# FACILITY REPORT

## ENERGY CONSUMPTION & COST SAVINGS REVIEW

**Facility:**

Winchester, Virginia Mfg. Plant

# Project Summary

During the initial meeting with Customer's facility management, our engineers demonstrated the technology with several objectives in mind;

- To reduce the amount of electricity consumed in the Customer plant.
- To reduce their monthly cost of electricity.
- To reduce the maintenance, repair, and replacement costs of the inductive motors used in the plant.

Once an agreement was reached with Customer, our engineers began addressing the needs described above. Our engineers began the engagement by identifying each electrical circuit in the building for preparing the proper installation plan for the facility. Documenting each circuit in the plant for type of load is important in order to lay out the strategic plan for incorporating our current-balancing technology throughout the plant.

- Our engineers have conducted a performance evaluation and technical assessment of the inductive equipment in the building.
- Our engineers then evaluated the engineering data collected in the plant and performed a financial analysis of the information generated during the building assessment.
- Our engineers reviewed the financial projections to determine the rationale for creating a custom installation plan for installing our Power Systems in the facility.

Once an installation plan was devised, our engineers began reviewing the facility-wide installation plan with the appointed electrical contractors. Our engineers and appointed electricians began the installation of our equipment onto the identified circuits in the facility. We completed the installation process for PHASE 1 of 3 PHASES in the plant onto the identified circuits for current balancing of the electrical circuits connected to each of their injection mold equipment in the plant.

Although the Customer project was structured into a 3-PHASE project, the results of PHASE 1 recognized a noticeable improvement in the electricity consumption for the plant. The following case study has been prepared to present the methodologies and scope of the Customer (Winchester, VA) plant project. Our technology solution has produced compelling and measurable results as outlined in this Case Study.

# Project Objectives

In order to detail our entire engineering approach, the primary aim of this project was to provide a comprehensive overview of the energy savings and energy management strategies for Customer Commercial Products, Inc.. To better explore the nature of energy management strategies in the study area, the project also investigated the barriers to and the driving forces for the implementation of our proprietary current-balancing technology and engineering protocols, along with calibrated energy efficiency measure.

Specifically, this Case Study was aimed to:

- Study energy efficiency and management strategies/measures undertaken in the Customer (Winchester) plant.
- Study the major energy efficiency barriers and driving forces prevailing in the Customer (Winchester) plant.
- Identify measures that can help reduce the energy usage in the Customer (Winchester) plant.
- Identify measures that can help improve energy management to bridge the present energy efficiency gap.

# Our Methodology for Customer

This research analyzed the level of implementation of our Current-Balancing technology and energy management and efficiency in the plant. It provides comprehensive information about the operating characteristics of equipment used and the electrical circuit's power quality condition in the facility derived from both primary and secondary sources from each of the main transformers in the plant.

The technology approach involved a much more scientific approach than traditional power factor correction technologies. The power factor correction approach was originally considered a temporary approach to fixing existing power quality concerns but was never designed as a permanent fix. Before providing an effective solution toward reducing the electrical demand in a facility, a qualified engineer must be able to adhere to a specific protocol designed to identify inefficiencies in an electrical circuit for contributing to the overall reduction in energy usage for saving money on their monthly electric bill.

Our technology leverages current-balancing technique that applies both electrical and RF principles for the purpose of signal tuning at the 6o-hertz frequency for improving current-flow under load conditions.

In order to improve efficient current flow for current-balancing at 60-hertz, tuning under load conditions were performed in parallel on each identified circuit of the electrical system. The reactive energy created in the inductive loads was caused by a multitude of factors between the power being supplied and the demand required from the equipment. Higher, but unnecessary reactive energy loads from the equipment have a tendency of amplifying the effects of 3, 5, 7 and 11 harmonic levels causing additional resistance on the line for disrupting current flow within the equipment, resistive loads and the returning power.

Electrical principles and calculations alone only present a narrow view of the overall consumption of energy. Additional RF principles were applied to achieve proper current-balancing at the desired frequency.

PHASE 1 of Customer’s projected 3-PHASE project has been completed. In Phase 1, our equipment was installed on specific identified circuits with the results shown in detail on the Comprehensive Energy Saving Report. *(Available on request)*.

The methods used in this case study are comprehensive and qualitative, tailored to answer and satisfy both the goals and research questions. The applied technology used in the project employs proprietary tuning technologies capable of balancing current-flow under load conditions, at the 60-hertz frequency, for reducing energy consumption in any 3-phase electrical system.

Our technology hardware and software solutions provided the driving force for ideal energy efficiency implementation.

# Project Scope and Definitions

Our approach was to identify the measure of useful energy output versus energy input with the Client, and it consisted of four (4) Levels or identifying factors that were evaluated: Applied Technology, User Equipment, Equipment Operation Efficiency, and Electrical System Performance.

> ***LEVEL 1: ELECTRICAL SYSTEM PERFORMANCE:*** *Electrical System Performance is the electrical system measure of energy efficiency which is determined by external but deterministic system indicators such as energy usage, production, cost, energy sources, environmental impact and technical indicators amongst others.*
>
> ***LEVEL 2: EQUIPMENT OPERATION EFFICIENCY:*** *Equipment Operation efficiency is a system-wide measure which is evaluated by considering the proper coordination of different system components. This coordination of system components consists of the physical, time, and human coordination parts. Operation efficiency has the following indicators: physical coordination indicators (sizing and matching); time coordination indicator (time control); and human coordination.*

***LEVEL 3: USER EQUIPMENT:*** *User Equipment efficiency is a measure of the energy output of isolated individual energy equipment with respect to given technology design specifications. The equipment efficiency is usually considered being separated from the system and having little interactive effect to other equipment or system components. Equipment efficiency is evaluated by considering the following indicators: capacity; specifications and standards; constraints; and maintenance. Equipment efficiency is specifically characterized by its standardization and constant maintenance.*

***LEVEL 4: APPLIED TECHNOLOGY:*** *Applied Technology for energy efficiency is a measure of efficiency of energy conversion, processing, transmission, and usage; and it is often measured by natural laws such as the energy conservation law. Applied Technology efficiency is often evaluated by the following indicators: feasibility; lifecycle cost and return on investment; and coefficients in the conversing/ processing/transmitting rate.*

Our technology and software solution was a deciding factor to equipment, operation, and performance efficiencies. The deterministic relationships between each further decomposed our 4-Level approach to energy efficiency.

# Project Activities

**Bill Analytics**

Our proposed energy management program consisted of three processes: energy auditing, energy targeting, and energy planning to begin. We have deployed Bill Analytics process to profile energy consumption and to identify the energy saving opportunities in the plant. Through this process, a rough objective or target such as possible percentage of energy savings or energy efficiency improvement was figured out. The process to determine such a reasonable energy efficiency improvement target is called energy targeting as used in our Bill Analytics. The Bill Analytics and planning process focused on the detailed energy efficiency improvement plans and it included energy policy support, organization structures and implementations. There were no clear-cut boundaries among energy auditing, energy targeting and energy planning since this approach was customized for Customer, depending on their electricity usage and size of facility. Below is the actual Bill Analytic generated from Customer's electric bill for establishing a project 'baseline' for the facility.

