MAUMEE ASSEMBLY & STAMPING

920 Illinois Avenue
Maumee, Ohio 43537

ASHRAE Level II Audit Report

August 29, 2017

mda engineering, inc.

#17106

Executive Summary

Facility Description

The facility was constructed in phases beginning in 1967 as a metal fabrication facility for a major U.S. automotive manufacturer. The major function of the facility was to produce stamped metal parts with minor sub-assembly. Plastics forming was implemented in the later years of use by the original owner. The facility was acquired in 2009 and is now being utilized for metal fabrication and sub-assembly of automotive and other industries by Maumee Assembly & Stamping.

The facility consist of the following area;

- Site: 70.14 acres
- Manufacturing: 423,910 sq. ft. (base foot print)
- Offices: 30,700 sq. ft. (base foot print)
- Ancillary: 308,152 sq. ft. (base foot print)
- TOTAL: 762,762 sq. ft. (base foot print)

Study Overview

The objective of this building evaluation and report is to provide the facility with a technical and economic strategy to modify the building systems and operating practices to achieve greater energy efficiency, reduce energy use while maintaining present or improving the levels of occupant comfort and reducing the cost of operating the facility and manufacturing operations.

This audit was conducted in accordance with applicable portions of ASHRAE's Energy Audit Guidelines for Commercial Buildings and included a thorough review of the mechanical and electrical systems, maintenance practices and operating procedures.

Energy Star ranking for a manufacturing facility is non-achievable; therefore not considered in this report.

Summary of Recommendations

The following table shows Energy Conservation Measures (ECM's) identified for energy reduction and operational cost savings:

Measure Description	Status	Natural Gas Savings (mbtu)	Electricity Saved (kWh)	Demand Reduction (kW)	Other Cost Savings	Annual Energy Cost Savings	Implementation Cost	Simple Payback Period (Years)	% Energy Savings (B)
ECM #1: STEAM BOILER DECOMMISSIONING	(I)	21,835	1,500,969	165	$126,834	$281,308	$645,588	1.58	23%
ECM#2: ROOF INSULATION IMPROVEMENTS	(I)	22,838	894,299	101	N/A	$269,242	$1,565,309	5.81	22%
ECM#3: POWER FACTOR CORRECTION IMPROVEMENTS	(I)	N/A	N/A	1236 (kVA)	$163,341	$163,341	$384,819	2.24	0%
Implementation Totals (A)		24,493	2,395,268	1,502	$290,175	$508,745	$2,595,716	3.25	28%
ECM #4: LED LIGHTING UPGRADE – QUONSET HUT	(R)	N/A	264,143	37.01	N/A	$20,133	$27,516	1.37	0.8%
ECM #5: LED LIGHTING UPGRADE – MAIN OFFICE	(R)	N/A	74,752	21.96	N/A	$5,697	$21,775	3.82	0.2%
ECM #6 LED LIGHTING UPGRADE - EXTERIOR	(R)	N/A	265,826	69.35	N/A	$20,261	$94,391	4.66	0.8%
ECM #7 LED LIGHTING UPGRADE – MAIN PLANT	(R)	N/A	1,118,523	156.79	N/A	$85,258	$771,259	9.05	3.3%
Recommended Totals		N/A	1,723,304	285.29	N/A	$131,349	$914,941	6.97	5.0%
Combined I & R Totals		24,493	4,118,572	1,787	$290,175	$640,094	$3,510,657	3.77	33%
ECM #8: PROCESS COOLING WATER SYSTEM IMPROVEMENTS	(FSR)	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D
ECM #9: OFFICE MULTI-ZONE AHU CONVERSION	(FSR)	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D
ECM #10: OFFICE HEATING BOILER CONVERSION	(FSR)	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D
ECM #11: COMPRESSED AIR SYSTEM IMPROVEMENTS	(FSR)	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D
ECM #12: SOLAR ARRAY & BATTERY STORAGE	(FSR)	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D
ECM #13: PRODUCTION AREA VENTILATION IMPROVEMENTS	(FSR)	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D
ECM #14: OFFICE CONTROLS UPGRADE	(FSR)	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D

Notes: Measure Status: Under Implementation (I); Recommended (R) Further Study Recommended (FSR), Not Recommended (NR)

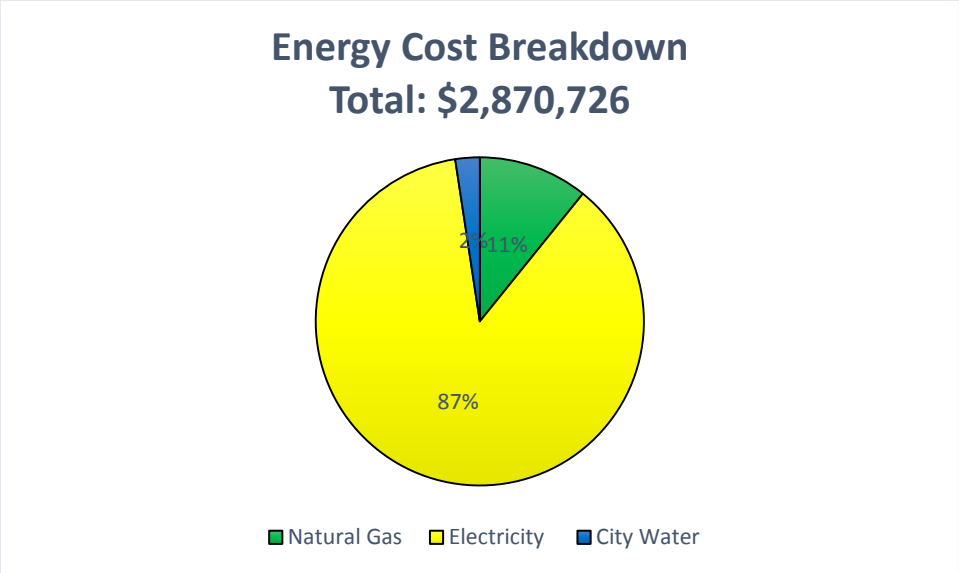
(A): ECM savings are not additive. Totals indicated represent savings if ECMs #1 thru #3 are implemented.

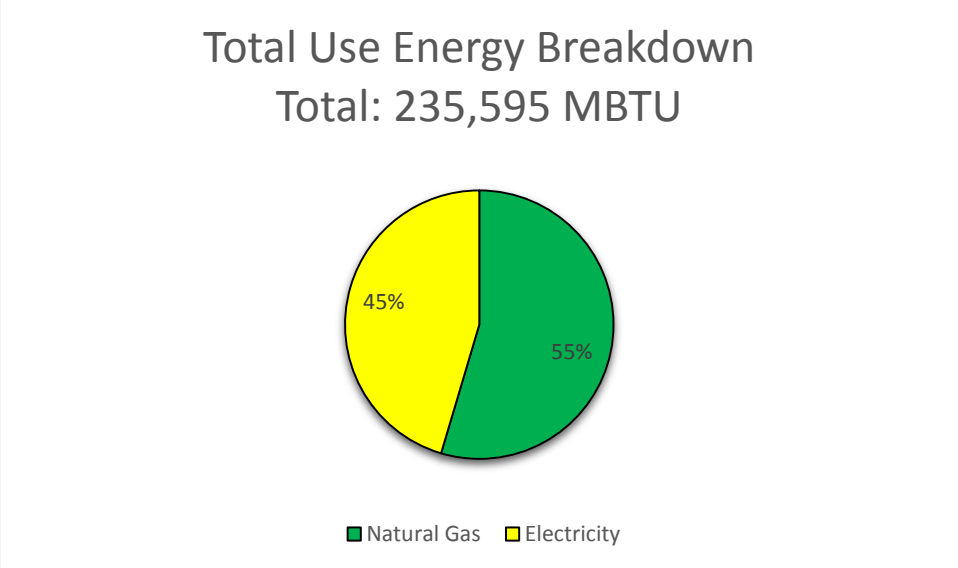
(B): % Energy Savings based on ECM Energy Reduction over total historic (project) Energy Usage.

Energy Usage

Energy usage at the building is comprised is comprised of natural gas, electricity and city water. The total cost in the 24 month period from June 2015 through July 2017 was $2,870,726.

	Units Consumed	Energy in MBTU	Cost $ Dollars	% Total Energy	% Total Cost
Natural Gas	MBTU	128,630	$311,430	54.6%	10.85%
Electricity	MBTU	106,965	$2,490,222	45.4%	86.75%
City Water	GAL	N/A	$69,074	N/A	2.4%
TOTALS	N/A	235,595	$2,870,726	100%	100%





Greenhouse Gas Emissions

Carbon Dioxide Equivalent (CO_2) is calculated based on the total energy consumed by the building, taking all greenhouse gasses and energy generation methods into account and results in a single quantity for simple comparison.

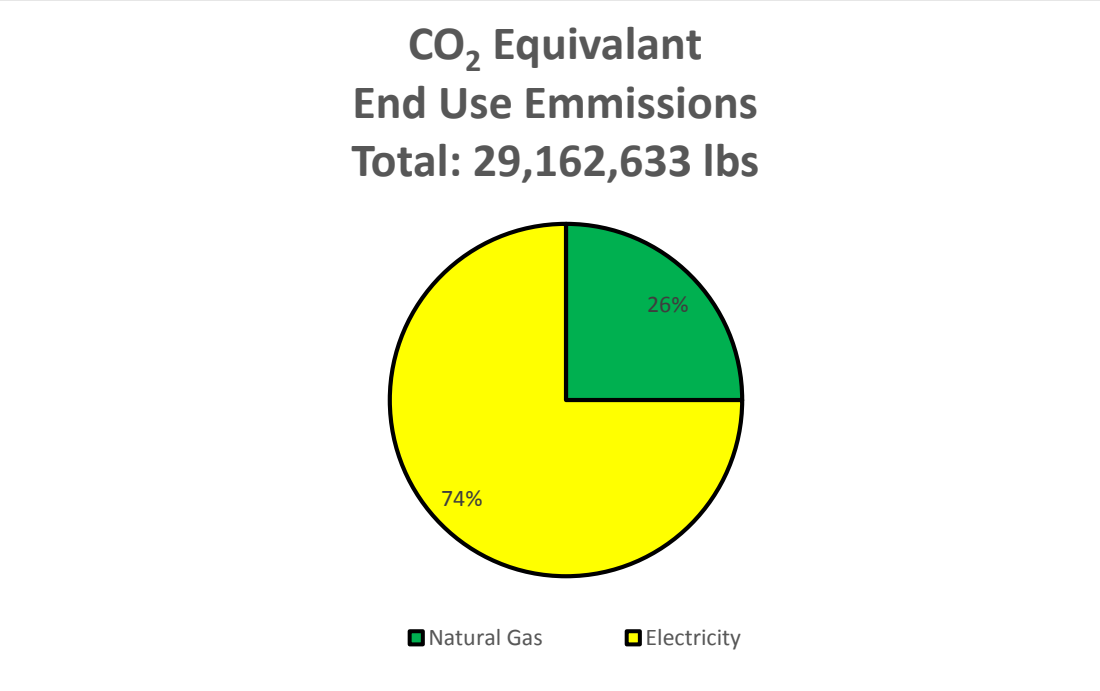
CO_2 Emissions are calculated by the following:

