monitoring

- **Input: Gas consumption,**
- **Output: Power Output, Flow, Temperature = energy**

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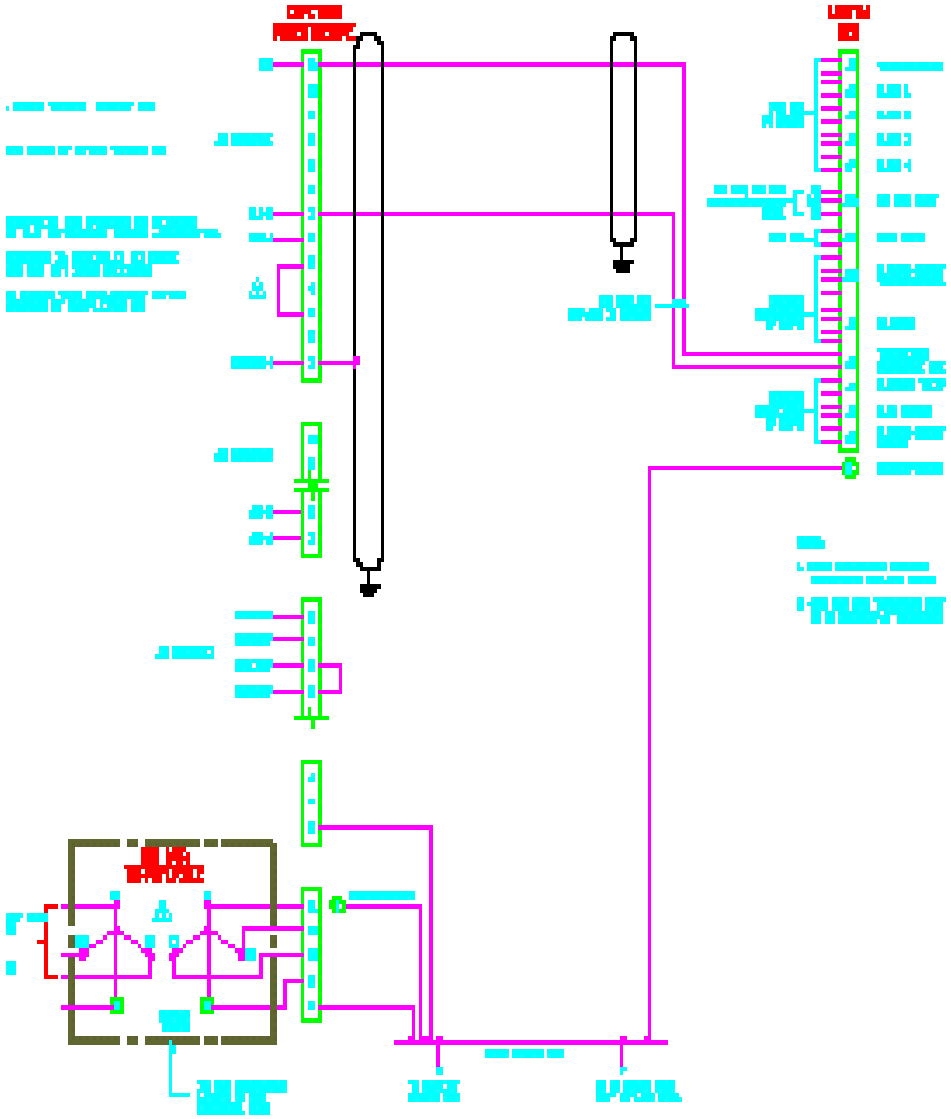
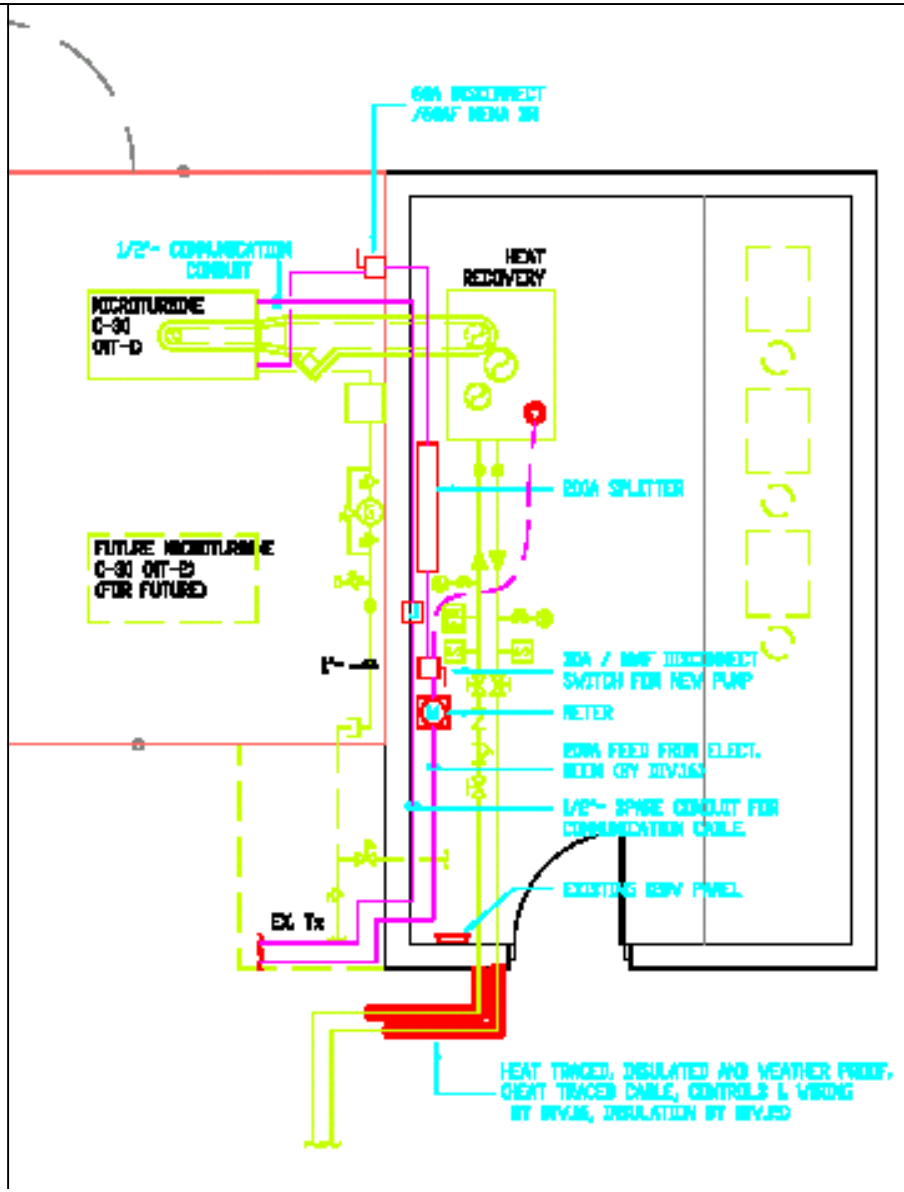
Electrical Interconnection





