CASE STUDY

REFRIGERATED WAREHOUSE - ARIZONA

Post Installation Analysis of

TruWatts®

MARCH 2022

BACKGROUND

Basic Power's electrical contractor, Glenn Plencner of the Illinois based RLP Group, visited this site in August 2021 to perform a site inspection and to confirm his initial TruWatts® unit sizing and placement decisions that were based upon 12 months of utility billing data. The RLP Group recommended that four 480-3 units should be installed on this service.

Utility Metering

Basic Power, Inc. obtained 2021 utility billing data to assess this project and estimate a technology solution.

This location has one electric utility service supplied by [redacted]

Energy Demand

Energy Demand is a measure (kW) of the rate of power consumed by a facility at any given moment. Utilities plan for the maximum value and usually arrive at this figure by averaging the highest fifteen minutes of consumption in every month. Utilities are required to provide the maximum kW when it is needed and hold this power in reserve until the facility's electrical load calls for it. There is a charge for this reserved power.

Energy Usage

Energy usage, measured in kilowatts per hour (kWh), is the total amount of power consumed over time.

Power Factor

Power Factor (PF) is a measure of efficiency stated as a number between 1 and 0. PF is impacted by the relationship of the Voltage and Current waveforms. When both are aligned, the PF is 1 (Unity), and an electrical current can flow in the system without obstruction and is 100% Real (Active) Power (kW) which is totally consumed by the load. As the waveforms diverge, the PF is lowered, and the amount of current required to operate the load increases. The percentage of Real (usuable) Power in a system decreases as the Reactive (non-usuable) Power (kVAR) increases. PF is affect by inductive motors, where voltage and current waveforms move them apart, by solar inverters that feed Active Power into the grid where the level of Reactive Power is fixed by the utility, and also by harmonic currents generated by non-linear loads such as LED lighting and digital devices.

Apparent Power (KVA)

Apparent power is the full sum of the Active Power (KW) and Reactive Power (KVAR) supplied by the Utility company

Reactive Power (KVAR)

Reactive power occurs when the phase angle between Voltage and Current becomes misaligned in the operation of inductive loads, such as motors. Additional current is needed to carry the reactive power and this increases line losses. TruWatts compensates for Reactive Power by supplying it from the stored capacitive power in its internal capacitor array and therefore reduces the line losses and the associated lost energy.

POST INSTALLATION ANALYSIS

Data for the Baseline and Comparison Periods was collected by the RLP Group utilizing a utility-grade Dranetz Power Meter connected to the Main Distribution Panel for this electrical load.

Electrical loads vary over time. To make an accurate assessment, the Baseline and Comparison periods must be of equal lengths during similar operational activity and sampling periods should be adjacent to each other.

RLP Group have supplied the full Dranetz Power Quality Report and the associated raw data for the baseline and comparison periods, and this is available for engineering review.