www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

- 1380.9 ≈ 1.380 CO_2/KWH

www.eia.gov/environment/emissions/co2_vol_mass.php

- 117.1lbs/MBH



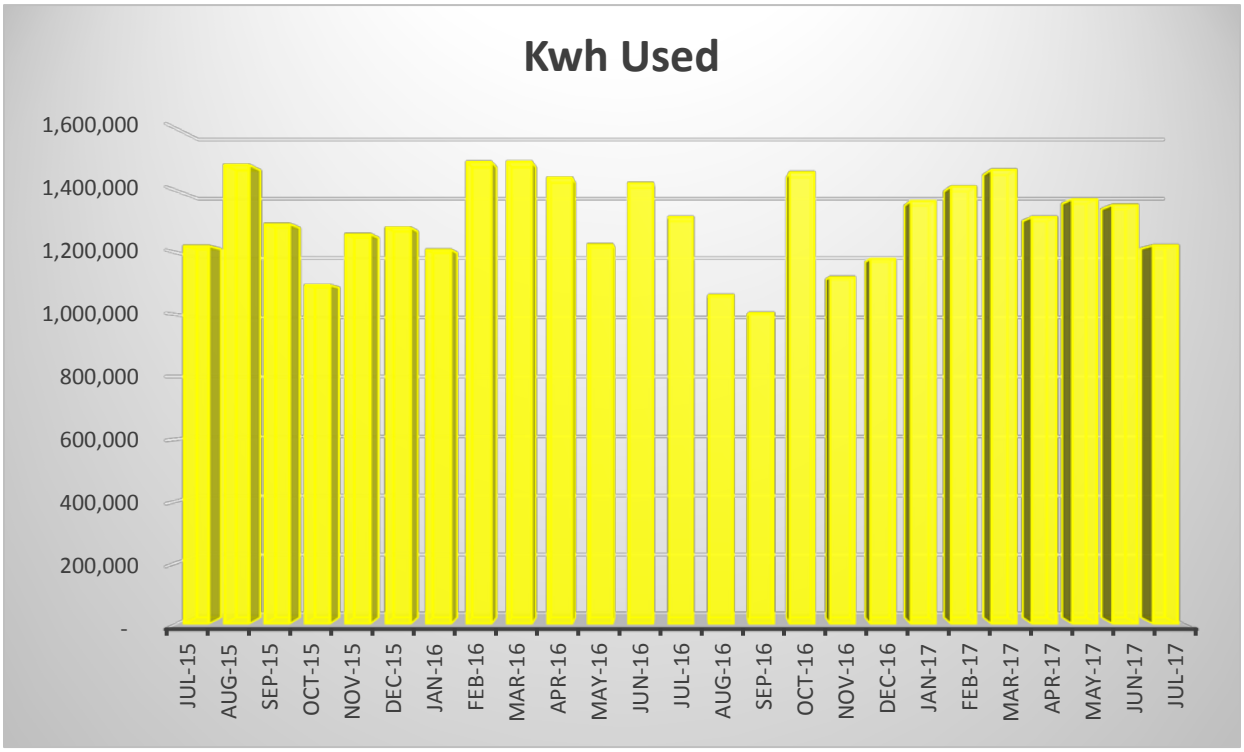
Electrical Power

Electricity is purchased from a third party supplier and delivered to the building by the Toledo Edison/First Energy Company.

Energy is presently purchased from DYNEGY based upon KWH measurement provided by Toledo Edison, A First Energy Company. The delivery charges are under The Toledo Edison Company GENERAL SERVICE – TRANSMISSIONS (RATE "GT") with applicable riders. Actual contracts for neither DYNEGY nor Toledo Edison have been provided, and all analysis is based upon monthly electric utility usage and delivery statements provided by MA&S.

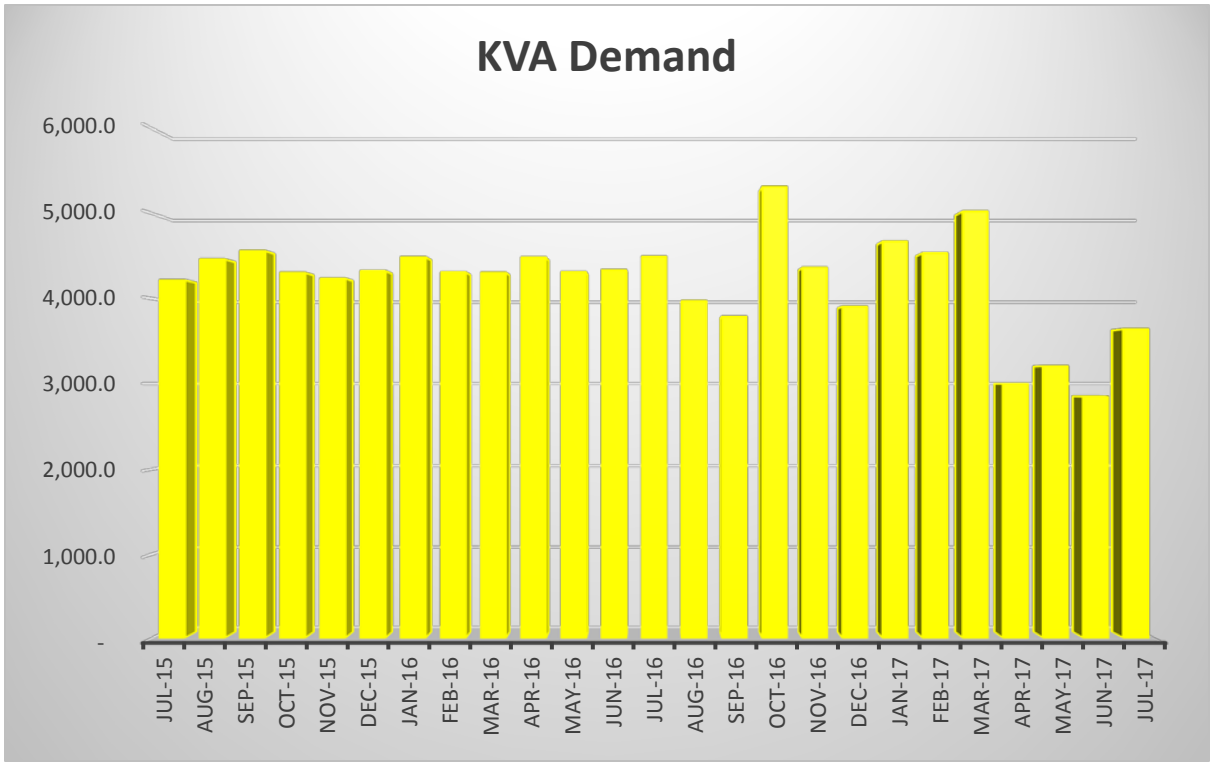
The electrical service is derived by a Toledo Edison Company owned and maintained 138kV to 12.47kV sectionalized substation with two 10MVA transformers. Utility revenue metering instruments are on the 12.47kV side of the system. The transformers serve a main-tie-main switchgear, which in turn sources multiple 12.47kV circuits into the facility.

Electrical usage has gradually increased since the 2009 MA&S acquisition as the manufacturing utilization of the facility increases. Due to the manufacturing usage of the facility, equal comparison to similar buildings is impractical.



Conversion Factor
http://help.columbiagasohio.com/app/answers/detail/a_id/296/kw/how%20do%20i%20convert%20between

- 1 Kilowatt hour = 3,412 Btu


KVA Demand
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5,000.0
4,000.0
3,000.0
2,000.0
1,000.0
-
JUL-15
AUG-15
SEP-15
OCT-15
NOV-15
DEC-15
JAN-16
FEB-16
MAR-16
APR-16
MAY-16
JUN-16
JUL-16
AUG-16
SEP-16
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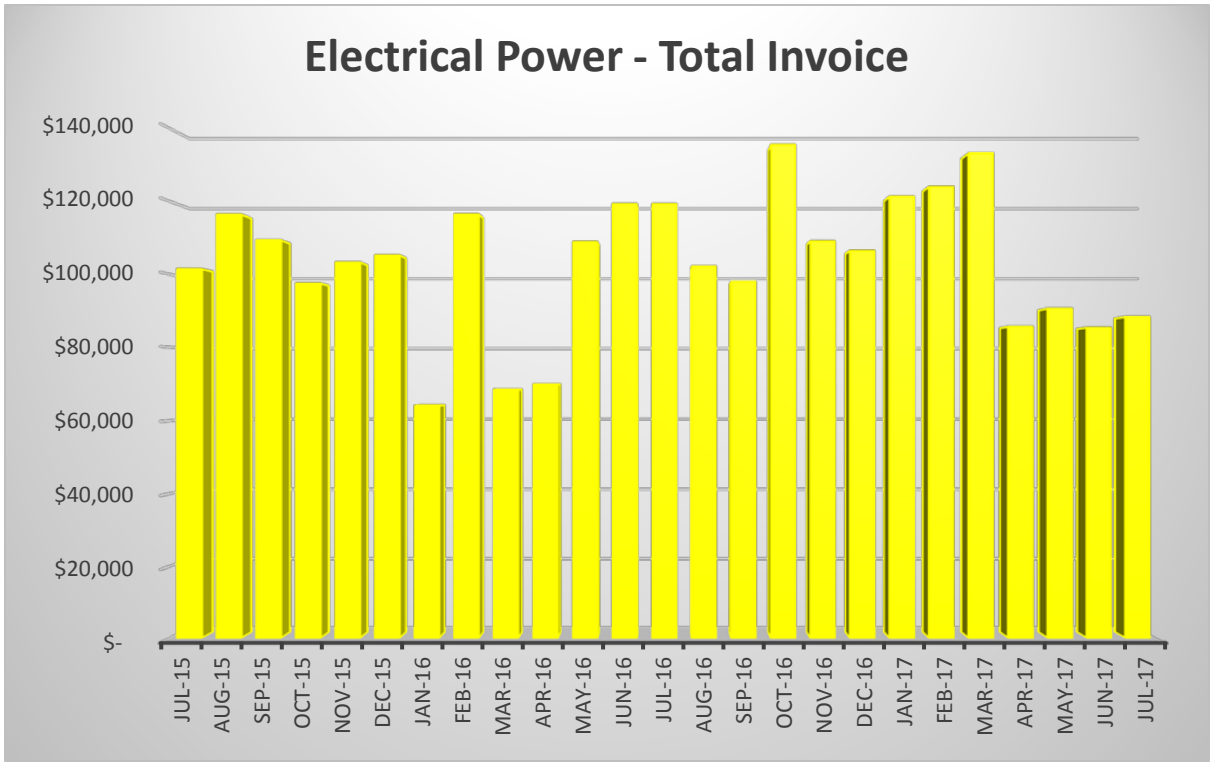
MAR-17
APR-17
MAY-17
JUN-17
JUL-17


Electrical Power - Total Invoice
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$60,000
$40,000
$20,000
$-
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SEP-15
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NOV-15
DEC-15
JAN-16
FEB-16
MAR-16
APR-16
MAY-16
JUN-16
JUL-16
AUG-16
SEP-16
OCT-16
NOV-16
DEC-16
JAN-17
FEB-17
MAR-17
APR-17
MAY-17
JUN-17
JUL-17

Natural Gas

Energy is presently purchased from Constellation, An Exelon Company based upon cfh measurement provided by Columbia Gas of Ohio. The delivery charges are under Columbia Gas of Ohio TARIFF and applicable riders. Actual contracts for neither Constellation nor Columbia Gas of Ohio have been provided, and all analysis is based upon monthly natural gas usage and delivery statements provided by MA&S.