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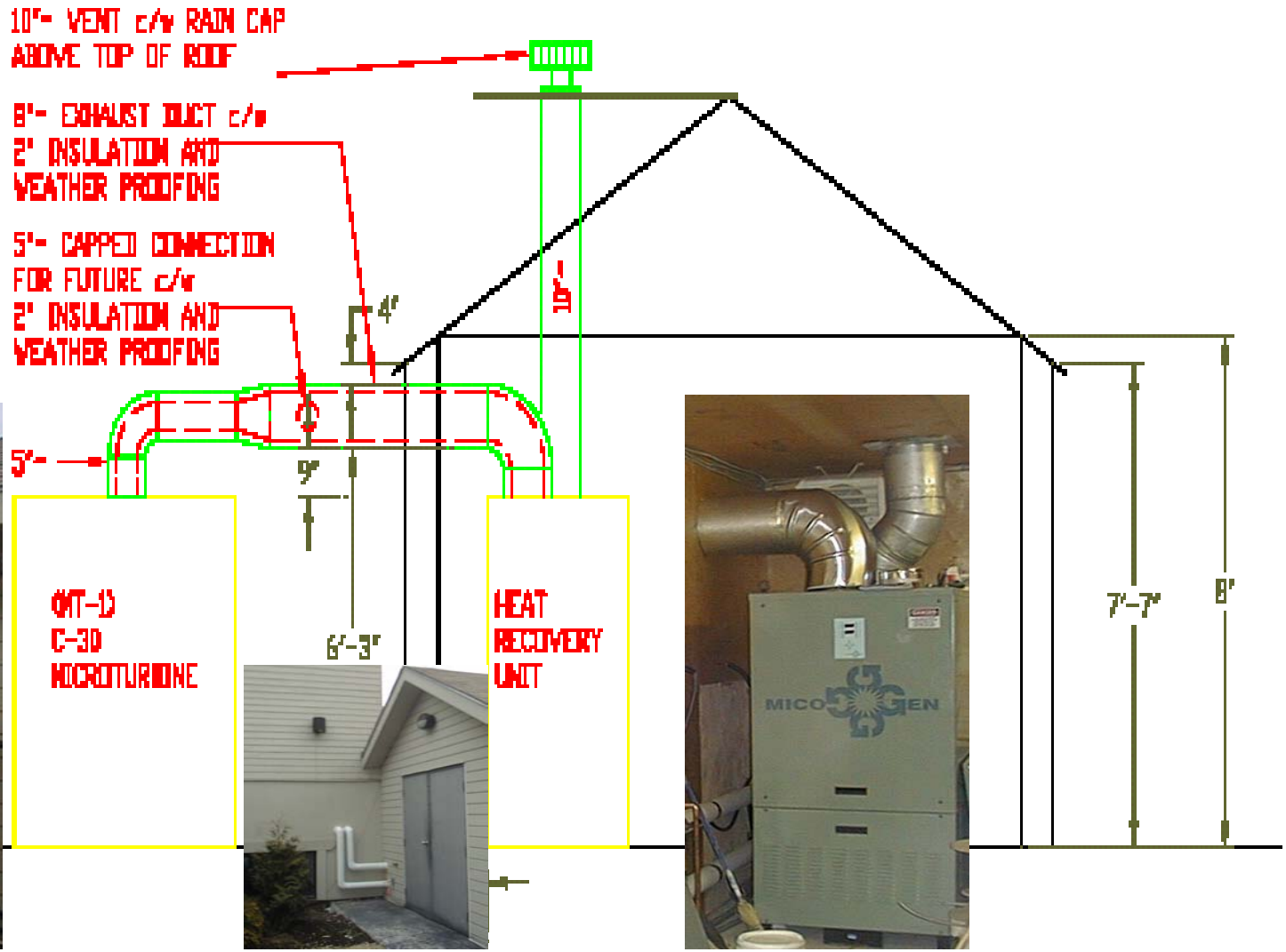
Mechanical