## *Figure 1: Actual Customer Bill Analytic*

XECO ENERGY CORPORATION

ENERGY CONSUMPTION ANALYTIC

### SUMMARY CONCLUSION FROM ELECTRIC BILL ANALYSIS

Estimated Savings Analysis from Client's Electric Bill

| | | XECO Savings Breakdown | Estimated Bill with Xeco Savings |
|---|---|---|---|
| **Month End Charge:** | **$403,463.82** | | |
| **Customer Charge** | $124.95 | | |
| Var Dist Charge - Energy | $4,024.11 | **$321.93** | |
| Var Dist Charge - Demand | $2,147.04 | **$171.76** | |
| Var Dist Charge - RKVA | $1,839.31 | **$294.29** | |
| Supply Charges - Energy | $130,573.37 | **$13,057.34** | |
| Power Supply Demand | $72,897.12 | **$6,560.74** | |
| WPA Fuel Adj | $152,980.39 | **$13,768.24** | |
| Rider OD12-Q | $38,740.61 | **$3,099.25** | |
| Rider OD12 | -$4,985.22 | **-$548.37** | |
| Security Lights (162 kWH) | $18.43 | | |
| Energy Data Service | $29.95 | | |
| City of Winchester Utility Tax | $117.70 | | |
| VA Consumption Tax | $4,457.54 | | |
| Sales & Use Surcharge | $498.52 | | |
| **Total Itemized Charges:** | **$403,463.82** | **$36,725.17** | **$366,738.65** |

| | | |
|---|---|---|
| **Estimated XECO % Savings:** | **9.10%** | |
| **Estimated Annual Savings:** | **$440,702.03** | |
| *Estimated Cost for XECO Equipment:* | *$379,255.99* | |
| *Estimated Cost for Parts & Installation:* | *$39,956.16* | |
| *Project Management/Engineering/Metering Fees:* | *$18,962.80* | Estimated Xeco Units |
| **Total Estimated Cost of Project:** | **$438,174.95** | **131** |
| **Estimated Client R.O.I. (Months):** | **12** | |

| | |
|---|---|
| Estimated CO2 Reduction in Facility (Metric Tons): | 5,596 |

*Note: CO2 calculations are based on EPA calculations*

**Walk-thru and Engineering Evaluation**

Our ‘Walk-Through’ and Engineering Evaluation is a complete energy evaluation process and serves as a guide for preparing the most optimum energy saving and energy efficiency program for Customer. Our complete engineering evaluation was structured into four levels: conceptual level, active level, technical level, and engineering level.

- **CONCEPTUAL LEVEL:** The conceptual level energy management is characterized by ‘identification’ as most of the activities involved are simple but effective identification which can be roughly analogized as the ‘80–20’ rule implying a 20% effort with a 80% savings in the areas of Customer’s electric bill where our technology can be most effective. This kind of identification is often finished by our Certified Project Manager through analyzing the energy system components and energy consumption utility data, even without adding more meters for data collection and thorough data statistics and analysis.

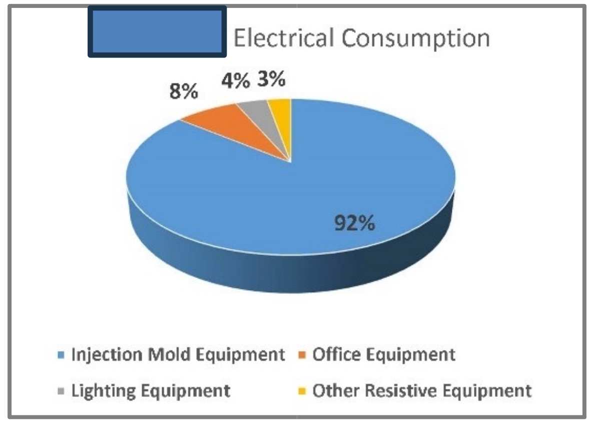
- **ACTIVE LEVEL:** The active level of energy management implies that further effort other than the ‘80–20’ rule must be applied, and often existing energy data may not be enough and additional metering is needed. After collecting enough data, the previously established conceptual energy management strategies will be improved and validated, therefore, this stage is featured by ‘validation’.

- **TECHNICAL LEVEL:** The technical level of energy management is featured by the implementation of the initiatives and the verification of the claimed energy savings that is included in our hardware and software technology solution; system retrofitting, automation and control; metering; creating a baseline; monitoring, evaluating, calculating energy usage; and verifying saving targets.

- **ENGINEERING LEVEL:** The engineering level of energy management involves advanced energy system modelling, benchmarking/baselining, and optimization. The engineering level in its content may overlap with the technical level at the strategic level, but it is often used to provide a technical viability analysis and circuit identification for the Customer’s electrical system. Making dedicated engineering comparisons, combinations, and optimization of technical solutions may be included in this level.

**Installation Process**

Before preparing for the installation process, our engineers determined specific circuits in the facility and the proportionate loads that make up the total load consumption of the facility. The Figure 2 chart represents the approximate load consumption measured for Customer, Winchester, Virginia plant. The Injection Molding Equipment in the facility represents approximately 92% of the total load consumption. Our Energy Management Solution (PHASE 1) was primarily focused on the specific circuits encompassing the injection mold equipment.

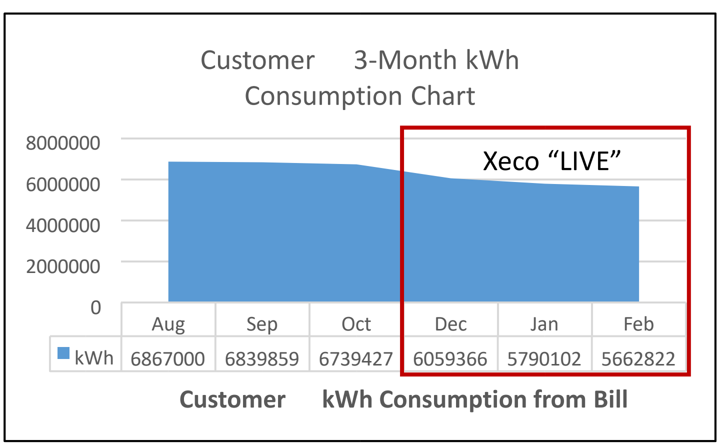



**Post Installation Meeting**

The post installation metering process was performed on each identified circuit after the installation and current-balance process was completed in the Customer (Winchester) facility. *(See Comprehensive Engineering Report for complete details and metering data)*

**Final Engineering Report Preparation and Evaluation**

Following the results of energy data analysis, installation and Post Installation Metering, **Figure 3** is obtained to show the payback periods and the corresponding percentage savings of a 'Before' and 'After' for energy consumption resulting from Customer's facility-wide retrofit of our technology hardware and software solutions. For the purpose of financial viability, Customer prioritizes the implementation of the initiatives with payback periods not exceeding 15-months. **Figure 3** and **Figure 3a** below illustrates a 14.35% reduction in kilowatt hour usage (kWh).



