Corporate Services Division

Sustainability and Innovation

Confidential

Technical Report

Title	:	Demgey hot water load control DRAFT
By	:	Raj Chetty - September 2008
Section Department	:	Energy Efficiency POWER SYSTEMS AND TECHNOLOGIES

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1 Summary

To follow

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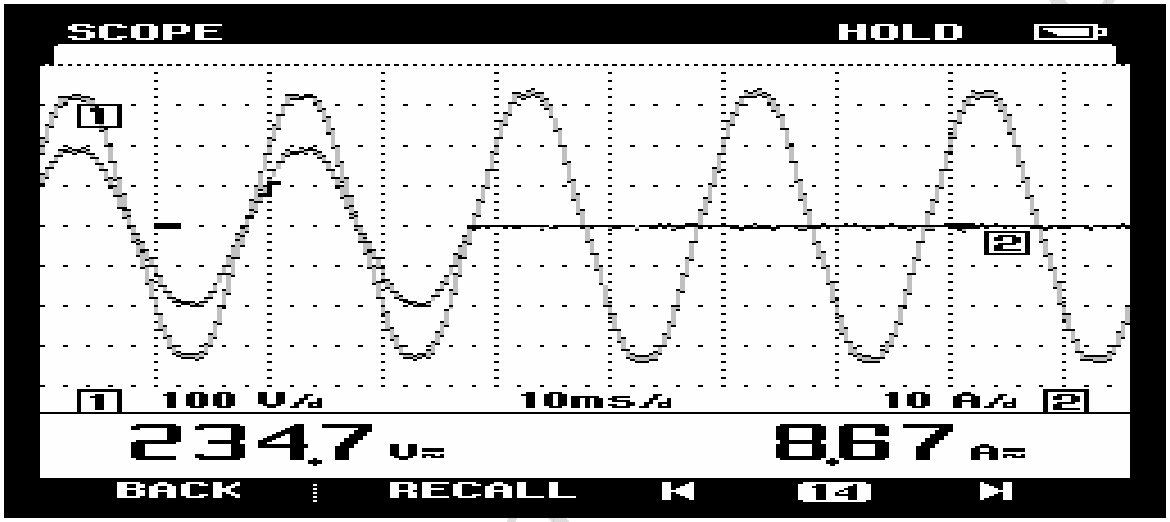
Introduction

The hot water load control system that was presented to the Energy Efficiency section to be tested. The controller works on the basis of filtering out a specified amount of cycles in a mains 50Hz sine wave. This should have the effect of reducing the average power delivered every 0.02 seconds. Average power is the function of average voltage and average current, hence if a specific amount of current cycles are filtered from 50 cycles in 1 second, there will be a proportional reduction in the average power

INSERT MATHS HERE

The following snapshot shows 3 out of 5 current cycles been filtered out. The switching is done at the zero crossing point.



3 Procedure

3.1 Equipment

A hot water cylinder (geyser) with the following specifications was used:

Geyser make	Geyser Allied Products (GAP)
Geyser type	Horizontal
Serial number	5862
Rating	230V 50Hz, 3kW
Capacity	150 litres
Working pressure	400kPA
Standing loss/hr	2.59kWh
Thermostat setting	60°C

A hot water usage pattern was simulated by means of a programmable logic controller operating a solenoid valve at the geyser outlet. The pattern used is illustrated in Figure 1.