The natural gas service is delivered at a high pressure main meter house at “the street” and routed underground to the facility main building where it is regulated to 6psig and distributed through-out the facility.

Natural gas points of use include:

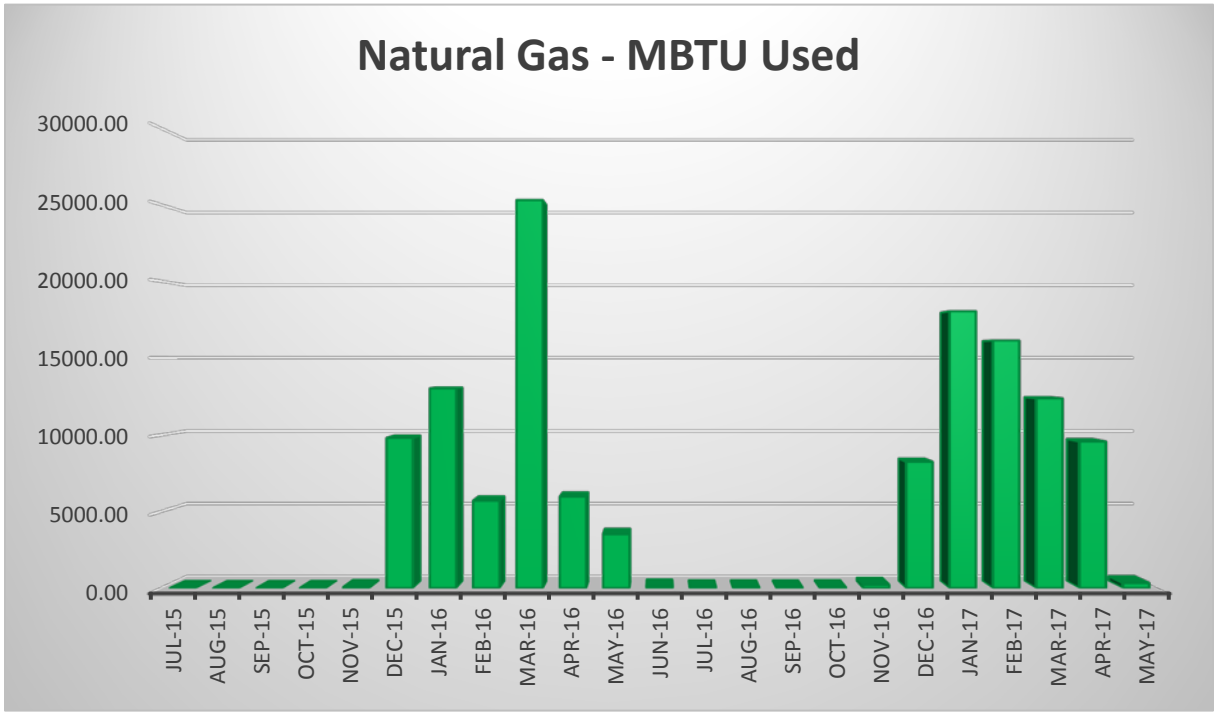
- Main steam boiler plant used only for main building heating during cold weather.
- Office building heating during cold weather.
- Domestic hot water heaters used year round.

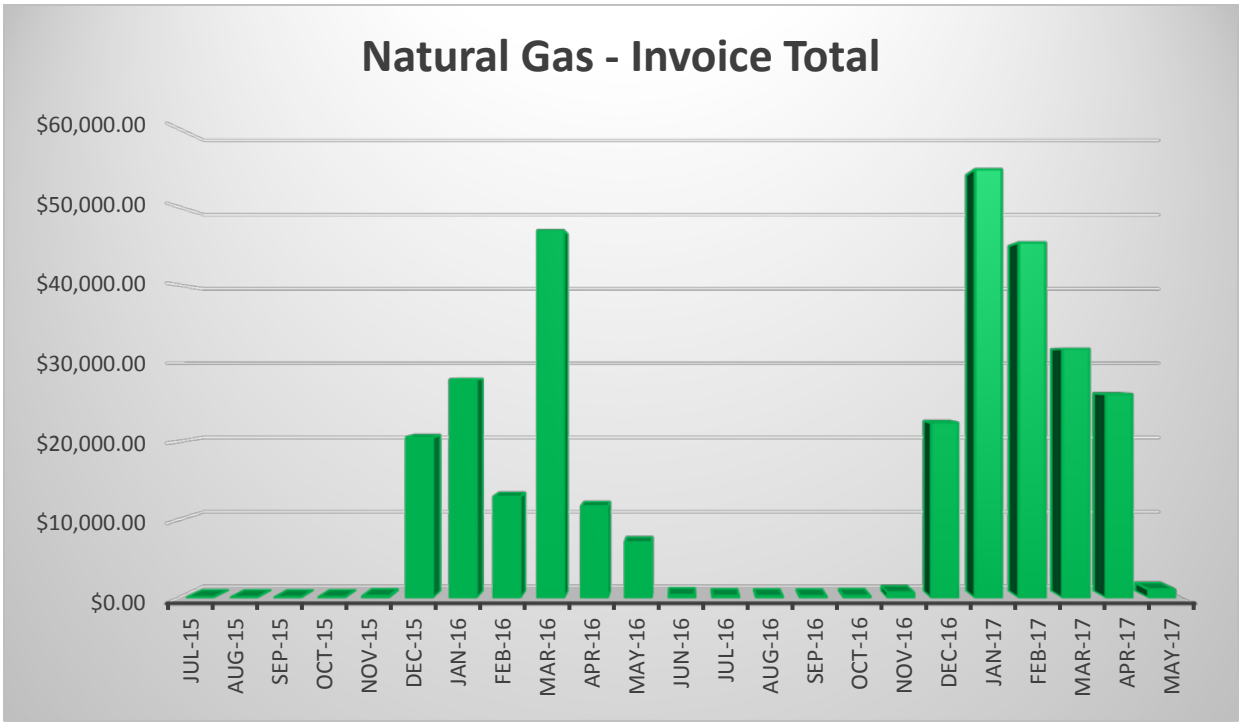
The facility natural gas usage graphs below demonstrate that natural gas is not utilized in the industrial manufacturing process of the facility.

Conversion Factors are calculated by the following:

http://help.columbiagasohio.com/app/answers/detail/a_id/296/kw/how%20do%20i%20convert%20between

- 1,000 Cubic feet per MCF ≈ 1,020,000 Btu’s
- 1 Dekatherm (DTH) ≈ 1,000,000 BTU’s




