Cool-store energy base-line guide

A practical guide to establishing the baseline energy usage of refrigeration systems in New Zealand cool-stores.

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PREFACE

This guide describes a practical process to produce an energy base-line for a cool-store (or cold-store).

An energy base-line is important to understand the size and general location of energy efficiency opportunities in a cool-store and the measure the performance of capital and operational projects.

This guide provides a process that a person with reasonable experience with Microsoft Excel could follow. The process requires a good level of understanding on the loads and performance of a cool-store to get a base-line which can be used reliably. Typical accuracies range between 5% and 10%.

As well as describing the steps required to produce an energy base-line, the guide includes comments and recommendations on the process involved. A flow chart for the process is provided as an appendix.

The guide has its origins in a study of cool-stores on a meat processing site. The relatively large number of different opportunities identified in that study, and the inter-relationships between potential efficiency projects, indicated the need for an energy base-line to measure the results of subsequent actions.

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1. INTRODUCTION

1.1 Base-line objective

The objective of an energy base-line is to enable the improvements achieved from energy efficiency projects (either operational or capital) to be reasonably quantified. It can either be used after a project has been implemented or on a continuous basis.

Comparing two different cool-stores may be possible using the base-line but it is not the main objective. Simpler performance indicators such as kWh per tonne are recommended for that purpose.

1.2 What is an energy base-line

An energy base-line is an equation that relates energy consumption of a process to the uncontrollable factors of that process e.g. production, ambient temperature. This equation can then be used to show what the energy consumption would have been if no improvements had occurred. It is determined from historical data and then used for a set amount of time. Once significant changes occur, the base-line would need to be determined again.

1.3 Factors affecting a cool-store energy base-line

The uncontrollable factors for a cool-store (from the operator's perspective) are:

1. Product load-in. Doors require opening, product may enter above the store temperature.
2. Product load-out. Doors require opening.
3. Product inside store. If multiple stores, this will dictate how many are required. Factors for the volume per product loaded-in will be required if there are multiple products stored.
4. Number of stores operating. This can be more appropriate to use than #3.
5. Ambient temperature. Dry-bulb affects the heat gain of the store, Wet-bulb affects the performance of the refrigeration plant.

Other factors also influence cool-store electricity but are controllable by the cool-store operator so should not be included in the energy base-line. It would be ideal to also monitor these but costs often dictate that this is not worthwhile. Of course, some of these will already be monitored for other reasons, so the data from that could be utilised to better understand the energy base-line. The controllable factors are:

1. Loading between stores
2. Refrigeration plant controls
3. Defrost method
4. Lighting
5. Underfloor heating method and controls
6. Store temperature controls and set-points

2. ENERGY METERING

Having reliable energy metering data is obviously key to being able to successfully calculate and use an energy base-line. The following sections detail the energy metering requirements for a cool-store.

2.1 Electricity metering

Automated meters that show the instantaneous kW and can log to a data historian are the ideal situation. This then allows the results of the base-line to be analysed in more detail if required. The data would also be available for other activities e.g. basis for upgrades, checking individual loads.

Manually read meters are also adequate for generating and using an energy base-line. For practical reasons, the ideal frequency of reading the meters is on a weekly basis. The ongoing costs required for this method are highly dependent on the other work that is required in the store e.g. weekly checks on the refrigeration plant may already be occurring so the marginal cost of starting to collect energy consumption data would then be relatively low.

Amp metering is acceptable for lighting and heating but not for motors. This is due to the varying power factor of motors meaning that converting data from amps to kW can give inaccuracy which is too high.

2.2 Estimating missing electricity loads

Often it is more cost effective to install electricity meters that don't cover every last electricity consumer in the cool-store. If this is the case then it is possible to estimate these non-metered loads. If the total estimated electricity is less than 10% of the total electricity usage, estimating missing data is acceptable. This would mean that if the estimates are 30% out, the total is only out by 3% which is comparable to the accuracy of a very good base-line equation.

Estimates can be made by taking instantaneous kW or amp measurements, assuming a load factor or inferring from similar plant. Two examples of where estimates are likely to be adequate (loads less than 10% of total) would be:

1. On a grid-store (which relies on natural air convection) it is likely that the entire store electricity requirement could be estimated. The electricity loads will only be minor loads such as lighting, underfloor heating and door heaters. The power to the refrigeration plant (compressors & condensers) will still require electricity metering.
2. Small electricity loads in the refrigeration plant (cooling tower pumps etc) can also be estimated. These loads are often reasonably constant.

2.3 Estimating missing heat loads

There may also be situations where a small section of the cool-store system is serviced by a second separate refrigeration plant. If possible, these two systems should have separate base-line equations but it is not always possible to split out the production data.

In this case, the electricity required for the 2nd refrigeration plant could be estimated by estimating both the heat-load and coefficient of performance (COP) of the refrigeration plant. Care should be taken to ensure that the COP used is the total COP, taking into account motor efficiency and other minor electricity loads. Compressor manufacturers will quote a COP based on refrigeration output divided by compressor shaft power. As for section 2.2, this should only be relied upon if the total estimated electricity is less than 10% of the total electricity usage.

2.4 Heat load metering

This is not absolutely necessary for an energy base-line. If it is available, it can be compared against the production records and then a COP calculated. If it is measured, two energy base-lines can be created. This will then provide additional information on reasons for variations e.g. if an increase is seen, is it increased heat load or is the refrigeration plant running less efficiently.

For cool-stores with a direct refrigerant system, measuring the heat load is very difficult. Measuring the refrigerant supplied to the stores is not effective as a large proportion returns down the vapour line. Cool-stores with indirect systems (Glycol etc), could measure the heat load by installing flow, supply temperature and return temperature metering.

The two other alternatives are:

1. Calculate the compressor throughput (kW) based on it's loading (Slide valve position, speed etc)
2. Measure the flow, supply temperature and return temperature on the cooling tower water (if cooling tower is used). Convert this into a kW figure and then subtract the power to the compressors.

3. FACTORS AFFECTING COOL-STORE ELECTRICITY

3.1 Production records

For cool-stores, weight loaded in and out is expected to be known and recorded already. For an energy base-line, the total weight inside the stores is also required. This can simply be calculated by adding the previous total weight plus inloads minus outloads. This value can be checked when stock-take occurs.

3.2 Weather Data

For a cool-store, dry-bulb ambient temperature is the most important data required. Wetbulb, wind, rain and sunshine hours also have an effect but these are not significant enough to justify sourcing and maintaining the data. Two options are available for obtaining ambient temperature data in New Zealand.

1. Install an ambient temperature transmitter.
2. Utilise Cliflo data (free subscription) available at http://cliflo.niwa.co.nz/ . This data is always at least one day behind so reporting needs to take place two or three days after the reporting period.

4. TIME BASIS

4.1 Data history

This is the time period that the energy base-line will be calculated from. Many industries that utilise cool-stores have seasonal operations so an entire year of data is required before calculating the energy base-line.

4.2 Data frequency

This is the frequency that the data would be aggregated or averaged over.

Using a shorter time scale (daily or shift based) means the data can show more opportunities for improvement. The downside of this is that there is often a large amount of noise in the data and the effects of carry-over and heat storage can be large at these lower time levels. The work required is also much greater and more people are required to make the system work.

At longer time frequencies (monthly or yearly) the results are difficult to comprehend as it is often too long ago to understand what caused a good or bad performance.

Experience has shown that creating and using the base-line on a weekly basis is a good compromise between the work required and the benefits gained. If automated meters are used, the data could still be split out on a daily or shift basis to see any obvious issues.

5. CREATING THE BASE-LINE

5.1 Units

Measuring energy in average kW per day is a helpful and easy to understand unit of measure. By using average kW, comparisons can easily be made to loads which are known (either from temporary metering or heat balance). Another added bonus of using average kW is that the scale of the cool-store energy consumption can be easily explained to non-technical people. A typical house uses approximately 1kW on average.

5.2 Multiple linear regression

For generating simple regression equations, the user can plot the output variable (energy consumption) against one input variable. The graph can then be used to generate a line of best fit and the equation shown. Since there are multiple factors affecting cool-store energy consumption, a multiple linear regression is required.

Microsoft Excel has a very helpful function for performing regressions located in the "Analysis ToolPak" add-in. The inputs to the function are a column of y values (energy consumption) and a range of x values (the factors). Detailed instructions on how to use this function are shown in Appendix 2. A brief description of the steps is:

1. Make an initial choice of factors affecting energy consumption, excluding ambient temperature
2. Run the regression analysis function
3. Check the R^2 and that each factor is significant (high tStat) and makes sense
4. Remove/Add/Change factors to get the best fit. This is the initial base-line
5. Check how the regression result changes with ambient temperature
6. If ambient temperature is significant and makes sense, add terms to take it into account. This is the final base-line

The reason for splitting ambient temperature from the other factors is that ambient temperature has an effect on top of the other factors. It is not a driver of electricity consumption by itself.

5.3 Example Base-line creation

Many different factors were tried for the regression for the example coolstore. The best fit was the base-line equation shown below:

Initial Base-line	=	122	kW base-load
(Average kW	+	131	kW each if stores 4,5,6 are on
per day)	+	87	kW if store 1 is on
	+	122	kW each if stores 2,3 are on
	+	0.0054	kW per load-in
	+	0.0022	kW per load-in yesterday
	+	0.0017	kW per load-in 2 days ago

Base-line (Average kW per day) = initial base-line X (0.9266 + 0.00731 X Average ambient dry-bulb temperature)

The raw results from the Microsoft Excel regression function are shown below:

Regression 5

Regression Statistics	
Multiple R	0.978
R Square	0.956
Adjusted R Square	0.956
Standard Error	46
Observations	365

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	16582791.89	2763798.648	1309.0605	4.253E-240
Residual	358	755839.7157	2111.284122		
Total	364	17338631.61			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	122.0513902	7.753339074	15.74178415	8.40854E-43	106.803577	137.2992033	106.803577	137.2992033
Load-in	0.005362894	0.000509206	10.53188216	8.95825E-23	0.004361484	0.006364304	0.004361484	0.006364304
Load-in yesterday	0.00220851	0.000575763	3.835797197	0.000147883	0.001076207	0.003340813	0.001076207	0.003340813
Load-in 2 days ago	0.001650921	0.000511291	3.228928066	0.001357443	0.00064541	0.002656431	0.00064541	0.002656431
PS4,5,6 operating	130.8945568	5.533324146	23.65568206	3.64885E-75	120.0126526	141.7764609	120.0126526	141.7764609
PS1 operating	86.55049635	7.290919029	11.87099953	1.24063E-27	72.21208424	100.8889085	72.21208424	100.8889085
PS2 operating	122.0702592	8.412356443	14.51082821	7.54924E-38	105.5264143	138.6141041	105.5264143	138.6141041

6. CHECKING THE BASE-LINE

Once the base-line has been generated it needs to be checked. The first check should be to simply graph the result of the regression equation against the total energy usage.