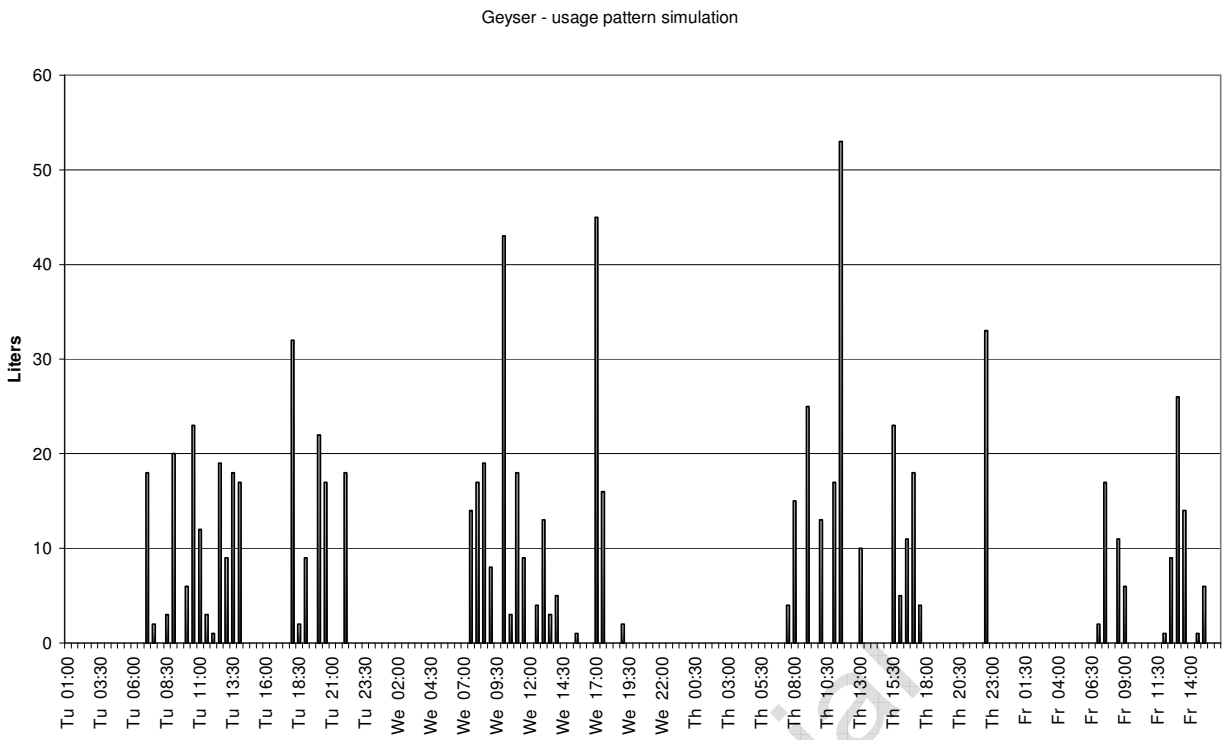
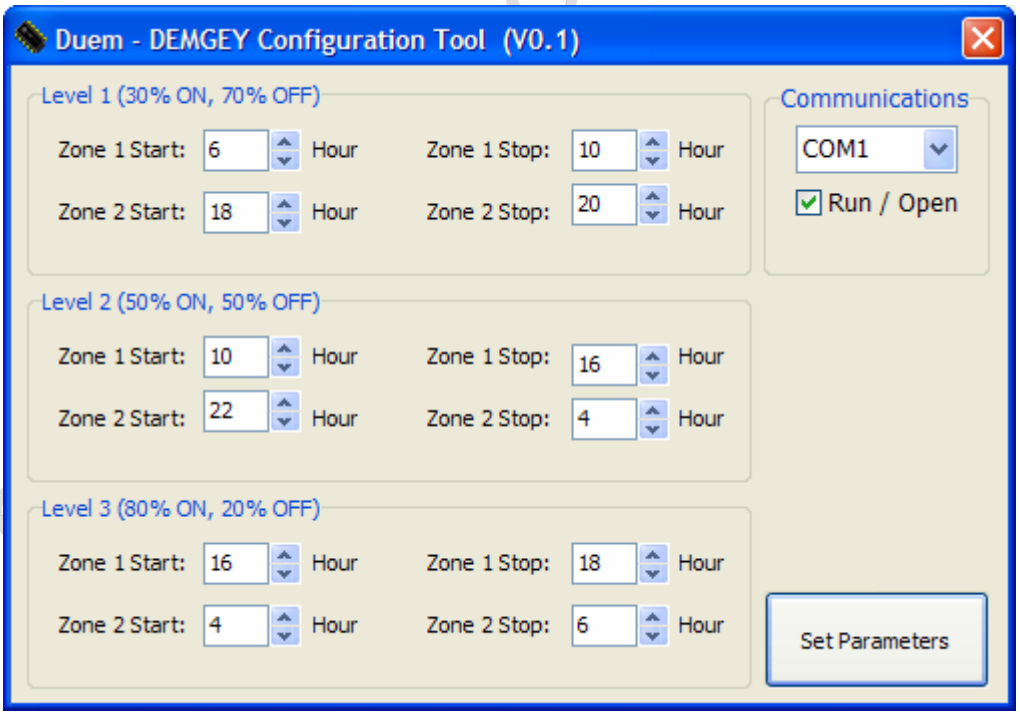


