



Corporate Services Division

Assurance and Forensic Department

Contracted the University of Cape Town to execute this project

Measurement and Verification

Project Name: Power Optimisa Test Unit

Project Number: 2008088

Report Type: Performance Assessment

Reporting Period: N/A

Compiled by:

A handwritten signature in black ink, appearing to read "J Manley".

Date: 21 Jul. 09

Jonathan Manley
M&V Team member
University of Cape Town

Authorised by:

A handwritten signature in black ink, appearing to read "G McKuur".

Date: 21 Jul. 09

Gerswynn McKuur
M&V Leader – Team
University of Cape Town

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1 EXECUTIVE SUMMARY

The Power Optimisa test unit, powered by technology supplied by the E- Four Corporation of Japan, was installed at Pick 'n Pay Family Store in Durbanville. The ESCo installed the device to lower the voltage and hence reduce the client's energy consumption. The device was correctly installed as originally proposed.

The energy savings are calculated using metered data and a service level adjustment to the baseline. The total energy saving was for June 2009 was calculated to be 14.068MWh, which is an 8.73% reduction from the baseline energy consumption of 161.217MWh.

INTRODUCTION

The first Power Optimisa unit in South Africa has been installed at the Pick 'n Pay Family Store in the De Ville Shopping Centre in Durbanville, Cape Town. It is proposed that the device, powered by technology supplied by the E- Four Corporation of Japan, saves power by reducing the voltage supplied to the load. Supplying lower voltage to the supermarkets' equipment results in lowered current and power. It is further proposed that this intervention will permanently reduce the energy consumed by the customer. There are a number of additional benefits to reducing the load voltage using the Power Optimisa, including extending the lifetime of equipment by optimizing operating voltages, reducing harmonics and eliminating spikes.

The M & V Performance Assessment report contains general information about the impact of the project including data on the demand and energy savings.

2 PROJECT DESCRIPTION

2.1 PROJECT INFORMATION

M&V Details			
M&V Company Name:		Energy Research Centre University of Cape Town	
M& V Contact Person:		Mr Jonathan Manley	
Postal Address:		Private Bag Rondebosch 7701 South Africa	
Phone:	021 650 4804	Fax:	021 650 2830
Cell:	076 307 4249	Email:	jonathan.manley@uct.ac.za
Client Details			
Name of Project Site:		Pick 'n Pay Family Store, Durbanville	
Address:		Cnr Wellington Street & Main Street Durbanville, Western Cape 7550	
Company Name (Client):		Pick 'n Pay Family Store, Durbanville	
Contact Person:		Mr Graham Pateras	
Phone:	021 975 2464	Fax:	
Cell:	082 771 1944	Email:	grahamp@pnpdbnvl.co.za
Type of site:		Retail	

ESCo Details			
ESCo		Power Optimisa	
Contact Person:		Mr Alan Palmer	
Phone:	021 403 6360	Fax:	
Cell:	083 225 2116	Email:	alan@poweroptimisa.com
ESKOM DSM Details			
Contact Person:		Mr Lawrence Padachi	
Phone:	011 800 3388	Fax:	0865 123 239
Cell:	083 788 3042	Email:	Lawrence.padachi@eskom.co.za
ESKOM AFD Details			
Contact Person:		Mr Ronny Dube	
Phone:	011 800 3796	Fax:	011 800 4556
Cell:	071 200 9397	Email:	ronny.dube@eskom.co.za

2.2 PROJECT OBJECTIVE

The objective of M&V is to measure and verify the energy, cost, load and power reductions resulting from the intervention done by the Power Optimisa, powered by technology supplied by the E- Four Corporation of Japan. These will be determined by following procedures as outlined in the M&V Plan.

2.3 SITE DESCRIPTION

The site for the project is the Pick 'n Pay Family Store in the De Ville shopping centre in Durbanville, about 30kms North of Cape Town.

2.4 SAVINGS CALCULATIONS

This is a pilot project for the Power Optimisa. It was therefore necessary to determine the method to calculate the savings.

2.4.1 Voltage Reduction

The metered data reflects the consistent lowering of the supply voltage. For the period 12th to 18th May 2009 – the time of use data confirms the correct operation of the equipment.