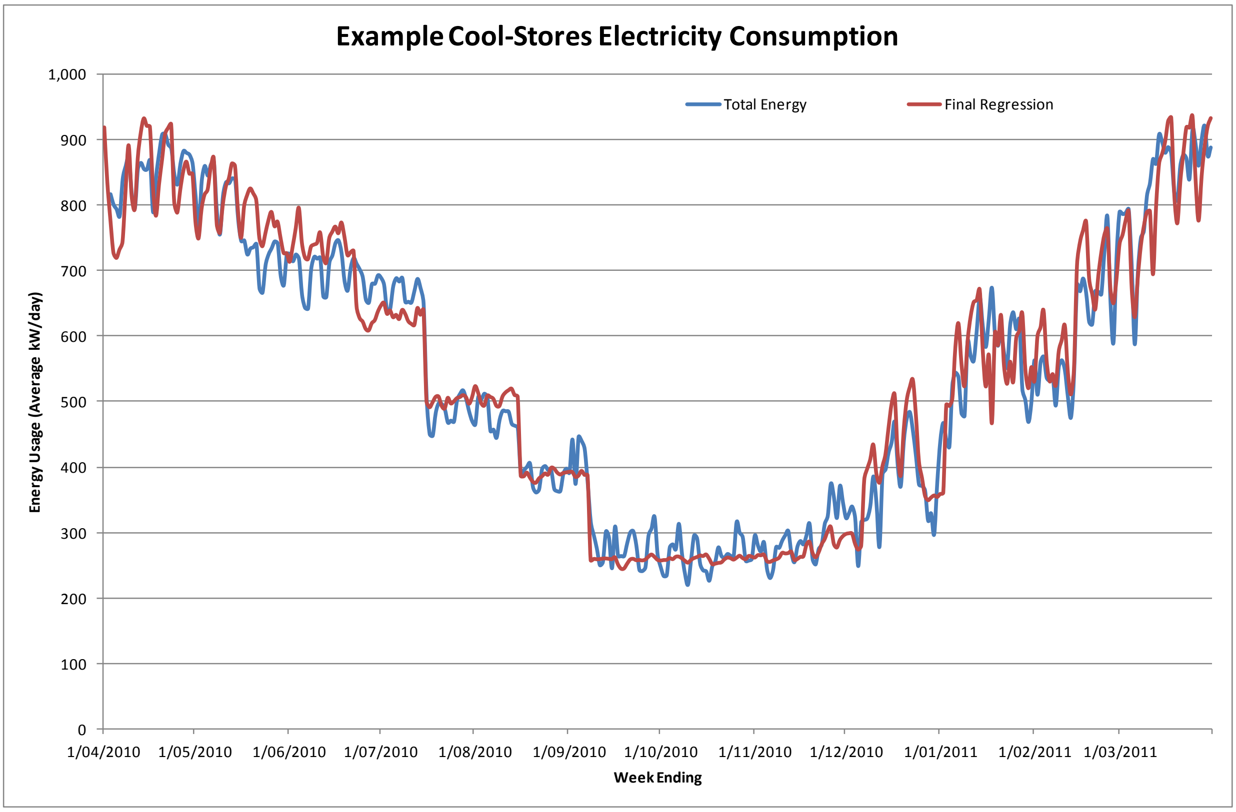


Figure 1: Performance of Electricity Base-line over a year

The second check is to calculate the error in the base-line for each day. Taking the absolute value of this error and then averaging this gives the average error. For the example above, the average error was 6.3%. The spreadsheet shown in Appendix 2 shows this calculation.

The third check is to try and match the values to other data available to see if it makes sense. This is easiest for the base-load electricity (fixed energy use). The base-load electricity could be compared against the electricity loads that are expected to remain constant e.g. cooling tower pumps, refrigeration distribution pumps.

7. USING THE BASE-LINE

Once the energy base-line equation is determined and checked, this can be useful for a number of purposes. A number of example graphs are shown in Appendix 3.

7.1 Measurement and Verification

This is used for measuring the actual savings of a particular energy efficiency project. The energy base-line is used to judge how much electricity the cool-store would have used if no changes were made, this can then be compared against the electricity actually used and the energy savings calculated. The uncertainty figures can be used to determine the overall accuracy of the calculated energy savings.

7.2 Monitoring and Targeting

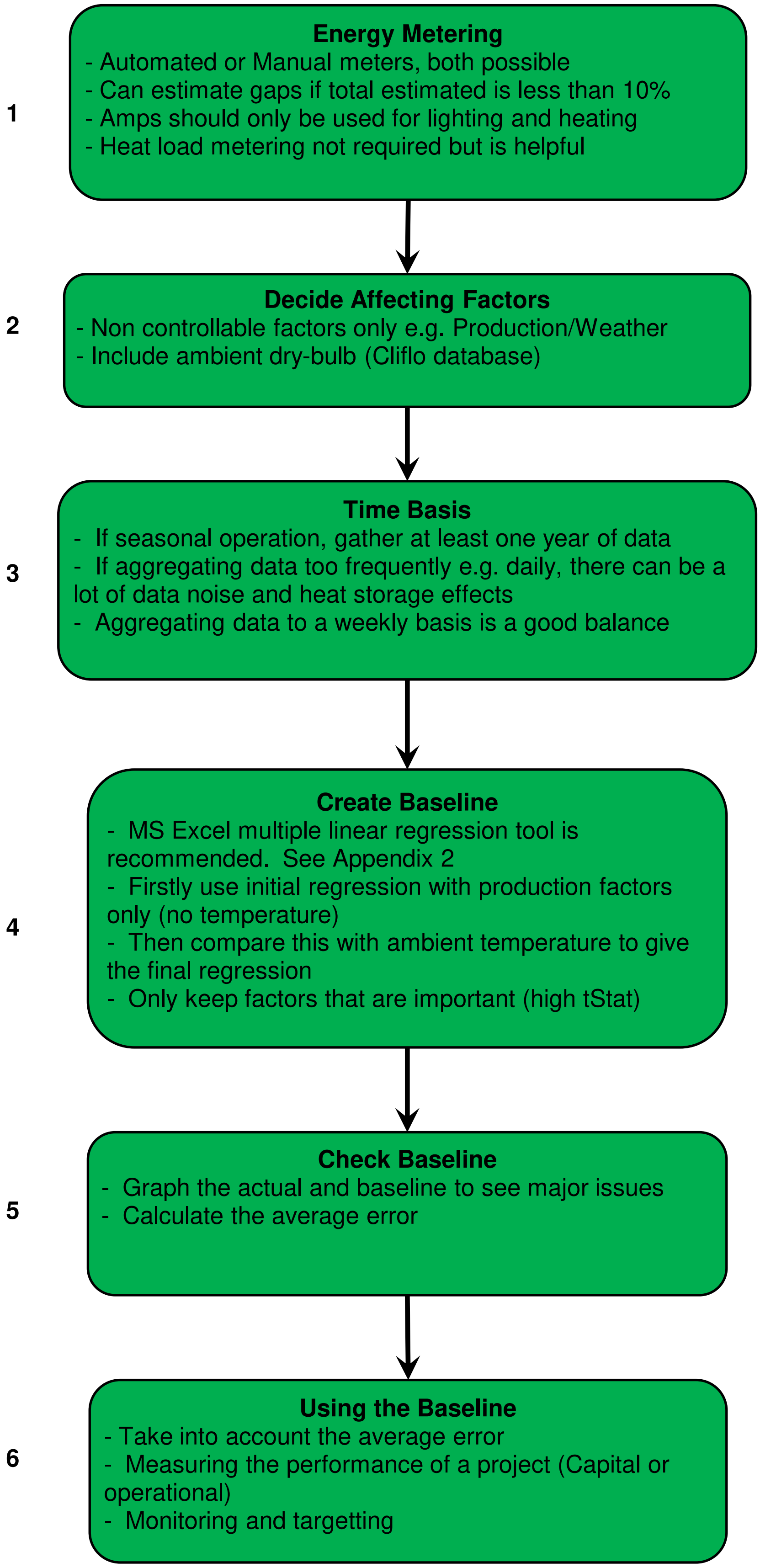
In this situation, management may set an energy savings target. The target (say 95%) could be applied to the base-line and the energy consumption compared against this. The plant can then aim to achieve this target.

7.3 Energy Budgets

The energy base-line may also be helpful for accounting purposes. Care needs to be taken that the accounting software can handle the relatively complex equations required; some form of simplification may be required.

Appendix 1. Flow-chart for the steps required

Energy Base-line FlowChart



Appendix 2. Excel spreadsheet for creating the base-line equation

Objective: Show a method and example for creating an energy base-line for a cool-store

Key:

Blue font = inputs

Black font = Calculations

Red font = estimates

Instructions:

1. Enter the data for the factors that affect coolstore energy consumption into the data sheet
2. Enter the coolstore energy consumption into the data sheet
3. Install the excel addin "Analysis ToolPak"
   - Excel 2007 - Home button, Excel options, Addins, Manage "Excel Addins", Go, Tick Analysis ToolPak, OK
4. Decide which of the factors to try first - recommend all for the first one except temperature
5. Link these to the section in the Data sheet called "Current Regression inputs"
6. Open "Data Analysis"
   - Excel 2007 - Right hand side of the "Data" tab
7. Scroll down to "Regression"
8. For Y-axis select the data in the column for "Total Energy"
9. For X-axis select the data in the columns for "Current Regression inputs"
10. For output range, select a cell in the "Regressions" sheet
11. Click OK
12. Investigate the values shown:
    - R^2 reasonable? Over 0.95 is a good regression
    - Coefficients should make sense (positive/negative)
    - Are tStats for each variable high enough? tStat is an indication of how important that variable is. Should be >5
13. Copy and paste (values and transpose) the coefficients into the space at the top of the "Current regression inputs" section
14. Look at the performance of the regression and the average absolute error
15. Remove/Change or add new factors
16. Back to step 5 until the result is acceptable and logical
17. Check the "Temperature effect Graph"
18. Make sure this is logical i.e. actual/regression is >100% at higher temperatures.
19. If not logical, determine the temperature constants by understanding what theoretical effect temperature would have
20. If logical, leave the values as is
21. Decide if you would analyse the regression on a daily basis or weekly basis.
22. The spreadsheet "Weekly roll-up" helps with this by showing the result of the regression as a weekly average
23. Check that the correct factors are shown in the baseline equation below

Output - Energy base-line equation

Initial Base-line	=		122	kW base-load				
(Average kW	+		131	kW each if stores 4,5,6 are on				
per day)	+		87	kW if store 1 is on				
	+		122	kW each if stores 2,3 are on				
	+		0.0054	kW per load-in				
	+		0.0022	kW per load-in yesterday				
	+		0.0017	kW per load-in 2 days ago				
Final Base-line	=	initial base-line X (	0.946209	+	0.00696	X	Average ambient dry-bulb temperature)	
(Average kW								
per day)								