Natural Gas - Invoice Total
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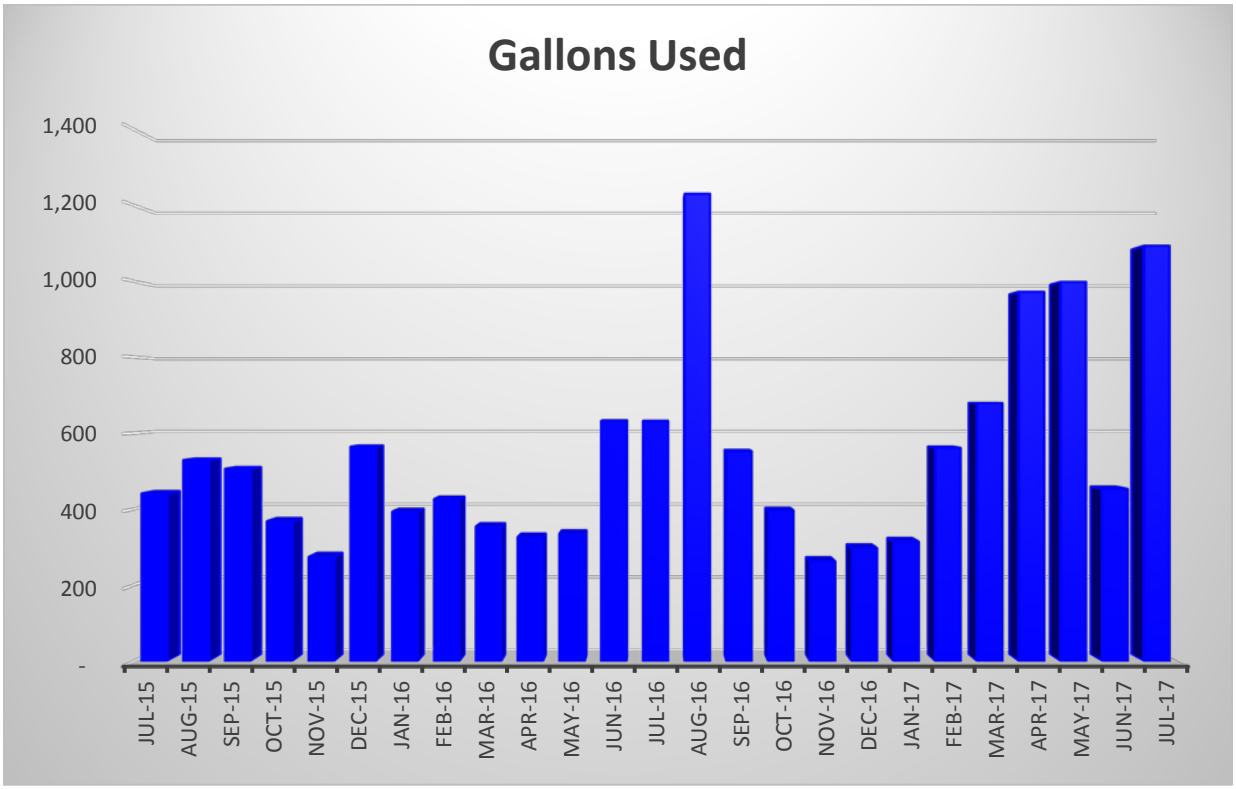
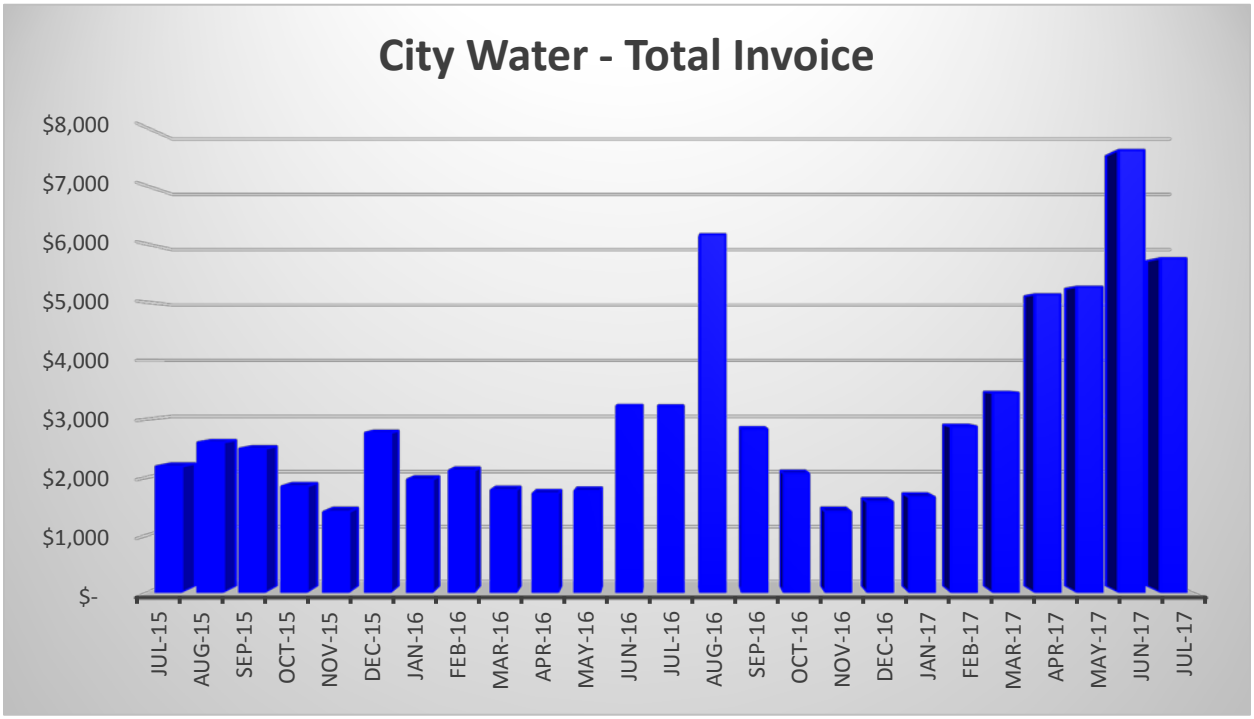
$50,000.00
$40,000.00
$30,000.00
$20,000.00
$10,000.00
$0.00
JUL-15
AUG-15
SEP-15
OCT-15
NOV-15
DEC-15
JAN-16
FEB-16
MAR-16
APR-16
MAY-16
JUN-16
JUL-16
AUG-16
SEP-16
OCT-16
NOV-16
DEC-16
JAN-17
FEB-17
MAR-17
APR-17
MAY-17

City Water

Domestic city water is separate from city provided fire water and metered through a backflow preventer system by the City of Maumee, OH.





Project Recommendations

Overview

Each recommended ECM is discussed in detail in this section with a brief recommendation on how to measure and verify savings after implementation. The recommended options are determined based on a combination of cost, magnitude of savings, and reasonableness of methods.

ECM's were evaluated after the site survey with collection of data necessary to perform the technical and economic analyses. This evaluation was completed to ASHRAE Level II standards through spreadsheet analysis. To assess energy savings associated with each measure, the baseline for consumption was compared individually to consumption totals calculated for each measure. The baseline for energy usage was obtained from monthly utility bills and analyzed against daily weather data where applicable. Cost savings were determined using the projected energy savings and incremental energy rates from energy bills.

All potential ECM's are listed in this section of the report as Recommended or Considered but Not Recommended based on technical and/or economic feasibility. Prior to implementation, confirmation of projected savings and cost may be required for capital intensive measures. The following assumptions were used in calculating the savings:

1. Energy costs remain relatively stable and consistent.
2. Building energy usage patterns remain relatively unchanged and consistent.
3. Building systems operation remains relatively unchanged with exception that any change is related to a recommended ECM.

An economic analysis was performed for each measure using historical cost estimates from similar projects and pricing solicited from vendors and installation contractors. The cost savings is divided by implementation costs in order to get simple payback for each measure.

ECM #1: Steam Boiler Plant Decommissioning

Existing Conditions

The existing steam boiler plant consists of two (2)500HP Cleaver Brooks #CEW-200-150 boilers; system designed for 100psi operation but has been operating at 80psi since MA&S has taken facility ownership. During MA&S ownership, peak load has been at approximately 80% of one (1) boiler to heat the manufacturing facility.

1. Boiler nameplate input = 20,925,000BTU/HR.
2. Boiler combustion fan nameplate = 30HP.
3. DA/Condensate System (in Boiler House) = 3@ 15HP.

Soft Water and Chemical Systems are intact and appear to have been used up until the most recent annual shut down.

City water make-up is metered but not recorded and includes two (2) backflow preventers.

Not able to identify condensate return collection/pump station(s) at this time.

There is no manufacturing process (i.e. parts washer, etc.) utilizing steam; therefore the steam boiler plant is shut down when not needed for building heating during cold weather months.

Twelve (12) roof mounted STRAND steam heat coil units have been required to maintain building temperature in the winter; the rooftop STRAND units mix indoor air with outside air, but most/all damper control is inoperable and fixed in the return air only position. Undetermined if the TRUCK VESTIBULE STRAND UNITS have been running during this time.

The two (2) 250,000 gallon fire protection water storage tanks utilize a P&F HX and circulation pump each for freeze protection; heat source of the house between the fire water storage tanks is electric.

The SPLITTER BUILDING is heated with five (5) propeller style steam unit heaters (SUH's) providing freeze protection for the building fire protection system; the steam pipe convection system is abandoned.

The insulated oily/water waste lines are steam heat traced with an unregulated tap from the SUH piping at the SPLITTER HOUSE; the INDUSTRIAL WASTE CONTROL HOUSE is equipped with electric unit heaters.

The MILLWRIGHT SHOP is heated and ventilated with a steam heating coil air handling unit.

The TRUCK REPAIR area is equipped with existing natural gas heaters.

The "quonset hut" spaces are equipped with existing natural gas radiant heat; questionable if this has been utilized during MA&S ownership. Need to field verify if the "quonset huts" are equipped with fire protection piping.

The CAR WASH VESTIBULE, used for washing of pallet/shipping rigs, is heated with a steam heating coil ventilation unit.

Measure Description

The existing steam boiler plant, piping, condensate and make-up water systems are to be abandoned in place; it is presently in a decommissioned state since ending of 2016/2017 heating season. The steam heating coil air handling units, unit heaters, convectors and related controls, piping and condensate return system will be abandoned in place as well.

100% outside air natural gas fired heating and ventilation (HV) units will be installed to provide heating and summer ventilation for the MAIN PLANT and MILLWRIGHT SHOP.

A high efficiency condensing hot water boiler system will be installed to provide heat source for the fire water storage system through new plate and flame heat exchangers.

The SPLITTER BUILDING wet-pipe fire protection system will be converted to a pressurized air dry-pipe system; this building is not an occupied space and does not require to be heated.

The INDUSTRIAL WASTE oily/water waste lines will be re-fitted with electric heat trace and new thermal insulation for freeze protection.

Repairs Required

Repairs to existing equipment is not required. The existing steam boiler plant and steam coil air handling equipment, unit heaters, convection heaters and related controls piping and condensate return system will be abandoned in place.

Operations and Maintenance Impacts

The new gas fired HV units will require less maintenance than the abandoned STRAND units as there is less damper control and lower motor horsepower; a new electronic control station will be provided with each unit for space temperature control.

24 hour boiler house operation personnel during the heating season is eliminated.

Auxiliary systems such as chemical treatment, water make-up, and condensate return associated with the steam boiler plant is eliminated.

Equipment Life

The new equipment is expected to have a useful service life of 30 years.

Savings

The savings results from a combination of:

- Improved utilization of natural gas heating efficiency.
- Pressurization of the building to eliminate cold air infiltration.
- Reduction of boiler operation personnel work hours.
- Elimination of annual boiler inspection and repairs.
- Elimination of steam and condensate piping maintenance.
- Elimination of steam pressure regulator and control valve maintenance.
- Reduction of domestic city water usage.
- Elimination of steam boiler system chemicals and water treatment.

- Elimination of maintenance of pneumatic and electric controls associated with the steam heating system.
- Elimination of steam condensate trap maintenance and inherent system losses.
- Elimination of steam condensate return collection and pumping units.

Measurement and Verification

Natural gas utility usage and cost as determined from the Utility invoices should be recorded, trended, compared to previous invoices and presented to management.

Operations and maintenance costs directly associated with the new HV units and freeze protection systems should be tracked and compared to the same of the decommissioned steam boiler heating system and equipment.

A facility air balance study should be performed to ensure excessive openings in the building envelope, including abandoned heating and ventilation equipment, are not degrading the effectiveness of the building air pressurization. This balance study should extend to the Office HVAC system to ensure this system is correctly balanced with respect to the MAIN PLANT.

End of ECM #1

ECM #2: Roof Insulation Improvements

Existing Conditions

The existing facility roof is of varying types, insulation values and condition. Sections of the existing roof are leaking causing wet roof insulation, structural decay and damage to the building user contents and processes. A mapping of the roof is presented as follows:

2017 Re-roofing Phase Plan for Maumee Assembly & Stamping

Measure Description

Replace varying sections of the existing as needed and improve insulation values where practical. Implement high reflective roof material on sections of the facility that are air-conditioned to reduce solar gain in those spaces.

Remove and cap un-used ventilation and similar openings.

Seal air leaks and weather openings at cracks and joints in the roof flashing system.

Repairs Required

Section A is 15,300 sq. ft. and is to be torn off and replaced including adding of 4” iso board insulation.

