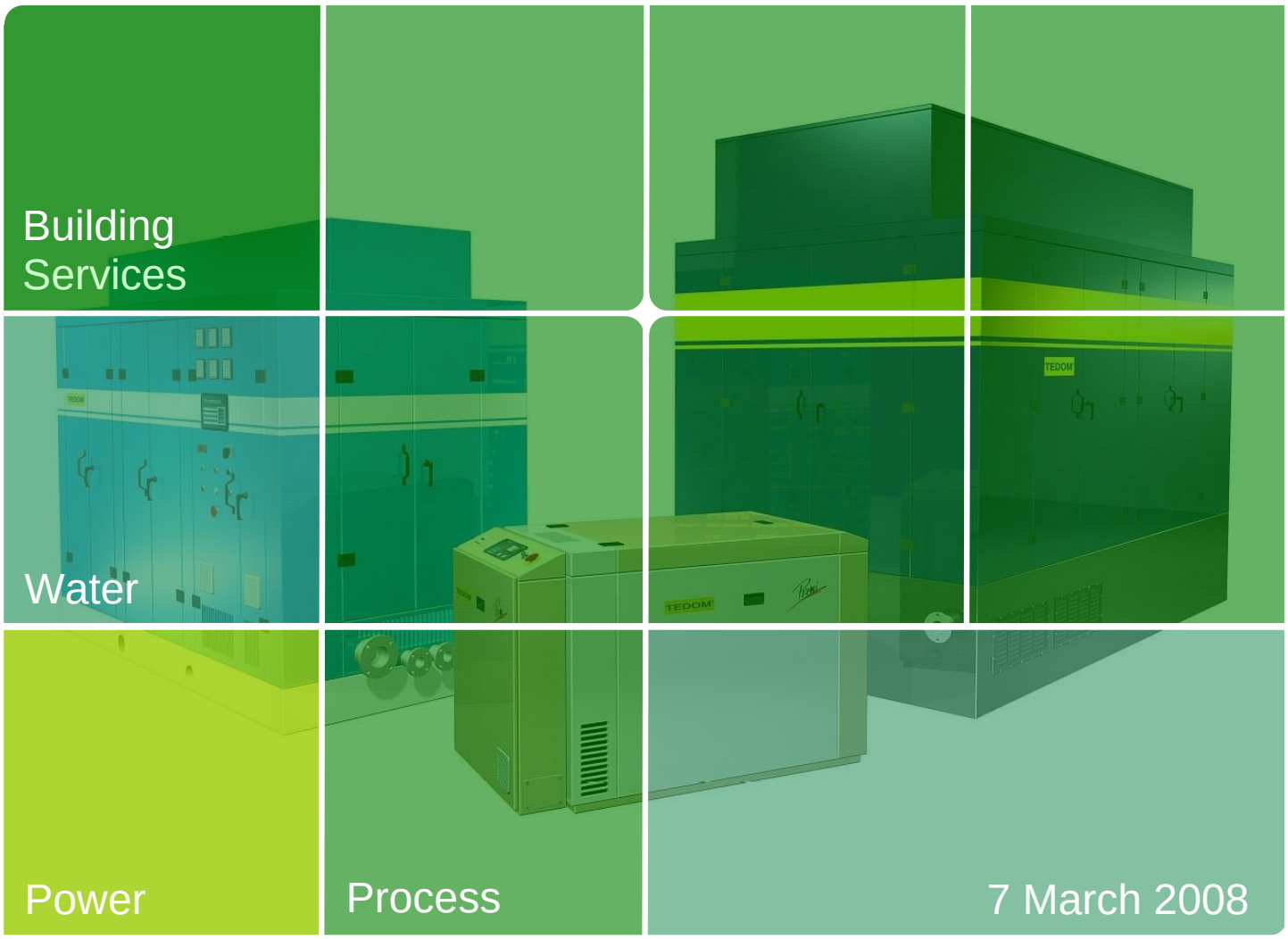

NSW Department of Planning – BASIX – Cogeneration Demonstration Project

Cambridge Apartments

Period Report:

Report 1 –	13th December 2007	to	7th February 2008
Report 2 –	8th February 2008	to	7th March 2008