	Factors Affecting Energy consumption											Energy Consumption								Regression outputs					Current Regression inputs						
Description	Store 1 on	Store 2 on	Store 3 on	Store 4 on	Store 5 on	Store 6 on	Load-ins	Load-outs	Inside stores	Dry-bulb ambient temp	Wet-bulb ambient temp	Engine Room	Store 4	Store 5	Store 6	Store 1	Store 2 and 3	Auxilliary Engine Room due to Store 2 and 3	Total Energy	Initial Regression	Actual/ initial Regression	Final Regression	Actual/Regression with temperature	Absolute error		Load-in	Load-in yesterday	Load-in 2 days ago	Stores 4,5,6 on	Store 1 on	Store 2 or 3 on
Unit	1=Yes	1=Yes	1=Yes	1=Yes	1=Yes	1=Yes	cartons	cartons	cartons	°C	°C	ave kW	ave kW	ave kW	ave kW	ave kW	ave kW	ave kW	ave kW	ave kW		ave kW									
																						0.0070	0.9462		122.0514	0.005363	0.002209	0.001651	130.8946	86.5505	122.0703
Annual Average	0.54	0.50	0.00	1.00	0.49	0.53	4886	5089	270002	10.27	8.78	301.98	61.22	56.75	59.76	11.08	15.48	39.22	544.51	539.19	1.02	547.99	1.00	36.85		4885.50	4876.87	4872.86	2.02	0.54	0.50
																2.0%	2.8%	7.2%				0.0070	0.9462	**6.8%**							
Thu 1/04/2010	1	1	0	1	1	1	18057	2442	500000	12.4	11.9	508	80	92	96	16	23	79	894	890	100%	918	97%	24		18057	18000	18000	3	1	1
Fri 2/04/2010	1	1	0	1	1	1	0	0	515615	15.3	13.7	508	60	70	78	16	23	79		793	0%	835	0%	835		0	18057	18000	3	1	1
Sat 3/04/2010	1	1	0	1	1	1	0	0	515615	12.4	11.3	494	60	69	77	16	23	79	817	753	109%	778	105%	40		0	0	18057	3	1	1
Sun 4/04/2010	1	1	0	1	1	1	0	0	515615	8.5	6.7	480	58	70	76	16	23	79	801	723	111%	727	110%	74		0	0	0	3	1	1
Mon 5/04/2010	1	1	0	1	1	1	0	0	515615	6.8	5.8	472	60	70	75	16	23	79	794	723	110%	719	110%	75		0	0	0	3	1	1
Tue 6/04/2010	1	1	0	1	1	1	0	0	515615	9.4	7.6	463	60	68	75	16	23	79	784	723	108%	732	107%	52		0	0	0	3	1	1
Wed 7/04/2010	1	1	0	1	1	1	1590	23099	515615	10.0	8.3	471	76	88	88	16	23	79	841	732	115%	744	113%	97		1590	0	0	3	1	1
Thu 8/04/2010	1	1	0	1	1	1	16774	23464	494106	8.5	6.9	481	74	92	95	16	23	79	861	817	105%	821	105%	39		16774	1590	0	3	1	1
Fri 9/04/2010	1	1	0	1	1	1	21190	15797	487416	10.1	8.3	489	81	92	94	16	23	79	873	877	100%	891	98%	18		21190	16774	1590	3	1	1
Sat 10/04/2010	1	1	0	1	1	1	0	0	492809	10.5	8.3	480	67	74	79	16	23	79	817	798	102%	813	100%	4		0	21190	16774	3	1	1
Sun 11/04/2010	1	1	0	1	1	1	0	0	492809	14.3	10.7	475	57	69	77	16	23	79	796	758	105%	793	100%	3		0	0	21190	3	1	1
Mon 12/04/2010	1	1	0	1	1	1	18661	17837	492809	15.9		500	72	87	79	16	23	79	856	823	104%	870	98%	14		18661	0	0	3	1	1
Tue 13/04/2010	1	1	0	1	1	1	19150	11822	493633	14.8	13.5	502	79	89	78	16	23	79	865	867	100%	910	95%	45		19150	18661	0	3	1	1
Wed 14/04/2010	1	1	0	1	1	1	19422	15579	500961	12.7	11.1	494	78	90	77	16	23	79	856	901	95%	932	92%	76		19422	19150	18661	3	1	1
Thu 15/04/2010	1	1	0	1	1	1	20538	16697	504804	9.7	8.2	489	78	91	80	16	23	79	855	908	94%	920	93%	65		20538	19422	19150	3	1	1
Fri 16/04/2010	1	1	0	1	1	1	20219	14406	508645	9.3	7.2	488	82	95	86	16	23	79	868	909	96%	919	94%	51		20219	20538	19422	3	1	1
Sat 17/04/2010	1	1	0	1	1	1	0	0	514458	12.5		516		75	81	16	23	79	790	802	98%	828	95%	39		0	20219	20538	3	1	1
Sun 18/04/2010	1	1	0	1	1	1	0	0	514458	12.8	11.6	513	64	70	80	16	23	79	845	757	112%	783	108%	61		0	0	20219	3	1	1
Mon 19/04/2010	1	1	0	1	1	1	16188	9621	514458	11.4	10.1	502	81	87	93	16	23	79	881	810	109%	831	106%	50		16188	0	0	3	1	1
Tue 20/04/2010	1	1	0	1	1	1	15900	0	521025	11.9	10.9	519	88	90	94	16	23	79	909	844	108%	869	105%	40		15900	16188	0	3	1	1
Wed 21/04/2010	1	1	0	1	1	1	18282	4344	536925	11.7	10.7	522	86	90	93	16	23	79	909	883	103%	908	100%	1		18282	15900	16188	3	1	1
Thu 22/04/2010	1	1	0	1	1	1	18803	11090	550863	12.0	11.2	510	82	91	93	16	23	79	893	891	100%	917	97%	24		18803	18282	15900	3	1	1
Fri 23/04/2010	1	1	0	1	1	1	18192	17057	558576	12.6	11.8	505	80	93	90	16	23	79	887	893	99%	923	96%	36		18192	18803	18282	3	1	1
Sat 24/04/2010	1	1	0	1	1	1	0	0	559711	9.5	8.7	503	66	82	78	16	23	79	847	795	107%	804	105%	42		0	18192	18803	3	1	1
Sun 25/04/2010	1	1	0	1	1	1	0	0	559711	14.3	13.3	505	60	74	76	16	23	79	832	753	110%	788	106%	44		0	0	18192	3	1	1
Mon 26/04/2010	1	1	0	1	1	1	16401	21960	559711	9.8	9.4	486	80	92	88	16	23	79	864	811	107%	823	105%	41		16401	0	0	3	1	1
Tue 27/04/2010	1	1	0	1	1	1	12965	15042	554152	11.6	10.4	497	83	93	94	16	23	79	883	829	107%	852	104%	32		12965	16401	0	3	1	1
Wed 28/04/2010	1	1	0	1	1	1	11965	17239	552075	11.6	10.0	501	81	90	90	16	23	79	881	843	104%	866	102%	15		11965	12965	16401	3	1	1
Thu 29/04/2010	1	1	0	1	1	1	10020	20011	546801	11.6	10.1	499	80	89	91	16	23	79	878	825	106%	847	104%	30		10020	11965	12965	3	1	1
Fri 30/04/2010	1	1	0	1	1	1	12697	13255	536810	10.1	9.0	491	79	88	89	16	23	79	864	833	104%	847	102%	17		12697	10020	11965	3	1	1
Sat 1/05/2010	1	1	0	1	1	1	0	0	536252	8.8	7.5	480	63	73	79	16	23	79	813	768	106%	774	105%	39		0	12697	10020	3	1	1
Sun 2/05/2010	1	1	0	1	1	1	0	0	536252	8.6	6.9	459	41	70	77	16	23	79	765	744	103%	749	102%	16		0	0	12697	3	1	1
Mon 3/05/2010	1	1	0	1	1	1	10567	11881	536252	10.2	8.9	475	69	88	88	16	23	79	838	780	107%	794	106%	44		10567	0	0	3	1	1
Tue 4/05/2010	1	1	0	1	1	1	11677	15474	534938	8.9	7.2	476	81	92	93	16	23	79	861	809	106%	816	106%	45		11677	10567	0	3	1	1
Wed 5/05/2010	1	1	0	1	1	1	12757	14371	531141	5.7	4.8	470	76	92	90	16	23	79	846	835	101%	823	103%	23		12757	11677	10567	3	1	1
Thu 6/05/2010	1	1	0	1	1	1	12431	14953	529527	11.0	8.1	481	81	91	93	16	23	79	863	837	103%	856	101%	7		12431	12757	11677	3	1	1
Fri 7/05/2010	1	1	0	1	1	1	13167	13570	527005	12.7	10.9	489	79	90	90	16	23	79	867	842	103%	872	99%	5		13167	12431	12757	3	1	1
Sat 8/05/2010	1	1	0	1	1	1	0	0	526602	7.2	6.2	467	52	74	79	16	23	79	790	773	102%	770	102%	19		0	13167	12431	3	1	1
Sun 9/05/2010	1	1	0	1	1	1	0	0	526602	10.0	8.8	455	35	70	78	16	23	79	756	745	101%	757	100%	1		0	0	13167	3	1	1
Mon 10/05/2010	1	1	0	1	1	1	11977	9812	526602	10.1	9.2	463	58	88	89	16	23	79	815	788	104%	800	102%	15		11977	0	0	3	1	1
Tue 11/05/2010	1	1	0	1	1	1	13961	10848	528767	8.3	7.3	469	64	93	92	16	23	79	836	825	101%	828	101%	8		13961	11977	0	3	1	1
Wed 12/05/2010	1	1	0	1	1	1	13130	13029	531880	7.1	6.4	470	66	91	90	16	23	79	834	844	99%	841	99%	7		13130	13961	11977	3	1	1
Thu 13/05/2010	1	1	0	1	1	1	14061	12385	531981	9.8	9.5	481	64	89	90	16	23	79	842	851	99%	863	98%	21		14061	13130	13961	3	1	1
Fri 14/05/2010	1	1	0	1	1	1	15519	15060	533657	7.8	7.7	471	69	90	91	16	23	79	839	859	98%	859	98%	20		15519	14061	13130	3	1	1
Sat 15/05/2010	1	1	0	1	1	1	0	0	534116	9.4	9.1	468	41	73	78	16	23	79	778	781	100%	790	98%	12		0	15519	14061	3	1	1
Sun 16/05/2010	1	1	0	1	1	1	0	0	534116	7.8	7.7	446	36	70	77	16	23	79	746	749	100%	749	99%	4		0	0	15519	3	1	1
Mon 17/05/2010	1	1	0	1	1	1	12222	10543	534116	9.4	9.1	394	59	88	88	16	23	79	746	789	95%	798	94%	52		12222	0	0	3	1	1
Tue 18/05/2010	1	1	0	1	1	1	10063	7913	535795	9.6	8.8	354	70	91	92	16	23	79	725	804	90%	815	89%	90		10063	12222	0	3	1	1
Wed 19/05/2010	1	1	0	1	1	1	10232	11074	537945	8.5	8.0	358	77	90	91	16	23	79	734	821	89%	825	89%	91		10232	10063	12222	3	1	1
Thu 20/05/2010	1	1	0	1	1	1	12330	12393	537103	5.8	5.3	357	79	90	92	16	23	79	736	829	89%	817	90%	81		12330	10232	10063	3	1	1
Fri 21/05/2010	1	1	0	1	1	1	9864	12955	537040	5.4	4.7	361	80	91	91	16	23	79	741	820	90%	807	92%	66		9864	12330	10232	3	1	1
Sat 22/05/2010	1	1	0	1	1	1	0	0	533949	4.8	4.4	349	55	73	78	16	23	79	673	765	88%	750	90%	77		0	9864	12330	3	1	1
Sun 23/05/2010	1	1	0	1	1	1	0	0	533949	7.1	6.9	348	51	72	77	16	23	79	667	740	90%	737	90%	70		0	0	9864	3	1	1
Mon 24/05/2010	1	1	0	1	1	1	5281	11950	533949	8.6	8.2	349	67	89	87	16	23	79	709	752	94%	756	94%	48		5281	0	0	3	1	1
Tue 25/05/2010	1	1	0	1	1	1	6044	0	527280	9.4	8.8	353	75	89	90	16	23	79	725	767	94%	776	93%	51		6044	5281	0	3	1	1
Wed 26/05/2010	1	1	0	1	1	1	7462	2131	533324	8.4	7.7	358	79	89	90	16	23	79	735	785	94%	789	93%	55		7462	6044	5281	3	1	1
Thu 27/05/2010	1	1	0	1	1	1	6265	8878	538655	4.8	3.8	364	81	91	91	16	23	79	745	783	95%	767	97%	22		6265	7462	6044	3	1	1
Fri 28/05/2010	1	1	0	1	1	1	7557	3687	536042	4.9	4.0	365	80	90	89	16	23	79	742	790	94%	774	96%	33		7557	6265	7462	3	1	1
Sat 29/05/2010	1	1	0	1	1	1	0	0	539912	7.5	7.0	364	61	73	76	16	23	79	692	750	92%	749	92%	57		0	7557	6265	3	1	1
Sun 30/05/2010	1	1	0	1	1	1	0	0	539912	5.9	5.2	361	53	72	75	16	23	79	678	736	92%	726	93%	49		0	0	7557	3	1	1
Mon 31/05/2010	1	1	0	1	1	1	5067	7696	539912	3.0	2.5	361	67	90	90	16	23	79	726	751	97%	726	100%	0		5067	0	0	3	1	1
Tue 1/06/2010	1	1	0	1	1	1	962	13541	537283	2.5	1.9	356	66	93	92	16	23	79	726	740	98%	713	102%	13		962	5067	0	3	1	1
Wed 2/06/2010	1	1	0	1	1	1	6920	5571	524704	1.4	0.8	349	63	93	92	16	23	79	715	771	93%	737	97%	22		6920	962	5067	3	1	1
Thu 3/06/2010	1	1	0	1	1	1	6265	14966	526053	6.0	5.0	350	71	93	94	16	23	79	725	774	94%	765	95%	40		6265	6920	962	3	1	1
Fri 4/06/2010	1	1	0	1	1	1	8902	15058	517352	7.6	6.8	358	70	86	86	16	23	79	718	796	90%	795	90%	77		8902	6265	6920	3	1	1
Sat 5/06/2010	1	1	0	1	1	1	0	0	511196	5.6	4.9	348	50	71	76	16	23	79	663	753	88%	742	89%	79		0	8902	6265	3	1	1
Sun 6/06/2010	1	1	0	1	1	1	0	0	511196	4.2	3.8	343	37	70	76	16	23	79	643	738	87%	720	89%	76		0	0	8902	3	1	1
Mon 7/06/2010	1	1	0	1	1	1	0	0	511196	6.5	5.6	343	37	69	76	16	23	79	642	723	89%	717	90%	75		0	0	0	3	1	1