Voltage reduction		Save mode	Baseline	reduction	V reduction
		V	V	V	%
Weekday					
Morning Off-peak	00:00-06:00	213.9	235.5	21.6	9.2%
Morning Standard	06:00-07:00	213.3	233.1	19.8	8.5%
Morning Peak	07:00-10:00	214.4	232.3	17.9	7.7%
Midday Standard	10:00-18:00	215.7	231.6	15.9	6.9%
Evening Peak	18:00-20:00	214.0	233.7	19.8	8.5%
Evening Standard	20:00-22:00	213.6	234.7	21.1	9.0%
Evening Off peak	22:00-00:00	213.8	235.3	21.4	9.1%
Saturday					
Morning Off-peak	00:00-07:00	213.6	234.7	21.1	9.0%
Morning Standard	07:00-12:00	213.2	232.7	19.5	8.4%
Off-Peak Midday	12:00-18:00	216.1	232.5	16.3	7.0%
Evening Standard	18:00-20:00	216.1	233.9	17.9	7.6%
Off-Peak Evening	20:00-24:00	214.1	235.2	21.0	8.9%
Sunday					
Sunday Off-peak	00:00-24:00	214.9	234.1	19.2	8.2%

2.4.2 Method for calculating savings

It was established that the total three-phase current in savings mode and baseline mode have a consistent linear relationship. This was calculated for the real and reactive components of the current.

Real Power and Current

For the real component of the current:

$$SavingsModeCurrent_{real} = SavingsModePower_{real} / Volts = W / V$$

$$SavingsModeCurrent_{reactive} = SavingsModePower_{reactive} / Volts = VAR / V$$

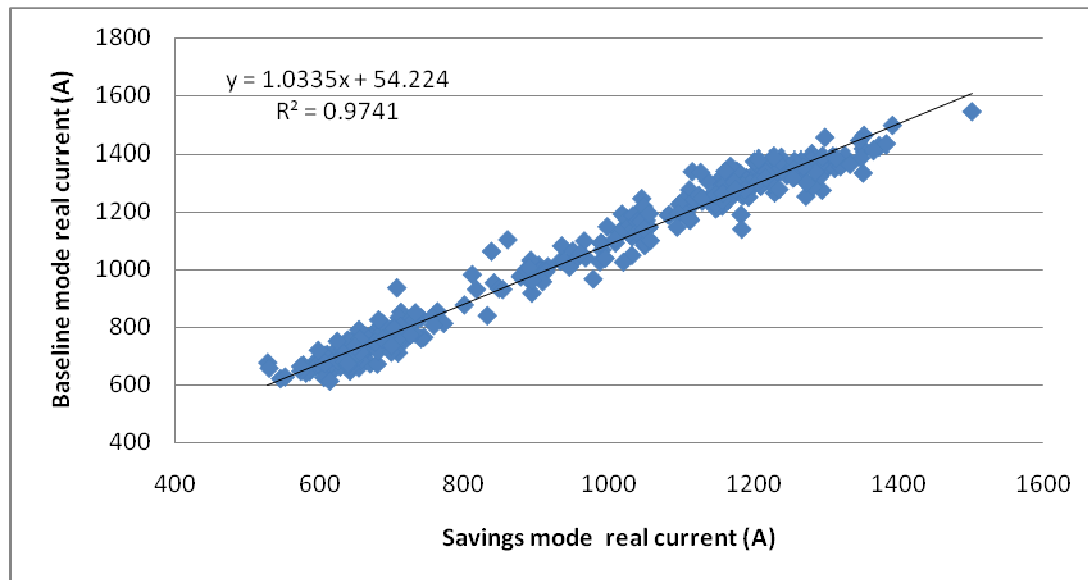


Figure 1 - Baseline mode versus savings mode Real Current

The linear relationship, expressed as

$$y = 1.0335x + 54.224$$

The Real component of the Baseline Current can then be used to calculate the Real Power.

$$BaselineCurrent_{real} = 1.0335 \times SavingsModeCurrent_{real} + 54.224$$

$$BaselinePower_{real} = Volts \times BaselineCurrent_{real}$$

Reactive Power and Current

Similarly, the Baseline mode Reactive Current (total three phase) can be used to calculate the Baseline Reactive Power (kVAr).