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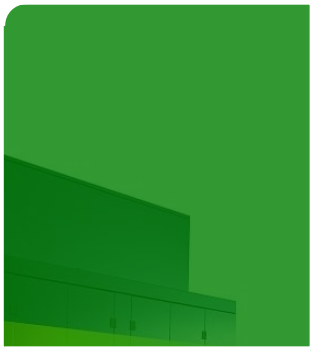
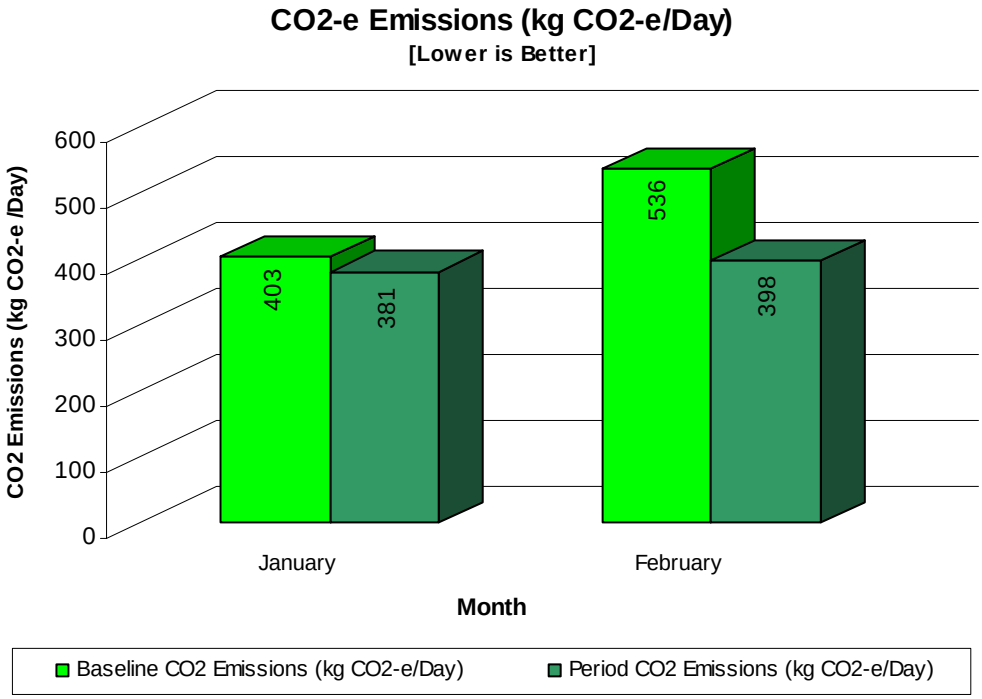


Table of Contents

1 Executive Summary

The first 2 reports have been combined as the initial January report offers little information due to commissioning and reduced occupancy levels.

For the second report (February) with the unit running in a building at close to 100% occupancy, **3997.94 kg CO2 was saved during February. This is shown in the graph below on a per day basis:**



The efficiency of the unit is running below the specified level due to demand starts and shut downs. The use of solar as a pre-heater also reduces the efficiency of the units.

Performance is expected to improve as the unit is optimised to run more of the time. The current setting appears to be too low. The unit should also be optimised to run during peak times when electricity prices are high.

The cost of the unit is shown in the table on the next page.

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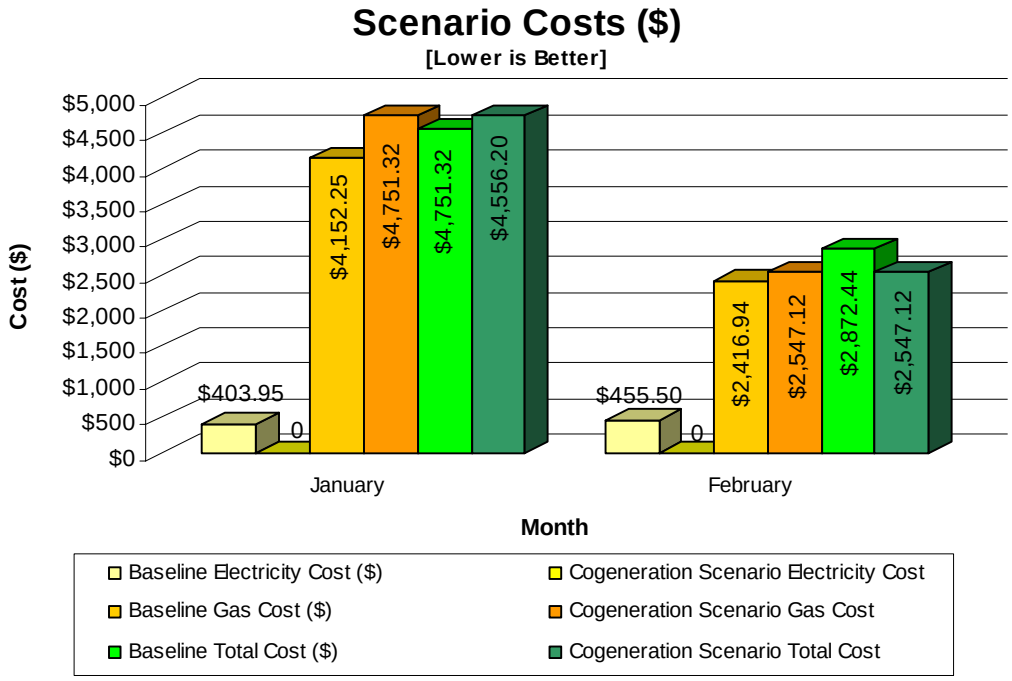

The savings from the unit are approximately $340 for February, which is low but is expected to increase after optimisation.

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2 Baseline Scenario

The baseline scenario comprises of two (2) Raypak Gas Boilers providing hot water and Energy Australia providing electricity.