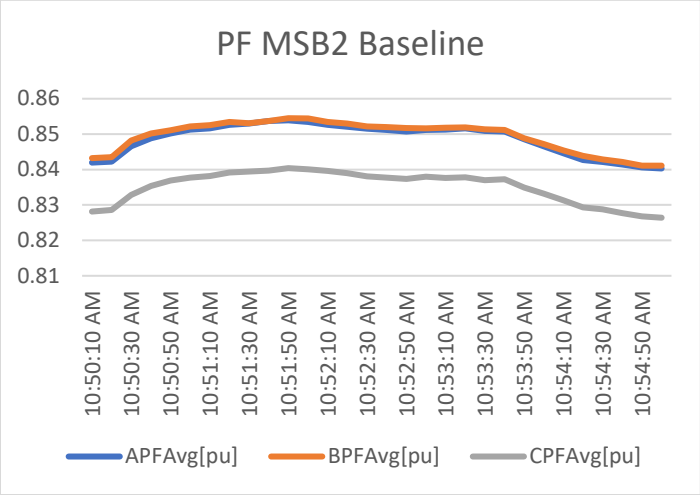
SUMMARY - MSB2

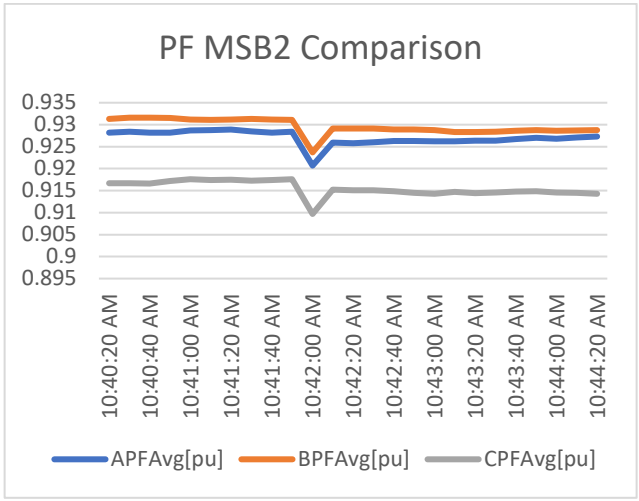
Please note that this is a spot assessment and intended to show the average anticipated power quality and energy efficiency improvements at this facility. All values are averaged values over the duration of the test. All assumptions on savings are based upon historical values taken from the latest utility billing data in the period Feb 2021 to Jan 2022. It is assumed that the energy profile and consumption patterns at the facility will remain the same as in the observed historical trends. ***Note: This M&V was conducted in March where power usage is low and therefore energy saving potential is also at its lowest level.***

Four 480-3 TruWatts® units are installed on this load.

Power Factor – System Efficiency

Power Factor	**TruWatts OFF** (Baseline)	**TruWatts ON** (Comparison)
Phase A	0.849	0.927
Phase B	0.850	0.930
Phase C	0.834	0.915
Average	**0.845**	**0.901**
Difference		0.056
% Difference		9.34%





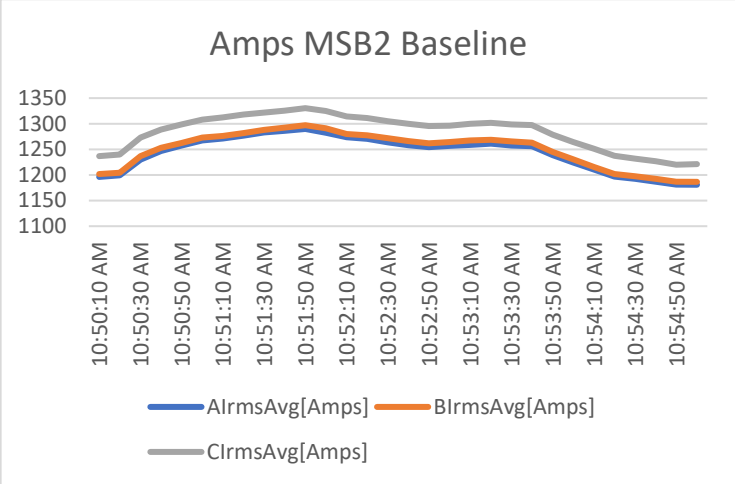
The efficiency of the Power Factor is measured as a value between 0 and 1, with 1 being the highest efficiency representing power that is 100% consumed by the load. Values below 1 (Unity) indicate that additional power is being drawn by the facility to overcome inefficiencies in the electrical system where voltage and current phases are not aligned correctly.

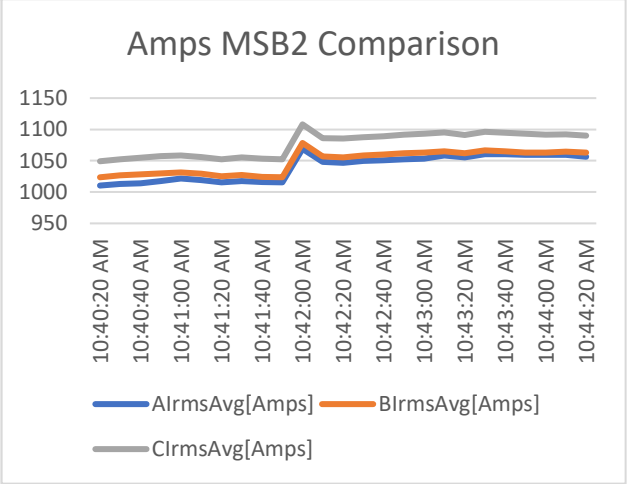
The Salt River Project levies a Power Factor Penalty Fee of approximately $9000 per year for this facility due to an average facility power factor of .84. This fee is to compensate for the utility's need to supply additional amperage to overcome the inefficiency existing in the system when the phase angle between voltage and current is distorted by inductive loads (motors and compressors) and/or high harmonic currents.

