Energy Efficiency Proposal

JULY 11TH, 2016

AN ENERGY SOLUTION COMPANY

WATERFORD GRADED SCHOOL DISTRICT

ENERGY MANAGEMENT SYSTEM REPLACEMENT, MECHANICAL OPTIMIZATION, & LIGHTING UPGRADE

THE TOWER ENERGY APPROACH

Tower Energy delivers energy efficiency solutions distinguishable by their whole-building design, grant procurement and innovative financing options. Proven time and again in a variety of locations and industries, the Tower Energy approach ensures you will reduce energy consumption, control utility costs and utilize best practices in sustainability.

Experienced engineers guide a customer from the initial assessment through installation, financing and documentation until the full return on investment is realized. Tower Energy is a certified Trade Ally of ComEd and Nicor Gas, and identifies and applies for all appropriate grants. Our partnerships with both AILCO Equipment Financing and Securant Bank present opportunities to reduce or eliminate out-of-pocket capital expenses by turning immediate utility savings toward manageable monthly payments.

TOWER ENERGY SOLUTIONS

As an energy solution company, Tower Energy identifies the problems in how your physical plant consumes and utilizes those resources, and then creates a program that benefits your bottom line immediately.

TOWER ENERGY LEADERSHIP

Ralph Bencriscutto
Co-founder, Tower Energy Partners

Ralph Bencriscutto formed Tower Energy International in 2009 on the strength of more than 25 years of creating and operating companies committed to sustainable and renewable energy systems. Mr. Bencriscutto is the principal system designer of more than 400 energy projects, from heavy industrial processes to commercial high-rise HVAC systems. General Motors, NASA's Kennedy Space Center, BRP Marine Propulsion and UTMC at Galveston are among his high-profile clients. His focus is on “whole building” energy usage to find symbiotic opportunities. Mr. Bencriscutto is a trade ally with Focus on Energy, Nicor and ComEd and is one of the most successful grant writers in the country.

PROJECT SUMMARY

Project Locations

Evergreen Elementary: 817 West Main Street, Waterford, WI, 53185
Trailside Elementary: 615 North Milwaukee Street
Woodfield Elementary: 905 Barnes Drive
Fox River Middle School: 921 West Main Street

Contents

Investment

The cost of the recommended implementation is **$695,438.** The Tower Energy team has identified **$79,832** in potential grants that reduce total project costs to **$615,606.**

Projected Savings

First-year total savings are expected to be **$152,723.** Over the first ten years after installation, allowing for an annual 3 percent increase in the rate charged by utilities, the total savings in energy and maintenance costs amount to **$1,750,798.**

Payback

The most critical component of an energy reduction program is the window to your return on investment – how quickly will your savings surpass the money you spent. By implementing the recommendations as proposed, Waterford Graded School District, can realize full payback in approximately **48 months**.

Project #1: Evergreen Elementary Energy Management System Functional Replacement

Existing Condition

- The existing Energy Management System (EMS) is plagued with legacy problems dating back to its' installation.
- The kitchen Make-up Air (MAU) Unit and associated exhaust fan are not integrated with the existing EMS.

Proposed Improvements

Install a Distech, Tridium-based Energy Management System (EMS) that will act as a functional system replacement. *Project #1* will include no substantial energy savings related to potential control routines improvements nor include any energy saving devices. *Project #2* is intended to act as an efficiency enhancement module when combined with *Project #1*. All existing components will be used with the exception of items listed below. No new control points will be added as part of this project with the exception of adding the water chiller, kitchen MUA, and exhaust fan to the proposed system.

The proposed system will include the following features:

- Remote controlled access
    - The entire EMS is accessible via the internet. The control system server becomes an internet site with a dedicated IP address that be accessed through a web browser. Local adjustments to the temperature settings can be restricted in places like the Cafeteria, if desired. Web access allow for adjustments to all settings. However, full or limited adjustment capability can still be granted in certain areas, if desired.
- Custom alarming and reporting
    - Custom alarms are generated and sent via text, or email notifications before mechanical failures are noticed in the form of comfort complaints.
- Visibility
    - The status of the entire facility is visible at a glance through the web portal. Staff can take action *before* comfort becomes a problem.