For the purpose of this report – the baseline scenario analysis uses gas consumption from the Raypak Gas Boilers and the electricity usage data from the Tedom F25AP Cogeneration Unit.

The gas consumption data and electricity usage data is priced according to the pricing schedule in **Section 6 – Data & Assumptions.**

2.1 Baseline Performance

The baseline performance for each period is outlined below. These figures include gas consumption and electricity usage.

2.1.1 Report 1 – 13/12/2007 to 07/02/2008

As detailed below, gas consumption and electricity usage figures for the period are 331,200 MJ and 3,730 kWh respectively.

Raypak Boilers		
Gas Unit Ratio (LHV)	MJ/m³	35.83
Gas Unit Ratio (HHV)	MJ/m³	38.35
Previous Meter Reading	m³	0
Current Meter Reading	m³	8,636
Period Usage	m³	8,636
Sub-Total Gas Consumption	MJ	331,204

Electricity Usage		
Peak Use	%	17.70%
Shoulder Use	%	25.40%
Off Peak Use	%	56.90%
Peak Use	kWh	660
Shoulder Use	kWh	947
Off Peak Use	kWh	2,121
Sub-Total Electricity Consumption	kWh	3,728

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2.1.2 Report 2 – 08/02/2008 to 07/03/2008

As detailed below, gas consumption and electricity usage figures for the period are 168,500 MJ and 4,240 kWh respectively.

Raypak Boilers		
Gas Unit Ratio (LHV)	MJ/m³	35.83
Gas Unit Ratio (HHV)	MJ/m³	38.35
Previous Meter Reading	m³	8,636
Current Meter Reading	m³	13,029
Period Usage	m³	4,394
Sub-Total Gas Consumption	MJ	168,507

Electricity Usage		
Peak Use	%	17.70%
Shoulder Use	%	25.40%
Off Peak Use	%	56.90%
Peak Use	kWh	750
Shoulder Use	kWh	1,077
Off Peak Use	kWh	2,413
Sub-Total Electricity Consumption	kWh	4,240

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2.2 Baseline Costs

Using the data outlined in **Section 2.1 - Baseline Performance**, the Baseline Costs were calculated for each period.

2.2.1 Report 1 – 13/12/2007 to 07/02/2008

Gas Costs for this period were $4,729 with Electricity Costs at $464. This gives a Total Baseline Cost of $5,193.

Raypak Boiler Gas Costs			
Gas Supply Fee	$	$	22.50
Gas Rate	$/MJ	$	0.014
Total Gas Cost	$	$	4,728.91
Energy Australia Electricity Costs			
Electricity Supply Fee	$	$	28.61
Electricity Rates			
Peak	$/kWh	$	0.212
Shoulder	$/kWh	$	0.061
Off Peak	$/kWh	$	0.112
Total Electricity Cost	$	$	463.84
Total Baseline Cost	$	$	5,192.75

2.2.2 Report 2 – 08/02/2008 to 07/03/2008

Gas Costs for this period were $2,417 with Electricity Costs at $524. This gives a Total Baseline Cost of $2,491.

Raypak Boiler Gas Costs			
Gas Supply Fee	$	$	22.50
Gas Rate	$/MJ	$	0.014
Total Gas Cost	$	$	2,416.99
Energy Australia			
Electricity Supply Fee	$	$	28.61
Electricity Rates			
Peak	$/kWh	$	0.212
Shoulder	$/kWh	$	0.061
Off Peak	$/kWh	$	0.112
Total Electricity Cost	$	$	523.61
Total Baseline Cost	$	$	2,940.60