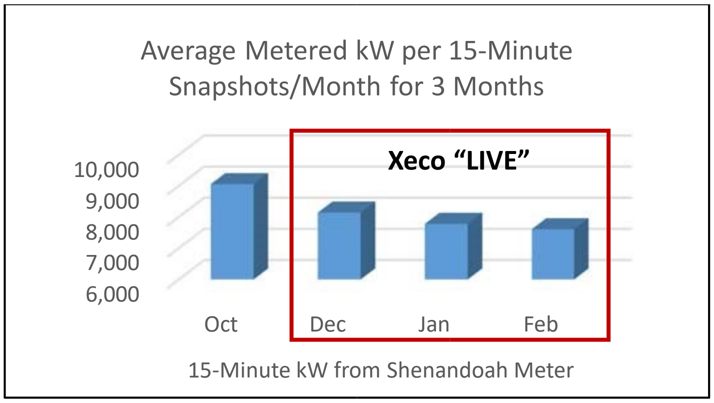



*Figure 3a: Shenandoah Meter Data Chart*

Our hardware equipment and software solution are the main technology used in the program and are the relevant items purchased and installed. Listed below are the identified circuits for the Customer Project. In ***Figure 3***, each circuit has been meter tested for Peak Amp Draw 'Before' and 'After', on each identified circuit in the facility. The measurements below are calculated against the 'Original Peak Amp Draw' from the original client's electric bill.

***Figure 3: Circuit Amp Draw Measurement***

| Traced Switch Gear | Mach ID Circuit # | (BEFORE) Peak Amp Draw | (AFTER) Peak Amp Draw | XECO400 | XECO600 | Amp Savings |
|---|---|---|---|---|---|---|
| 16 | M01 | 497.31 | 441.72 | 0 | 2 | 55.59 |
| 16 | M02 | 188.02 | 161.60 | 0 | 2 | 26.42 |
| 16 | M03 | 207 | 178.58 | 0 | 1 | 28.42 |
| 16 | M04 | 376 | 329.98 | 0 | 1 | 46.02 |
| 16 | M05 | 186 | 161.09 | 0 | 1 | 24.91 |
| 16 | M06 | 188.02 | 163.12 | 0 | 1 | 24.90 |
| 16 | M07 | 192 | 167.89 | 0 | 1 | 24.11 |
| 16 | M08 | 130.2 | 112.81 | 2 | 0 | 17.39 |
| 16 | M09 | 225 | 169.51 | 0 | 1 | 55.49 |
| 16 | M10 | 254.6 | 224.53 | 0 | 1 | 30.07 |
| 15 | M11 | 315 | 277.91 | 0 | 2 | 37.09 |
| 9 | M12 | 319.45 | 291.96 | 0 | 2 | 27.49 |
| 13 | M13 | 252.6 | 211.71 | 0 | 1 | 40.89 |
| 12 | M14 | 277.68 | 245.46 | 0 | 1 | 32.22 |
| 17 | M15 | 428.19 | 384.80 | 0 | 2 | 43.39 |
| 16 | M16 | 376.1 | 336.72 | 0 | 1 | 39.38 |
| 12 | M17 | 240 | 208.48 | 0 | 1 | 31.52 |
| 17 | M18 | 483.2 | 443.04 | 0 | 2 | 40.16 |
| 17 | M19 | 288 | 246.96 | 0 | 1 | 41.04 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 13 | M20 | 324.58 | 295.01 | 0 | 1 | 29.57 |
| 3 | M21 | 306.5 | 276.58 | 0 | 1 | 29.92 |
| 12 | M22 | 267 | 239.98 | 0 | 1 | 27.02 |
| 17 | M23 | 368 | 319.76 | 0 | 1 | 48.24 |
| 17 | M24 | 271 | 239.60 | 0 | 1 | 31.40 |
| 17 | M25 | 386.45 | 341.50 | 0 | 1 | 44.95 |
| 17 | M26 | 386 | 354.63 | 0 | 1 | 31.37 |
| 3 | M27 | 395 | 338.75 | 0 | 2 | 56.25 |
| 16 | M28 | 233 | 211.71 | 0 | 1 | 21.29 |
| 18 | M29 | 602.3 | 543.57 | 0 | 2 | 58.73 |
| 1 | M30 | 431 | 384.80 | 0 | 2 | 46.20 |
| 15 | M31 | 236 | 213.15 | 0 | 1 | 22.85 |
| 15 | M32 | 481 | 435.90 | 0 | 2 | 45.10 |
| 18 | M33 | 255 | 236.14 | 0 | 1 | 18.86 |
| 0 | M34 | 348 | 293.68 | 0 | 1 | 54.32 |
| 4 | M35 | 282 | 243.45 | 0 | 2 | 38.55 |
| 5 | M36 | 342 | 288.87 | 0 | 2 | 53.13 |
| 6 | M37 | 412.3 | 376.02 | 0 | 1 | 36.28 |
| 6 | M38 | 330 | 296.10 | 0 | 1 | 33.90 |
| 11 | M39 | 329 | 282.32 | 0 | 1 | 46.68 |
| 5 | M40 | 423 | 370.27 | 0 | 2 | 52.73 |
| 9 | M41 | 145 | 121.96 | 0 | 1 | 23.04 |
| 10 | M42 | 284.62 | 256.79 | 0 | 1 | 27.83 |
| 10 | M43 | 224 | 172.35 | 0 | 1 | 51.65 |
| 9 | M44 | 318.46 | 289.71 | 0 | 1 | 28.75 |
| 9 | M45 | 507 | 435.82 | 0 | 2 | 71.18 |
| 10 | M46 | 294.2 | 252.43 | 0 | 2 | 41.77 |
| 15 | M47 | 623 | 572.22 | 0 | 3 | 50.78 |
| 15 | M48 | 492 | 446.34 | 0 | 3 | 45.66 |
| 15 | M49 | 765.1 | 677.77 | 0 | 3 | 87.33 |
| 15 | M50 | 538 | 419.47 | 0 | 3 | 118.53 |
| 15 | M51 | 617 | 544.75 | 0 | 3 | 72.25 |
| 10 | M52 | 758 | 672.40 | 0 | 5 | 85.60 |
| 10 | M53 | 412 | 362.84 | 0 | 3 | 49.16 |
| 10 | M54 | 627 | 444.21 | 0 | 4 | 182.79 |
| 5 | M55 | 64.3 | 48.65 | 2 | 0 | 15.65 |
| 1 | M56 | 63.34 | 48.65 | 2 | 0 | 14.69 |
| 10 | M57 | 117.6 | 87.93 | 3 | 0 | 29.67 |
| 17 | M58 | 96.27 | 81.43 | 2 | 0 | 14.84 |
| 17 | M59 | 108 | 81.43 | 2 | 0 | 26.57 |
| 0 | M60 | 66.5 | 59.51 | 2 | 0 | 6.99 |
| 17 | M61 | 66.5 | 58.12 | 2 | 0 | 8.38 |
| 10 | M62 | 88.4 | 68.43 | 3 | 0 | 19.97 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **0** | M63 | | 0.00 | 0 | 0 | 0 |
| **0** | M64 | | 0.00 | 0 | 0 | 0 |
| **0** | M65 | | 0.00 | 0 | 0 | 0 |
| **0** | M66 | | 0.00 | 0 | 0 | 0 |
| **0** | M67 | | 0.00 | 0 | 0 | 0 |
| **0** | M68 | | 0.00 | 0 | 0 | 0 |
| **0** | M69 | | 0.00 | 0 | 0 | 0 |
| **0** | M70 | | 0.00 | 0 | 0 | 0 |
| **0** | M71 | | 0.00 | 0 | 0 | 0 |
| **0** | M72 | | 0.00 | 0 | 0 | 0 |
| **0** | M73 | | 0.00 | 0 | 0 | 0 |
| **0** | M74 | | 0.00 | 0 | 0 | 0 |
| **0** | M75 | | 0.00 | 0 | 0 | 0 |
| **0** | M76 | | 0.00 | 0 | 0 | 0 |
| **0** | M77 | | 0.00 | 0 | 0 | 0 |
| **0** | M78 | | 0.00 | 0 | 0 | 0 |
| **0** | M79 | | 0.00 | 0 | 0 | 0 |
| **0** | M80 | | 0.00 | 0 | 0 | 0 |
| **0** | M81 | | 0.00 | 0 | 0 | 0 |
| **0** | M82 | | 0.00 | 0 | 0 | 0 |
| **0** | M83 | | 0.00 | 0 | 0 | 0 |
| **16** | M84 | 2341.40 | 2195.76 | 0 | 2 | 145.64 |
| **0** | M85 | | 0.00 | 0 | 0 | 0 |
| **0** | M86 | | 0.00 | 0 | 0 | 0 |