Equipment Retrofit Details

- Hot Water/Chilled Water Systems
  - Existing valves retained for use
  - Existing differential pressure sensors replaced by current switches
  - Existing temperature sensors replaced
- RAHU-1, -2, -3, & AHU-1
  - Existing valves and damper actuators retained for use
  - Existing differential pressure sensors replaced by current switches
  - Existing freeze protection thermostats retained for use
  - Existing temperature sensors replaced
- IT RTU, Tech Office RTU, GAHU-1, and RACU-1
  - Existing valves and damper actuators retained for use
  - Existing differential pressure sensors replaced by current switches
  - Existing temperature sensors replaced
- Unit Ventilators
  - Existing outdoor air/return air and face & bypass damper actuators usage retained
  - Hot water valves and actuators retained for use
  - Existing freeze protection thermostats retained
  - Existing temperature sensors replaced
  - Zone temperature sensor replaced
- VAV terminal units
  - Damper actuator replaced
  - Existing temperature sensors replaced
  - Zone temperature sensor replaced

Hot water valves and actuators retained for used, if applicable.

Specifications

- Energy management system
  - Furnish and install a complete Distech Tridium-based Energy Management System consisting of the following:
    - One (1) JACE (web server / front end) that communicates with new controllers, houses graphics package, and allows global scheduling
    - Existing Enclosures 1 through 13 use retained with new panel inserts
    - Existing communication network wiring replaced with BacNet specified shielded, twisted pair
    - Existing zone sensor (thermostat) wiring replaced with cat 5e cable
    - All other control wiring use retained

- Nine (9) Distech ECB 300/400/600 series LED display controllers for the following equipment:
    - AHU-1 (Music), RAHU-1&-2 (Classrooms), RAHU-3 (Gym), GAHU-1 (District Offices), RACU-1 (School Offices), IT Room RTU, and Tech Offices RTU), RE-1 thru 6, 10-12 (Exhaust Fans)
- Thirty-three (33) Distech ECB-103 controllers for Unit Ventilators
- Nine (9) Distech ECB-VAV controllers for Variable Air Volume units with integrated damper actuator
- Furnish one (1) PC workstation and set up connection
- As-built drawings included

Recommended Contingency Fund

Due to the retrofit nature of this project, Tower Energy recommends a contingency fund allowance in place. Near the completion of the project, Tower Energy will conduct a commissioning of the proposed system to verify proper operation of new and existing systems. At that time, Tower Energy may discover existing, unknown deficiencies. Corrective action should be taken as these deficiencies could impact savings projections going forward. After each deficiency is identified, Tower Energy will request, in writing, authorization to complete corrective action, prior to repair.

Tower Energy recommends a contingency fund of: $10,000

Project #1 Costs and Savings

Gross Installed Cost	**$136,012**
Less Utility Grants	**($0)**
Net Installed Cost	**$136,012**
Annual Savings	**$0**
Ten Year Savings	**$0**
Payback, in Months	**N/A**
First Year Return on Investment	**N/A**

Project #2: Evergreen Elementary EMS Efficiency & Optimization

Existing Condition

Evergreen Elementary School's heating and cooling needs are served by a variety of systems.

- Three large air distribution systems serve interior spaces in addition to the Gymnasium area.
    - These three systems deliver a constant volume of air, unable to respond to changes in occupancy or environmental demands. The areas are "zoned" with heating coils existing in the air ducting, but there is no ability to modulate air volume.
    - The constant volume nature of the air delivery systems, combined with the lack of capability of the fluid system to provide heating and cooling simultaneously, means many of the zones throughout the building are uncomfortable in summer.
    - One air distribution, serving the school offices, changes air delivery volume to match demand, but uses an antiquated technology called "air bypass" to achieve this result.
    - Most perimeter rooms (i.e. classrooms, lunchroom, etc.) utilize individual terminal units called "unit ventilators" to temper air in their respective spaces.
- The majority of the facility is served by high efficiency water boilers and a high efficiency water chiller.
    - The water pumps that distribute heated or chilled water, depending on the season, deliver the water at a fixed volume, regardless of demand from terminal units.
- All existing equipment introduces fixed minimum quantities of outdoor air to satisfy air quality requirements under maximum occupancy conditions. The systems do not have the capability to determine occupancy levels to adjust the amount of outdoor air introduction accordingly.

Proposed Improvements

- Variable Speed Drive (VSD) integration
    - A VSD can be added to each Air Handling Unit fan, School Offices Rooftop Unit fan, and system water pumps so airflow is matched to demand. Flows will automatically change to maximize comfort and cooling performance. Electrical consumption bears a cubic relationship to the fan speed, meaning a 20% reduction in fan speed equals a 50% reduction in electrical costs. This will save a substantial amount of energy throughout the facility.