Regression 1

Regression Statistics	
Multiple R	0.967684791
R Square	0.936413854
Adjusted R Square	0.935707342
Standard Error	55.33977764
Observations	365

ANOVA

	df	SS	MS	F	Significance F
Regression	4	16236134.85	4059033.713	1325.402663	6.8322E-214
Residual	360	1102496.756	3062.490989		
Total	364	17338631.61			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	152.3968445	7.553262821	20.1762931	4.19622E-61	137.5427838	167.2509053	137.5427838	167.2509053
Load-in	0.009978851	0.000567361	17.58820157	2.02848E-50	0.008863094	0.011094608	0.008863094	0.011094608
Operating Days	-39.25434262	8.269313754	-4.746989144	2.98435E-06	-55.51657153	-22.99211371	-55.51657153	-22.99211371
Store m³	0.005936418	0.000108539	54.69389847	1.7427E-176	0.005722968	0.006149867	0.005722968	0.006149867
Load-out	0.001107362	0.000743056	1.490281488	0.137025848	-0.000353913	0.002568637	-0.000353913	0.002568637

Operating Days is obviously not a good parameter. Also, tStat for Cartons out is too low so should be excluded

Regression 2

Regression Statistics	
Multiple R	0.965537013
R Square	0.932261724
Adjusted R Square	0.93188748
Standard Error	56.96002793
Observations	365

ANOVA

	df	SS	MS	F	Significance F
Regression	2	16164142.6	8082071.298	2491.049114	2.4042E-212
Residual	362	1174489.011	3244.444781		
Total	364	17338631.61			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	133.8570479	6.618068411	20.22599942	2.08452E-61	120.8423599	146.8717358	120.8423599	146.8717358
Load-in	0.008957543	0.000463119	19.3417768	9.51343E-58	0.008046802	0.009868284	0.008046802	0.009868284
Store m³	0.006010046	0.000103753	57.92651125	3.5945E-185	0.005806012	0.00621408	0.005806012	0.00621408

Good tStats on all factors

Regression 3

Regression Statistics	
Multiple R	0.974248542
R Square	0.949160222
Adjusted R Square	0.94887934
Standard Error	49.3463399
Observations	365

ANOVA

	df	SS	MS	F	Significance F
Regression	2	16457139.43	8228569.715	3379.204394	6.6506E-235
Residual	362	881492.1766	2435.061261		
Total	364	17338631.61			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	128.0855079	5.751972395	22.26810198	8.27102E-70	116.7740314	139.3969845	116.7740314	139.3969845
Load-in	0.005849605	0.000417641	14.00630376	6.42345E-36	0.005028298	0.006670912	0.005028298	0.006670912
Stores operating	124.9957998	1.844743118	67.75783501	9.8126E-208	121.368041	128.6235586	121.368041	128.6235586

Still good tStats. Lower standard error and better R^2 than Regression 2.

Regression 4

Regression Statistics	
Multiple R	0.974681316
R Square	0.950003667
Adjusted R Square	0.949448153
Standard Error	49.07103672
Observations	365

ANOVA

	df	SS	MS	F	Significance F
Regression	4	16471763.61	4117940.904	1710.132037	1.1076E-232
Residual	360	866867.992	2407.966644		
Total	364	17338631.61			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	123.8976033	8.274733697	14.97300189	9.6417E-40	107.6247156	140.1704909	107.6247156	140.1704909
Load-in	0.006348799	0.000462301	13.73302653	8.35718E-35	0.005439648	0.007257949	0.005439648	0.007257949
PS4,5,6 operating	130.2062432	5.905628455	22.04782169	8.7277E-69	118.5923796	141.8201067	118.5923796	141.8201067
PS1 operating	108.674989	6.89688536	15.75711112	6.4761E-43	95.11174396	122.238234	95.11174396	122.238234
PS2 operating	125.1597733	8.972008367	13.9500286	1.16499E-35	107.5156424	142.8039041	107.5156424	142.8039041

Slightly better R^2, still good tStats. Makes more sense to split out the store types.

Regression 5

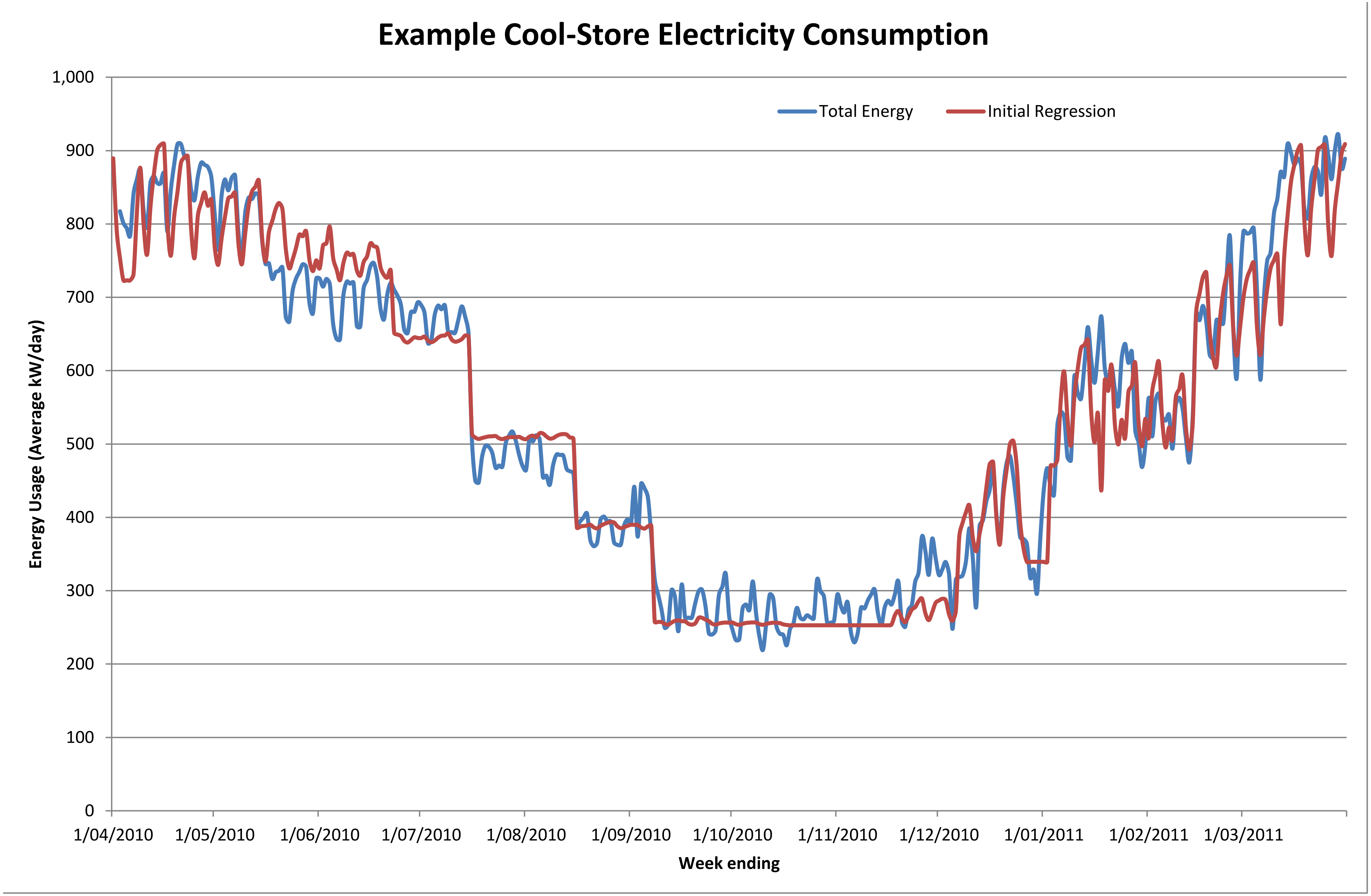
Regression Statistics	
Multiple R	0.978
R Square	0.956
Adjusted R Square	0.956
Standard Error	46
Observations	365