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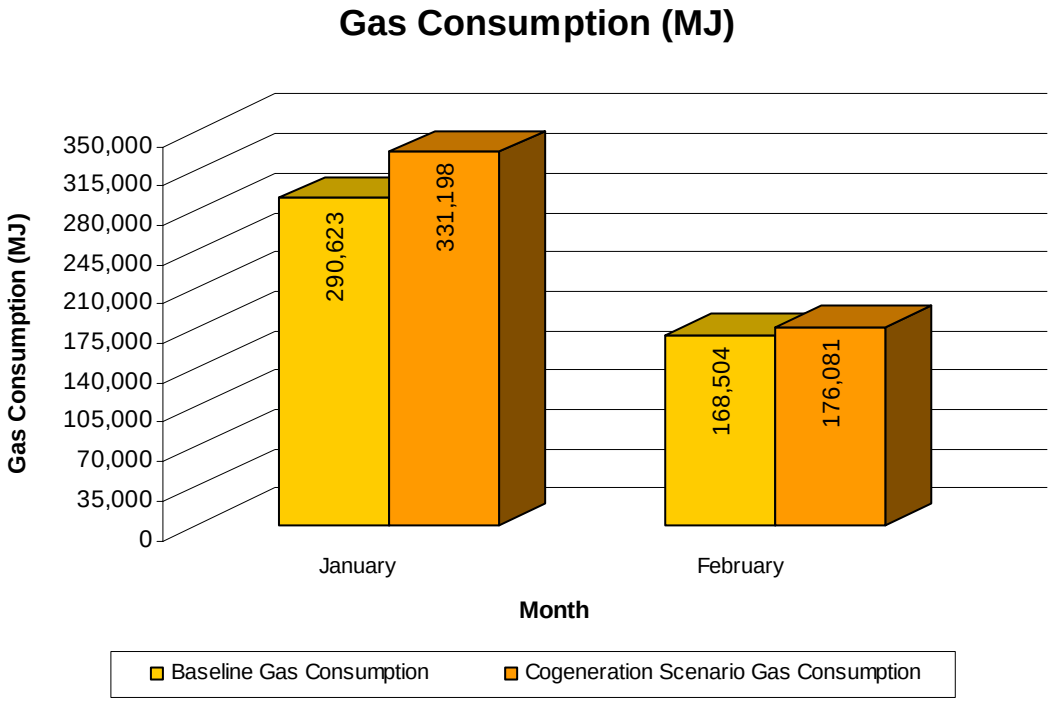
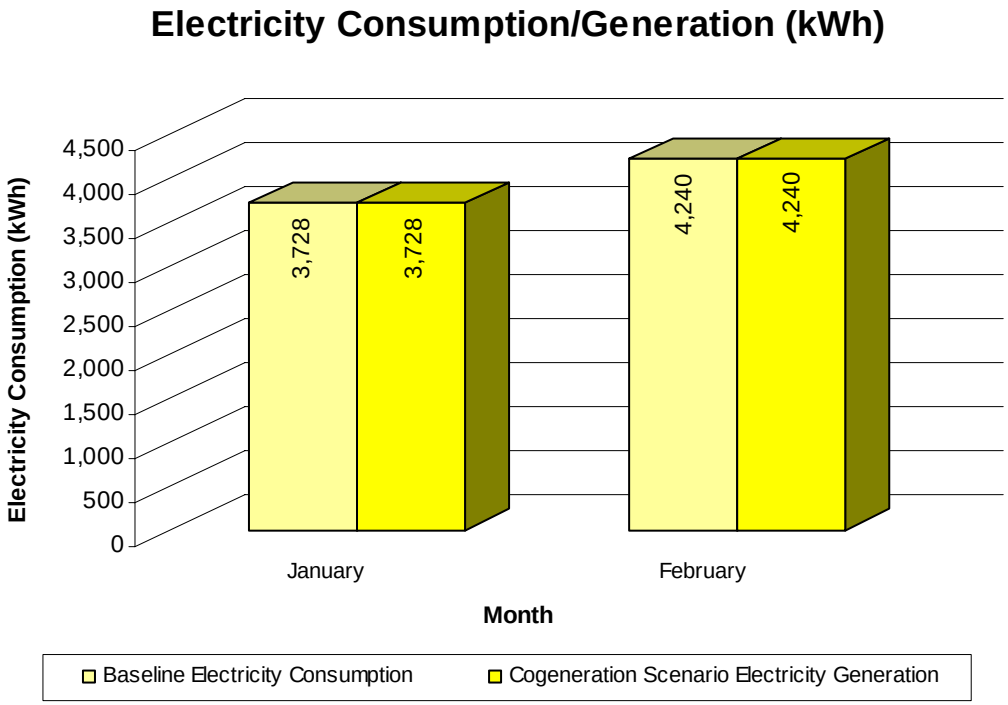
2.3 Summary

For the period of Report 1, Raypak Gas Boiler gas consumption was 331,204 MJ with electricity consumption being 3,728 kWh. For the period of Report 2, Raypak Gas Boiler gas consumption was 168,507 MJ with electricity consumption being 4,420 kWh.





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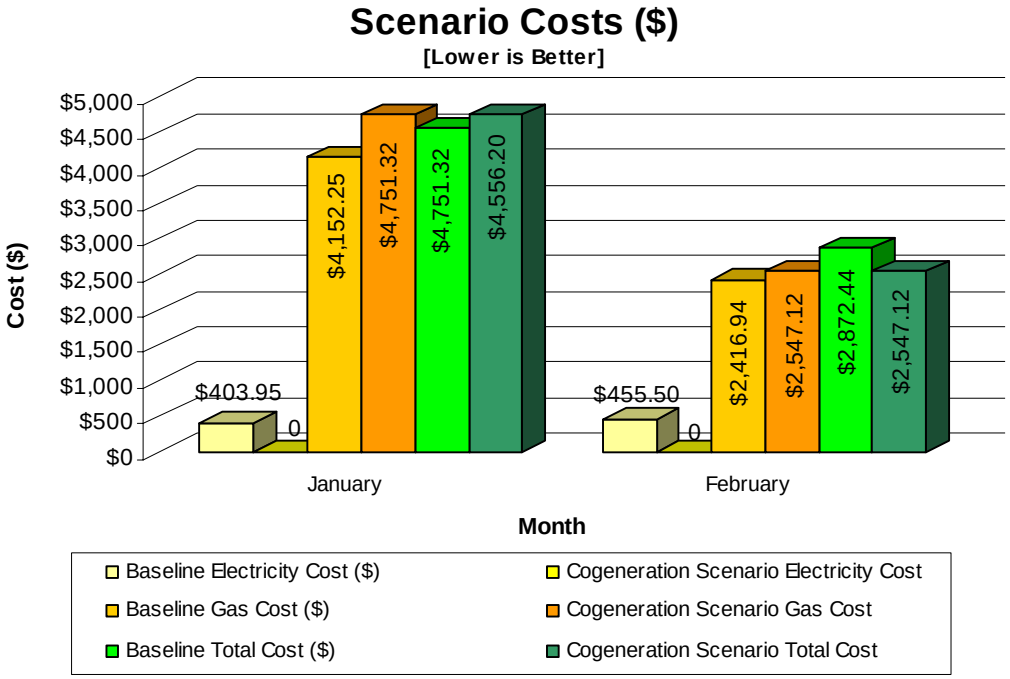
For the period of Report 1, gas and electricity costs were $4728.91 and $463.84 respectively, with the total cost being $5,192.75. For the period of Report 2, gas and electricity costs were $2416.99 and $523.61 respectively, with the total cost being $2,940.60.