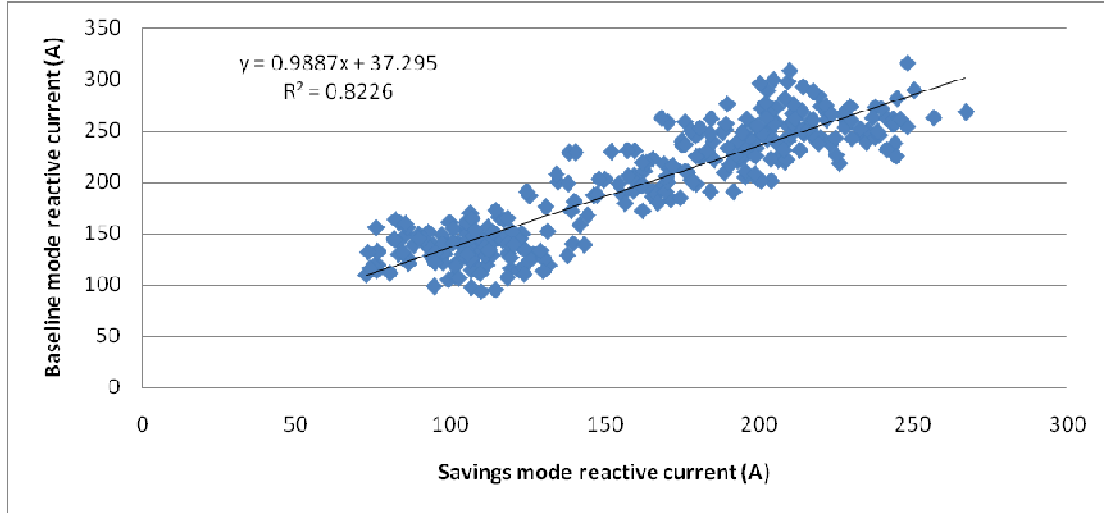


Figure 2 - Baseline mode versus savings mode Reactive Current

The linear relationship for the Reactive Current is expressed as:

$$y = 0.9887x + 37.295$$

The Reactive component of the Baseline Current can then be used to calculate the Reactive Power.

$$BaselineCurrent_{reactive} = 0.9887 \times SavingsModeCurrent_{reactive} + 37.295$$

$$BaselinePower_{reactive} = Volts \times BaselineCurrent_{reactive}$$

It is therefore possible to calculate the Real (kW) and Reactive (kVAr) Baseline Power from the Real and Reactive metered Savings Mode Power.

This in turn can be used to calculate the Baseline Apparent Demand (kVA).

2.5 DATA ACQUIRED

Data was downloaded for the month of June, 2009 from 1st to 30th June 2009.

There was metered data missing from 27th June 20:22 to 28th June 8:23am.

3 PERFORMANCE INDICATORS

3.1 DEMAND SAVINGS

The Baseline profiles were calculated using the metered data. These demand profiles for Baseline and Savings mode were calculated for 01 – 30 June 2009.