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Performance

2003 May 29 22:45:00	3490	18	12628.188
2003 May 29 23:00:00	3491	18.01	12634.146
2003 May 29 23:15:00	3493	18.02	12640.14
2003 May 29 23:30:00	3495	18.04	12646.098
2003 May 29 23:45:00	3496	18.05	12652.074
Cumulative	**(m^3)**	**(MWh)**	**(kWh)**

	Gas Consumption (m^3)	Thermal Energy (MWh)	Electrical Energy (kWh)
Hourly input: output	6 (m^3)	0.05 (MWh)	23.886 (kWh)
Energy Equivalent	36145.144	18050	12652.074

Efficiency (Gas energy equivalent/Thermal + electrical energy) 84.94%

Feasibility Stage 1

Cash Flow Analysis for Hot Water CHP Equipment Purchase - Blue Mountain

Inputs				
Equipment Installed Cost	$150,000			
Installed Cost per kWe	$5,000			
Maintenance Cost	$0.015	per kWh		
Average Electric Utility Energy Rate	$0.090	per kWh		
Average Electric Utility Demand Rate	$0.00	per kW per Month		
Average Gas Rate	$10.50	per MM BTU (HHV)		
Nominal kWe Rating	30	kW		
Average Hot Water Load	60	kW thermal	= 204,780	BTU / hr
Efficiency of Traditional Hot Water Heater	75%	based on LHV		
Hours of Operation	8,760	hours per year		
Heat Rate	12,200	BTU per kWh (HHV)		