- Variable Air Volume (VAV) Conversion
    - Convert RAHU-1, -2, and -3 to VAV systems. Retrofit VAV terminal units can be installed to create air distribution zones. RAHU-1 & -2 to receive VAVs upstream of existing hot water booster coils. RAHU-3 to receive cooling only retrofit VAVs without booster coils.
    - VAV Conversion will also mitigate comfort concerns caused by the constant volume nature of the systems.
- School Offices VAV enhancement
    - The existing system is currently a VAV system, but a bypass damper is used. Bypass damper to be disabled in the shut position and a VSD installed on the RTU supply fan.
- Integrate new water chiller, currently operating in standalone mode, with proposed EMS.
- Integrate MUA and kitchen exhaust fan with EMS. This will include enable/disable and monitoring only; existing burner controls retained for use.

Specifications

- Niagara 4 upgrade included, when available, likely fall of 2016
- Variable speed drives
    - Furnish and install six (6) Altivar Series Schneider VSDs on the following equipment:
        - RAHU-1 supply fan only, RAHU-2 supply fan only, RAHU-3 supply fan only, RACU-1 supply fan, and two (2) system water pumps
        - Each motor will be tested with an oscilloscope after VSD installation and a shaft grounding ring will be installed, if shaft voltage is present.
- VAV Terminal Units
    - Furnish and install twenty-three (23) Nailor Industries retrofit terminal units
    - Twenty-Three (23) Distech ECB-VAV controllers for Variable Air Volume units with integrated damper actuator
    - Zone temperature sensor upgraded (includes integrated occupancy sensor & CO2 sensor)
- Energy Consumption Monitoring System
    - Furnish and install one (1) Eniscope 8-channel module, manufactured by B.E.S.T.
- Hot Water/Chilled Water Systems
    - Install water pressure transducers
- RAHU-1, -2, -3, & AHU-1
    - Install static pressure transducers
    - Install carbon dioxide sensors
- IT RTU, Tech Office RTU, GAHU-1, and RACU-1
    - Install carbon dioxide sensors
- Unit Ventilators
    - Zone temperature sensor upgraded (includes integrated occupancy sensor & CO2 sensor)

Proposed Control Strategies

- Supply Static Pressure Reset
  - Duct pressure set point automatically adjust higher or lower in response to actual demand in associated zones
- Demand Controlled Ventilation
  - Outside air introduction will track building occupancy, detected through CO2 levels. This strategy allows outdoor air introduction to be minimized during periods of low or no occupancy
- Supply Temperature Reset
  - Air temperature supplied by RAHUs will change in response to outdoor conditions. On hot days, the target will be a lower temperature and on cold days, the target will be warmer.
- Enhanced Visibility
  - Actual electric usage of (3) RAHUs, water chiller, and the building as a whole will be available in real-time via the cloud. Gas consumption of the boilers will also be available. Robust analytic services are included for (24) months.

Additive-Alternate Bids

Facilities staff report that the hot water valve actuators in the Unit Ventilators are unreliable and require frequent replacement. The existing Honeywell actuators are known to be unreliable. Retrofit kits are not available. The installed nature of the valves makes it difficult to replace, so they were excluded from the base project, understanding that they could be replaced on a case-by-case basis. Also, after study of the facility, Tower Energy found that the relief fans on RAHU-1, -2. & -3 are not used. Tower Energy is not including installation of variable speed drives in this application because the fans have been shut off. If revised control strategy and airflow distribution results in building pressurization problems, the VSDs will need to be installed. Tower Energy does not recommend installation at this time.

Tower Energy provides the following Additive-Alternate bids:

- Additive-Alternate Bid #1: Replace (33) unit ventilator hot water valves and actuators: **$7,600**
- Additive-Alternate Bid #2: Replace (14) booster coil hot water valves and actuators: **$3,300**
- Additive-Alternate Bid #3: Furnish and install (3) VSDs on RAHU relief fans: **$9,600**