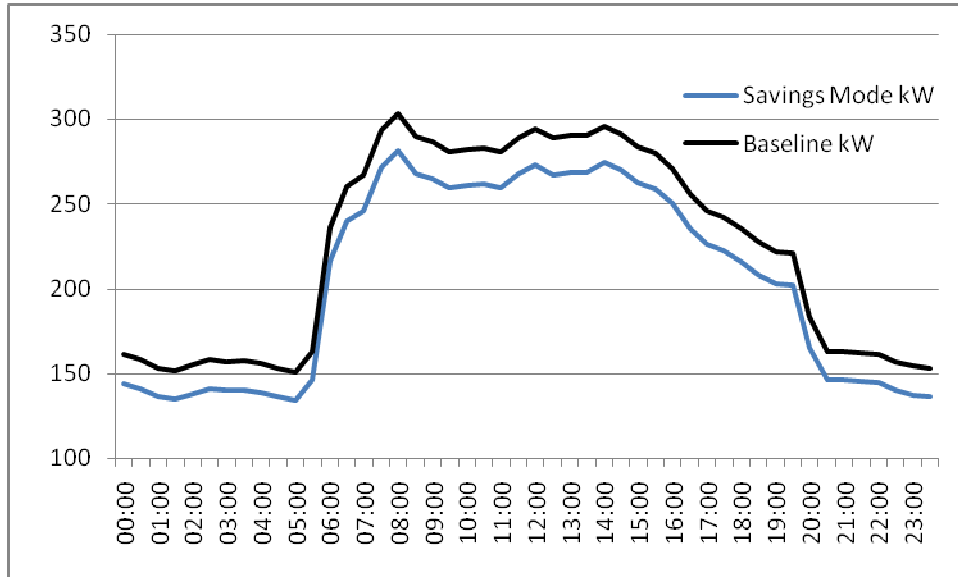


Figure 3 – Averaged demand Profiles – Weekdays

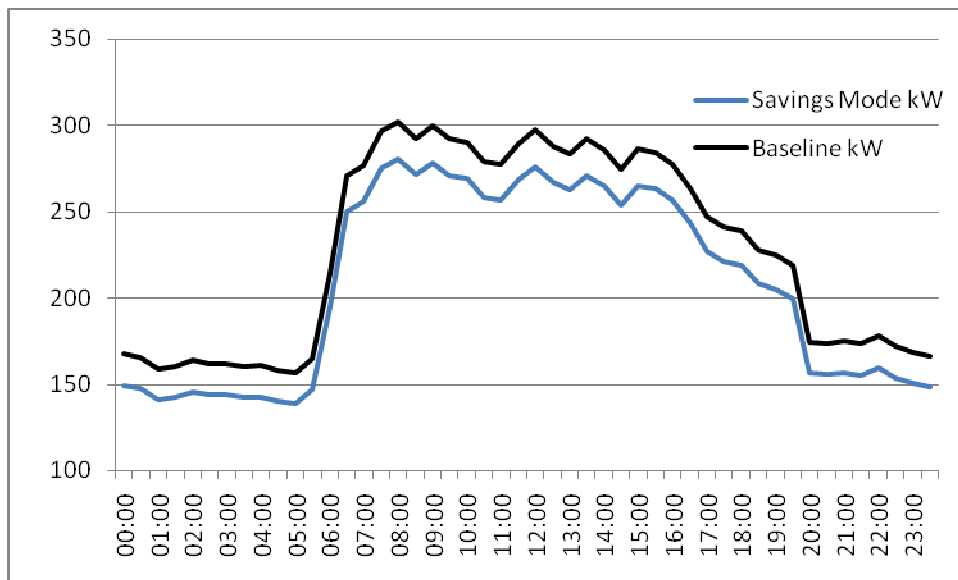


Figure 4 – Averaged demand profiles – Saturday

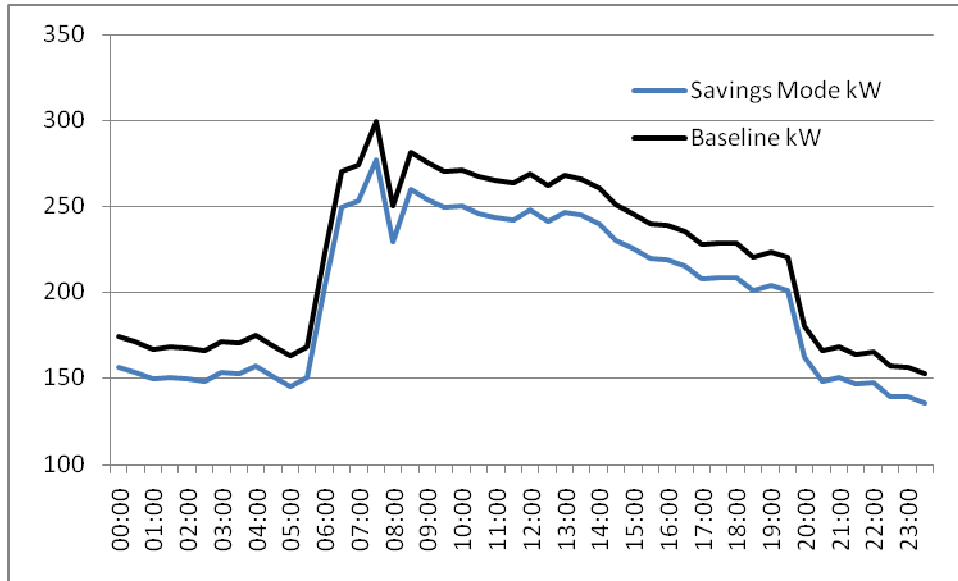


Figure 5 – Average demand (kW) profiles – Sunday

Demand Saving		Save mode kW	Baseline kW	Impact kW	kW %	Save mode kVAr	Baseline kVAr	kVAr %
Weekday								
Morning Off-peak	00:00-06:00	139.0	156.4	17.4	11.1%	26.0	34.4	24.6%
Morning Standard	06:00-07:00	228.0	248.3	20.3	8.2%	44.9	53.1	15.5%
Morning Peak	07:00-10:00	265.5	287.0	21.5	7.5%	52.5	60.6	13.4%
Middy Standard	10:00-18:00	258.1	279.3	21.2	7.6%	49.7	57.8	14.0%
Evening Peak	18:00-20:00	207.0	226.6	19.6	8.7%	40.1	48.4	17.1%
Evening Standard	20:00-22:00	150.3	168.1	17.8	10.6%	27.6	36.1	23.4%
Evening Off peak	22:00-00:00	139.3	156.8	17.4	11.1%	26.9	35.4	24.0%
Saturday								
Morning Off-peak	00:00-07:00	155.3	173.2	18.0	10.4%	30.6	39.1	21.6%
Morning Standard	07:00-12:00	269.8	291.5	21.7	7.4%	52.0	60.1	13.5%
Off-Peak Middy	12:00-18:00	256.7	278.0	21.3	7.6%	47.9	56.1	14.5%
Evening Standard	18:00-20:00	208.0	227.7	19.7	8.6%	40.1	48.4	17.1%
Off-Peak Evening	20:00-24:00	154.7	172.6	18.0	10.4%	29.0	37.5	22.6%
Sunday								
Sunday Off-peak	00:00-24:00	197.9	217.3	19.4	8.9%	38.0	46.3	18.0%

Table 1 - Real and Reactive power time of use Demand savings

The Apparent demand savings are calculated from the Real and Reactive components.

Demand Saving		Save mode	Baseline	Impact	kVA save	Save mode	Baseline
		kVA	kVA	kVA	%	P.f.	P.f
Weekday							
Morning Off-peak	00:00-06:00	141.4	160.2	18.8	11.7%	0.983	0.977
Morning Standard	06:00-07:00	232.4	253.9	21.6	8.5%	0.981	0.978
Morning Peak	07:00-10:00	270.6	293.3	22.7	7.7%	0.981	0.978
Midday Standard	10:00-18:00	262.8	285.2	22.4	7.9%	0.982	0.979
Evening Peak	18:00-20:00	210.8	231.7	20.9	9.0%	0.982	0.978
Evening Standard	20:00-22:00	152.9	171.9	19.1	11.1%	0.984	0.978
Evening Off peak	22:00-00:00	141.9	160.7	18.8	11.7%	0.982	0.976
Saturday							
Morning Off-peak	00:00-07:00	158.2	177.6	19.3	10.9%	0.981	0.976
Morning Standard	07:00-12:00	274.8	297.6	22.8	7.7%	0.982	0.979