| **Original Peak Amp Draw** | **NEW Peak Amp Draw** | **Total Amp Draw Savings** |
|---|---|---|
| **20,110** | **17,397** | **2,713** |

**<u>Note:</u>** Circuits M63 – M83 and Circuits M85 – M86 were not addressed in the Case Study which represents additional circuits and Switch Gears in the facility that will be included in a future installation.

***Figure 5*** represents each Identified Trace Circuits for the Xeco Project and includes the proportionate share breakdown of each circuit, for totaling the facility's entire electrical circuit.

**Figure 5; Identified Trace Circuits**

| Circuit (Switch Gear) | Identifier (Trace ID) | % Amp Draw (Facility) | % Amp Draw Reduction | Circuit (Switch Gear) | Identifier (Trace ID) | % Amp Draw (Facility) | % Amp Draw Reduction |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 16 | M01 | 2.47% | 11.18% | 0 | M34 | 1.73% | 15.61% |
| 16 | M02 | 0.93% | 14.05% | 4 | M35 | 1.40% | 13.67% |
| 16 | M03 | 1.03% | 13.73% | 5 | M36 | 1.70% | 15.54% |
| 16 | M04 | 1.87% | 12.24% | 6 | M37 | 2.05% | 8.80% |
| 16 | M05 | 0.92% | 13.39% | 6 | M38 | 1.64% | 10.27% |
| 16 | M06 | 0.93% | 13.24% | 11 | M39 | 1.64% | 14.19% |
| 16 | M07 | 0.95% | 12.56% | 5 | M40 | 2.10% | 12.47% |
| 16 | M08 | 0.65% | 13.36% | 9 | M41 | 0.72% | 15.89% |
| 16 | M09 | 1.12% | 24.66% | 10 | M42 | 1.42% | 9.78% |
| 16 | M10 | 1.27% | 11.81% | 10 | M43 | 1.11% | 23.06% |
| 15 | M11 | 1.57% | 11.77% | 9 | M44 | 1.58% | 9.03% |
| 9 | M12 | 1.59% | 8.61% | 9 | M45 | 2.52% | 14.04% |
| 13 | M13 | 1.26% | 16.19% | 10 | M46 | 1.46% | 14.20% |
| 12 | M14 | 1.38% | 11.60% | 15 | M47 | 3.10% | 8.15% |
| 17 | M15 | 2.13% | 10.13% | 15 | M48 | 2.45% | 9.28% |
| 16 | M16 | 1.87% | 10.47% | 15 | M49 | 3.80% | 11.41% |
| 12 | M17 | 1.19% | 13.13% | 15 | M50 | 2.68% | 22.03% |
| 17 | M18 | 2.40% | 8.31% | 15 | M51 | 3.07% | 11.71% |
| 17 | M19 | 1.43% | 14.25% | 10 | M52 | 3.77% | 11.29% |
| 13 | M20 | 1.61% | 9.11% | 10 | M53 | 2.05% | 11.93% |
| 3 | M21 | 1.52% | 9.76% | 10 | M54 | 3.12% | 29.15% |
| 12 | M22 | 1.33% | 10.12% | 5 | M55 | 0.32% | 24.34% |
| 17 | M23 | 1.83% | 13.11% | 1 | M56 | 0.31% | 23.19% |
| 17 | M24 | 1.35% | 11.59% | 10 | M57 | 0.58% | 25.23% |
| 17 | M25 | 1.92% | 11.63% | 17 | M58 | 0.48% | 15.41% |
| 17 | M26 | 1.92% | 8.13% | 17 | M59 | 0.54% | 24.60% |
| 3 | M27 | 1.96% | 14.24% | 0 | M60 | 0.33% | 10.51% |
| 16 | M28 | 1.16% | 9.14% | 17 | M61 | 0.33% | 12.61% |
| 18 | M29 | 3.00% | 9.75% | 10 | M62 | 0.44% | 22.59% |
| 1 | M30 | 2.14% | 10.72% | | | | |
| 15 | M31 | 1.17% | 9.68% | | | | |
| 15 | M32 | 2.39% | 9.38% | | | | |
| 18 | M33 | 1.27% | 7.40% | | | | |

**Real-Time "Startup" Baseline Monitoring of Project**

**Figure 6** is a Baseline Monitor designed for calculating a 'real-time guide to the Project Engineer for tracking the results of the XECO project. The energy consumption indicator for the Customer plant is considered, and a result of 13.52% total energy saving against the established baseline of 11.25% after the implementation of the XECO hardware and software technology *Figure 6: Customer Baseline Monitor* solution. The 'Baseline Monitor' is based on the calculated amp draw from the Customer Electric Bill compared to the actual amp draw test of the circuit and should not be confused with the actual 'before' and 'after' meter test of the circuit.

| BASELINE MONITOR FROM BILL ANALYTIC | | |
|---|---|---|
| **Amp Draw** | BASELINE | Startup |
| **XECO Savings** | EXCEEDED BY | Baseline |
| **13.52%** | 2.27% | 11.25% |

**Figure 5** Identifies the 'real-time' values used by the Project Engineer for tracking results derived from the XECO. A review of the energy bill established a base line value of 11.25%. Implementation of the XECO hardware and software technology resulted in an additional 2.27% increase savings value of 13.52%. The saving values are based on calculated kW reading from the electric bill with 'real-time' kW readings.