Sections B, D, E, F, G, H & K totaling 333,600 sq. ft. is scheduled for removal of gravel and install aluminum chip surface.

Section C is scheduled for new reflective overlay of 27,800 sq. ft. of white granule and 2,500 sq. ft. of black roof.

Sections I & J totaling 27,500 sq. ft. is scheduled for new reflective overlay of gravel roofs.

Operations and Maintenance Impacts

The scheduled roof replacements and repairs will prevent future structural decay and damage to the building contents and process equipment.

Sporadic, un-planned and emergency repairs requirements will be minimized.

Equipment/System Life

The new roof systems have a 20-year labor and material warranty.

Savings

Energy savings is implemented by making improvements to the following;

1. CONVECTION; close and seal weather gaps and unused openings.
2. RADIATION; increase reflectance values on roof sections over air-conditioned sections of the building.
3. CONDUCTION; improve thermal resistivity by increasing the insulation R-value of the roof.

Energy savings from conduction is also realized when water-soaked fiberglass insulation dries out after a roof repair, as the intended spatial voids in the insulation material will again be filled with air rather than water. Air is less conductive than water, therefore the existing insulation is again performing to the intended R-value.

Section A-15,300 sq. ft.;

1. R-value goes from R 5 to R25.
2. Some missing roofing allowing air movement energy loss.

Sections B, D, E, F, G, H & K totaling 333,600 sq. ft.;

1. Wet insulation becomes dry and increases the R value.
2. Existing reflectivity approximately increases from 20% to 75%.
3. Un-used penetrations removed, decreasing energy loss from air movement.

Sections C totaling 30,300 sq. ft.;

1. Wet insulation becomes dry and increases the R value.
2. 27,800 sq. ft. goes from 25% reflectivity to 75% reflectivity with white granule application.
3. 2,500 sq. ft. goes from 3% reflectivity to 75% reflectivity with black roof application.

Sections I & J totaling 27,500 sq. ft.;

1. Wet insulation becomes dry and increases the R value.

2. Goes from 20% reflectivity to 75% reflectivity with high reflective gravel roof over air conditioned office.

Other considerations;

1. The “wet insulation” represents approximately 5% of the total roof area, resulting in increase of R value.

2. Un-used penetration removal represents approximately 1/10th of 1% but could still be substantial energy loss like a chimney.

Measurement and Verification

Thermal imaging technology should be utilized to verify the integrity of the roofing system an insulation.

Infrared thermal gun thermometer can be used to perform spot check of roof thermal insulation performance from the bottom side of deck to be compared with the temperature on the exterior side of the roof.

Air conditioning energy savings M&V would require extensive electrical metering, measurement of outdoor conditions, sophisticated software application and is considered to be prohibitive.

End of ECM #2

ECM #3: Power Factor Correction

Existing Conditions

The existing primary substation included two (2) power factor correction capacitor banks connected to the 12.47kV facility distribution switchgear on the load side of the Utility revenue metering. These capacitors where found to be non-functional and out of service when MA&S took ownership of the facility.

The average power factor as measured by the utility revenue metering had been 56 to 60%. The utility (Toledo Edison Company) GENERAL SERVICE – TRANSMISSION (RATE "G") is based upon KVA demand and KWH used. Low power factor increases the monthly demand charge and resulting blended cost per KWH by measurement of KVA demand in lieu of KW demand.

Measure Description

MA&S has implemented replacement of the existing 12.47kV power factor correction capacitor banks with one (1) 1,011kVAr and one (1) 2,022kVAr automatic control step capacitor banks. The new equipment was brought on line with initial operational savings realized in the April 2017 utility invoice. The improved power factor operating target is an average of 98%+ without going leading.

Repairs Required

No repairs were made, as the existing equipment was replaced with new.

Operations and Maintenance Impacts

The new capacitors are automatic and control off of current and voltage transformers in the 12.47kV distribution switchgear.

Routine maintenance is expected to be less costly than the original system with vacuum contactors and enclosed capacitors requiring less maintenance and repair than the open structure capacitors and oil switching.

Equipment/System Life

The new equipment life expectancy is 30 years, with periodic replacement of failed capacitor units.

Savings

The majority of the power factor savings are realized by reducing the reactive KVA of the electrical power system such that the KVA billing demand is reduced to be closer to the actual KW demand.

A small portion of savings is realized by an I^2R loss reduction of the electrical power system, and is conservatively estimated at 2% by industry/engineering standards.

Measurement and Verification

Electrical utility usage and cost determined from the Utility invoices should be recorded, trended and compared to previous invoices. The Utility does not provide direct information, but can provide reports of kVAr usage and resultant power factor upon special request.

Electrical power values including power factor, should be continuously monitored as the load side of the utility revenue metering. Automatic status/alarms should be created to notify responsible personnel if any parameter is not within specification.

The power factor correction capacitors, switching equipment and automatic controllers should be inspected, cleaned and calibrated in accordance with NETA recommendations.

End of ECM #3

ECM #4: LED Lighting Upgrade of Quonset Hut Storage Buildings

Existing Conditions

The Quonset Hut Storage Buildings are used as storage and staging ancillary to the manufacturing process. These spaces are presently lighted with 400watt metal halide industrial luminaries.

Measure Description

The existing metal halide fixtures are recommended to be replaced with new 95watt LED luminaires with integral drivers on a one-to-one direct change-out basis.

Repairs Required

No repairs are expected.

Operations and Maintenance Impacts

Routine maintenance is expected to be less costly than the present lighting system as LED luminaires have a longer life expectancy than metal halide lighting systems. Full replacement with new fixtures will avoid needed present and future re-lamping and ballast replacement cost of the existing HID fixtures.

Equipment/System Life

The new LED lighting fixtures are expected to have a useful service life of 11 years without maintenance. Fixtures are guaranteed for 5 year by a new manufacturer's warranty.

Savings

Energy savings is realized by direct one-for-one replacement of fixtures with lower wattage luminaires of equal or better lumen output/utilization.

Measurement and Verification

Measurement of operating hours for lighting with manual or localized control is cost prohibitive. Power draw of individual fixtures and/or branch circuits before and after replacement should be measured with a handheld ammeter/wattmeter and energy savings verified with the initial calculations based upon estimated hours of use.

End of ECM #4

ECM #5: LED Lighting Upgrade of Main Office

Existing Conditions

The Offices are used for administrative and operations personnel. These spaces are presently lighted with 4-lamp fluorescent lay-in troffers equipped with T-8 lamps and matching electronic ballasts.

Measure Description

The existing fluorescent lamps are recommended to be replaced with new 11watt LED equivalent lamps with integral drivers on a one-for-one direct change-out basis. The existing fluorescent ballasts will remain in place.

Repairs Required

No repairs are expected. Replacement of acrylic lenses would enhance the aesthetics and quality of light in the space.

Operations and Maintenance Impacts

Routine maintenance is expected to be less costly than the present lighting system as LED luminaires have a longer life expectancy than fluorescent lighting systems. Full replacement with new fixtures will avoid needed present and future re-lamping and ballast replacement cost of the existing florescent lamp systems.

Equipment/System Life

The new LED fluorescent replacement lamps are expected to have a useful service life of 10 years without maintenance.

Savings

Energy savings is realized by direct one-for-one replacement of lamps with lower wattage lamps of equal or better lumen output/utilization.

HVAC (air conditioning) savings will be realized due to less heat gain to the conditioned spaces during air conditioning.

Measurement and Verification

Measurement of operating hours for lighting with manual or localized control is cost prohibitive. Power draw of individual fixtures and/or branch circuits before and after replacement should be measured with a handheld ammeter/wattmeter and energy savings verified with the initial calculations based upon estimated hours of use.

End of ECM #5

ECM #6: LED Lighting Upgrade of the Building Exterior

Existing Conditions

The Building Exterior lighting consist of a mix of high pressure sodium and metal halide building and pole mounted luminaires for night time operations and security.

Measure Description

The existing HID fixtures are recommended to be replaced one-for-one with new LED luminaires with integral drivers providing a consistent light source with lumen output matched for the application.

Repairs Required

No repairs are required.

Operations and Maintenance Impacts

Routine maintenance is expected to be less costly than the present lighting system as LED luminaires have a longer life expectancy than HID lighting systems. Full replacement with new fixtures will avoid needed present and future re-lamping and ballast replacement cost of the existing HID fixtures.

Equipment/System Life

The new LED lighting fixtures are expected to have a useful service life of 10 years without maintenance. Fixtures are guaranteed for 5 years by a manufacturer's warranty.

Savings

Energy savings is realized by direct one-for-one replacement of fixtures with lower wattage luminaires of equal or better lumen output/utilization.

Measurement and Verification

Measurement of operating hours for lighting with photo-electric/astronomical time clock control is cost prohibitive. Power draw of individual fixtures and/or branch circuits before and after replacement should be measured with a handheld ammeter/wattmeter and energy savings verified with the initial calculations based upon estimated hours of use.

End of ECM #6

ECM #7: LED Lighting Upgrade of the Main Plant

Existing Conditions

The Main Plant lighting consist of a mix of metal halide and fluorescent industrial high bay luminaires for the manufacturing processes and related indoor ancillary areas.

Measure Description

The existing HID fixtures are recommended to be replaced one-for-one with new LED luminaires with integral drivers providing a consistent light source. Lumen output to match or be greater than the existing for the application.

Repairs Required

No repairs are required.

Operations and Maintenance Impacts

Routine maintenance is expected to be less costly than the present lighting system as LED luminaires have a longer life expectancy than HID and fluorescent lighting systems. Full replacement with new fixtures will avoid needed present and future re-lamping and ballast replacement cost of the existing HID and fluorescent fixtures.

Equipment/System Life

The new LED fluorescent replacement lamps are expected to have a useful service life of 10 years without maintenance. Fixtures are guaranteed for 5 years by a manufacturer's warranty.

Savings

Energy savings is realized by direct one-for-one replacement of lamps with lower wattage luminaires of equal or better lumen output/utilization.

Measurement and Verification

Measurement of operating hours for lighting with manual or localized control is cost prohibitive. Power draw of individual fixtures and/or branch circuits before and after replacement should be measured with a handheld ammeter/wattmeter and energy savings verified with the initial calculations based upon estimated hours of use.