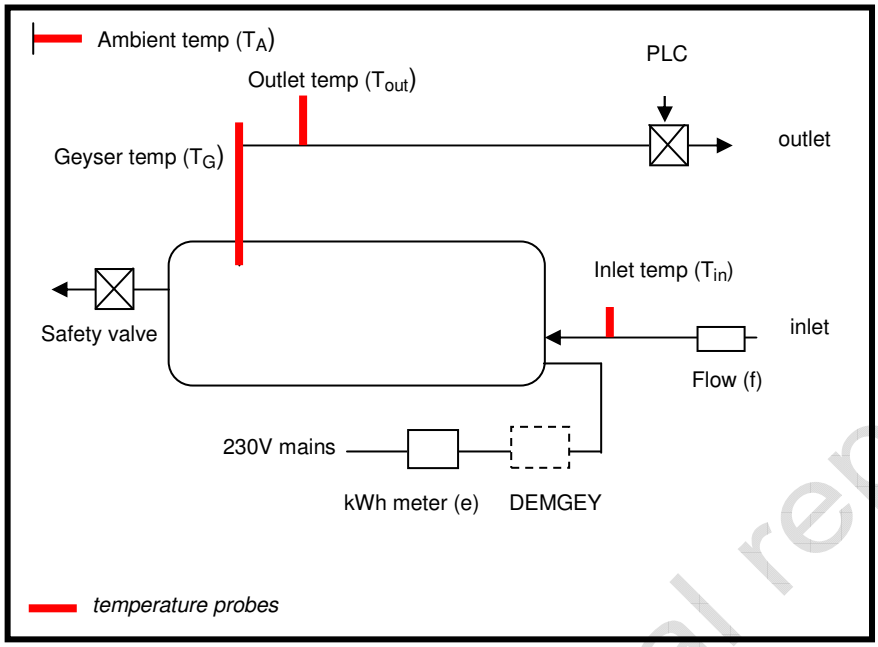
Figure 1. Hot water usage pattern simulated by PLC

3.2 Geyser controller

The controller was set with the following ON/OFF cycle periods. The rationale behind this was to shift consumption out of Eskom peak times:



3.3 Parameters measured



Parameter	Measurand	Measurement	Description
Inlet temperature	T_{in} (°C)	Thermocouple type?	Measures inlet/cold water temp
Outlet temperature	T_{out} (°C)	Thermocouple type?	Measures outlet/hot water temp
Geyser temperature	T_G (°C)	Thermocouple type?	Measures internal geyser temp
Ambient temperature	T_A (°C)	Thermocouple type?	Measure ambient temp
Total Flow (in)	f (litres)	Flow meter	Measure total water flow in
Total energy	e (kWh)	Single phase energy meter class 1,0	Measure total energy consumed

3.4 Tests conducted

3.4.1 Baseline test

A baseline test was run from the period 21 July 2008 to 25 July 2008. The purpose of this test was to establish baseline reference data for the parameters been measured. The geyser was switched on and left to run with a simulated hot water usage pattern as described. The test parameters were measured every 1min with a total of 5701 samples over the 95 hour period test run.