Project #2 Savings Summary

System	Project	Therms	kWh	Gas Savings	Electricity Savings
RAHU-1	Variable Speed Drive	0	36,636	$0	$4,726
	DCV	5,294	5,120	$2,753	$1,525
	VAV Conversion	6,353	57,173	$3,304	$7,375
RAHU-2	Variable Speed Drive	0	36,636	$0	$4,726
	DCV	5,294	5,120	$2,753	$1,525
	VAV Conversion	6,353	57,173	$3,304	$7,375
RAHU-3	Variable Speed Drive	0	12,209	0	$1,575
	DCV	2,144	1,270	$1,115	$580
	VAV Conversion	1,429	17,152	$743	$2,213
Office RTU	Variable Speed Drive	0	4,419	0	$570
	DCV	94	168	$49	$42
System Pump 1	Variable Speed Drive	0	8,395	0	$1,083
System Pump 2	Variable Speed Drive	0	8,395	0	$1,083
Classrooms	UV Occupancy Sensors	405	4,026	$211	$519
	Total	27,366	253,892	$14,232	$34,914

Project #2 Costs and Savings (Assumes implementation of *Project #1*)

Gross Installed Cost	$92,412
Less Utility Grants	($26,710)
Net Installed Cost	$65,702
Annual Savings	$49,146
Ten Year Savings	$563,404
Payback, in Months	16
First Year Return on Investment	75%

Project #3 (a, b, & c): EMS Integration Upgrade at Trailside, Woodfield, & Fox River Schools

Existing Condition

The existing EMS at Trailside, Woodfield, and Fox River Schools is antiquated and does not offer current energy savings strategies. WGSD also desires to allow remote access to all four schools in the district with one point of access. *Project #3* will allow that when combined with *Project #1*. Because the existing EMS is in good repair, an integration can be completed. That means the infrastructure and components remain in place, drastically reducing capital costs. Data from the network can be extracted and pulled into a modern interface, or front end, allowing implementation of advanced control strategies

IMPORTANT: WGSD desires to move toward a non-proprietary system to minimize limits of service providers that are able to service the system. Honeywell is currently using two proprietary protocols that JACEs can communicate with, but limits programming access. *Project #3* retains use of these controllers. They could be replaced with open controllers on a case-by-case basis in the future, should failures occur. *Project #4* replaces these proprietary controllers so advance programming strategies can be implemented.

Proposed Improvements

Install a Distech, Tridium-based Energy Management System (EMS) that will act as a functional system replacement. *Project #3* will include no substantial energy savings related to potential control routines improvements nor include any energy saving devices. *Project #4* is intended to act as an efficiency enhancement module when combined with *Project #3*. All existing components will be used with the exception of items listed below. No new control points will be added as part of this project.

The proposed system will include the following features:

- Remote controlled access
    - The entire EMS is accessible via the internet. The control system server becomes an internet site with a dedicated IP address that be accessed through a web browser.

Local adjustments to the temperature settings can be restricted in places like the Cafeteria, if desired. Web access allow for adjustments to all settings. However, full or limited adjustment capability can still be granted in certain areas, if desired.

- Custom alarming and reporting
  - Custom alarms are generated and sent via text, or email notifications before mechanical failures are noticed in the form of comfort complaints.
- Visibility
  - The status of the entire facility is visible at a glance through the web portal. Staff can take action *before* comfort becomes a problem.

Equipment Integration Details

- Trailside
  - (5) AHUs
  - Hot water plant with (2) boilers, (2) primary pumps, and (2) secondary pumps
  - Water chiller (hard wired points only)
  - (48) VAV terminal devices
  - (3) Cabinet heaters
  - (2) Unit heaters
- Woodfield
  - (5) AHUs
  - Hot water plant with (2) boilers, (2) primary pumps, and (2) secondary pumps
  - Water chiller (hard wired points only)
  - (52) VAV terminal devices
  - (3) Cabinet heaters
  - (2) Unit heaters
- Fox River
  - (4) AHUs
  - Hot water plant with (3) boilers, (3) primary pumps, and (2) secondary pumps
  - Water chiller (hard wired points only)
  - (33) Unit ventilators
  - (11) Booster coils
  - (4) Fan/coil cooling units
  - (1) Convector
  - (1) Unit Heater

Specifications

- Energy management system
  - Furnish and install a complete Distech Tridium-based Energy Management System consisting of the following:
    - One (1) JACE (web server / front end) that communicates with new controllers, houses graphics package, and allows global scheduling

Project #3 Costs and Savings

(a) Trailside

Gross Installed Cost	$46,391
Less Utility Grants	($0)
Net Installed Cost	$46,391
Annual Savings	$0
Ten Year Savings	$0
Payback, in Months	N/A
First Year Return on Investment	N/A