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3 Cogeneration Scenario

The cogeneration scenario comprises of one (1) Tedom F25AP Gas Cogeneration Unit, generating electricity and a proportion of the hot water for the site with the remainder of the hot water required being generated by two (2) Raypak Gas Boilers.

3.1 Cogeneration Performance

This section details the Operational statistics and operational efficiency of the Tedom F25AP Gas Cogeneration Unit.

3.1.1 Unit Operational Statistics

The operational statistics for the Tedom F25AP Gas Cogeneration Unit are detailed below. These operational statistics include the operating hours of the Cogeneration Unit, the Electricity and Heat produced, Operating Temperatures and Gas Consumption data.

3.1.1.1 Report 1 – 13/12/2007 to 07/02/2008

For the period of Report 1, the Cogeneration Unit had run for a total of 152 hours, of which, 70 were commissioning hours. In this time, a total of 3,728 kWh of Electricity was produced and a total of 7,296 kWr of heat.

Gas consumption for these outputs was 1,520 m³ or 58,314 MJ – with supply pressure being 2 kPa.

The unit was started 235 times and had an average exhaust output temperature of 620 ºC, dropping to 140 ºC after the heat exchanger. Secondary water temperature was 70 ºC.

Tedom F25AP Cogeneration Unit Operational Statistics		
Parameter	**Units**	**Value**
Unit Running Time		
Total Running Hours	Hrs	152
Total Commissioning Hours	Hrs	70
Unit Energy Production		
Total Electricity Produced	kWh	3,728
Total Heat Produced	kWr	7,296
Unit Running Statistics		
Number of Starts	No	236
Maintained Secondary Water Temp	ºC	70
Average Exhaust Temp Prior to HE	ºC	620
Average Exhaust Temp After HE	ºC	140
Unit Gas Supply Statistics		
Previous Meter Reading	m³	0
Current Meter Reading	m³	1,520
Total Gas Consumption	m³	1,520
Total Gas Consumption	MJ	58,314
Gas Supply Pressure	kPa	2

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Raypak Meter Reading	m³	7,577

3.1.1.2 Report 2 – 08/02/2008 to 07/03/2008

For the period of Report 2, the Cogeneration Unit had run for a total of 326 hours, of which, 70 were commissioning hours. In this time, a total of 7,968 kWh of Electricity was produced and a total of 15,648 kWr of heat.

Gas consumption for these outputs was 3,142 m³ or 120,508 MJ – with supply pressure being 2 kPa.

The unit was started 297 times and had an average exhaust output temperature of 620 ºC, dropping to 140 ºC after the heat exchanger. Secondary water temperature was 70 ºC.

Tedom F25AP Cogeneration Unit Operational Statistics		
Parameter	**Units**	**Value**
Unit Running Time		
Total Running Hours	Hrs	326
Total Commissioning Hours	Hrs	0
Unit Energy Production		
Previous Period Electricity Produced	kWh	3,728
Current Period Electricity Produced*	kWh	4,240
Total Electricity Produced	kWh	7,968
Previous Period Heat Produced	kWr	7,296
Current Period Heat Produced*	kWr	8,352
Total Heat Produced	kWr	15,648
Unit Running Statistics		
Number of Starts	No	297
Maintained Secondary Water Temp	ºC	70
Average Exhaust Temp Prior to HE	ºC	620
Average Exhaust Temp After HE	ºC	140
Unit Gas Supply Statistics		
Previous Period Gas Consumption	m³	1,520
Current Period Gas Consumption*	m³	1,622
Total Gas Consumption	m³	3,142
Total Gas Consumption*	MJ	120,508
Gas Supply Pressure	kPa	2
Raypak Meter Reading	m³	11,971

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3.1.2 Unit Operational Efficiency

The operating efficiencies of the Tedom F25AP Gas Cogeneration Unit are detailed below. The operating efficiencies are comprised of the Electrical, Thermal and Overall Unit efficiencies – presented as a percentage, calculated as the kW output (Electrical, Thermal, Total) divided by kW input (Fuel/Gas).