The operational efficiency has been improved in many aspects. For example, the plant's injection molding equipment has been better tuned to the electrical system during operation. Each identified circuit includes a load from each injection molding machine in the Customer plant, since the majority of load in the facility is derived from such equipment.

In **Figure 7**, Identified Circuits are labelled as M01 – M62. Each circuit has been measured for energy efficiency using a Dent ElitePRO XC Power Meter/Data Logger and Current Transformers (CT's). Measurements include 'Before' and 'After' results of Kilowatts, Kilowatt Peaks, Kilowatt-Hours, Kilovolt Amps, Kilovolt Amp/Reactive,
Power factor, Amps and Voltage. ***(Meter calibrated on August 08, 2013. Calibration documents available upon request)***

**Figure 7; Installation Check and Balance Performance Chart After XECO Installation**

| Installation Check and Balance | | | | | |
|---|---|---|---|---|---|
| SG # | Trace Circuit | Performance | Savings | Status | Load in Project |
| 16 | M01 | Below Baseline | 11.18% | {Add XECO} | 2.473% |
| 16 | M02 | Approved | 14.05% | Complete | 0.935% |
| 16 | M03 | Approved | 13.73% | Complete | 1.029% |
| 16 | M04 | Approved | 12.24% | Complete | 1.870% |
| 16 | M05 | Approved | 13.39% | Complete | 0.925% |
| 16 | M06 | Approved | 13.24% | Complete | 0.935% |
| 16 | M07 | Approved | 12.56% | Complete | 0.955% |
| 16 | M08 | Approved | 13.36% | Complete | 0.647% |
| 16 | M09 | Approved | 24.66% | Complete | 1.119% |
| 16 | M10 | Approved | 11.81% | Complete | 1.266% |
| 15 | M11 | Approved | 11.77% | Complete | 1.566% |
| 9 | M12 | Below Baseline | 8.61% | {Add XECO} | 1.589% |
| 13 | M13 | Approved | 16.19% | Complete | 1.256% |
| 12 | M14 | Approved | 11.60% | Complete | 1.381% |
| 17 | M15 | Below Baseline | 10.13% | {Add XECO} | 2.129% |
| 16 | M16 | Below Baseline | 10.47% | {Add XECO} | 1.870% |
| 12 | M17 | Approved | 13.13% | Complete | 1.193% |
| 17 | M18 | Below Baseline | 8.31% | {Add XECO} | 2.403% |
| 17 | M19 | Approved | 14.25% | Complete | 1.432% |
| 13 | M20 | Below Baseline | 9.11% | {Add XECO} | 1.614% |
| 3 | M21 | Below Baseline | 9.76% | {Add XECO} | 1.524% |
| 12 | M22 | Below Baseline | 10.12% | {Add XECO} | 1.328% |
| 17 | M23 | Approved | 13.11% | Complete | 1.830% |
| 17 | M24 | Approved | 11.59% | Complete | 1.348% |
| 17 | M25 | Approved | 11.63% | Complete | 1.922% |
| 17 | M26 | Below Baseline | 8.13% | {Add XECO} | 1.919% |
| 3 | M27 | Approved | 14.24% | Complete | 1.964% |
| 16 | M28 | Below Baseline | 9.14% | {Add XECO} | 1.159% |
| 18 | M29 | Below Baseline | 9.75% | {Add XECO} | 2.995% |
| 1 | M30 | Below Baseline | 10.72% | {Add XECO} | 2.143% |
| 15 | M31 | Below Baseline | 9.68% | {Add XECO} | 1.174% |
| 15 | M32 | Below Baseline | 9.38% | {Add XECO} | 2.392% |
| 18 | M33 | Below Baseline | 7.40% | {Add XECO} | 1.268% |
| 0 | M34 | Approved | 15.61% | Complete | 1.731% |
| 4 | M35 | Approved | 13.67% | Complete | 1.402% |
| 5 | M36 | Approved | 15.54% | Complete | 1.701% |

**Figure 7; Installation Check and Balance Performance Chart After XECO Installation**

| Installation Check and Balance | | | | | | |
|---|---|---|---|---|---|---|
| SG # | | Trace Circuit | Performance | Savings | Status | Load in Project |
| 6 | | M37 | Below Baseline | 8.80% | {Add XECO} | 2.050% |
| 6 | | M38 | Below Baseline | 10.27% | {Add XECO} | 1.641% |
| 11 | | M39 | Approved | 14.19% | Complete | 1.636% |
| 5 | | M40 | Approved | 12.47% | Complete | 2.103% |
| 9 | | M41 | Approved | 15.89% | Complete | 0.721% |
| 10 | | M42 | Below Baseline | 9.78% | {Add XECO} | 1.415% |
| 10 | | M43 | Approved | 23.06% | Complete | 1.114% |
| 9 | | M44 | Below Baseline | 9.03% | {Add XECO} | 1.584% |
| 9 | | M45 | Approved | 14.04% | Complete | 2.521% |
| 10 | | M46 | Approved | 14.20% | Complete | 1.463% |
| 15 | | M47 | Below Baseline | 8.15% | {Add XECO} | 3.098% |
| 15 | | M48 | Below Baseline | 9.28% | {Add XECO} | 2.447% |
| 15 | | M49 | Approved | 11.41% | Complete | 3.805% |
| 15 | | M50 | Approved | 22.03% | Complete | 2.675% |
| 15 | | M51 | Approved | 11.71% | Complete | 3.068% |
| 10 | | M52 | Approved | 11.29% | Complete | 3.769% |
| 10 | M53 | Approved | 11.93% | Complete | | 2.049% |
| 10 | M54 | Approved | 29.15% | Complete | | 3.118% |
| 5 | M55 | Approved | 24.34% | Complete | | 0.320% |
| 1 | M56 | Approved | 23.19% | Complete | | 0.315% |
| 10 | M57 | Approved | 25.23% | Complete | | 0.585% |
| 17 | M58 | Approved | 15.41% | Complete | | 0.479% |
| 17 | M59 | Approved | 24.60% | Complete | | 0.537% |
| 0 | M60 | Below Baseline | 10.51% | {Add XECO} | | 0.331% |
| 17 | M61 | Approved | 12.61% | Complete | | 0.331% |
| 10 | M62 | Approved | 22.59% | Complete | | 0.440% |
| | | | | | | |
| Average % Amp Load Savings per Install: | | | | 12.08% | | 100.00% |

NOTE: Due to a fixed budget for the project, the 'Add XECO' indicator above shows circuits that could use additional tuning. However, the baseline for the project has been met, but if additional tuning were applied, additional savings would be achieved.