(b) Woodfield

Gross Installed Cost	$46,886
Less Utility Grants	($0)
Net Installed Cost	$46,886
Annual Savings	$0
Ten Year Savings	$0
Payback, in Months	N/A
First Year Return on Investment	N/A

(c) Fox River

Gross Installed Cost	$46,665
Less Utility Grants	($0)
Net Installed Cost	$46,665
Annual Savings	$0
Ten Year Savings	$0
Payback, in Months	N/A
First Year Return on Investment	N/A

Project #4 (a, b, & c): EMS Efficiency & Optimization at Trailside, Woodfield, & Fox River Schools

Trailside & Woodfield

Existing Condition

- Four large air distribution systems serve the majority of the building.
    - The Kitchen/Cafeteria (AH-3) and Gymnasium (AH-4) AHUs deliver a constant volume of air, unable to respond to changes in occupancy or environmental demands. The Kitchen/Cafeteria areas are “zoned” with heating coils existing in the air ducting, but there is no ability to modulate air volume.
    - The two AHUs that serve the balance of the building utilize VAVs and VSD, a modern distribution system design.
- The majority of the facility is served by high efficiency water boilers and a high efficiency water chiller.
    - The water pumps that distribute heated or chilled water, depending on the season, deliver the water at a fixed volume, regardless of demand from terminal units.
- All existing equipment introduces fixed minimum quantities of outdoor air to satisfy air quality requirements under maximum occupancy conditions. The systems do not have the capability to determine occupancy levels to adjust the amount of outdoor air introduction accordingly.
- Return air temperature and humidity sensors are located in mixed air ducting, which is the incorrect location, at Woodfield on the four main (4) AHUs. It is apparent that the sensors have been relocated to the proper duct at Trailside.

Proposed Improvements

- Variable Speed Drive (VSD) integration
    - A VSD can be added to each to AH-3, AH-4, (2) hot water pumps, and (1) chilled water pump so flow is matched to demand. Flows will automatically change to maximize comfort and cooling performance. Electrical consumption bears a cubic relationship to the fan speed, meaning a 20% reduction in motor speed equals a 50% reduction in electrical costs. This will save a substantial amount of energy throughout the facility.

- Variable Air Volume (VAV) Conversion
    - Convert AH-3 and AH-4 to VAV systems. Retrofit VAV terminal units can be installed in AH-3 ducting to create air distribution zones.
- VAV Standby Mode
    - Occupancy sensors can be installed in each of (48) at Trailside & (52) at Woodfield zones to place each area into a standby mode where ventilation rates are automatically reduced and temperature set point slightly set back to trim power consumption while the room is vacant
- Relocate return air temperature and humidity sensors to the correct location on AH-1, 2, 3, & 4

Specifications

- Niagara 4 upgrade included, when available, likely fall of 2016
- Variable speed drives
    - Furnish and install five (5) Altivar Series Schneider VSDs on the following equipment:
        - AH-3, AH-4, (2) hot water pumps, and (1) chilled water pump
        - Each fan motor will be tested with an oscilloscope after VSD installation and a shaft grounding ring will be installed, if shaft voltage is present.
- VAV Terminal Units
    - Furnish and install three (3) Nailor Industries retrofit terminal units
    - Three (3) Distech ECB-VAV controllers for Variable Air Volume units with integrated damper actuator
    - Occupancy sensor added to (48) at Trailside & (52) at Woodfield VAV terminals
- Energy Consumption Monitoring System
    - Furnish and install one (1) Eniscope 8-channel module, manufactured by B.E.S.T.
- Hot Water/Chilled Water Systems
    - Install (1) water pressure transducer for each system
- AH-3, AH-4
    - Install static pressure transducers
- AH-1, AH-2, AH-3, AH-4
    - Install carbon dioxide sensors

Proposed Control Strategies

- Supply Static Pressure Reset
  - Duct pressure set point automatically adjust higher or lower in response to actual demand in associated zones
- Demand Controlled Ventilation
  - Outside air introduction will track building occupancy, detected through CO2 levels. This strategy allows outdoor air introduction to be minimized during periods of low or no occupancy
- Supply Air Temperature Reset
  - Air temperature supplied by AHUs will change in response to outdoor conditions. On hot days, the target will be a lower temperature and on cold days, the target will be warmer.
- Supply Water Temperature Reset
  - Water temperature supplied by the boilers will change in response to outdoor conditions. On cold days, the target will be a higher temperature and on mild days, the target will be cooler.
- Enhanced Visibility
  - Actual electric usage of (4) AHUs, water chiller, (2) boilers and the building as a whole will be available in real-time via the cloud. Gas consumption of the boilers will also be available. Robust analytic services are included for (24) months.