3.1.2.1 Manufacturer Specified Efficiencies & Outputs

Tedom have specified efficiencies & outputs of their F25AP Gas Cogeneration Unit. These are based upon the conditions outlined in **Section 6 – Data & Assumptions.**

Operating Efficiencies & Outputs		
Parameter	**Units**	**Value**
Tedom Specified Efficiencies (Using LHV)		
Tedom Specified Electrical Efficiency	%	29.86%
Tedom Specified Thermal Efficiency	%	56.14%
Tedom Specified Overall Unit Efficiency	%	86.01%
Tedom Specified Outputs/Consumption		
Tedom Specified Electrical Output	kWe	25.00
Tedom Specified Thermal Output	kWr	47.00

3.1.2.2 Report 1 – 13/12/2007 to 07/02/2008

Note: The period for Report 1 includes commissioning of the unit, therefore efficiencies are slightly lower than can be expected during normal operation. A comparison of the efficiency change is given in **Section 3.3 - Summary**.

For the period of Report 1, the electrical efficiency of the Tedom F25AP Gas Cogeneration Unit was 24.64%, with thermal efficiency being 48.21%. This gives an overall unit efficiency of 72.85%.

Desired electrical output for the period was 24.70 kWe, with the unit achieving 24.53 kWe. Average thermal output was 48 kWr.

Operating Efficiencies & Outputs		
Parameter	**Units**	**Value**
Operating Efficiencies (Using LHV)		
Electrical Efficiency	%	24.64%
Thermal Efficiency	%	48.21%
Overall Unit Efficiency	%	72.85%
Operating Outputs		
Desired Electrical Output	kWe	24.70
Average Electrical Output	kWe	24.53
Average Thermal Output	kWr	48.00

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3.1.2.3 Report 2 – 08/02/2008 to 07/03/2008

For the period of Report 2, the electrical efficiency of the Tedom F25AP Gas Cogeneration Unit was 26.26%, with thermal efficiency being 51.74%. This gives an overall unit efficiency of 78.00%.

Desired electrical output for the period was 24.70 kWe, with the unit achieving 24.44 kWe. Average thermal output was 48 kWr.

Operating Efficiencies & Outputs		
Parameter	**Units**	**Value**
Operating Efficiencies (Using LHV)		
Electrical Efficiency	%	26.26%
Thermal Efficiency	%	51.74%
Overall Unit Efficiency	%	78.00%
Operating Outputs		
Desired Electrical Output	kWe	24.70
Average Electrical Output	kWe	24.44
Average Thermal Output	kWr	48.00