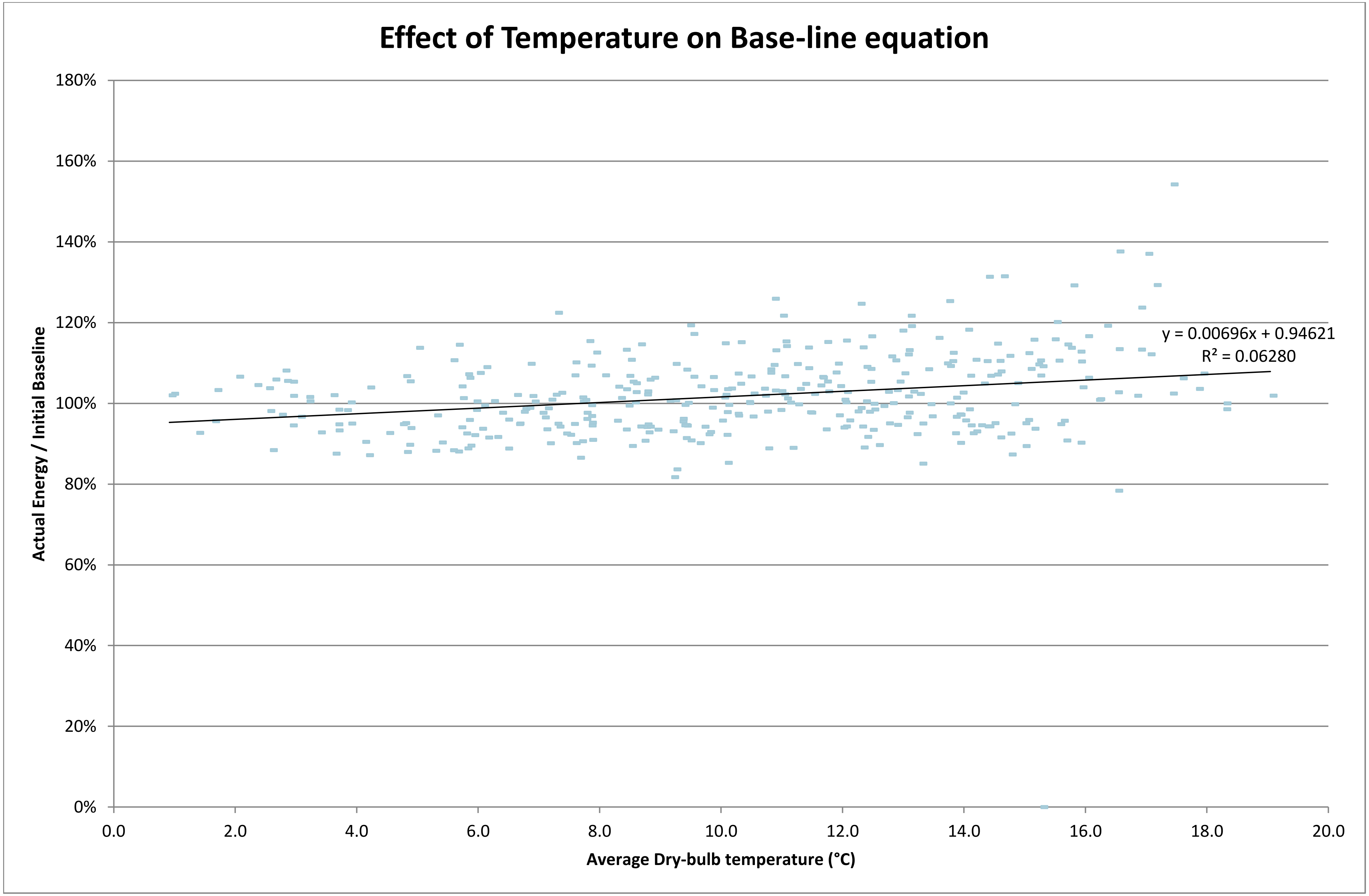
ANOVA

	df	SS	MS	F	Significance F
Regression	6	16582791.89	2763798.648	1309.0605	4.253E-240
Residual	358	755839.7157	2111.284122		
Total	364	17338631.61			

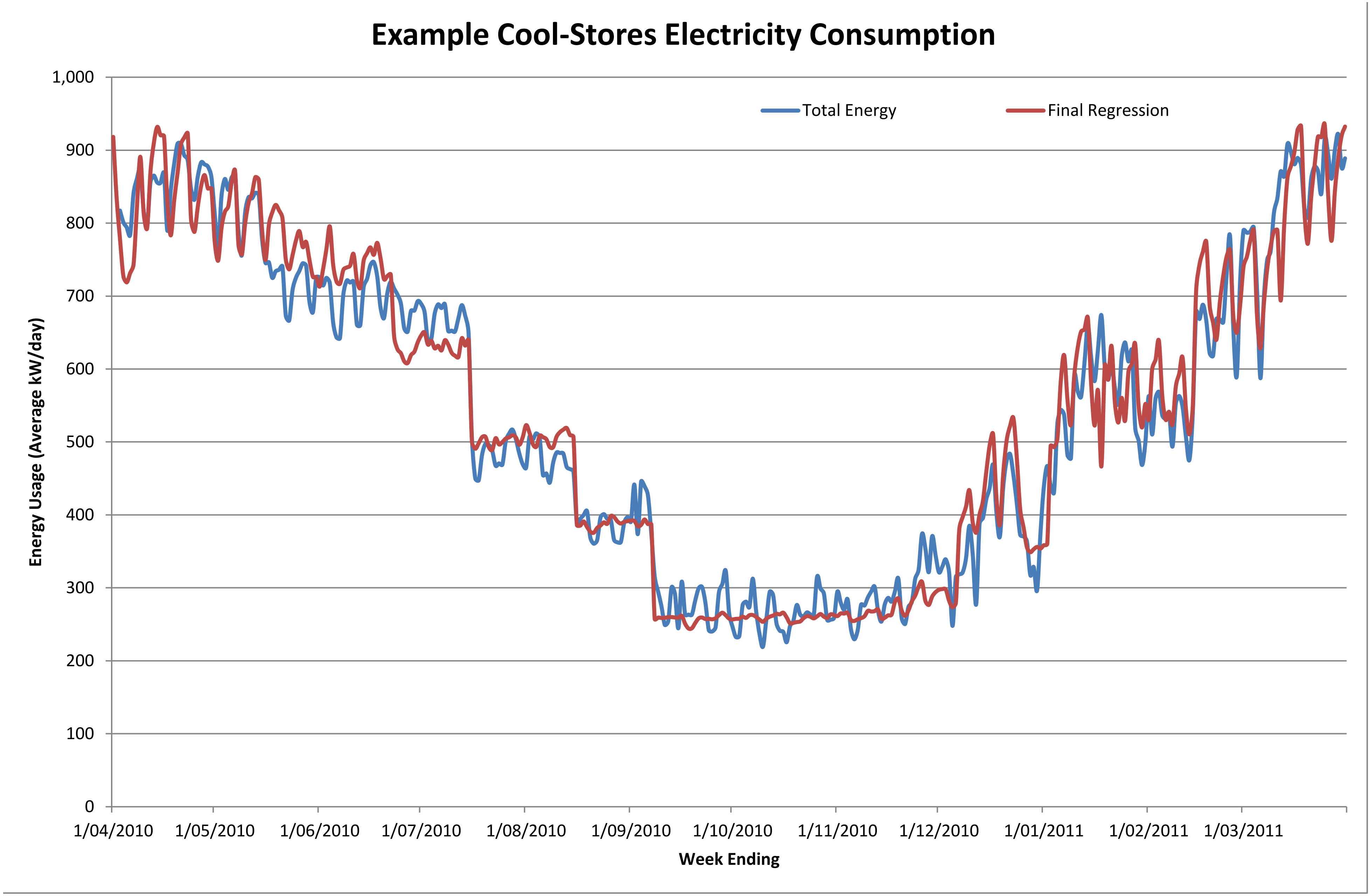
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	122.0513902	7.753339074	15.74178415	8.40854E-43	106.803577	137.2992033	106.803577	137.2992033
Load-in	0.005362894	0.000509206	10.53188216	8.95825E-23	0.004361484	0.006364304	0.004361484	0.006364304
Load-in yesterday	0.00220851	0.000575763	3.835797197	0.000147883	0.001076207	0.003340813	0.001076207	0.003340813
Load-in 2 days ago	0.001650921	0.000511291	3.228928066	0.001357443	0.00064541	0.002656431	0.00064541	0.002656431
PS4,5,6 operating	130.8945568	5.533324146	23.65568206	3.64885E-75	120.0126526	141.7764609	120.0126526	141.7764609
PS1 operating	86.55049635	7.290919029	11.87099953	1.24063E-27	72.21208424	100.8889085	72.21208424	100.8889085
PS2 operating	122.0702592	8.412356443	14.51082821	7.54924E-38	105.5264143	138.6141041	105.5264143	138.6141041

Tried to reduce day to day variability by including the cartons processed in the last two days. The tStats are just high enough to stay included