3.4.2 Geyser control test

After the baseline test was run, the DEMGEY control equipment was connected to the geyser supply and the test was repeated. A comparison was made to see what potential savings can be achieved with using the DEMGEY geyser controller.

3.4.3 Quality of supply

A Fluke Power quality analyser was used to test the quality of supply after the DEMGEY was installed. This test involved harmonics measurements for both voltage and current

4 Results

4.1 Baseline test summated results

Test period: 21/07/08 to 25/07/08
Test samples (1min): 5701

	T_{in} (°C)	T_{out} (°C)	T_G (°C)	T_A (°C)	Flow	kWh
average	32.502	53.246	60.597	21.741	0.236	-
max	47.346	63.554	64.324	23.334	55.352	-
min	14.771	47.306	56.352	20.013	0.000	-
Total	-	-	-	-	1346.0	18.76

Data from this test was then used to plot a profile of all the test parameters (Appendix 1A).

4.2 Geyser under control (DEMGEY) results

Test period: 18/08/08 to 22/08/08
Test samples (1min): 5701

	T_{in} (°C)	T_{out} (°C)	T_G (°C)	T_A (°C)	Flow	kWh
average	32.962	52.027	58.652	25.383	0.209	-
max	45.730	61.388	62.230	30.516	54.399	-
min	15.451	29.588	30.954	22.817	0.000	-
Total	-	-	-	-	1193.8	10.18

Data from this test was then used to plot a profile of all the test parameters (Appendix 1B).

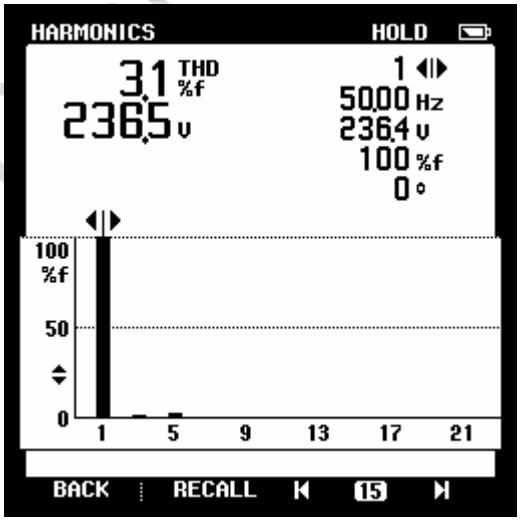
4.3 Comparison of results

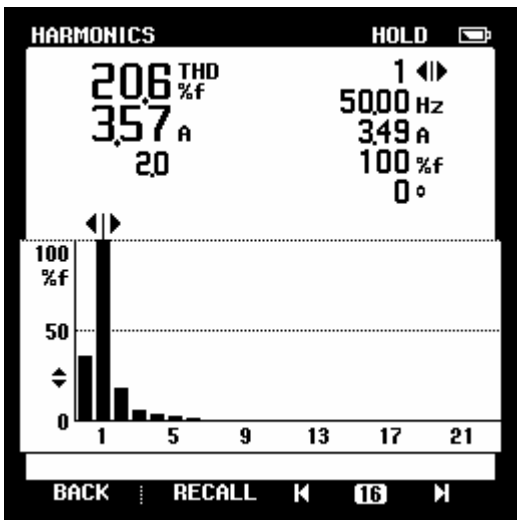
(Baseline as reference)

	Baseline	DEMGEY	Diff	% diff
Ave temp T_{out} (°C)	53.246	52.027	1.22	2.28%
Ave temp T_G (°C)	60.597	58.652	1.95	3.25%
Ave temp T_A (°C)	21.741	25.383	-3.64	-16,75%
Energy (kWh)	18.76	10.18	8.58	45.73%

Data from the baseline test and DEMGEY controller test were then plotted on a common axis to establish a comparison profile (Appendix 2). As can be seen from this comparison, the geyser temperature differed by less than two degrees Celsius and the electrical energy consumed by less than 8.5kWh over the same test period.