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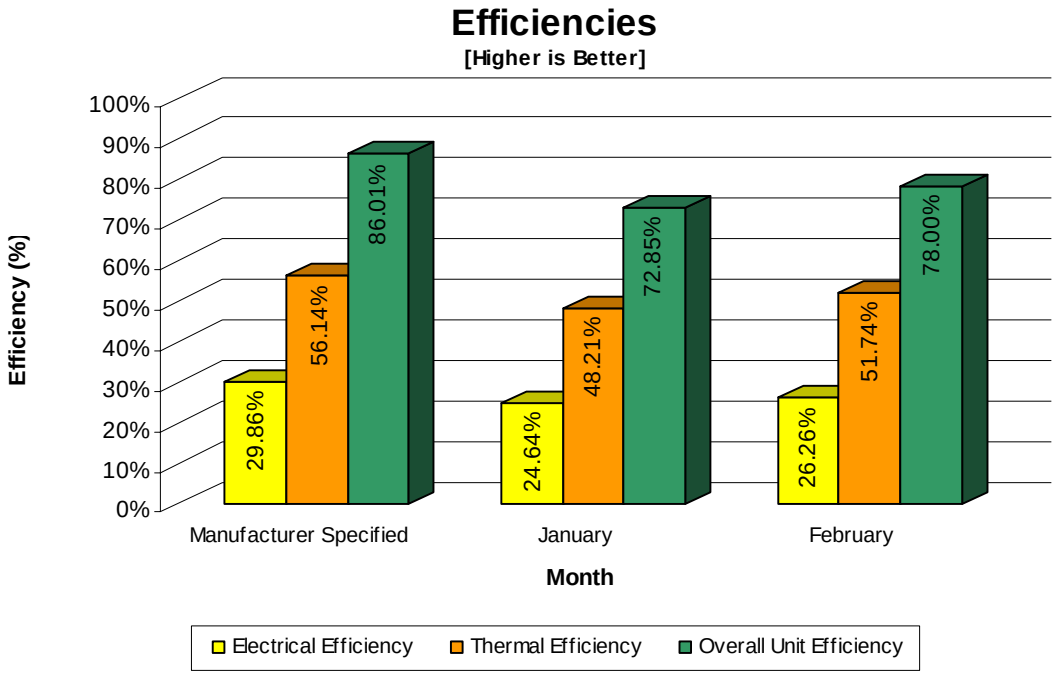
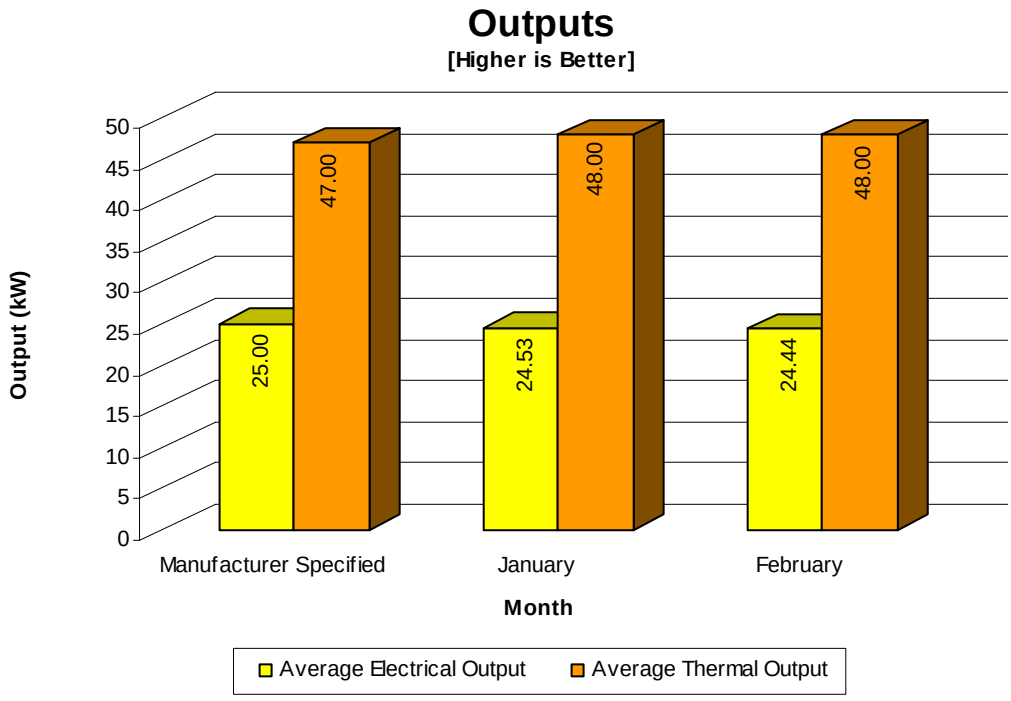
3.1.3 Graphs





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4 Financial & Performance Analysis

4.1 Cogeneration Costs

The cogeneration unit cost $185,000 for the complete project including engineering, installation and commissioning.

The initial 12 months maintenance is covered by the defects liability period.

Report 1:

Current Costs			
Cogen & Boiler Gas Costs			
Gas Supply Fee	$	$	45.00
Gas Rate	$/MJ	$	0.014
Total Gas Cost	$	$	4,751.32

Report 2:

Current Costs			
Cogen & Boiler Gas Costs			
Gas Supply Fee	$	$	45.00
Gas Rate	$/MJ	$	0.014
Total Gas Cost	$	$	2,547.12

Total running costs are from gas usage of the engine for the first year.

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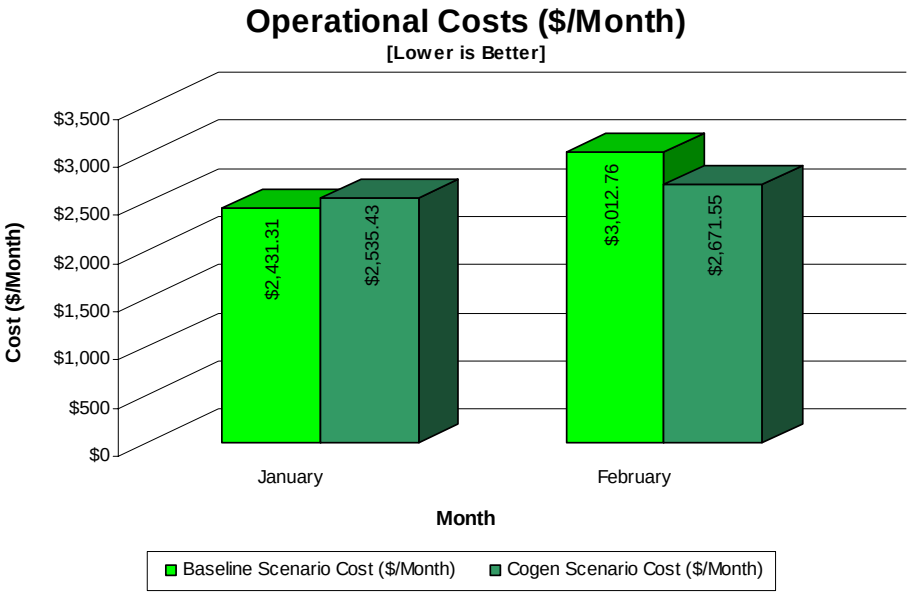