End of ECM #7

APPENDIX

ECM #1: **Steam Boiler Decommissioning**

MEASURE DESCRIPTION	Electical Consumption (kWH)		Gas consumption (btu)	
	Existing Condition	New Equipment	Existing Condition	New Equipment
Primary Heating	0	0	60,837,940	39,546,608
Other Heating Accessories	135,902.00	28,478	0	0
Cooling Compressor	150,779	140,397	0	0
Condenser Fans	58,601	58,176	0	0
Condenser Pump	44,811	44,811	0	0
Other Cooling Accessories	8,455	8,455	0	0
Supply Fans	2,707,206	1,538,983	0	
Pumps	272,946	58,431	0	
Base Utilities	10,976,280	10,976,280	3,013,097	2,469,750
Lighting Heat Gain	1,034,144	1,034,144	0	0
Miscellaneous Load	43,610	43,610	0	0
Total	15,432,734	13,931,765	63,851,037	42,016,358

Building Total Existing (btu)	116,507,525
Building Total New Equipment (btu)	89,551,540

ENERGY SAVINGS

Natural Gas Savings EQUATION	(63851037-42016358)/1000		
Natural Gas Savings RESULT	21,835	MBH	
Electricity Saving EQUATION	(15432734-13931765)		
Electricity Saving RESULT	1,500,969	kWH	
Energy Usage Savings EQUATION	((15432734*3.412)+63851037)-((13931765*3.412)+42016358)		
Annual Energy Usage Savings RESULT	26,955,985.23		BTU
BLENDED cost of Energy Usage	$ 0.01044		per BTU
Annual NET Energy Usage Savings	$ 281,308.00		

OTHER SAVINGS

Reduction of full time steam boiler operations	$	116,834
Annual steam boiler repairs	$	9,938
Annual steam boiler chemical treatment		Undetermined
Annual steam and condensate system repairs and maintenance		Undetermined
Total OTHER SAVINGS	$	126,772

ECM #2: **Roof Insulation Improvements**

MEASURE DESCRIPTION	**Electical Consumption** (kWH)		**Gas consumption** (btu)	
	Existing Condition	**Roof Improvements**	**Existing Condition**	**Roof Improvements**
Primary Heating	0	0	60,837,940	37,999,280
Other Heating Accessories	135,902.00	132,249	0	0
Cooling Compressor	150,779	105,283	0	0
Condenser Fans	58,601	56,867	0	0
Condenser Pump	44,811	44,758	0	0
Other Cooling Accessories	8,455	8,455	0	0
Supply Fans	2,707,206	1,871,380	0	
Pumps	272,946	265,417	0	
Base Utilities	10,976,280	10,976,280	3,013,097	3,013,097
Lighting Heat Gain	1,034,144	1,034,144	0	0
Miscellaneous Load	43,610	43,610	0	0
Total	15,432,734	14,538,443	63,851,037	41,012,377

Building Total Existing (btu)	116,507,525
Building Total New Equipment (btu)	90,617,545

ENERGY SAVINGS

Natural Gas Savings EQUATION	(63851037-41012377)/1000		
Natural Gas Savings RESULT	22,839	MBH	
Electricity Saving EQUATION	(15432734-14538443)		
Electricity Saving RESULT	894,291	kWH	
Energy Usage Savings EQUATION	((15432734*3.412)+63851037)-((14538443*3.412)+41012377)		
Annual Energy Usage Savings RESULT	25,889,980.89		BTU
BLENDED cost of Energy Usage	$ 0.01040		per BTU
Annual NET Energy Usage Savings	$ 269,242.00		

ECM #1 & 2 Combined: **Roof Insulation Improvements & New Equipment**

MEASURE DESCRIPTION	**Electical Consumption** (kWH)	
	Existing Condition	**Renovations**
Primary Heating	0	0
Other Heating Accessories	135,902.00	28,993
Cooling Compressor	150,779	101,135
Condenser Fans	58,601	56,563
Condenser Pump	44,811	44,758
Other Cooling Accessories	8,455	8,455
Supply Fans	2,707,206	597,673
Pumps	272,946	58,915
Base Utilities	10,976,280	10,976,280
Lighting Heat Gain	1,034,144	1,034,144
Miscellaneous Load	43,610	43,610
Total	15,432,734	12,950,526
Building Total Existing (btu)	116,507,525	
Building Total New Equipment (btu)	83,545,177	

	ENERGY SAVINGS	
Natural Gas Savings EQUATION	(63851037-39357982)/1000	
Natural Gas Savings RESULT	24,493	MBH
Electricity Saving EQUATION	(15432734-12950526)	
Electricity Saving RESULT	2,482,208	kWH
Energy Usage Savings EQUATION	((15432734*3.412)+63851037)-((12950526*3.412)	
Annual Energy Usage Savings RESULT	32,962,348.70	
BLENDED cost of Energy Usage	$ 0.01048	
Annual NET Energy Usage Savings	$ 345,404.00	

ECM #3: **Power Factor Correction Improvements**

The following table data is reproduced dirctly form the Toledo Edison Company Billing Account Summary for Account #110065141225

DATE	KVAR	DEMAND	KWH	Toledo Edison Charges	CENTS/KWH	REMARKS
17-Jul		3640.6	1,223,424	$ 34,209.37	2.80	New Power Factor Correction Equipment on-line
17-Jun		2854.2	1,354,133	$ 25,483.01	1.88	New Power Factor Correction Equipment on-line
17-May		3205.6	1,372,147	$ 29,921.75	2.18	New Power Factor Correction Equipment on-line
17-Apr		2997.9	1,314,619	$ 27,475.68	2.09	New Power Factor Correction Equipment on-line
		3174.58	1,316,081	$ 29,272.45	2.24	Average Values ***with*** auto PFC equipment on-line
17-Mar		5024.9	1,467,375	$ 51,421.17	3.50	
17-Feb		4533.8	1,413,087	$ 45,157.09	3.20	
17-Jan		4670.8	1,366,128	$ 44,576.71	3.26	
16-Dec		3905.1	1,179,835	$ 39,742.41	3.37	
16-Nov		4363.2	1,121,299	$ 45,863.67	4.09	
16-Oct		5315.8	1,459,368	$ 53,966.65	3.70	
16-Sep		3787.5	1,005,163	$ 40,781.22	4.06	
16-Aug		3972.7	1,063,080	$ 42,401.00	3.99	
16-Jul		4493.1	1,314,532	$ 45,390.58	3.45	
16-Jun		4335.4	1,424,333	$ 41,417.93	2.91	
16-May		4310.9	1,226,621	$ 43,390.08	3.54	
16-Apr		4483.6	1,441,440	$ 42,933.69	2.98	
16-Mar		4305.0	1,493,121	$ 38,880.20	2.60	
16-Feb		4308.5	1,492,661	$ 36,756.79	2.46	
16-Jan		4486.8	1,209,225	$ 42,797.23	3.54	
15-Dec		4342.8	1,280,433	$ 36,828.14	2.88	
15-Nov		4235.6	1,259,625	$ 36,003.55	2.86	
15-Oct		4303.7	1,094,717	$ 39,041.48	3.57	
15-Sep		4561.2	1,292,343	$ 40,334.00	3.12	
15-Aug		4461.7	1,482,782	$ 37,218.37	2.51	
		4410.11	1,304,358	$ 42,245.10	3.28	Average Values ***without*** auto PFC equipment on-line

TOTAL 24 MONTH KWH SUM = 31,351,491
AVERAGE 12 MONTH KWH = 15,675,746

ENERGY COST SAVINGS

Electrical Energy Cost Savings EQUATION {15675745.5}*{3.2795-2.2375}/100
Annual Electrical Energy Cost Savings RESULT $ 163,341.27 dollars

Electrical Demand Savings EQUATION 4410.105-3174.575
Monthly Electrical Demand Savings RESULT 1236 kVA

The cost of electrical demand is blended with the kWH Electrical Energy Usage above.

ECM #4: **LED Lighting Upgrade for the Quonset Hut Storage Buildings**

MEASURE DESCRIPTION	QTY.	WATTAGE
Remove 400watt metal halide lamps	102	458
Install 95watt replacement LED lamps	102	95
Hours per day of usage M-F	24	
Days per week of usage M-F	5	
Weeks per year of usage M-F	50	
Annual Sub-Total Hours M-F shift work	*6000*	
Hours per day of usage SAT	18	
Days per week of usage SAT	1	
Weeks per year of usage SAT	50	
Annual Sub-Total Hours SATURDAY shift work	*900*	
Hours per day of usage SUN	9	
Days per week of usage SUN	1	
Weeks per year of usage SUN	26	
Annual Sub-Total Hours SUNDAY shift work	*234*	

ENERGY SAVINGS

Electrical Energy Usage Savings EQUATION	{{(458-95)*102}*(6000+900+234)}/1000		
Annual Electrical Energy Usage Savings RESULT		264143	kWH
BLENDED cost of Electrical Energy Usage	$	0.07622	per kWH
Annual NET Energy Usage Savings	$	20,133.02	

Electrical Demand Savings EQUATION	{(458-95)*102}/1000	
Monthly Electrical Demand Savings RESULT	37.026	kVA

The cost of electrical demand is blended with the kWH Electrical Energy Usage above.

% ENERGY REDUCTION (based on described ECM as stand alone energy cost)

Present Electrical Energy Usage EQUATION	(102*458)*(6000+900+234)/1000
Present Electrical Energy Usage RESULT	333272 kWH
Energy Savings over Present ECM item usage EQUATION	(264143.484/333271.944)*100
Energy Savings over Present ECM item usage RESULT	79%

ECM #5: **LED Lighting Upgrade for the Main Office**

MEASURE DESCRIPTION	QTY.	WATTAGE
Remove 32watt T8 fluorescent lamps	1220	32
Install 12watt replacement LED lamps	1220	14
Hours per day of usage M-F	10	
Days per week of usage M-F	6	
Weeks per year of usage M-F	50	
Annual Sub-Total Hours M-F shift work	*3000*	
Hours per day of usage SAT	6	
Days per week of usage SAT	1	
Weeks per year of usage SAT	50	
Annual Sub-Total Hours SATURDAY shift work	*300*	
Hours per day of usage SUN	6	
Days per week of usage SUN	1	
Weeks per year of usage SUN	26	
Annual Sub-Total Hours SUNDAY shift work	*104*	

ENERGY SAVINGS

Electrical Energy Usage Savings EQUATION	(((32-14)*1220)*(3000+300+104))/1000	
Annual Electrical Energy Usage Savings RESULT	74752	kWH
BLENDED cost of Electrical Energy Usage	$ 0.07622	per kWH
Annual NET Energy Usage Savings	$ 5,697.59	

Electrical Demand Savings EQUATION	((32-14)*1220)/1000		
Monthly Electrical Demand Savings RESULT	21.96	kVA	The cost of electrical demand is blended with the kWH Electrical Energy Usage above.