By improving the power factor to 9.0 there is a potential saving of approximately $9000 from the removal of the utility power factor penalty fee.

Amperage – Current over 5 Minutes

Running Amps	**TruWatts OFF** (Baseline)	**TruWatts ON** (Comparison)
Phase A	1245.8	1040.5
Phase B	1252.2	1049.0
Phase C	1286.5	1077.2
Total	**3784.5**	**3166.7**
Difference		-618 Amps
% Difference		16.32%

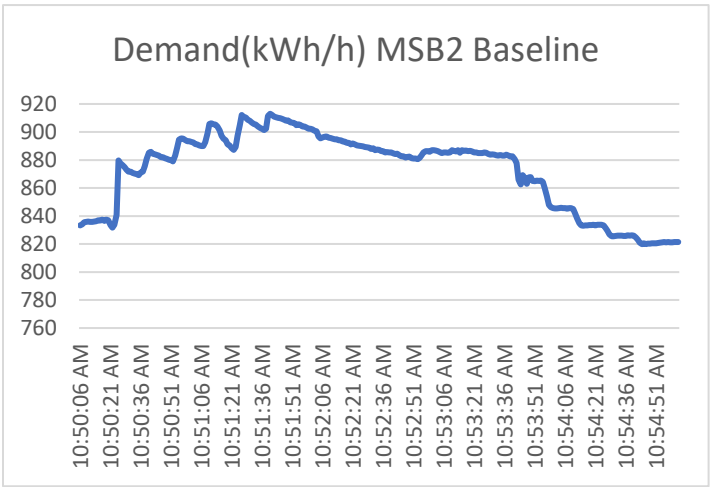


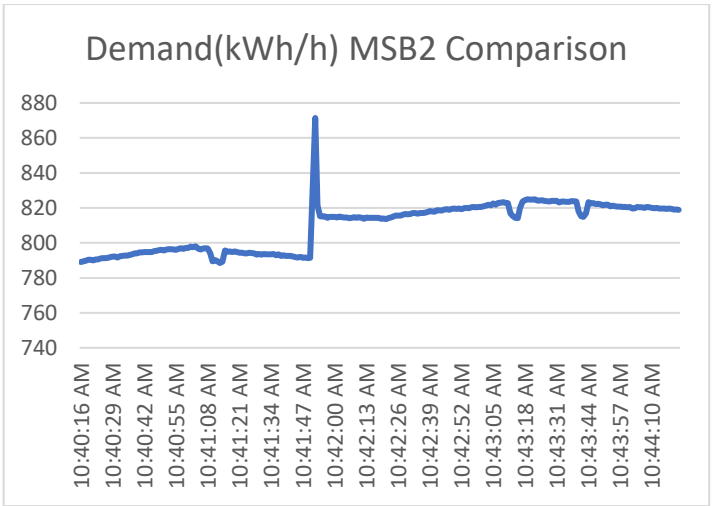


The reduction in amperage is a direct result of the improvement of the Power Factor as the TruWatts® compensates for the Reactive Power and realigns the phase angles between Voltage and Current.

KW – Demand

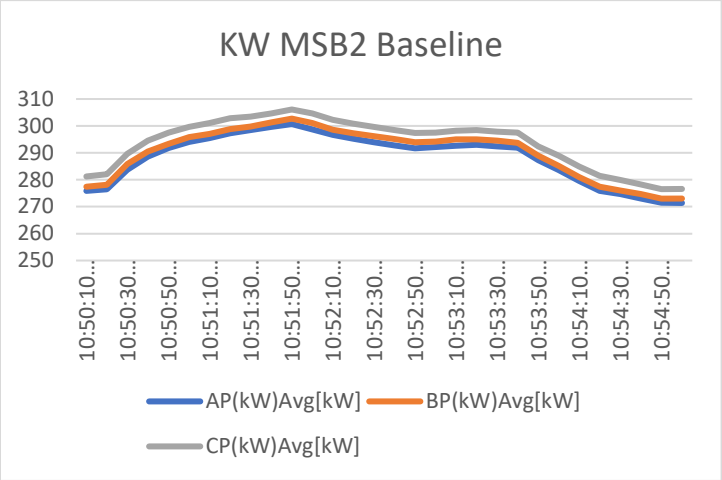
KW- Demand	**TruWatts OFF** (Baseline)	**TruWatts ON** (Comparison)
Average Total Demand	872.8	810
Total	**8.72.8**	**810**
Difference		-62.8 kW
% Difference		7.19%