Fox River

Existing Condition

- Three air distribution systems serve the Gymnasium and Administration areas.
    - The Admin AHU (AH-1) delivers a constant volume of air, unable to respond to changes in occupancy or environmental demands. AH-1 is “zoned” with heating coils existing in the air ducting, but there is no ability to modulate air volume.
    - The two AHUs (AH-3 & AH-4) that serve the gym also deliver air at a constant volume
- Classrooms are served by Unit Ventilator terminals
- The majority of the facility is served by high efficiency water boilers and a high efficiency water chiller.
    - The water pumps that distribute heated or chilled water, depending on the season, deliver the water at a fixed volume, regardless of demand from terminal units.
- All existing equipment introduces fixed minimum quantities of outdoor air to satisfy air quality requirements under maximum occupancy conditions. The systems do not have the capability to determine occupancy levels to adjust the amount of outdoor air introduction accordingly.

Proposed Improvements

- Variable Speed Drive (VSD) integration
    - A VSD can be added to each to AH-1, AH-3, AH-4, (2) hot water pumps, and (1) chilled water pump so flow is matched to demand. Flows will automatically change to maximize comfort and cooling performance. Electrical consumption bears a cubic relationship to the fan speed, meaning a 20% reduction in motor speed equals a 50% reduction in electrical costs. This will save a substantial amount of energy throughout the facility.
- Variable Air Volume (VAV) Conversion
    - Convert AH-1 into VAV systems. Retrofit VAV terminal units can be installed in AH-3 ducting to create air distribution zones.
- Unit Ventilator Standby Mode
    - Occupancy sensors can be installed in each of (48) UV zones to place each area into a standby mode where ventilation rates are automatically reduced and temperature set point slightly set back to trim power consumption while the room is vacant.

Specifications

- Niagara 4 upgrade included, when available, likely fall of 2016
- Variable speed drives
    - Furnish and install five (6) Altivar Series Schneider VSDs on the following equipment:
        - AH-1, AH-3, AH-4, (2) hot water pumps, and (1) chilled water pump
        - Each fan motor will be tested with an oscilloscope after VSD installation and a shaft grounding ring will be installed, if shaft voltage is present.
- VAV Terminal Units
    - Furnish and install three (11) Nailor Industries retrofit terminal units
    - Three (11) Distech ECB-VAV controllers for Variable Air Volume units with integrated damper actuator
    - Occupancy sensor added to (33) UV terminals
- Energy Consumption Monitoring System
    - Furnish and install one (1) Eniscope 8-channel module, manufactured by B.E.S.T.
- Hot Water/Chilled Water Systems
    - Install (1) water pressure transducer for each system
- AH-1
    - Install static pressure transducer
- AH-1, AH-3, AH-4
    - Install carbon dioxide sensors

Proposed Control Strategies

- Supply Static Pressure Reset
    - Duct pressure set point automatically adjust higher or lower in response to actual demand in associated zones
- Demand Controlled Ventilation
    - Outside air introduction will track building occupancy, detected through CO2 levels. This strategy allows outdoor air introduction to be minimized during periods of low or no occupancy
- Supply Air Temperature Reset
    - Air temperature supplied by AHUs will change in response to outdoor conditions. On hot days, the target will be a lower temperature and on cold days, the target will be warmer.
- Supply Water Temperature Reset
    - Water temperature supplied by the boilers will change in response to outdoor conditions. On cold days, the target will be a higher temperature and on mild days, the target will be cooler.
- Enhanced Visibility
    - Actual electric usage of (4) AHUs, water chiller, (3) boilers and the building as a whole will be available in real-time via the cloud. Gas consumption of the boilers will also be available. Robust analytic services are included for (24) months.

Project #4 Costs and Savings (Assumes implementation of *Project #3*)

(a) Trailside

Gross Installed Cost	$56,896
Less Utility Grants	($4,960)
Net Installed Cost	$51,936
Annual Savings	$21,843
Ten Year Savings	$250,460
Payback, in Months	29
First Year Return on Investment	42%

(b) Woodfield

Gross Installed Cost	$57,597
Less Utility Grants	($4,960)
Net Installed Cost	$52,637
Annual Savings	$22,187
Ten Year Savings	$254,349
Payback, in Months	28
First Year Return on Investment	42%

(c) Fox River

Gross Installed Cost	$70,047
Less Utility Grants	($13,454)
Net Installed Cost	$56,593
Annual Savings	$7,735
Ten Year Savings	$88,673
Payback, in Months	87
First Year Return on Investment	14%

Lighting System Upgrade for Trailside, Woodfield, and Fox River

Existing Conditions

The existing interior lighting systems are florescent T8 technology that is aging and will require significant amounts of maintenance going forward. The disadvantage of the T8 is not the light level but rather the poor life expectancy of both the ballasts and bulbs. The systems are also inefficient by today's standards and require special disposal of lamps as they burn out.