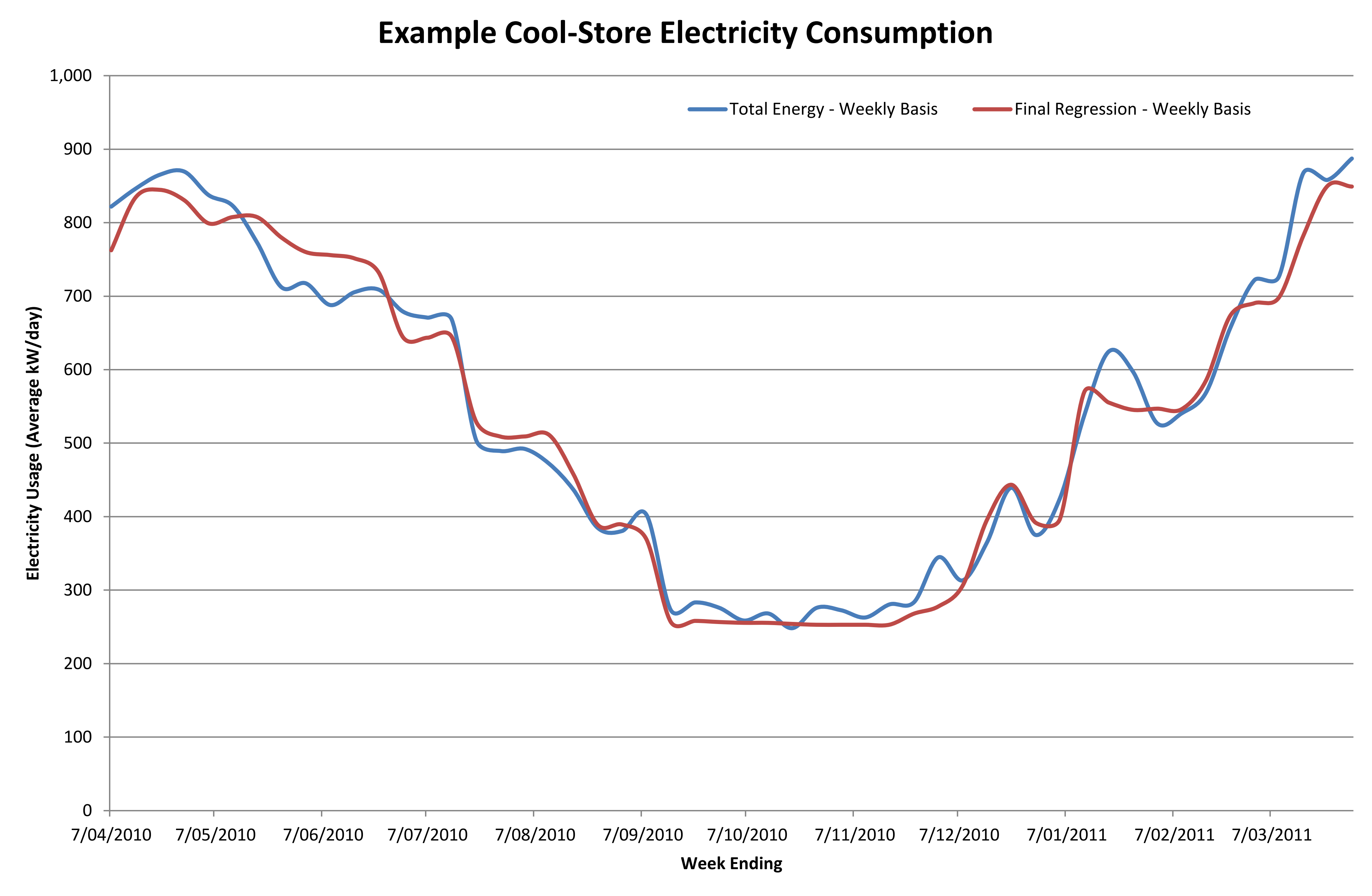

Example Cool-Store Electricity Consumption
Total Energy
Initial Regression
Energy Usage (Average kW/day)
1,000
900
800
700
600
500
400
300
200
100
0
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
Week ending



Effect of Temperature on Base-line equation
180%
160%
140%
120%
100%
80%
60%
40%
20%
0%
Actual Energy / Initial Baseline
y = 0.00696x + 0.94621
R² = 0.06280
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Average Dry-bulb temperature (°C)


Example Cool-Stores Electricity Consumption
Total Energy
Final Regression
Energy Usage (Average kW/day)
1,000
900
800
700
600
500
400
300
200
100
0
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
Week Ending

	Total Energy - Weekly Basis	Final Regression - Weekly Basis	Total Energy - Final Regression	Absolute Error	% Error
Annual average	**544.3**	**538.2**	**6.2**	**28.0**	**5.3%**
Week ending					
Wed 7/04/2010	822	763	59	59	7%
14/04/2010	846	834	12	12	1%
21/04/2010	865	845	21	21	2%
28/04/2010	870	831	39	39	4%
5/05/2010	838	799	38	38	5%
12/05/2010	823	808	15	15	2%
19/05/2010	773	808	-35	35	5%
26/05/2010	712	780	-68	68	10%
2/06/2010	717	760	-43	43	6%
9/06/2010	688	756	-68	68	10%
16/06/2010	705	752	-46	46	7%
23/06/2010	709	732	-23	23	3%
30/06/2010	679	644	35	35	5%
7/07/2010	671	644	27	27	4%
14/07/2010	668	645	23	23	3%
21/07/2010	504	529	-25	25	5%
28/07/2010	489	509	-20	20	4%
4/08/2010	492	509	-17	17	3%
11/08/2010	472	511	-39	39	8%
18/08/2010	437	458	-21	21	5%
25/08/2010	385	389	-4	4	1%
1/09/2010	380	389	-9	9	2%
8/09/2010	403	369	33	33	8%
15/09/2010	273	257	16	16	6%
22/09/2010	283	258	25	25	9%
29/09/2010	276	257	19	19	7%
6/10/2010	259	256	3	3	1%
13/10/2010	268	256	13	13	5%
20/10/2010	248	254	-6	6	2%
27/10/2010	276	253	23	23	8%
3/11/2010	273	253	20	20	7%
10/11/2010	263	253	10	10	4%
17/11/2010	281	253	27	27	10%
24/11/2010	283	268	15	15	5%
1/12/2010	345	278	67	67	19%
8/12/2010	313	306	7	7	2%
15/12/2010	365	396	-31	31	8%
22/12/2010	439	443	-4	4	1%
29/12/2010	375	392	-17	17	5%
5/01/2011	425	397	28	28	7%
12/01/2011	538	570	-32	32	6%
19/01/2011	624	555	69	69	11%
26/01/2011	597	545	52	52	9%
2/02/2011	527	547	-20	20	4%
9/02/2011	540	546	-6	6	1%
16/02/2011	568	585	-17	17	3%
23/02/2011	657	673	-17	17	3%
2/03/2011	722	691	31	31	4%
9/03/2011	726	698	28	28	4%
16/03/2011	867	782	85	85	10%
23/03/2011	858	850	8	8	1%
30/03/2011	887	849	38	38	4%


Example Cool-Store Electricity Consumption
Total Energy - Weekly Basis
Final Regression - Weekly Basis
Electricity Usage (Average kW/day)
1,000
900
800
700
600
500
400
300
200
100
0
7/04/2010
7/05/2010
7/06/2010
7/07/2010
7/08/2010
7/09/2010
7/10/2010
7/11/2010
7/12/2010
7/01/2011
7/02/2011
7/03/2011
Week Ending

Appendix 3. Excel spreadsheet for utilising base-line equation

Objective: Show a method and example for using an energy base-line for coolstore

Key:

Blue font = inputs

Black font = Calculations

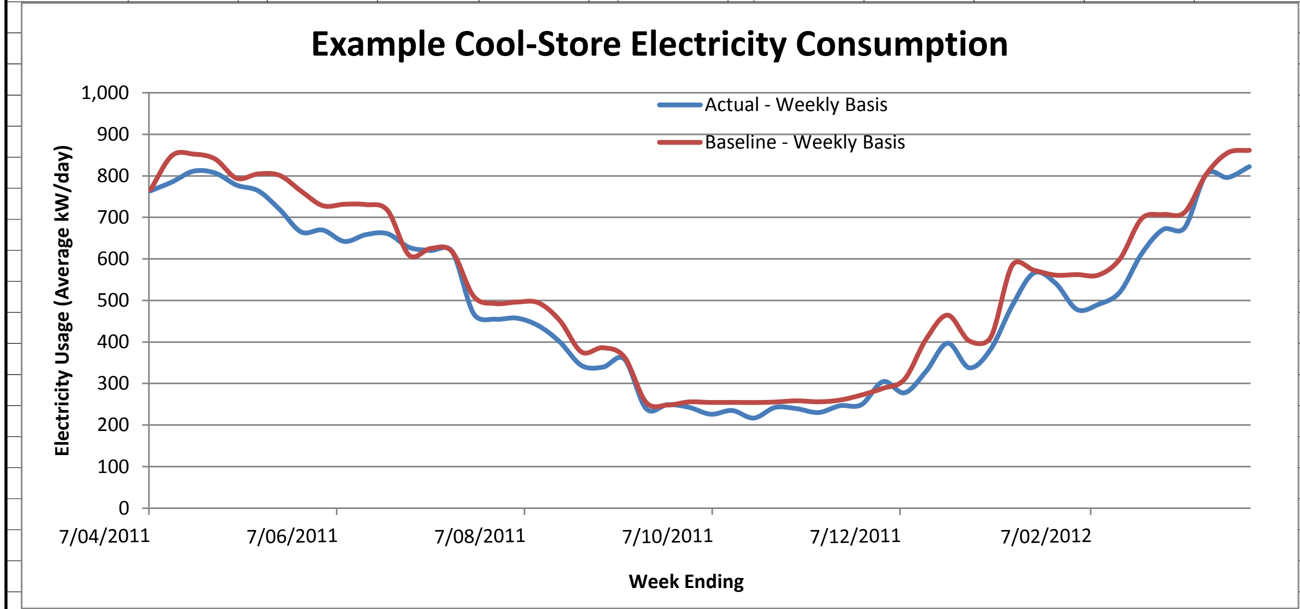
Red font = estimates

Energy base-line equation				**Expected Savings**		**Target equation**		
Initial Base-line	=	122	kW base-load	12	kW base-load	=	110	kW base-load
(Average kW	+	131	kW each if stores 4,5,6 are on	13	kW each if stores 4,5,6 are on	+	118	kW each if stores 4,5,6 are on
per day)	+	87	kW if store 1 is on	9	kW if store 1 is on	+	78	kW if store 1 is on
	+	122	kW each if stores 2,3 are on	12	kW each if stores 2,3 are on	+	110	kW each if stores 2,3 are on
	+	0.0054	kW per load-in	0.00054	kW per load-in	+	0.0048	kW per load-in
	+	0.0022	kW per load-in yesterday	0.00022	kW per load-in yesterday	+	0.0020	kW per load-in yesterday
	+	0.0017	kW per load-in 2 days ago	0.00017	kW per load-in 2 days ago	+	0.0015	kW per load-in 2 days ago