Off-Peak Midday	12:00-18:00	261.2	283.6	22.4	7.9%	0.983	0.980
Evening Standard	18:00-20:00	211.8	232.8	20.9	9.0%	0.982	0.978
Off-Peak Evening	20:00-24:00	157.4	176.7	19.3	10.9%	0.983	0.977
Sunday							
Sunday Off-peak	00:00-24:00	201.5	222.1	20.6	9.3%	0.982	0.978

Table 2- Apparent Demand savings and Power factor improvements

From the measurements and calculations for 01 – 30 June 2009 it was found:

The average Real Power reduction was reduced from 223.764kW to 204.230kW (8.73%)

The average Reactive Power was reduced from 47.486kVAr to 39.200kVAr (17.45%)

The average power factor improved from 0.978 to 0.982

The average Apparent Power was reduced from 228.747kVA to 207.959kVA (9.09%)

A full schedule of the averaged results can be seen in Appendices A, B and C.

3.2 ENERGY SAVINGS

During June 2009 there were 22 week days, 4 Saturdays and 4 Sundays. The hours of missing data from 27th to 28th of June have been assigned average time of use data for that period.

Savings are calculated using the metered data, and deriving the baseline energy use.

	Weekdays	Saturdays	Sundays	
	MWh	MWh	MWh	Total
Baseline	118.479	21.880	20.858	161.217
Actual	108.159	19.991	19.000	147.150
Impact	10.320	1.890	1.858	14.068
Impact (%)	8.71%	8.64%	8.91%	8.73%

Table 3 - Total energy savings for June 2009

3.3 MONETARY SAVING

Pick 'n Pay Durbanville is on the Unicity Peak and Off-Peak Tariff. Peak times are from 6:00am to 11:00pm on weekdays. Off-peak times are after 11:00pm to 6:00am and weekends.

Peak times unit charge: R0.4855 /kWh

Off-peak unit charge: R0.2403 /kWh

	Wkd - Peak	Wk - Off-peak	Saturday	Sunday	
	MWh	MWh	MWh	MWh	Total
Baseline	94.442	24.037	21.880	20.858	161.217
Actual	86.802	21.357	19.991	19.000	147.150
Impact	7.640	2.681	1.890	1.858	14.068
Tariff	0.4855	0.2403	0.2403	0.2403	
Saving	R 3 709	R 644	R 454	R 446	R 5 254

Table 4 - Monetary savings based on Unicity Peak and off-peak tariff

The monetary saving was calculated on the tariffs for June 2009. An increase in tariffs will increase the monetary savings potential of the Power Optimisa.