The existing exterior lighting systems are a combination of metal halide (MH) and high pressure sodium (HPS) that is aging, inefficient and expensive to maintain.

Proposed Improvements

Interior Systems

The interior lighting system can be converted to LED using a high technology, self-ballasted tube that can also utilize the fixtures existing light holders and wiring. This newer technology is dominating the market due to the lower installed costs.

This proposal includes one-for-one bulb replacement in the classrooms and three-to-two de-lamping in the hallways. The technology has a rated life of 23 years with your current usage or 50,000 hours. Replacement after the 25 years will likely cost less than a T8 tube does today even without the consideration of the ballast which in that time frame would probably be replaced three times. The tube is also non-hazardous for disposal or if broken.

Exterior systems

The exterior is proposed to be a combination of new LED fixtures to replace the wall packs, along with smaller systems, and a robust pulse start retrofit of the bigger heads that also utilizes a special twin arc lamp for double the life expectancy and little lumen depreciation. By utilizing this technology on the larger poles, the existing pole heads can be utilized that are still in good condition, while still realizing between 43-60% reduction in energy usage. This lowers the installed costs. Maintenance costs are also cut in half going forward, as a pole system requires a boom truck to access and electricians to repair.

Specifications- General

All numbers are in fixtures, e.g. 2 means 2 fixtures and 2L (2 lamp) means number of bulbs in the fixture. All ballasts are removed during process. Fixtures will all be marked with OSHA approved stickers indicating the fixture has been modified for line voltage. All components are UL listed and will be installed according to the listing requirements. Tubes will be all rated DLC under the ambient lighting category and will be eligible for the Focus on Energy rebate which also controls quality and efficiency levels. Color temperature to be 5000K, unless desired otherwise.

All bulbs and ballasts will be removed from the site for proper recycling unless they are wanted for use in maintaining other facilities.

Existing dual or triple lighting options will remain as existing unless the fixture is de-lamped as in the hallways. Emergency lighting systems if in place will have existing battery ballast system remaining in place- this will not be removed.

Work to be done to accommodate normal school operations.

Project #5: Trailside Lighting System Upgrade

Main School Areas:

- Re-lamp *312,* 3L T8 in Classrooms (118, 122, 123, 125, 126, 127, 132, 135, 140, 143, 145, 149, 150, 151, 152, 154, 155, 156, 157, 174, 175, 176, 178, 179, 180) to *312*, 3L tLED
- Re-lamp *38,* 3LT8 in Art and Reading rooms (110, 185, 186), to *38,* 3L tLED
- Re-lamp *70,* 2LT8 in storage rooms (129, 130, 133, 134, 137, 138, 141, 147, 159 160, 164, 165, 168, 173, and basement 004), to *70* 2L tLED
- Re-Lamp *29*, 3LT8 in storage rooms (105, 117, 118, 128, 144, 181, 188, + basement 001, 002), to *29* 3L tLED
- Re-lamp *49*, 3LT8 in offices (106, 108, 109, 112, 113, 114, 158, 169, 182, 183, 184, 187, 189) to *49, 3L tLED*
- Re-lamp *98*, 3LT8 in hallway/lobby to *98* 2L tLED
- Replace *54*, 2'x2' U-tube in Cafeteria, Hallway, Pass), to *54* 2L 2' tLED
- Re-lamp *24*, 3LT8 in Cafeteria, to *24*, 3L tLED
- Re-lamp *11*, 3LT8 in Administrative Wing (100, 104, 105), to *11, 3L tLED*
- Replace 20 exit signs to LED
- Re-lamp *18,* 2LT8 high output in Gymnasium to *18*, 2L tLED
- Replace *18*, 6LT8 high output in Gymnasium to 150W LED new fixture
- Re-lamp *36*, 3LT8 in receiving storage (161) and basement (003) to *36*, 3L tLED
- Re-lamp *8*, 3LT8 in reading resource (120) to *8*, 3L tLED
- Re-lamp *43*, 3LT8 in computer rooms (124, 153, 177, 190) to *43*, 3L tLED
- Re-lamp *34*, 2LT8 in bathrooms (107, 110, 111, 115, 116) to *34*, 2L tLED
- Re-lamp *2,* 3LT8 in bathrooms (115A, 162A) to *2,* 2L tLED