4.4 Quality of supply measurements.





The voltage harmonics measured was 3.1% THD and is less that the acceptable 5% allowed. The current harmonic content measured was 20.6% THD and above the acceptable??. This however needs to be verified and measured with laboratory standard equipment

5 Conclusion

Analysis of data collected from baseline tests compared to data collected after installing the DEMGEY geyser controller showed a 45% reduction in electrical energy consumed with only a 3.25% reduction in geyser temperature. The average ambient temperature conditions were higher during the DEMGEY test which meant that the losses were lower than the baseline but this could not have contributed significantly to the lower energy consumption recorded since the average cold water temperature was the same for both tests. Further power quality tests need to be done to ensure that if multiple devices are installed on the LV network, this will not effect system power quality.

6 Recommendations

It is recommended that a pilot project be run with a significant sample size to confirm these test results as well as to gauge consumer acceptance and input to refine the development. This controller can reduce the energy consumed by a HWC by cycling power as opposed to ON/OFF control while still maintaining a suitable hot water outlet temperature then it is recommended. All necessary safety standards and tests MUST be done prior to any commercialisation.

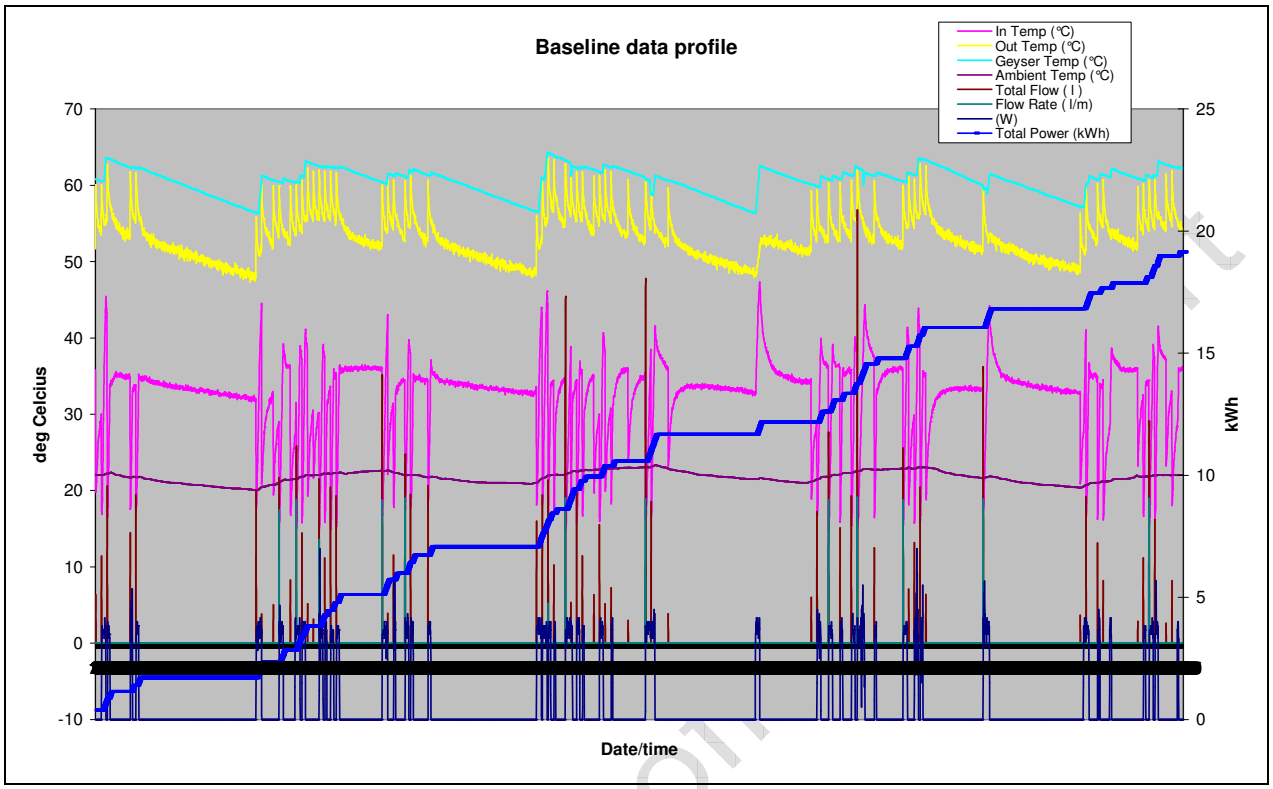
Eskom does not endorse this or any other product.