Blue Mountain	Cdn $	U.S. $
M3S-28R-FG4-AUMO	$ 60,000	$ 37,500
MG4-C2	$ 21,500	$ 13,438
engineering	$ 5,000	$ 3,125
monitoring system	$ 3,000	$ 1,875
Electrical	$ 16,000	$ 10,000
Mechanical	$ 25,500	$ 15,938
M & E upgrades + Misc.	$ 14,000	$ 8,750
Estimated shipping cost	$ 1,500	$ 938
Project Management	$ 3,500	$ 2,188
Total Project Price	$ 150,000	$ 93,750

Year	0	1	2	3	4	5	6	7	8	9	10
Energy Bill Savings											
Avoided Site Electric Energy Costs		$23,652	$23,652	$23,652	$23,652	$23,652	$23,652	$23,652	$23,652	$23,652	$23,652
Avoided Site Electric Demand Charge		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Avoided Traditional Water Heater Gas Cost		$27,905	$27,905	$27,905	$27,905	$27,905	$27,905	$27,905	$27,905	$27,905	$27,905
		$51,557	$51,557	$51,557	$51,557	$51,557	$51,557	$51,557	$51,557	$51,557	$51,557
Fuel for CHP		($33,665)	($33,665)	($33,665)	($33,665)	($33,665)	($33,665)	($33,665)	($33,665)	($33,665)	($33,665)
Net Energy Bill Savings		$17,892	$17,892	$17,892	$17,892	$17,892	$17,892	$17,892	$17,892	$17,892	$17,892
Expenses											
Maintenance Costs		($3,942)	($3,942)	($3,942)	($3,942)	($3,942)	($3,942)	($3,942)	($3,942)	($3,942)	($3,942)
Net Variable Cost Savings											
Savings Before Depreciation & Taxes		$13,950	$13,950	$13,950	$13,950	$13,950	$13,950	$13,950	$13,950	$13,950	$13,950
Return on Investment											
Equipment Installed Cost	$150,000	assumes straight line, no residual value									
Depreciation Tax Benefit	60%	$18,000	$18,000	$18,000	$18,000	$18,000					
Savings Before Taxes		$31,950	$31,950	$31,950	$31,950	$31,950	$13,950	$13,950	$13,950	$13,950	$13,950
Annual Cash Flow	($150,000)	$31,950	$31,950	$31,950	$31,950	$31,950	$13,950	$13,950	$13,950	$13,950	$13,950
				5 year Cummulative savings		*$159,750*			*10 year Cummulative savings*		*$229,500*
Net Present Value at 10%	$3,592										
Internal Rate of Return	11%										
Payback Period	4.7	years									

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Feasibility Stage 2

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Cash Flow Analysis for Hot Water CHP Equipment Purchase

Blue Mountain	Cdn $	U.S. $
M3S-28R-FG4-AUMO	$ 60,000	$ 37,500
MG4-C2	$ 21,500	$ 13,438
engineering	$ 5,000	$ 3,125
monitoring system	$ 3,000	$ 1,875
Electrical	$ 16,000	$ 10,000
Mechanical	$ 25,500	$ 15,938
M & E upgrades + Misc.	$ 14,000	$ 8,750
Estimated shipping costs	$ 1,500	$ 938
Project Management	$ 3,500	$ 2,188
60R-HG4-BUMO	$ 79,088	$ 49,430
Upgrades, i.e., comp., etc,	$ 40,000	$ 28,571
Total Project Price	$ 269,088	$ 171,751