% ENERGY REDUCTION (based on described ECM as stand alone energy cost)

Present Electrical Energy Usage EQUATION	(1220*32)*(3000+300+104)/1000
Present Electrical Energy Usage RESULT	132892 kWH
Energy Savings over Present ECM item usage EQUATION	(74751.84/132892.16)*100
Energy Savings over Present ECM item usage RESULT	56%

ECM #6: **LED Lighting Upgrade for the Building Exterior**

Replacement based on RAB

MEASURE DESCRIPTION	QTY.	Existing WATTAGE	Proposed WATTAGE	Savings WATTAGE
Replace 1000watt HPS Area Flood Lights	34	1120	314	806
Replace 400watt HPS Area Flood Lights	116	458	154	304
Replace 250watt HPS Wall Packs	6	280	50	230
Replace 250watt HPS Area Flood Lights	26	280	76	204

Annual Outdoor Lighitng Hours -Astronomical Schedule *3833*

ENERGY SAVINGS

Electrical Energy Usage Savings EQUATION ((((34*806)+(116*304)+(6*230)+(26*204))*3833)/1000

Annual Electrical Energy Usage Savings RESULT 265826 kWH

BLENDED cost of Electrical Energy Usage $ 0.07622 per kWH

Annual NET Energy Usage Savings $ 20,261.27

Electrical Demand Savings EQUATION ((34*806)+(116*304)+(6*230)+(26*204))/1000

Monthly Electrical Demand Savings RESULT 69.352 kVA

The cost of electrical demand is blended with the kWH Electrical Energy Usage above.

% ENERGY REDUCTION (based on described ECM as stand alone energy cost)

Present Electrical Energy Usage EQUATION ((34*1120)+(116*458)+(6*280)+(26*280))*3833/1000

Present Electrical Energy Usage RESULT 383944 kWH

Energy Savings over Present ECM item usage EQUATION (265826.216/383943.944)*100

Energy Savings over Present ECM item usage RESULT 69%

ECM #7: **LED Lighting Upgrade for the Main Plant**

MEASURE DESCRIPTION	QTY.	Existing WATTAGE	Proposed WATTAGE	Savings WATTAGE
Replace 400watt MH Industrials	9	465	197	268
Replace 8lamp 32watt T8 fluorescent High Bays	576	256	113	143
Replace 8lamp 32watt T8 fluorescent High Bays	656	256	179	77
Replace 8lamp 32watt T8 fluorescent High Bays	30	256	93	163
Replace 2lamp 96watt T12HO fluourescent HB's	234	192	121	71

Hours per day of usage M-F	24
Days per week of usage M-F	5
Weeks per year of usage M-F	50
Annual Sub-Total Hours M-F shift work	*6000*
Hours per day of usage SAT	18
Days per week of usage SAT	1
Weeks per year of usage SAT	50
Annual Sub-Total Hours SATURDAY shift work	*900*
Hours per day of usage SUN	9
Days per week of usage SUN	1
Weeks per year of usage SUN	26
Annual Sub-Total Hours SUNDAY shift work	*234*

ENERGY SAVINGS

Electrical Energy Usage Savings EQUATION {((9*268)+(576*143)+(656*77)+(30*163)+(234*71))*(6000+900+234)}/1000

Annual Electrical Energy Usage Savings RESULT 1118583 kWH

BLENDED cost of Electrical Energy Usage $ 0.07622 per kWH

Annual NET Energy Usage Savings $ 85,258.37

Electrical Demand Savings EQUATION {(9*268)+(576*143)+(656*77)+(30*163)+(234*71)}/1000

Monthly Electrical Demand Savings RESULT 156.796 kVA

The cost of electrical demand is blended with the kWH Electrical Energy Usage above.

% ENERGY REDUCTION (based on described ECM as stand alone energy cost)

Present Electrical Energy Usage EQUATION {(9*465)+(576*465)+(656*256)+(30*256)+(234*192))*(6000+900+234)/1000

Present Electrical Energy Usage RESULT 2655168 kWH

Energy Savings over Present ECM item usage EQUATION (1118582.664/2655167.79)*100

Energy Savings over Present ECM item usage RESULT 42%

Economic Summary

Project Information

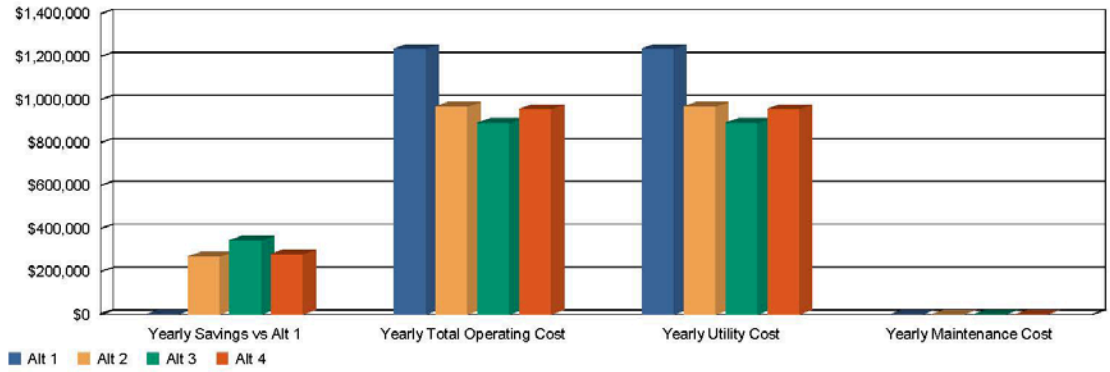
Location	Maumee
Project Name	MAS
User	
Company	
Comments	

Study Life: 20 years
Cost of Capital: 10 %
Alternative 1: Existing Condtions
Alternative 2: ECM #2
Alternative 3: ECM #1 & ECM #2 Combined
Alternative 4: ECM #1

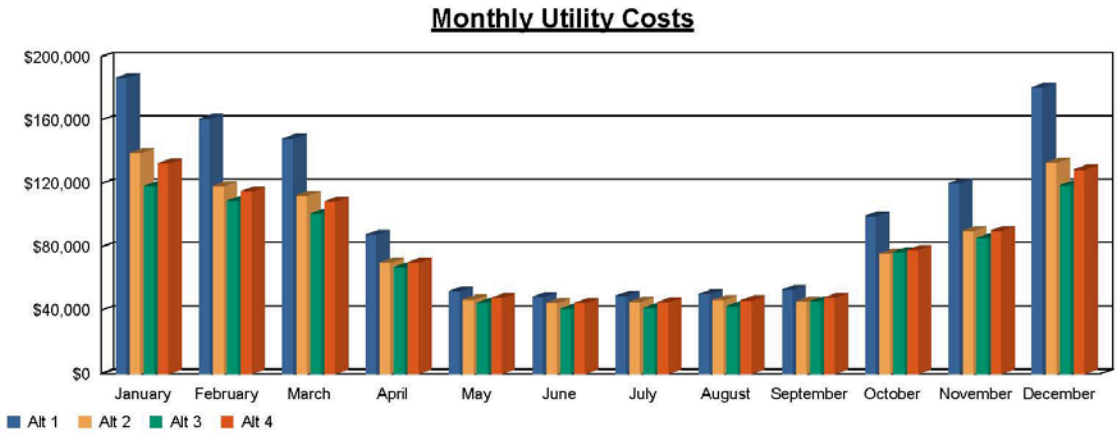
Economic Comparison of Alternatives

	Yearly Savings ($)	First Cost Difference ($)	Cumulative Cash Flow Difference ($)	Simple Payback (yrs.)	Net Present Value ($)	Life Cycle Payback (yrs.)	Internal Rate of Return (%)	Life Cycle Cost Difference
Alt 2 vs Alt 1	269,242	0	5,384,845	No Payback	2,292,211	No Payback	1,000.0	2,292,211.00
Alt 3 vs Alt 1	345,404	0	6,908,079	No Payback	2,940,618	No Payback	1,000.0	2,940,618.00
Alt 4 vs Alt 1	281,308	0	5,626,153	No Payback	2,394,930	No Payback	1,000.0	2,394,930.00
Alt 2 vs Alt 3	-76,162	0	-1,523,234	No Payback	-648,407	No Payback	Does Not Payback	-648,407.30
Alt 2 vs Alt 4	-12,065	0	-241,308	No Payback	-102,720	No Payback	Does Not Payback	-102,719.60
Alt 3 vs Alt 4	64,096	0	1,281,926	No Payback	545,688	No Payback	1,000.0	545,687.70

Annual Operating Costs



	Yearly Savings vs Alt 1	Yearly Total Operating Cost ($)	Yearly Utility Cost ($)	Yearly Maintenance Cost ($)	Plant kWh/ton-hr
Alt 1	0	1,237,433	1,237,433	0	1.174
Alt 2	269,242	968,190	968,190	0	1.625
Alt 3	345,404	892,029	892,029	0	1.650
Alt 4	281,308	956,125	956,125	0	1.257


Monthly Utility Costs
$200,000
$160,000
$120,000
$80,000
$40,000
$0
January
February
March
April
May
June
July
August
September
October
November
December
Alt 1
Alt 2
Alt 3
Alt 4

ENERGY CONSUMPTION SUMMARY

By MDA Engineering

	Elect Cons. (kWh)	Gas Cons. (kBtu)	Water Cons. (1000 gals)	% of Total Building Energy	Total Building Energy (kBtu/yr)	Total Source Energy* (kBtu/yr)
Alternative 1						
Primary heating						
Primary heating		60,837,940		52.2 %	60,837,940	64,039,936
Other Htg Accessories	135,902		520	0.4 %	463,835	1,391,644
Heating Subtotal	**135,902**	**60,837,940**	**520**	**52.6 %**	**61,301,775**	**65,431,580**
Primary cooling						
Cooling Compressor	150,779			0.4 %	514,609	1,543,980
Tower/Cond Fans	58,601		934	0.2 %	200,006	600,078
Condenser Pump	44,811			0.1 %	152,942	458,871
Other Clg Accessories	8,455			0.0 %	28,857	86,579
Cooling Subtotal....	**262,647**		**934**	**0.8 %**	**896,413**	**2,689,508**
Auxiliary						
Supply Fans	2,707,206			7.9 %	9,239,694	27,721,854
Pumps	272,946			0.8 %	931,563	2,794,968
Stand-alone Base Utilities	10,976,280	3,013,097		34.7 %	40,475,140	115,569,048
Aux Subtotal....	13,956,432	3,013,097		43.5 %	50,646,399	146,085,872
Lighting						
Lighting	1,034,144			3.0 %	3,529,534	10,589,660
Receptacle						
Receptacles	43,610			0.1 %	148,842	446,572
Cogeneration						
Cogeneration				0.0 %	0	0
Totals						
Totals**	**15,432,734**	**63,851,036**	**1,454**	**100.0 %**	**116,522,957**	**225,243,184**

* Note: Resource Utilization factors are included in the Total Source Energy value.
** Note: This report can display a maximum of 7 utilities. If additional utilities are used, they will be included in the total.