**Figure 8** illustrates a summary snapshot of calculated measurements performed on identified circuits for PHASE 1 Project in the Customer Commercial Products, Inc. (Winchester, Virginia) plant. The following calculated results are as follows;

| | Xeco Energy Efficiency Results | | | |
|---|---|---|---|---|
| | Before | After | Savings | Savings (%) |
| Amp Draw: | 22,451 | 19,739 | 2,713 | 12.08% |
| kVA Demand: kVAR | 9,356.6 | 8,606.5 | 750.1 | 8.02% |
| Reactive: | 5,598.8 | 3,979.4 | 1,619.4 | 28.92% |
| Power Factor Efficiency: | 0.718 | 0.795 | 0.077 | 10.65% |
| kW Peak Supply: | 10,597 | 9,317 | 1,280 | 12.08% |
| kWh Consumption: | 5,331,787 | 4,688,503 | 643,284 | 12.07% |
| ** CO2 (Metric Tons): | 45,133 | 39,687 | 5,445 | 12.07% |

*Figure 8: PHASE 1 'Snapshot' Results of Customer Project*

The calculated results for the Customer Energy Management Project exceeded the baseline of 11.25% energy saving by +.83% or 12.08%. Due to the reduction in energy consumption for Customer (Winchester, VA) plant, there are additional benefits besides 'energy savings' that should be noted and is listed below.

- *Due to the reduction of heat on the line and in the equipment from the reduced resistance levels and less reactive energy, Customer will experience less costs for maintenance on the equipment directly connected to the identified circuits for current-balancing as a result from less 'Start-up' loads and less heat during operation.*
- *Due to the reduced harmonic levels on Level 3, 5, 7 and 11, Customer will experience better lighting efficiencies as electronic ballast and DC circuits in the plant are less compromised.*
- *Due to the improved current flow of the electrical system, Customer will experience less heat as well as better efficiency levels between the primary and secondary from the plants Switch Gear Transformers.*
- *Customer has reduced the Carbon Footprint (CO2 Emissions) in the plant by 81.76 metric tons of carbon emissions.*

## Monthly Energy Consumption and Billing Comparisons

Billing comparisons for energy efficiency projects represent an important part in measuring the results for Customer. **Figure 9** illustrates the metered results from our Hardware and Software Protocol Solution compared to Customer's monthly electric bill.

**Figure 9; Comparison of Actual Electric Bills;**

**Actual Bill**

| BILL ITEMIZATION | | | Jan-2014 Meter Comparison | |
|---|---|---|---|---|
| | | | January | |
| | | | 8521 | Avg kW/15 min. Snapshot |
| | | | x | |
| | | | 744 | hrs. per Billing Month |
| Shenandoah's Calculation for kW & kWh | XPS Baseline Set | Shenandoah-Supply | 6,339,302 | kWh Calculated Usage |
| | October | January | | |
| Avg kW/15 min. Snapshot (kW Multiplier): | 9,058 | 7,782 | 5,535,189 | (kWh BEFORE 'Rubberamid 'RTH') |
| | x | x | 4,891,900 | (kWh AFTER 'Rubbermaid 'RTH') |
| Shenandoah's METER Run-Time Hours: | 744 hrs. | 744 hrs. | -643,289 | (KWH Savings from Equip.) |
| Calculated kWH's: | 6,739,409 | 5,790,102 | | |
| kWh | 6,739,409 | 5,790,102 | 5,696,013 | |
| Demand | 10,627 | 10,181 | 9,559 | (Calc. KW Peak from Equip. |
| RKVA | 7,745 | 7,150 | 6,023 | |
| | | | | |
| Basic Chg | $124.95 | $124.95 | $124.95 | |
| Va Dist-Energy | $4,515.42 | $3,879.37 | $3,816.33 | |
| Var Dist-Demand | $2,231.71 | $2,136.55 | $2,101.83 | |
| Var Dist-RKVA | $2,010.17 | $1,841.25 | $1,811.33 | |
| SVEC Dist. Charges (Regulated) Subtotal | $8,882.25 | $7,982.12 | $7,854.44 | |
| Supply Chg-Energy | $146,515.14 | $125,876.81 | $123,831.32 | |
| Power Supply Demand | $75,771.94 | $72,590.53 | $68,158.00 | |
| WPA Fuel Adj | $32,349.16 | $27,792.49 | $27,340.86 | |
| Rider OD13-Q | $77,505.27 | $66,587.94 | $65,504.15 | |
| Rider OD-12/Ods-13 | -$10,985.52 | -$9,438.11 | -$9,284.50 | |
| Rider OD-14 | $145,280.17 | $142,679.41 | $140,292.80 | |
| SVEC Electricity Supply Charges Subtotal | $466,436.16 | $426,089.07 | $415,842.62 | |
| Security Lights | $18.43 | $18.43 | $18.43 | |
| City of Winchester Util Tax | $117.70 | $117.70 | $117.70 | |
| VA Cons. Tax | $5,325.32 | $4,298.61 | $4,195.87 | |
| Sales & Use Tax | $1.60 | $1.60 | $1.60 | |
| Total Current Charges | $480,781.46 | $438,507.53 | $428,030.66 | |

**Bill vs. Meter Savings Comparison**

| * Shenandoah | vs. | ** Our Solution |
|---|---|---|
| $42,273.93 | | $52,750.80 |

***Reference: Shenandoah Electric Bill** ***(Available upon request) ** Our 'Comprehensive Engineering Report' is available upon request.***

Note: It was suggested to Shenandoah that their meter may need to be calibrated or that there may be a loose connection on one of the CT's for the meter.

**Figure 10** below illustrates the comparison of Customer's 'Run-time Hours' and KWH used

Date: 3/6/2014

Location: 7-097-02-094

Source: Run-time Report/Machine Power Consumption

**Energy Consumption Breakdown by Machine**

| | Energy Consumption Comparison by Run-Time Hours | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan-14** | | | | | **Jan-13** | | | | |
| | **RTH** | **Amps** | **Volts** | **KW** | **KWH** | **RTH** | **Amps** | **Volts** | **KW** | **KWH** |
| | 29817.7 | 18,052 | 472 | 8,521 | 3,927,823 | 31302.4 | 20,680 | 472 | 9,761 | 4,727,152 |
| *LESS ---* | *-4.74%* | *-12.71%* | | *-12.71%* | *-16.91%* | | | | | |

Run-Time Hours are 4.74% LESS than January 2013
Amp Redution is 12.71% LESS than January 2013
Kilowatts are 12.71% LESS than January 2013
KiloWatt Hours are 16.91% LESS than January 2013

NOTE: Run-Time Hours are 4.74% LESS, but KWH is 12.17% LESS at 16.91%.

****NOTE: Customer (Winchester) plant operates at full capacity 24 hours per day.**

**Customer Commercial Products, Inc. (Winchester, VA plant) Project STEPS.**

The Customer energy efficiency project has been further designed into three **(3) STEPS**:
**STEP 1:** Completed

**STEP 2:** Proposed Switch Gear to further improve energy efficiency.

**STEP 3:** Continued monitoring of the plant's electricity consumption and continued interaction with Customer's electricity provider.

NOTE: For **STEP 2**, it is recommended that additional work be done on each Switch Gear in the facility to better tune and balance between line and transformer for even better energy efficiency. **Figure 11** illustrates a test on Customer's Switch Gear #16 and has performed the effects of a completely balanced circuit under load conditions. It is anticipated that a **STEP 2** will include the remaining 17 Switch Gears.