3.4 REDUCTION IN EMISSIONS

Emissions reductions for the associated energy use can be calculated using Eskom's emissions factors. The emissions reductions are based on the decreased energy consumption of 14.1 MWh.

Jun-09	Energy	CO ₂	SO ₂	NO _x	Par	Water use	Coal use
	(MWh)	(t)	(kg)	(kg)	(kg)	(kl)	ton
		1	8.69	4.39	0.23	1.44	0.56
Savings	14.1	14.1	122.2	61.8	3.2	20.3	7.9

Table 5 - Emission reductions for reduced consumption

4 CONCLUDING COMMENTS

The Power Optimisa unit has effectively reduced both the demand and energy consumption at the client's site. The reduced voltage has decreased the load, and savings will continue to occur as long as the Power Optimisa is in service. An increase in tariffs will increase the monetary savings potential of the Power Optimisa.

The total energy saving was for June 2009 was calculated to be 14.068MWh, which is an 8.73% reduction from the baseline energy consumption of 161.217MWh.

APPENDIX A – AVERAGED WEEKDAY SAVINGS

weekday

time	kW PO	kW BL		kVAr PO	kVAr BL			kW PO	kW BL		kVAr PO	kVAr BL	
00:00:00	143.817	161.407	10.9%	26.836	35.317	24.0%	12:00:00	272.976	294.730	7.4%	53.017	61.091	13.2%
00:30:00	140.759	158.247	11.1%	27.546	36.020	23.5%	12:30:00	267.343	288.931	7.5%	52.214	60.312	13.4%
01:00:00	136.227	153.559	11.3%	25.923	34.411	24.7%	13:00:00	268.816	290.422	7.4%	50.865	58.957	13.7%
01:30:00	134.701	151.979	11.4%	25.851	34.339	24.7%	13:30:00	268.964	290.547	7.4%	53.084	61.131	13.2%
02:00:00	137.769	155.156	11.2%	22.729	31.257	27.3%	14:00:00	274.645	296.435	7.4%	50.166	58.258	13.9%
02:30:00	140.826	158.322	11.1%	26.559	35.048	24.2%	14:30:00	270.254	291.894	7.4%	50.195	58.285	13.9%
03:00:00	139.559	157.006	11.1%	25.235	33.734	25.2%	15:00:00	262.340	283.735	7.5%	50.083	58.188	13.9%
03:30:00	140.063	157.520	11.1%	26.606	35.085	24.2%	15:30:00	259.109	280.385	7.6%	50.510	58.602	13.8%
04:00:00	138.643	156.036	11.1%	26.391	34.861	24.3%	16:00:00	250.351	271.346	7.7%	50.322	58.425	13.9%
04:30:00	136.258	153.553	11.3%	25.964	34.427	24.6%	16:30:00	235.690	256.235	8.0%	45.192	53.381	15.3%
05:00:00	133.749	150.978	11.4%	25.802	34.278	24.7%	17:00:00	226.317	246.532	8.2%	43.729	51.924	15.8%
05:30:00	145.818	163.435	10.8%	26.004	34.467	24.6%	17:30:00	222.185	242.266	8.3%	40.782	49.013	16.8%
06:00:00	216.301	236.240	8.4%	42.469	50.720	16.3%	18:00:00	215.647	235.553	8.5%	42.567	50.809	16.2%
06:30:00	239.675	260.394	8.0%	47.303	55.497	14.8%	18:30:00	208.171	227.855	8.6%	40.699	48.981	16.9%
07:00:00	246.109	267.013	7.8%	49.555	57.703	14.1%	19:00:00	202.430	221.933	8.8%	39.647	47.948	17.3%
07:30:00	271.779	293.549	7.4%	52.796	60.911	13.3%	19:30:00	201.718	221.198	8.8%	37.529	45.855	18.2%
08:00:00	281.548	303.618	7.3%	54.434	62.511	12.9%	20:00:00	164.858	183.102	10.0%	30.803	39.204	21.4%
08:30:00	268.221	289.833	7.5%	53.757	61.834	13.1%	20:30:00	145.712	163.333	10.8%	25.883	34.353	24.7%
09:00:00	265.188	286.692	7.5%	52.867	60.950	13.3%	21:00:00	145.745	163.361	10.8%	26.776	35.231	24.0%
09:30:00	259.876	281.188	7.6%	51.495	59.584	13.6%	21:30:00	145.042	162.652	10.8%	27.124	35.587	23.8%
10:00:00	261.309	282.620	7.5%	52.012	60.061	13.4%	22:00:00	144.331	161.922	10.9%	28.538	36.989	22.8%
10:30:00	261.558	282.875	7.5%	49.805	57.877	13.9%	22:30:00	139.704	157.170	11.1%	26.525	35.019	24.3%
11:00:00	259.413	280.693	7.6%	50.704	58.791	13.8%	23:00:00	137.050	154.409	11.2%	26.573	35.054	24.2%
11:30:00	267.797	289.373	7.5%	51.908	59.991	13.5%	23:30:00	136.270	153.601	11.3%	25.851	34.340	24.7%