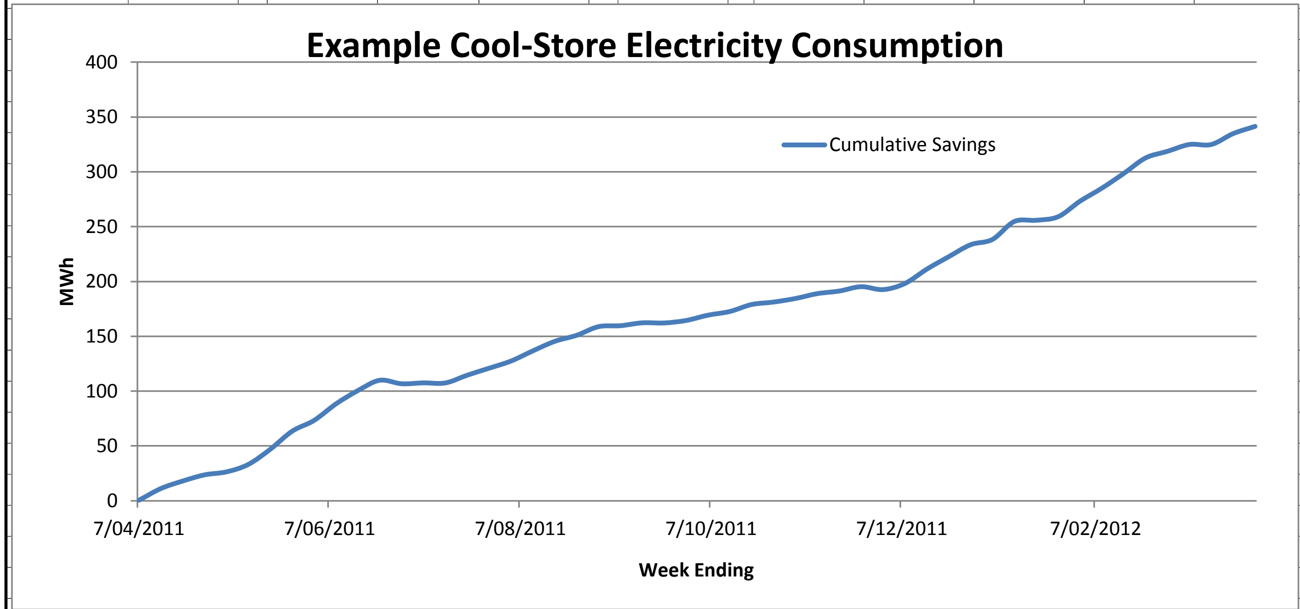
Final Base-line (Average kW per day)	=	initial base-line X (	0.926612	+	0.007312	X	Average ambient dry-bulb temperature)

Average Error 6.3%

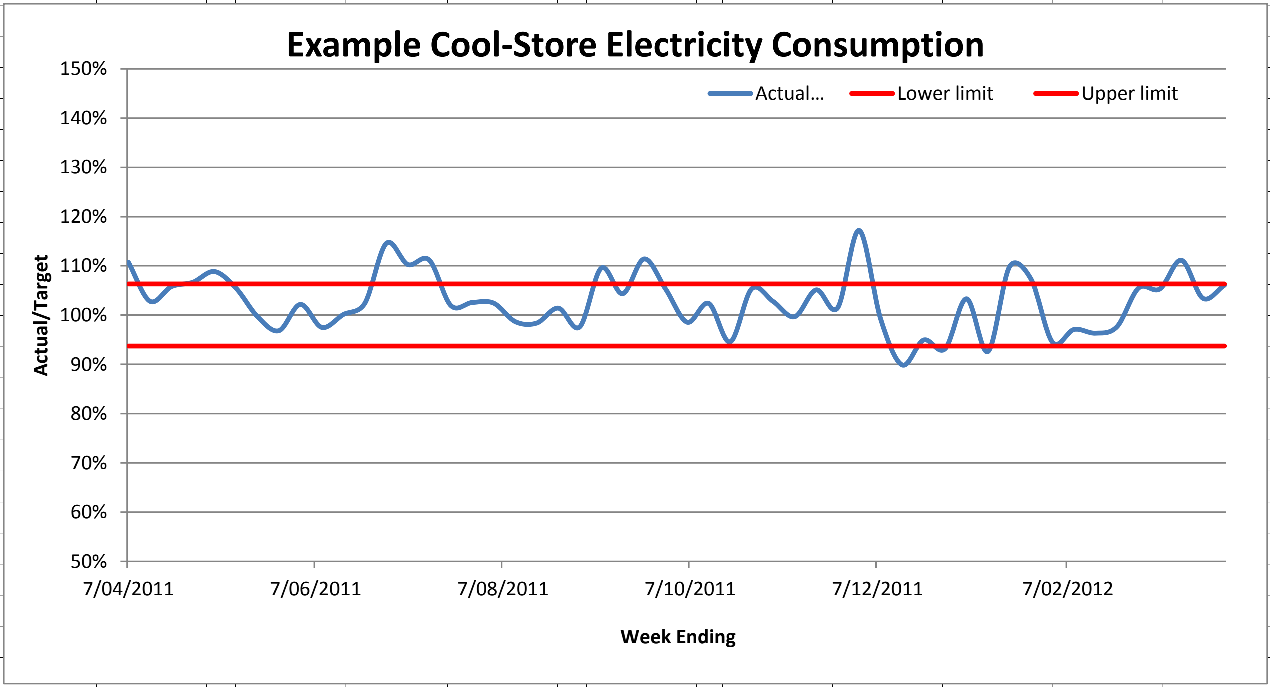
Graphs



This is good as an overview



Cumulative savings (Cusum)
Good for showing the savings achieved



Actual vs target graph for M&T

Limits are set based on the average error.
If over or under, reasons should be investigated.
Good for finding trends