ENERGY CONSUMPTION SUMMARY

By MDA Engineering

	Elect Cons. (kWh)	Gas Cons. (kBtu)	Water Cons. (1000 gals)	% of Total Building Energy	Total Building Energy (kBtu/yr)	Total Source Energy* (kBtu/yr)
Alternative 2						
Primary heating						
Primary heating		37,999,280		41.9 %	37,999,280	39,999,244
Other Htg Accessories	132,249		501	0.5 %	451,367	1,354,236
Heating Subtotal	**132,249**	**37,999,280**	**501**	**42.4 %**	**38,450,647**	**41,353,480**
Primary cooling						
Cooling Compressor	105,283			0.4 %	359,332	1,078,103
Tower/Cond Fans	56,867		579	0.2 %	194,088	582,322
Condenser Pump	44,758			0.2 %	152,761	458,328
Other Clg Accessories	8,445			0.0 %	28,823	86,477
Cooling Subtotal....	**215,354**		**579**	**0.8 %**	**735,003**	**2,205,230**
Auxiliary						
Supply Fans	1,871,380			7.1 %	6,387,020	19,162,976
Pumps	265,417			1.0 %	905,869	2,717,880
Stand-alone Base Utilities	10,976,280	3,013,097		44.7 %	40,475,140	115,569,048
Aux Subtotal....	13,113,078	3,013,097		52.7 %	47,768,032	137,449,904
Lighting						
Lighting	1,034,144			3.9 %	3,529,534	10,589,660
Receptacle						
Receptacles	43,610			0.2 %	148,842	446,572
Cogeneration						
Cogeneration				0.0 %	0	0
Totals						
Totals**	**14,538,435**	**41,012,376**	**1,080**	**100.0 %**	**90,632,055**	**192,044,848**

* Note: Resource Utilization factors are included in the Total Source Energy value.
** Note: This report can display a maximum of 7 utilities. If additional utilities are used, they will be included in the total.

ENERGY CONSUMPTION SUMMARY

By MDA Engineering

	Elect Cons. (kWh)	Gas Cons. (kBtu)	Water Cons. (1000 gals)	% of Total Building Energy	Total Building Energy (kBtu/yr)	Total Source Energy* (kBtu/yr)
Alternative 3						
Primary heating						
Primary heating		36,888,232		44.2 %	36,888,232	38,829,720
Other Htg Accessories	28,993			0.1 %	98,953	296,888
Heating Subtotal	**28,993**	**36,888,232**		**44.3 %**	**36,987,185**	**39,126,608**
Primary cooling						
Cooling Compressor	101,135			0.4 %	345,172	1,035,620
Tower/Cond Fans	56,563		559	0.2 %	193,048	579,203
Condenser Pump	44,758			0.2 %	152,781	458,328
Other Clg Accessories	8,445			0.0 %	28,823	86,477
Cooling Subtotal....	**210,901**		**559**	**0.9 %**	**719,804**	**2,159,627**
Auxiliary						
Supply Fans	597,673			2.4 %	2,039,859	6,120,188
Pumps	58,915			0.2 %	201,076	603,289
Stand-alone Base Utilities	10,976,280	2,469,750		47.8 %	39,931,794	114,997,104
Aux Subtotal....	11,632,868	2,469,750		50.5 %	42,172,728	121,720,576
Lighting						
Lighting	1,034,144			4.2 %	3,529,534	10,589,660
Receptacle						
Receptacles	43,610			0.2 %	148,842	446,572
Cogeneration						
Cogeneration				0.0 %	0	0
Totals						
Totals**	**12,950,516**	**39,357,984**	**559**	**100.0 %**	**83,558,095**	**174,043,056**

* Note: Resource Utilization factors are included in the Total Source Energy value.
** Note: This report can display a maximum of 7 utilities. If additional utilities are used, they will be included in the total.

Project Name: MAS
Dataset Name: 17106 MAS.trc

TRACE® 700 v6.3.3 calculated at 08:35 AM on 08/29/2017
Alternative - 3 Energy Consumption Summary report page 1

ENERGY CONSUMPTION SUMMARY

By MDA Engineering

	Elect Cons. (kWh)	Gas Cons. (kBtu)	Water Cons. (1000 gals)	% of Total Building Energy	Total Building Energy (kBtu/yr)	Total Source Energy* (kBtu/yr)
Alternative 4						
Primary heating						
Primary heating		39,546,608		44.2 %	39,546,608	41,628,008
Other Htg Accessories	28,478			0.1 %	97,195	291,614
Heating Subtotal	**28,478**	**39,546,608**		**44.3 %**	**39,643,803**	**41,919,624**
Primary cooling						
Cooling Compressor	140,397			0.5 %	479,175	1,437,658
Tower/Cond Fans	58,176		845	0.2 %	198,556	595,727
Condenser Pump	44,811			0.2 %	152,942	458,871
Other Clg Accessories	8,455			0.0 %	28,857	86,579
Cooling Subtotal....	**251,840**		**845**	**1.0 %**	**859,529**	**2,578,845**
Auxiliary						
Supply Fans	1,538,983			5.9 %	5,252,547	15,759,217
Pumps	58,431			0.2 %	199,426	598,337
Stand-alone Base Utilities	10,976,280	2,469,750		44.6 %	39,931,794	114,997,104
Aux Subtotal....	12,573,694	2,469,750		50.7 %	45,383,768	131,354,656
Lighting						
Lighting	1,034,144			3.9 %	3,529,534	10,589,650
Receptacle						
Receptacles	43,610			0.2 %	148,842	446,572
Cogeneration						
Cogeneration				0.0 %	0	0
Totals						
Totals**	**13,931,765**	**42,016,360**	**845**	**100.0 %**	**89,565,474**	**186,889,344**

* Note: Resource Utilization factors are included in the Total Source Energy value.
** Note: This report can display a maximum of 7 utilities. If additional utilities are used, they will be included in the total.

Project Name: MAS
Dataset Name: 17106 MAS.trc

TRACE® 700 v6.3.3 calculated at 08:35 AM on 08/29/2017
Alternative - 4 Energy Consumption Summary report page 1

MONTHLY ENERGY CONSUMPTION

By MDA Engineering

------- Monthly Energy Consumption -------

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 1	**Existing Condtions**												
Electric													
On-Pk Cons. (kWh)	1,327,594	1,200,138	1,337,635	1,272,094	1,290,289	1,250,261	1,281,737	1,292,616	1,248,945	1,318,120	1,289,562	1,323,744	15,432,734
On-Pk Demand (kW)	2,019	2,022	2,023	2,021	2,017	1,991	1,993	1,991	2,019	2,019	2,022	2,018	2,023
Gas													
On-Pk Cons. (therms)	132,827	112,221	95,133	38,899	3,654	1,489	1,023	1,831	6,085	48,566	69,712	127,072	638,510
On-Pk Demand (therms/hr)	255	269	230	151	81	8	6	9	64	180	196	258	269
Water													
Cons. (1000gal)	135	128	146	125	94	108	124	103	92	123	140	137	1,454

Energy Consumption		
Building	180,737	Btu/(ft2-year)
Source	349,371	Btu/(ft2-year)
Floor Area	644,711	ft2

Environmental Impact Analysis	
CO2	27,895,900 lbm/year
SO2	193,593 gm/year
NOX	48,375 gm/year

MONTHLY ENERGY CONSUMPTION

By MDA Engineering

------- Monthly Energy Consumption -------

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 2	**ECM #2**												
Electric													
On-Pk Cons. (kWh)	1,253,906	1,133,604	1,263,490	1,198,701	1,212,054	1,175,960	1,204,328	1,216,517	1,169,473	1,242,170	1,217,967	1,250,267	14,538,435
On-Pk Demand (kW)	1,920	1,920	1,922	1,921	1,886	1,867	1,870	1,866	1,921	1,922	1,922	1,920	1,922
Gas													
On-Pk Cons. (therms)	89,325	73,677	63,129	24,286	1,246	624	369	787	1,639	28,209	43,200	83,631	410,124
On-Pk Demand (therms/hr)	185	195	167	106	55	3	2	4	25	127	142	187	195
Water													
Cons. (1000gal)	119	113	125	96	53	59	66	59	51	97	121	122	1,080

Energy Consumption		
Building	140,578	Btu/(ft2-year)
Source	297,877	Btu/(ft2-year)
Floor Area	644,711	ft2

Environmental Impact Analysis	
CO2	26,279,382 lbm/year
SO2	182,374 gm/year
NOX	45,572 gm/year

MONTHLY ENERGY CONSUMPTION

By MDA Engineering

------- Monthly Energy Consumption -------

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 3	**ECM #1 & ECM #2 Combined**												
Electric													
On-Pk Cons. (kWh)	1,094,818	989,750	1,104,408	1,061,214	1,103,296	1,071,790	1,097,053	1,108,731	1,062,285	1,101,793	1,064,215	1,091,164	12,950,517
On-Pk Demand (kW)	1,707	1,707	1,709	1,717	1,719	1,726	1,730	1,724	1,716	1,713	1,709	1,707	1,730
Gas													
On-Pk Cons. (therms)	74,878	69,744	57,695	26,404	3,242	679	393	989	5,579	34,217	44,225	75,537	393,580
On-Pk Demand (therms/hr)	126	135	115	82	41	4	2	15	45	93	99	128	135
Water													
Cons. (1000gal)	34	34	39	41	51	62	72	62	46	42	39	36	559

Energy Consumption

Building	129,606	Btu/(ft2-year)
Source	269,955	Btu/(ft2-year)
Floor Area	644,711	ft2

Environmental Impact Analysis

CO2	23,409,096 lbm/year
SO2	162,455 gm/year
NOX	40,595 gm/year

MONTHLY ENERGY CONSUMPTION

By MDA Engineering

------- Monthly Energy Consumption -------

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 4	**ECM #1**												
Electric													
On-Pk Cons. (kWh)	1,178,021	1,065,009	1,187,889	1,142,348	1,186,540	1,152,706	1,180,799	1,192,052	1,142,475	1,185,096	1,144,632	1,174,200	13,931,766
On-Pk Demand (kW)	1,817	1,820	1,825	1,834	1,843	1,856	1,858	1,851	1,837	1,828	1,822	1,816	1,858
Gas													
On-Pk Cons. (therms)	85,740	72,816	62,157	26,590	3,211	1,288	863	1,582	5,041	32,680	45,953	82,242	420,164
On-Pk Demand (therms/hr)	162	170	146	96	53	7	5	8	46	116	125	164	170
Water													
Cons. (1000gal)	51	52	60	65	78	94	109	91	68	64	58	54	845

Energy Consumption		
Building	138,923	Btu/(ft2-year)
Source	289,881	Btu/(ft2-year)
Floor Area	644,711	ft2

Environmental Impact Analysis	
CO2	25,182,780 lbm/year
SO2	174,764 gm/year
NOX	43,671 gm/year

End of Report