7 References

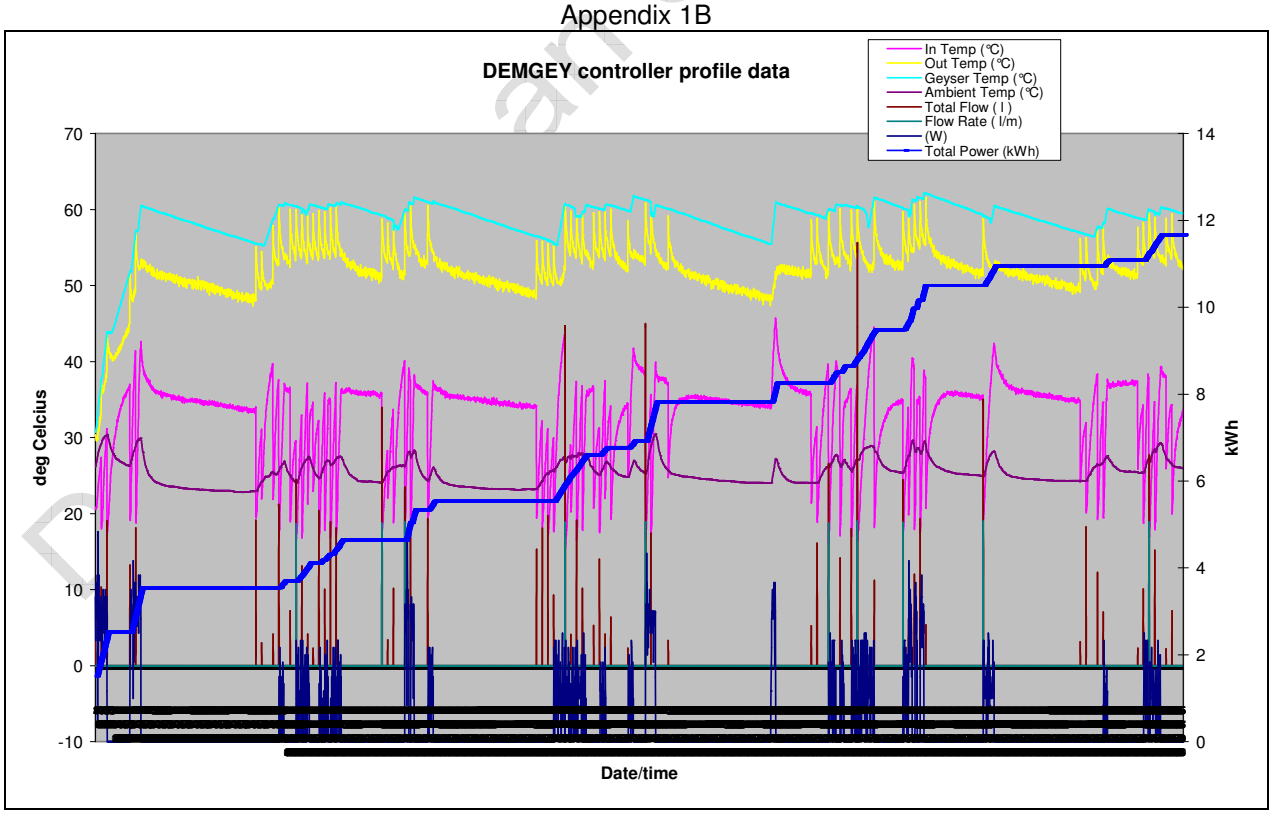
To follow

Appendices

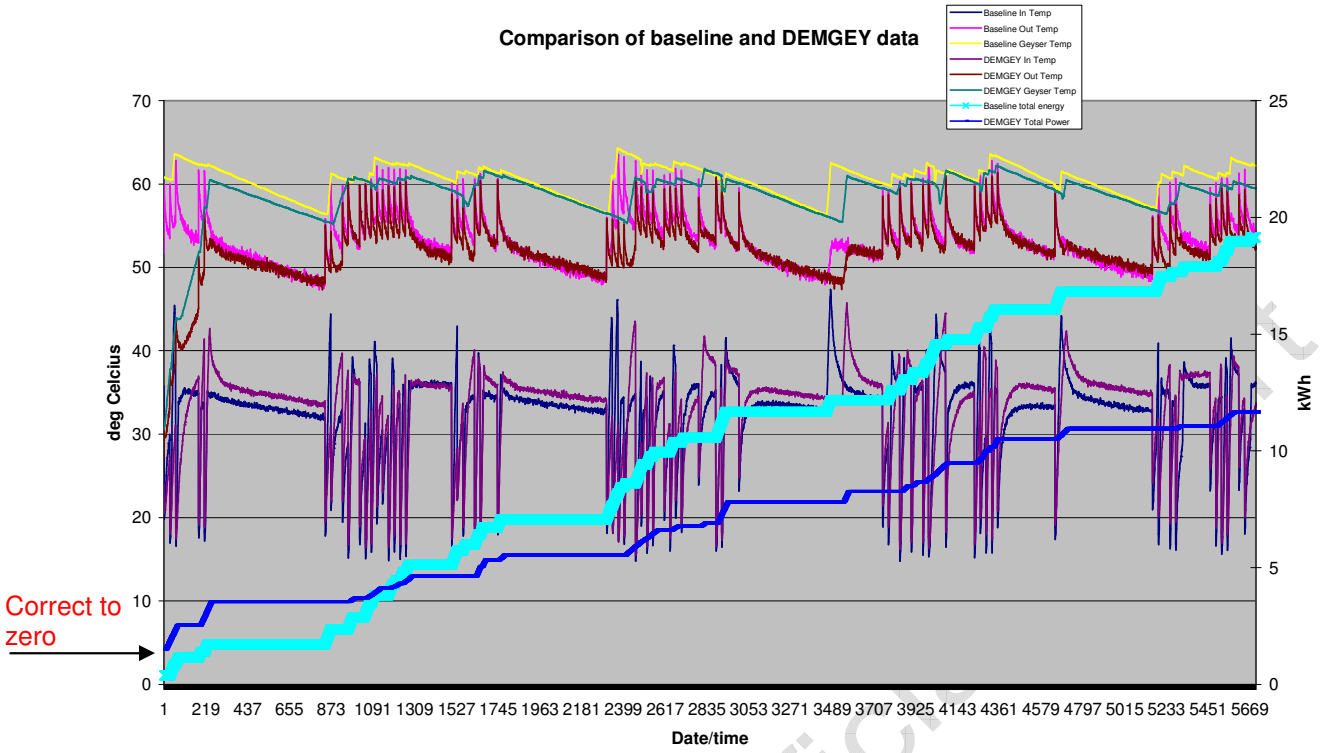
Appendix 1A



Appendix 1B



Appendix 2



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8 Distribution List

Demand Side Management
PS&T