Calculated 'Full-Facility' Analysis - Equipment: Switch Gear #16

CUSTOMER NAME: Rubbermaid Commercial Products, Inc.

| | | |
|---|---|---|
| Kilowatt Hours was REDUCED by: | 10.0% | kWH Cost Metered |
| kVA (Demand) was REDUCED by: | 6.9% | Power Quality Test Metered |
| kVAR (Reactive Energy) was REDUCED by: | 65.3% | Power Quality Test Metered |
| Power Factor (Efficiency) was IMPROVED by: | 19.2% | Power Quality Test Metered |
| Amperage (Load Consumption) was REDUCED by: | 6.9% | Power Quality Test Metered |
| CO2 Emission (Carbon Footprint) was REDUCED by: | 0.00 | Metric Tons per Year |

PROVIDER NAME: Shenandoah Valley Elec Coop

| | | |
|---|---|---|
| PROVIDER'S KW SUPPLY REDUCED by: | 120 | Kilowatts (KW) |

***Figure 11: Summary Analysis from Switch Gear #16 Test Report***

**Customer (Winchester, VA) plant Carbon Emission Reduction.**

As a result of reducing the electricity consumption in the Customer facility, additional benefits are also achieved resulting in reduced Carbon ($CO_2$) Emissions in the plant. **Figure 12** illustrates the current $CO_2$ reduction results in the Customer plant. ***<u>(A comprehensive CO2 report is available upon request)</u>***

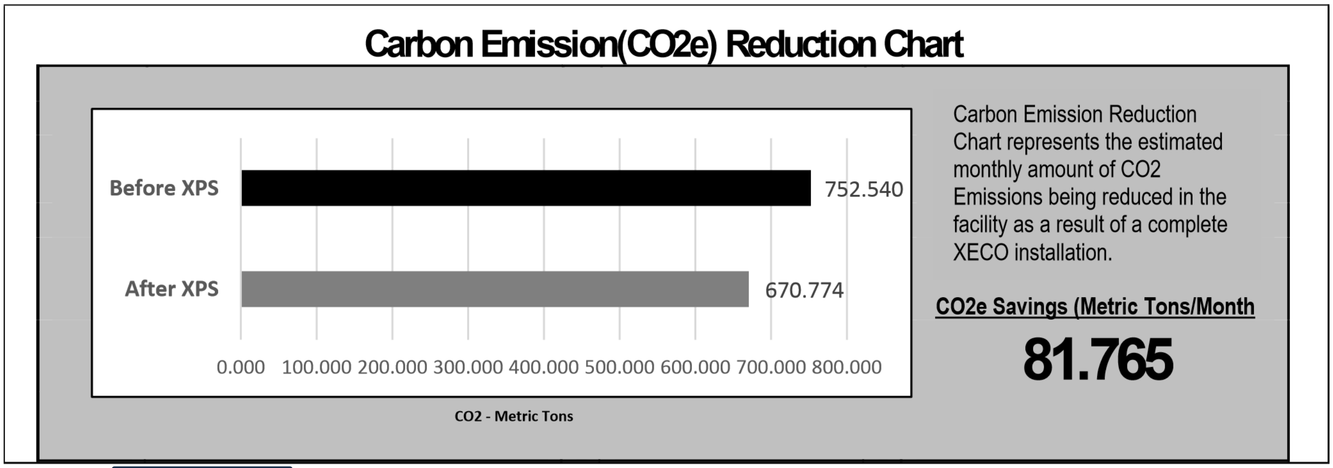



*Figure 12: [redacted] Carbon Emission Reduction Chart*

**30-Day Facility Test with ITRON Sentinel Form 5S KVA Meter (Utility Co.)**

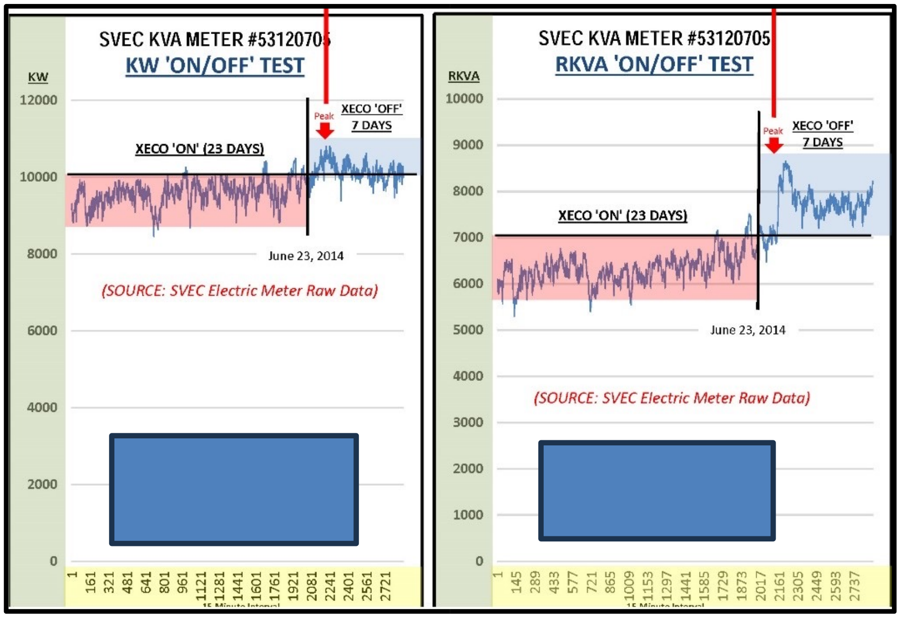
A scheduled 30-Day facility test was conducted to determine the specific level of kilowatt reduction for equipment identified throughout the facility with our technology installed. The meter used for the test was Customer's fixed ITRON Sentinel Form 5S (45S) meter, Serial Number 53-120-705. This meter has been permanently installed and used by Shenandoah Valley Electric Cooperative to measure the total electricity consumption in the facility each month in order to calculate the electric bill. The meter is accurate plus or minus 2 percent as mandated by ANSI STD> C-12.1-8.1.3.3. On April 29, 2014, the meter was inspected and tested for calibration by Reliable Meter Services, Rock Hill, South Carolina. The average registration of the meter series test is 99.96 percent.

Prior to the test, Our engineer inspected each of our device to insure that each device was 'ON' and correctly operating as designed. The full-facility test began with our equipment turned 'ON'. Our equipment remained 'ON' for 23 days before being turned 'OFF' for the last 7 days of the month. Subsequently all of our equipment was turned 'OFF' in the Customer facility in order to determine how much the load would increase in the facility as measured by the meter supplied by the utility company (Shenandoah Valley Electric Cooperative).

Shenandoah Valley Electric Cooperative (Metering Department) supplied detailed metering data consisting of Kilowatt and KVAR meter readings measured in 15-minute intervals. There were 2,880 15minute 'snapshots' collected from the ITRON meter. The results of the 30-Day test indicate the Kilowatt consumption in the facility had increased by 5.19% and the

KVAR had increased by 17.34% as a result of turning our equipment 'OFF' during the last 7 days of the month.