	Factors Affecting Energy consumption											Energy Consumption								Base-line outputs				Target outputs			
Description	Store 1 on	Store 2 on	Store 3 on	Store 4 on	Store 5 on	Store 6 on	Load-ins	Load-outs	Inside stores	Dry-bulb ambient temp	Wet-bulb ambient temp	Engine Room	Store 4	Store 5	Store 6	Store 1	Store 2 and 3	Auxilliary Engine Room due to Store 2 and 3	Total Energy	Energy Base-line	Actual/Base-line	Savings (Base-line - Actual)	Cumulative Difference	Energy Target	Actual/Target	Actual - Target	Cumulative Difference
Unit	1=Yes	1=Yes	1=Yes	1=Yes	1=Yes	1=Yes	cartons	cartons	cartons	°C	°C	ave kW	ave kW	ave kW	ave kW	ave kW	ave kW	ave kW	ave kW	ave kW			MWh	ave kW			MWh
Annual Average	0.54	0.50	0.00	1.00	0.49	0.53	4886	5089	270002	10.27	8.80	271.78	58.17	53.91	56.77	8.79	11.47	39.22	500.10	539.34	93%	39.24		485.41	103%	14.69	
							18000																				
							18000									1.8%	2.3%	7.8%									
Fri 1/04/2011	1	1	0	1	1	1	18057	2442	500000	12.4	11.9	458	76	87	91	16	23	79	830	905	92%	75	2	814	102%	16	0
Sat 2/04/2011	1	1	0	1	1	1	0	0	515615	15.3	13.7	457	57	66	74	16	23	79	772	823	94%	51	3	741	104%	31	1
Sun 3/04/2011	1	1	0	1	1	1	0	0	515615	12.4	11.3	444	57	66	73	16	23	79	758	766	99%	9	3	690	110%	68	3
Mon 4/04/2011	1	1	0	1	1	1	0	0	515615	8.5	6.7	432	55	66	72	16	23	79	743	715	104%	-28	3	644	115%	100	5
Tue 5/04/2011	1	1	0	1	1	1	0	0	515615	6.8	5.8	424	57	66	71	16	23	79	737	706	104%	-30	2	636	116%	101	8
Wed 6/04/2011	1	1	0	1	1	1	0	0	515615	9.4	7.6	416	57	65	71	16	23	79	727	720	101%	-7	2	648	112%	79	9
Thu 7/04/2011	1	1	0	1	1	1	1590	23099	515615	10.0	8.3	424	72	83	83	16	23	79	781	732	107%	-49	0	659	119%	122	12
Fri 8/04/2011	1	1	0	1	1	1	16774	23464	494106	8.5	6.9	433	71	88	90	16	23	79	799	808	99%	8	1	727	110%	73	14
Sat 9/04/2011	1	1	0	1	1	1	21190	15797	487416	10.1	8.3	440	77	87	89	16	23	79	811	877	92%	66	2	789	103%	22	15
Sun 10/04/2011	1	1	0	1	1	1	0	0	492809	10.5	8.3	432	63	70	75	16	23	79	758	801	95%	42	3	720	105%	38	16
Mon 11/04/2011	1	1	0	1	1	1	0	0	492809	14.3	10.7	427	54	66	73	16	23	79	738	782	94%	44	4	704	105%	34	16
Tue 12/04/2011	1	1	0	1	1	1	18661	17837	492809	15.9	13.8	450	69	82	75	16	23	79	794	859	92%	65	6	773	103%	21	17
Wed 13/04/2011	1	1	0	1	1	1	19150	11822	493633	14.8	13.5	452	75	84	74	16	23	79	803	897	89%	95	8	808	99%	-5	17
Thu 14/04/2011	1	1	0	1	1	1	19422	15579	500961	12.7	11.1	445	74	85	73	16	23	79	794	918	86%	124	11	827	96%	-32	16
Fri 15/04/2011	1	1	0	1	1	1	20538	16697	504804	9.7	8.2	440	74	86	76	16	23	79	794	906	88%	112	14	815	97%	-21	16
Sat 16/04/2011	1	1	0	1	1	1	20219	14406	508645	9.3	7.2	439	78	90	82	16	23	79	807	905	89%	98	16	814	99%	-7	15
Sun 17/04/2011	1	1	0	1	1	1	0	0	514458	12.5	11.8	465	62	71	77	16	23	79	792	816	97%	24	17	735	108%	58	17
Mon 18/04/2011	1	1	0	1	1	1	0	0	514458	12.8	11.6	462	61	66	76	16	23	79	783	772	101%	-11	16	695	113%	88	19
Tue 19/04/2011	1	1	0	1	1	1	16188	9621	514458	11.4	10.1	452	77	82	88	16	23	79	817	818	100%	1	16	736	111%	81	21
Wed 20/04/2011	1	1	0	1	1	1	15900	0	521025	11.9	10.9	467	84	85	89	16	23	79	843	856	99%	12	17	770	110%	73	23
Thu 21/04/2011	1	1	0	1	1	1	18282	4344	536925	11.7	10.7	470	82	85	89	16	23	79	844	894	94%	51	18	805	105%	39	23
Fri 22/04/2011	1	1	0	1	1	1	18803	11090	550863	12.0	11.2	459	78	86	88	16	23	79	829	904	92%	75	20	813	102%	15	24
Sat 23/04/2011	1	1	0	1	1	1	18192	17057	558576	12.6	11.8	455	76	88	86	16	23	79	823	910	90%	87	22	819	101%	4	24
Sun 24/04/2011	1	1	0	1	1	1	0	0	559711	9.5	8.7	453	62	78	74	16	23	79	785	792	99%	6	22	712	110%	73	26
Mon 25/04/2011	1	1	0	1	1	1	0	0	559711	14.3	13.3	455	57	70	72	16	23	79	771	777	99%	6	22	699	110%	72	27
Tue 26/04/2011	1	1	0	1	1	1	16401	21960	559711	9.8	9.4	437	76	88	84	16	23	79	803	810	99%	7	22	729	110%	74	29
Wed 27/04/2011	1	1	0	1	1	1	12965	15042	554152	11.6	10.4	447	78	88	89	16	23	79	820	839	98%	18	23	755	109%	65	31
Thu 28/04/2011	1	1	0	1	1	1	11965	17239	552075	11.6	10.0	451	77	85	86	16	23	79	817	853	96%	35	24	768	106%	50	32
Fri 29/04/2011	1	1	0	1	1	1	10020	20011	546801	11.6	10.1	449	76	85	87	16	23	79	815	835	98%	20	24	751	108%	63	33
Sat 30/04/2011	1	1	0	1	1	1	12697	13255	536810	10.1	9.0	442	75	83	85	16	23	79	802	834	96%	32	25	751	107%	52	35
Sun 1/05/2011	1	1	0	1	1	1	0	0	536252	8.8	7.5	432	60	69	75	16	23	79	754	761	99%	7	25	685	110%	69	36
Mon 2/05/2011	1	1	0	1	1	1	0	0	536252	8.6	6.9	413	39	66	73	16	23	79	710	736	96%	27	26	663	107%	47	38
Tue 3/05/2011	1	1	0	1	1	1	10567	11881	536252	10.2	8.9	427	66	83	84	16	23	79	778	781	100%	3	26	703	111%	75	39
Wed 4/05/2011	1	1	0	1	1	1	11677	15474	534938	8.9	7.2	429	77	87	89	16	23	79	800	802	100%	3	26	722	111%	78	41
Thu 5/05/2011	1	1	0	1	1	1	12757	14371	531141	5.7	4.8	423	72	87	86	16	23	79	786	809	97%	23	26	728	108%	58	43
Fri 6/05/2011	1	1	0	1	1	1	12431	14953	529527	11.0	8.1	433	77	86	88	16	23	79	802	843	95%	42	27	759	106%	43	44
Sat 7/05/2011	1	1	0	1	1	1	13167	13570	527005	12.7	10.9	440	76	86	85	16	23	79	805	859	94%	54	29	773	104%	32	44
Sun 8/05/2011	1	1	0	1	1	1	0	0	526602	7.2	6.2	420	50	70	75	16	23	79	733	757	97%	25	29	681	108%	51	46
Mon 9/05/2011	1	1	0	1	1	1	0	0	526602	10.0	8.8	410	34	66	74	16	23	79	701	745	94%	44	30	670	105%	31	46
Tue 10/05/2011	1	1	0	1	1	1	11977	9812	526602	10.1	9.2	416	55	83	84	16	23	79	757	788	96%	31	31	709	107%	48	47
Wed 11/05/2011	1	1	0	1	1	1	13961	10848	528767	8.3	7.3	422	60	88	88	16	23	79	776	814	95%	38	32	733	106%	43	49
Thu 12/05/2011	1	1	0	1	1	1	13130	13029	531880	7.1	6.4	423	62	86	85	16	23	79	775	826	94%	52	33	744	104%	31	49
Fri 13/05/2011	1	1	0	1	1	1	14061	12385	531981	9.8	9.5	433	61	85	86	16	23	79	781	849	92%	68	35	764	102%	17	50
Sat 14/05/2011	1	1	0	1	1	1	15519	15060	533657	7.8	7.7	424	66	86	86	16	23	79	780	845	92%	65	36	760	103%	19	50
Sun 15/05/2011	1	1	0	1	1	1	0	0	534116	9.4	9.1	421	39	70	74	16	23	79	721	777	93%	56	38	699	103%	22	51
Mon 16/05/2011	1	1	0	1	1	1	0	0	534116	7.8	7.7	401	34	66	73	16	23	79	692	737	94%	45	39	663	104%	29	51
Tue 17/05/2011	1	1	0	1	1	1	12222	10543	534116	9.4	9.1	354	56	83	84	16	23	79	695	785	89%	90	41	707	98%	-11	51
Wed 18/05/2011	1	1	0	1	1	1	10063	7913	535795	9.6	8.8	319	67	86	87	16	23	79	677	802	84%	125	44	722	94%	-45	50
Thu 19/05/2011	1	1	0	1	1	1	10232	11074	537945	8.5	8.0	322	73	86	87	16	23	79	685	811	84%	126	47	730	94%	-45	49
Fri 20/05/2011	1	1	0	1	1	1	12330	12393	537103	5.8	5.3	321	75	86	87	16	23	79	687	803	86%	116	50	723	95%	-35	48
Sat 21/05/2011	1	1	0	1	1	1	9864	12955	537040	5.4	4.7	325	76	87	87	16	23	79	692	792	87%	101	52	713	97%	-21	48
Sun 22/05/2011	1	1	0	1	1	1	0	0	533949	4.8	4.4	314	52	70	74	16	23	79	628	736	85%	108	55	663	95%	-34	47
Mon 23/05/2011	1	1	0	1	1	1	0	0	533949	7.1	6.9	313	48	69	74	16	23	79	622	724	86%	102	57	652	95%	-30	46
Tue 24/05/2011	1	1	0	1	1	1	5281	11950	533949	8.6	8.2	314	63	84	82	16	23	79	662	744	89%	82	59	670	99%	-8	46
Wed 25/05/2011	1	1	0	1	1	1	6044	0	527280	9.4	8.8	318	71	85	86	16	23	79	677	764	89%	87	61	687	98%	-10	46
Thu 26/05/2011	1	1	0	1	1	1	7462	2131	533324	8.4	7.7	322	75	85	85	16	23	79	686	776	88%	90	63	698	98%	-13	45
Fri 27/05/2011	1	1	0	1	1	1	6265	8878	538655	4.8	3.8	328	77	86	87	16	23	79	696	753	92%	58	65	678	103%	18	46
Sat 28/05/2011	1	1	0	1	1	1	7557	3687	536042	4.9	4.0	328	76	86	84	16	23	79	692	760	91%	68	66	684	101%	8	46
Sun 29/05/2011	1	1	0	1	1	1	0	0	539912	7.5	7.0	327	58	69	72	16	23	79	645	736	88%	91	69	663	97%	-18	45
Mon 30/05/2011	1	1	0	1	1	1	0	0	539912	5.9	5.2	325	50	68	72	16	23	79	632	714	89%	82	71	642	98%	-10	45
Tue 31/05/2011	1	1	0	1	1	1	5067	7696	539912	3.0	2.5	325	64	85	85	16	23	79	677	712	95%	35	71	641	106%	36	46
Wed 1/06/2011	1	1	0	1	1	1	962	13541	537283	2.5	1.9	321	63	88	88	16	23	79	677	699	97%	22	72	629	108%	48	47

	Actual - Weekly Basis Ave kW	Baseline - Weekly Basis Ave kW	Actual /Baseline	Savings (Base-line - Actual) Ave kW	Cumulative Savings MWh	Target - Weekly Basis Ave kW	Actual /Target	Limits	
Annual average	**499.2**	**538.3**	**93%**		**341.5**	**484.5**	**103%**		
Week ending									
Thu 7/04/2011	764	767	100%	3	0	690	111%	94%	106%
14/04/2011	785	849	93%	63	11	764	103%	94%	106%
21/04/2011	811	852	95%	41	18	767	106%	94%	106%
28/04/2011	807	841	96%	34	24	756	107%	94%	106%
5/05/2011	778	794	98%	16	26	715	109%	94%	106%
12/05/2011	764	805	95%	41	33	724	106%	94%	106%
19/05/2011	719	801	90%	82	47	721	100%	94%	106%
26/05/2011	665	763	87%	98	63	686	97%	94%	106%
2/06/2011	670	728	92%	59	73	655	102%	94%	106%
9/06/2011	642	732	88%	90	88	658	98%	94%	106%
16/06/2011	658	731	90%	72	100	658	100%	94%	106%
23/06/2011	661	717	92%	56	110	645	102%	94%	106%
30/06/2011	628	609	103%	-19	107	548	115%	94%	106%
7/07/2011	620	625	99%	5	108	563	110%	94%	106%
14/07/2011	618	617	100%	0	107	556	111%	94%	106%
21/07/2011	468	510	92%	42	115	459	102%	94%	106%
28/07/2011	455	493	92%	38	121	443	103%	94%	106%
4/08/2011	457	496	92%	39	127	447	102%	94%	106%
11/08/2011	439	495	89%	55	137	445	99%	94%	106%
18/08/2011	400	452	89%	52	145	406	98%	94%	106%
25/08/2011	343	376	91%	33	151	339	101%	94%	106%
1/09/2011	339	386	88%	47	159	348	98%	94%	106%
8/09/2011	358	363	99%	5	160	327	110%	94%	106%
15/09/2011	239	255	94%	16	162	229	104%	94%	106%
22/09/2011	249	248	100%	-1	162	223	111%	94%	106%
29/09/2011	242	256	95%	13	164	230	105%	94%	106%
6/10/2011	226	255	89%	29	169	229	99%	94%	106%
13/10/2011	235	255	92%	20	173	229	102%	94%	106%
20/10/2011	217	254	85%	38	179	229	95%	94%	106%
27/10/2011	242	256	95%	13	181	230	105%	94%	106%
3/11/2011	239	259	92%	19	185	233	103%	94%	106%
10/11/2011	230	256	90%	26	189	231	100%	94%	106%
17/11/2011	246	260	95%	14	191	234	105%	94%	106%
24/11/2011	249	273	91%	24	195	245	101%	94%	106%
1/12/2011	304	289	105%	-16	193	260	117%	94%	106%
8/12/2011	277	311	89%	33	198	280	99%	94%	106%
15/12/2011	329	407	81%	78	211	366	90%	94%	106%
22/12/2011	397	465	85%	68	223	418	95%	94%	106%
29/12/2011	338	403	84%	65	234	363	93%	94%	106%
5/01/2012	383	412	93%	29	238	370	103%	94%	106%
12/01/2012	488	585	83%	97	255	527	93%	94%	106%
19/01/2012	566	573	99%	7	256	515	110%	94%	106%
26/01/2012	542	561	97%	19	259	505	107%	94%	106%
2/02/2012	478	562	85%	84	273	506	94%	94%	106%
9/02/2012	490	561	87%	71	285	505	97%	94%	106%
16/02/2012	521	600	87%	80	299	540	96%	94%	106%
23/02/2012	612	697	88%	84	313	627	98%	94%	106%
1/03/2012	671	707	95%	36	319	636	105%	94%	106%
8/03/2012	675	712	95%	37	325	641	105%	94%	106%
15/03/2012	804	804	100%	0	325	723	111%	94%	106%
22/03/2012	796	855	93%	59	335	770	103%	94%	106%
29/03/2012	822	861	95%	39	342	775	106%	94%	106%