Inputs

Equipment Installed Cost	$270,000			
Installed Cost per kWe	$3,000			
Maintenance Cost	$0.010	per kWh		
Average Electric Utility Energy Rate	$0.090	per kWh		
Average Electric Utility Demand Rate	$10.49	per kW per Month		
Average Gas Rate	$10.50	per MM BTU (HHV)		
Nominal kWe Rating	90	kW		
Average Hot Water Load	180	kW thermal	=	614,340 BTU / hr
Efficiency of Traditional Hot Water Heater	75%	based on LHV		
Hours of Operation	8,760	hours per year		
Heat Rate	12,200	BTU per kWh (HHV)		

Year	0	1	2	3	4	5	6	7	8	9	10
Energy Bill Savings											
Avoided Site Electric Energy Costs		$70,956	$70,956	$70,956	$70,956	$70,956	$70,956	$70,956	$70,956	$70,956	$70,956
Avoided Site Electric Demand Charge		$11,329	$11,329	$11,329	$11,329	$11,329	$11,329	$11,329	$11,329	$11,329	$11,329
Avoided Traditional Water Heater Gas Cost		$83,714	$83,714	$83,714	$83,714	$83,714	$83,714	$83,714	$83,714	$83,714	$83,714
		$165,999	$165,999	$165,999	$165,999	$165,999	$165,999	$165,999	$165,999	$165,999	$165,999
Fuel for CHP		($100,994)	($100,994)	($100,994)	($100,994)	($100,994)	($100,994)	($100,994)	($100,994)	($100,994)	($100,994)
Net Energy Bill Savings		$65,005	$65,005	$65,005	$65,005	$65,005	$65,005	$65,005	$65,005	$65,005	$65,005
Expenses											
Maintenance Costs		($5,913)	($5,913)	($5,913)	($5,913)	($5,913)	($5,913)	($5,913)	($5,913)	($5,913)	($5,913)
Net Variable Cost Savings											
Savings Before Depreciation & Taxes		$59,092	$59,092	$59,092	$59,092	$59,092	$59,092	$59,092	$59,092	$59,092	$59,092
Return on Investment											
Equipment Installed Cost	$270,000	assumes straight line, no residual value									
Depreciation Tax Benefit	60%	$32,400	$32,400	$32,400	$32,400	$32,400					
Savings Before Taxes		$91,492	$91,492	$91,492	$91,492	$91,492	$59,092	$59,092	$59,092	$59,092	$59,092
Annual Cash Flow	($270,000)	$91,492	$91,492	$91,492	$91,492	$91,492	$59,092	$59,092	$59,092	$59,092	$59,092
					5 year Cummulative savings	*$457,461*				*10 year Cummulative savings*	*$752,922*

Net Present Value at 10%	$196,289
Internal Rate of Return	29%
Payback Period	3.0 years

Lessons Learned

- Stay away from flammable materials *(photo)*
- Buy in from all groups as to scope of project
- Dual Mode vs. Grid-Connect *Re: expectations during blackouts*
- Enclosure forethought *Re: Canadian winters*
- Capstone's iCHP unit over Turbine and separate HX
- Start with a feasibility study, then design the system, then verify with approval agencies, then negotiate price

Approvals

- TSSA (Technical Safety Std Authority) *Regulate boilers, etc,*
- *ORD issued April 2003 to classify microturbines for Ontario*
- "Hydro One" Re: Interconnection Agreement
- OEB *(Ontario Energy Board)* coming with new interconnection standards - *not a factor on Blue Mountain.*
- ESA - Electrical Safety Authority Re: Electrical inter-connection

Canadian & Ontario Market

•Canada "committed" to Kyoto accord

•Canadian Markets - B.C., QC, & Man. Have Hydro-electricity

•Alberta de-regulated, Ontario's de-regulation reversed after Ontario Hydro broken into OPG & Hydro One.

•Stranded debt of former Ontario Hydro @ $ 20.2 Billion & rising *(Province's population @ 10M)*

•Power shortage risks:

1.Nuclear Plants - 3 plants producing 40% of province's power, one of which is experiencing downtime due to a lengthy, costly refurbishment *($1,25B for one of 4 reactors, closed in 1997 to have been re-opened in 2000 @ a total cost of $780M, is now estimated @ $4B for all 4 units).*

2. Commitment to de-commissioning Coal plants *(30% of province's power)*