***Figure 13*** below is a chart that has been prepared from the data collected by the meter supplied by Shenandoah Valley Electric Cooperative (Customer's Electricity Provider) to illustrate the results of the 30day test.




| | KW | RKVA | 7-DAY INCREASE ON BILL | | |
|---|---|---|---|---|---|
| Daily Usa | (15 Min Avg Below) | | KWH | RKVA | |
| XECO **ON** (June 1-23) | 9621 | 6431 | 88,536 | 1,349 | (Loss Savings from 7 day shut-down) |
| XECO **OFF** (June 23-30) | 10148 | 7780 | KW x 168 Hrs. = KWH (7 Days = 168 Hrs.) | | |
| -Day Increase | 527 | 1349 | 527 kW x 168 hours = 88,536 kWh | | |

*Figure 13: ITRON Facility Meter Data - 7-Day Test Results Chart*

The kilowatt average per each 15-Minute 'Snapshot' during the first 23 days (**Our Equipment 'ON'**) was 9,621 kW compared to 10,148 kW during the last 7 days (**Our Equipment 'OFF'**). Turning the equipment 'OFF' resulted in a kilowatt average increase of 527 kilowatts every 15-minutes or an increase of 5.47%.

The kVAR average per each 15-Minute 'Snapshot' during the first 23 days (**'ON'**) was 6,431 kVAR compared to 7,780 kVAR during the last 7 days (**'OFF'**). Turning our equipment 'OFF' resulted in a kVAR average increase of 1,349 kVAR every 15-minutes or an increase of 20.97%.

In ***Figure 14***, Customer Commercial Products received the monthly electric bill. The monthly electric bill indicates that both the KW Peak and KVAR Peak was recorded at their highest Peaks the day after the Xeco units were turned 'OFF', or as indicated on the bill.

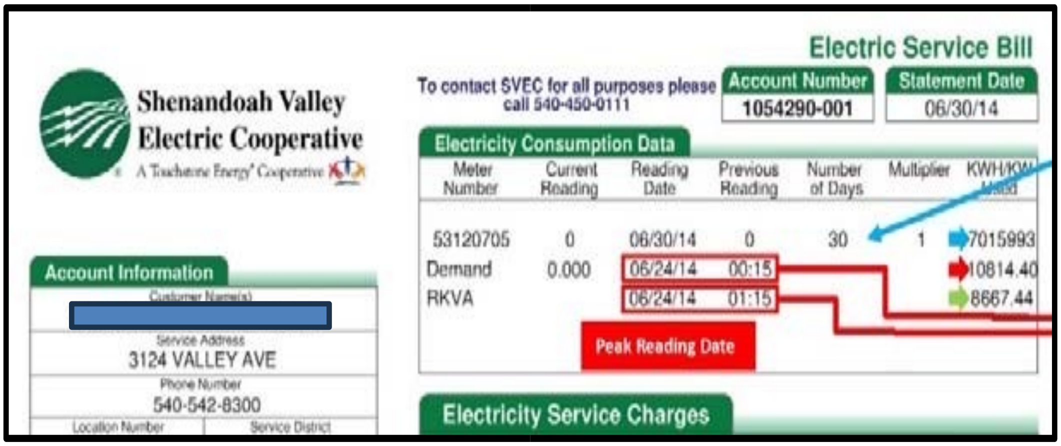



*Figure 14: Customer Electricity Consumption Data from Electric Bill*

The kilowatt PEAK during the first 23 days (**Our Equipment 'ON'**) was recorded at 10,498 kW compared to 10,814.40 kW during the last 7 days (**Our Equipment 'OFF'**). Turning the equipment 'OFF' resulted in a kilowatt PEAK increase of 316.4 kilowatts or an increase of 3%. The KVAR PEAK during the first 23 days (**Our Equipment 'ON'**) was recorded at 7,520 kVAR compared to 8,667 kVAR during the last 7 days (**Our Equipment 'OFF'**). Turning the equipment 'OFF' resulted in a kVAR increase of 1,147 kVAR or an increase of 15.25%.

## CONCLUSION

The Energy Management Program designed for Customer Winchester plant) was very comprehensive and covered most of the important aspects in energy efficiency using proprietary current balancing technology and a customized engineering protocol to specifically measure the results. Under our complete engineering framework, we were able to improve the performance of the energy management program at the Winchester plant.

This paper provides information and insight into our Technology and the performance of the Energy Management Solution program installed at Customer (Winchester plant) from a comprehensive, 4-Level engineering and analysis approach. This approach defined three criteria for the sustainability of a facility-wide energy program: organizational structure, compatibility of performance indices, and engineering support. Based on the three criteria and our solution's efficiency indicators, the energy initiatives of Customer (Winchester) have been analyzed and possible energy efficiency improvement opportunities have been found. The results of this case study indicated the significant potential for the application of our energy management technology and energy saving projects at other Newell-Customer facilities.

**Source:**

**Installation and Metering Test Equipment:**

- **Dent Industries Power Quality Meter, Model No. ElitePRO XC, Serial No. XC1307109 (Calibrated by U.S. Calibration, Aug. 2013) Attached**
- **ITRON KVA Meter, Model SS3S4L, Serial Number 53120705 (Calibrated by Powermetrix, Feb. 20, 2014) Attached**
- **Mastech Power Quality Handheld Meter**
- **Xeco Engineering Protocol Software**

**Software: ELOG Data Logger Software (Version**

**ELOG 13) Xeco Engineering Test Parameters:**

**Setup Table Description: 3-Phase, 3-Wire**

**Memory Type: Ring**

**Line Frequency: 60 Hertz**

**Integration Period: 1 Second**

**Logger Description Line: Dent ELITEpro XC; Serial No. XC1307109**

**(Calibration Trace: National Institute of Standards and Technology (NIST)**

**Instruments: Hewlett-Packard 34401A, Serial #: US36141163**

**Hewlett-Packard 34401A, Serial #: MY41039517**

**Logger Serial No.: XC1307109**

**Logger Type: ELITEpro XC**

**Firmware: ES400.226**

**Peak Demand Minutes: 15 Minutes**

**Current Transformer (CT)**

**Power 1: Power: VHi: L1, VLo: N; PT=1.000; CT=5000.000; CT Type=ROCOIL; Phase Shift=0.000 Power 2: Power: VHi: L2, VLo: N; PT=1.000; CT=5000.000; CT Type=ROCOIL; Phase Shift=0.000 Power 3: Power: VHi: L3, VLo: N; PT=1.000; CT=5000.000; CT Type=ROCOIL; Phase Shift=0.000**

**Power 5: Power Sum: 1, 2, 3**

**Utility Meter Specifications:**

**Meter Type: ITRON Sentinal Form 5S Meter (Meter Specifications Attached)**

**Provider: Shenandoah Valley Electric Cooperative**

**Model No.: SS3S4L (Powermetrix Load Meter Calibration Test Attached)**

**Serial No.: 53120705**

**Meter No.: 53120705**

Project Manager: ______________________________________________

**Gregory A. Dockery, CEO/Project Manager**
*Member: IEEE and IEEE-SA (Standards Association)*

Engineering Review: ______________________________________________

**B.M. Wu, PhD., E.E.**

Engineering Review: ______________________________________________

**M. Timothy Orth, M.S., E.E.**

Engineering Review: ______________________________________________

**Marc A. Ramirez, P.E.**