APPENDIX B – AVERAGED SATURDAY SAVINGS

Saturday

time	kW PO	kW BL		kVAr PO	kVAr BL			kW PO	kW BL		kVAr PO	kVAr BL	
00:00:00	149.688	167.481	10.6%	26.637	35.125	24.2%	12:00:00	275.673	297.501	7.3%	53.833	61.885	13.0%
00:30:00	147.717	165.463	10.7%	28.759	37.236	22.8%	12:30:00	266.718	288.291	7.5%	49.791	57.920	14.0%
01:00:00	141.521	159.044	11.0%	28.987	37.451	22.6%	13:00:00	262.376	283.821	7.6%	48.215	56.375	14.5%
01:30:00	142.788	160.378	11.0%	29.483	37.958	22.3%	13:30:00	270.985	292.677	7.4%	49.940	58.051	14.0%
02:00:00	145.960	163.650	10.8%	28.187	36.672	23.1%	14:00:00	264.340	285.829	7.5%	46.392	54.556	15.0%
02:30:00	143.870	161.502	10.9%	28.742	37.230	22.8%	14:30:00	253.642	274.829	7.7%	46.914	55.112	14.9%
03:00:00	144.087	161.705	10.9%	27.310	35.799	23.7%	15:00:00	265.042	286.608	7.5%	48.658	56.834	14.4%
03:30:00	142.578	160.110	10.9%	28.535	36.985	22.8%	15:30:00	263.163	284.635	7.5%	49.714	57.857	14.1%
04:00:00	143.016	160.563	10.9%	29.496	37.936	22.2%	16:00:00	256.473	277.743	7.7%	45.991	54.192	15.1%
04:30:00	140.805	158.280	11.0%	29.043	37.490	22.5%	16:30:00	243.028	263.849	7.9%	46.014	54.215	15.1%
05:00:00	139.058	156.457	11.1%	28.274	36.717	23.0%	17:00:00	227.171	247.451	8.2%	44.479	52.691	15.6%
05:30:00	147.308	164.967	10.7%	28.532	36.962	22.8%	17:30:00	220.897	240.984	8.3%	41.469	49.726	16.6%
06:00:00	195.143	214.391	9.0%	37.767	46.082	18.0%	18:00:00	219.085	239.132	8.4%	42.244	50.507	16.4%
06:30:00	249.993	271.069	7.8%	49.082	57.264	14.3%	18:30:00	208.194	227.898	8.6%	40.544	48.841	17.0%
07:00:00	255.734	276.938	7.7%	49.270	57.405	14.2%	19:00:00	205.153	224.757	8.7%	40.269	48.571	17.1%
07:30:00	275.301	297.199	7.4%	53.273	61.389	13.2%	19:30:00	199.525	218.921	8.9%	37.488	45.807	18.2%
08:00:00	280.230	302.242	7.3%	53.409	61.488	13.1%	20:00:00	156.632	174.645	10.3%	30.085	38.525	21.9%
08:30:00	271.016	292.737	7.4%	50.758	58.879	13.8%	20:30:00	155.851	173.817	10.3%	30.037	38.464	21.9%
09:00:00	278.366	300.294	7.3%	54.125	62.182	13.0%	21:00:00	157.067	175.090	10.3%	28.086	36.546	23.1%
09:30:00	270.895	292.582	7.4%	53.735	61.802	13.1%	21:30:00	155.437	173.404	10.4%	28.802	37.253	22.7%
10:00:00	269.050	290.671	7.4%	52.892	60.966	13.2%	22:00:00	159.646	177.834	10.2%	30.699	39.183	21.7%
10:30:00	257.720	278.968	7.6%	48.613	56.740	14.3%	22:30:00	153.953	171.905	10.4%	28.381	36.861	23.0%
11:00:00	256.392	277.609	7.6%	48.491	56.628	14.4%	23:00:00	150.567	168.361	10.6%	29.686	38.120	22.1%
11:30:00	268.241	289.816	7.4%	51.357	59.435	13.6%	23:30:00	148.307	166.056	10.7%	26.623	35.112	24.2%