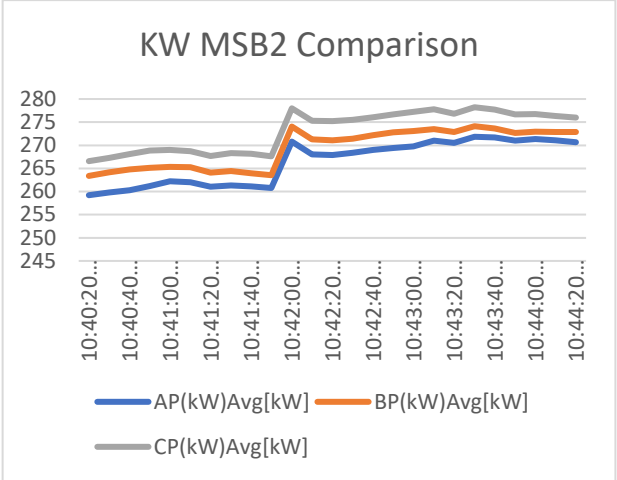




The reduction in kW Demand is a result of lower current and kWh which in turn reduces the peak kW demand upon which the monthly utility demand charge is based.

KWH – Active Power	**TruWatts OFF** (Baseline)	**TruWatts ON** (Comparison)
Phase A	288.93	266.56
Phase B	290.76	269.48
Phase C	294.42	273.23
Total	**874.1**	**809.30**
Difference		-64.8 kW
% Difference		7.41%





The reduction in kWh is a result of lower current which in turn reduces energy lost as heat in cables, connectors, and components. These losses are identified as IR^2 losses.

KVA – Apparent Power	**TruWatts OFF** (Baseline)	**TruWatts ON** (Comparison)
Phase A	340.3	287.54
Phase B	342.1	289.92
Phase C	352.4	298.48
Total	**1034.8**	**875.9**
Difference		-176.9
% Difference		15.35%

The reduction in KVA (Real Power) is a result of the Reactive Power compensation (KVAR) injected into the electrical system by the TruWatts unit(s).

KVAR – Reactive Power	**TruWatts OFF** (Baseline)	**TruWatts ON** (Comparison)
Phase A	178.43	106.61
Phase B	177.67	104.24
Phase C	190.31	116.80
Total	**546.4**	**327.7**
Difference		218.7
% Difference		40.02%

The reduction in KVAR (Reactive Power) in the system is due to the capacitive correction of the TruWatts unit(s).

CONCLUSION

Basic Power, Inc. conducted a comprehensive Power Quality survey at the large cold food storage facility in Arizona. Our assumptions as to the low power factor existing at this plant, based upon industry type and review of utility billing, were confirmed by the data collected. A PQ solution was designed to improve the power factor to the point at which the PF penalty was removed by the utility and to provide expanded system capacity and a reduction in kW and kWh. An additional engineering assessment was conducted to confirm the projected cost savings.

Costs savings, due to the optimization of the power quality of the electrical system within this facility, generated enough revenue to offset the cost of the TruWatts® technology installation in [redacted] months.

ENGINEERING ASSESSMENT

An engineering assessment was undertaken by Basic Power's in-house Electrical Engineer to review the values in the observed M&V data and compare them to standard mathematical models for calculating power factor improvements, amperage reduction, IR2 line loss reduction and potential kWh savings:

Engineering calculations correlate with values observed in the M&V test conducted by RLP Group at this location.

PHOENIX AZ MAIN SWITCH BOARD (MSB)2				
Base Line		4x480-3		4x480-3	
	Base Line	Eng. Calculation	%	M&V Observation	%
PF	0.85	0.93274	10%	0.924	9%
Amps	1261	1021	19%	1055.566667	16%
kW	874.1	810.1	7%	809.3	7%
kWH	872.8	808.8	7%	810	7%
kVAr	546	330	40%	327.7	40%
kVA	1035	874.7353943	15%	875.9	15%