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4.2 Performance Summary

4.2.1 January Report

Performance Summary		
Report 1		
Item	**Units**	**Value**
Baseline Operational Cost	Month	$2,431.31
Period Operational Cost	Month	$2,535.43
Operational Cost Savings	Month	-$104.12
Baseline Emissions	kg CO2-e/Day	403
Period Emissions	kg CO2-e/Day	381
Emissions Saved	kg CO2-e/Day	22.70
Electrical Output	kWe	24.53
Electrical Efficiency	%	24.64%
Thermal Output	kWr	48.00
Thermal Efficiency	%	48.21%
Combined Efficiency	%	72.85%
Payback Period	Years	-148.07

Due to commissioning gas cost usage this does not reflect the actual costs of the unit.

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4.2.1 February Report

Report 2		
Item	**Units**	**Value**
Baseline Operational Cost	Month	$3,012.76
Period Operational Cost	Month	$2,671.55
Operational Cost Savings	Month	$341.21
Baseline Emissions	kg CO2-e/Day	536
Period Emissions	kg CO2-e/Day	398
Emissions Saved	kg CO2-e/Day	137.86
Electrical Output	kWe	24.44
Electrical Efficiency	%	26.26%
Thermal Output	kWr	48.00
Thermal Efficiency	%	51.74%
Combined Efficiency	%	78.00%
Payback Period	Years	45.18

The performance is expected to improve as the unit is optimised to run more of the time. The current setting appears to be too low. The unit should also be optimised to run during peak times when electricity prices are high.

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5 Environmental Analysis

5.1 January Report

As can be seen in the table below even despite the losses associated with commissioning the unit, there is still a CO2 reduction in the first 57 days of operation.

Report 1	
Number of Days:	**57**

CO2 Emissions & Savings		
Parameter	**Units**	**Value**
Gas & Electricity Consumption (Baseline)		
Natural Gas Consumed	MJ	290,623
Electricity Consumed	kWh	3,728
Gas & Electricity Consumption (Current)		
Natural Gas Consumed	MJ	331,198
Electricity Consumed	kWh	0
Emissions Factors		
Natural Gas Emissions Factor	kg CO2-e/GJ	65.5
Electricity End Use Emissions Factor	kg CO2-e/kWh	1.06
CO2 Emissions & Savings		
Baseline Scenario	kg CO2-e/Day	403
Cogen Scenario	kg CO2-e/Day	381
Emissions Saved	kg CO2-e/Day	22.70

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5.2 February Report

With the unit running in a building at close to 100% occupancy, 3997.94 kg CO2 was saved during the month.

Report 2	
Number of Days:	**29**

CO2 Emissions & Savings		
Parameter	**Units**	**Value**
Gas & Electricity Consumption (Baseline)		
Natural Gas Consumed	MJ	168,504
Electricity Consumed	kWh	4,240
Gas & Electricity Consumption (Current)		
Natural Gas Consumed	MJ	176,081
Electricity Consumed	kWh	0
Emissions Factors		
Natural Gas Emissions Factor	kg CO2-e/GJ	65.5
Electricity End Use Emissions Factor	kg CO2-e/kWh	1.06
CO2 Emissions & Savings		
Baseline Scenario	kg CO2-e/Day	536
Cogen Scenario	kg CO2-e/Day	398
Emissions Saved	kg CO2-e/Day	137.86

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6 Definitions

Commissioning – To install and make ready for service or use through operational testing and if necessary, performance or operational parameter adjustment.

Joule – A unit of energy equal to the work done when a 1 Newton force acts through a distance of 1 meter.

kW – kilo Watt, A unit of power equal to 1,000 Watts.

kPa – kilo Pascal, A unit of pressure equal to 1,000 Pascals.

MJ – Mega Joule, A unit of energy equal to 1,000 Joules.

Newton – A unit of force required to accelerate a 1 kilogram (kg) mass by 1 meter per second squared.

Overall Unit Efficiency – A measure of Electrical and Thermal (Heat) Energy output as a percentage of Fuel Energy input.

Pascal – A unit of pressure equal to 1 Newton per Square Meter.

Total Efficiency – See **Overall Unit Efficiency**.

Watt – A unit of power equal to one Joule per second.

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7 Data & Assumptions

1. The Electricity cost of the building has been based on the "House" electricity bill received from Mirvac.
2. Gas cost is based on the current metering of the cogeneration unit ONLY and not the Raypack boilers on the site. Therefore actual gas cost could be much cheaper.
3. The cogeneration meter (EC143612) is a sub meter of the 2 main building Alinta Gas meters (06F903376, 06F903376).
4. Gas prices assumed are: $14.21 / GJ
5. Electricity Price has been assumed to be uniform for peak, shoulder and off peak which is conservative as loads tend to be more during peak and shoulder times.
6. Electricity price is 21.2cents/kWh peak, 11.2cents/kWh shoulder, 6.1cents/kWh shoulder,

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8 Appendix

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