APPENDIX C – AVERAGED SUNDAY SAVINGS

Sunday

time	kW PO	kW BL		kVAr PO	kVAr BL			kW PO	kW BL		kVAr PO	kVAr BL	
00:00:00	155.853	173.870	10.4%	30.241	38.701	21.9%	12:00:00	247.758	268.724	7.8%	48.466	56.631	14.4%
00:30:00	152.939	170.853	10.5%	28.887	37.358	22.7%	12:30:00	241.020	261.778	7.9%	45.324	53.536	15.3%
01:00:00	149.129	166.930	10.7%	28.238	36.726	23.1%	13:00:00	246.767	267.738	7.8%	45.513	53.737	15.3%
01:30:00	150.385	168.236	10.6%	28.904	37.391	22.7%	13:30:00	245.045	265.935	7.9%	48.418	56.593	14.4%
02:00:00	149.668	167.489	10.6%	23.096	31.643	27.0%	14:00:00	239.863	260.556	7.9%	45.156	53.351	15.4%
02:30:00	147.852	165.590	10.7%	28.736	37.205	22.8%	14:30:00	230.162	250.578	8.1%	43.588	51.834	15.9%
03:00:00	152.857	170.806	10.5%	29.135	37.628	22.6%	15:00:00	225.336	245.624	8.3%	45.222	53.473	15.4%
03:30:00	152.169	170.069	10.5%	31.353	39.805	21.2%	15:30:00	219.649	239.744	8.4%	46.189	54.427	15.1%
04:00:00	156.674	174.667	10.3%	29.905	38.333	22.0%	16:00:00	218.962	239.026	8.4%	45.245	53.488	15.4%
04:30:00	151.150	168.947	10.5%	29.920	38.340	22.0%	16:30:00	215.044	234.947	8.5%	41.661	49.924	16.6%
05:00:00	145.039	162.618	10.8%	27.217	35.658	23.7%	17:00:00	207.898	227.533	8.6%	41.832	50.074	16.5%
05:30:00	150.091	167.818	10.6%	29.460	37.862	22.2%	17:30:00	208.404	228.095	8.6%	40.168	48.455	17.1%
06:00:00	203.739	223.261	8.7%	40.395	48.672	17.0%	18:00:00	208.460	228.178	8.6%	41.921	50.206	16.5%
06:30:00	249.505	270.512	7.8%	51.298	59.418	13.7%	18:30:00	200.626	220.084	8.8%	40.668	48.969	17.0%
07:00:00	253.059	274.227	7.7%	49.482	57.651	14.2%	19:00:00	203.878	223.447	8.8%	39.825	48.137	17.3%
07:30:00	277.231	299.190	7.3%	52.292	60.417	13.4%	19:30:00	201.041	220.482	8.8%	36.953	45.275	18.4%
08:00:00	229.685	250.083	8.2%	42.859	51.112	16.1%	20:00:00	161.853	179.961	10.1%	29.736	38.125	22.0%
08:30:00	260.039	281.439	7.6%	50.426	58.583	13.9%	20:30:00	148.013	165.702	10.7%	25.233	33.704	25.1%
09:00:00	254.192	275.340	7.7%	46.803	54.963	14.8%	21:00:00	150.057	167.863	10.6%	26.847	35.333	24.0%
09:30:00	249.498	270.456	7.7%	49.742	57.846	14.0%	21:30:00	146.163	163.862	10.8%	26.279	34.788	24.5%
10:00:00	250.245	271.259	7.7%	49.603	57.730	14.1%	22:00:00	147.192	164.904	10.7%	25.798	34.297	24.8%
10:30:00	246.060	266.956	7.8%	47.064	55.235	14.8%	22:30:00	139.280	156.719	11.1%	26.387	34.874	24.3%
11:00:00	243.925	264.759	7.9%	46.238	54.424	15.0%	23:00:00	138.987	156.433	11.2%	24.039	32.564	26.2%
11:30:00	242.381	263.153	7.9%	46.075	54.256	15.1%	23:30:00	135.185	152.472	11.3%	24.703	33.199	25.6%