Exterior:

- Re-lamp *11*, 400W parking poles with *11*, 200W pulse start with twin ark lamp technology.
- Replace *11*, 100W wall packs with *11*, 30W LED wall packs- new fixture

Project #5 Costs and Savings

Gross Installed Cost	**$47,935**
Less Utility Grants	**($10,912)**
Net Installed Cost	**$37,023**
Annual Electrical Savings	**$14,579**
Annual Maintenance Savings	**$4,296**
Total Annual Savings	**$18,875**
Ten Year Savings	**$210,089**
Payback, in Months	**24**
First Year Return on Investment	**51%**

Project #6: Woodfield Elementary Lighting System Upgrade

Main School Areas:

- Re-lamp *312,* 3L T8 in Classrooms (118, 122, 123, 125, 126, 127, 132, 135, 140, 143, 145, 149, 150, 151, 152, 154, 155, 156, 157, 174, 175, 176, 178, 179, 180) to *312*, 3L tLED+4 extra not seen in as built docs), to *360*, 3L tLED
- Re-lamp *38,* 3LT8 in Art and Reading rooms (110, 185, 186), to *38,* 3L tLED
- Re-lamp *70,* 2LT8 in storage rooms (129, 130, 133, 134, 137, 138, 141, 147, 159 160, 164, 165, 168, 173, and basement 004), to *70* 2L tLED
- Re-Lamp *29*, 3LT8 in storage rooms (105, 117, 118, 128, 144, 181, 188, + basement 001, 002), to *29* 3L tLED
- Re-lamp *49*, 3LT8 in offices (106, 108, 109, 112, 113, 114, 158, 169, 182, 183, 184, 187, 189) to *49, 3L tLED*
- Re-lamp *98*, 3LT8 in hallway/lobby to *98* 2L tLED
- Replace *54*, 2'x2' U-tube in Cafeteria, Hallway, Pass), with *54* 2L 2' tLED
- Re-lamp *24*, 3LT8 in Cafeteria, to *24*, 3L tLED
- Re-lamp *11*, 3LT8 in Administrative Wing (100, 104, 105), to *11, 3L tLED*
- Replace *20* exit signs with LED
- Re-lamp *18,* 2LT8 high output in Gymnasium to *18*, 2L tLED
- Replace *18*, 6LT8 high output in Gymnasium with 150W LED (new fixture)
- Re-lamp *36*, 3LT8 in receiving storage (161) and basement (003) to *36*, 3L tLED
- Re-lamp *8*, 3LT8 in reading resource (120) to *8*, 3L tLED
- Re-lamp *43*, 3LT8 in computer rooms (124, 153, 177, 190) to *43*, 3L tLED
- Re-lamp *34*, 2LT8 in bathrooms (107, 110, 111, 115, 116) to *34*, 2L tLED
- Re-lamp *2,* 3LT8 in bathrooms (115A, 162A) to *2,* 2L tLED

Exterior:

- Re-lamp *11*, 400W parking poles with *11*, 200W pulse start with twin ark lamp technology.
- Replace *11*, 100W wall packs with *11*, 30W LED wall packs- new fixture

Gross Installed Cost	**$53,086**
Less Utility Grants	**$10,744**
Net Installed Cost	**$42,342**
Annual Electrical Savings	**$15,494**
Annual Maintenance Savings	**$4,762**
Total Annual Savings	**$20,256**
Ten Year Savings	**$225,244**
Payback, in Months	**25**
First Year Return on Investment	**48%**

Project #7: Fox River Middle School Lighting System Upgrade

First Floor:

- Re-lamp *36*, 3LT8 in Cafeteria to *36*, 3L tLED, and *20*, 2L8 to *20* tLED in kitchen area (rooms 112, 115, 117, 118, 119A)
- Re-lamp *24*, 2L T8 in rooms (120, 121, 122, 28, 130, 130B, 104, 104A, 105, 107A, 141, 143, 144A, Copy Room) to *24* 2L tLED
- Re-lamp *80*, 3LT8 in classrooms (130, 130A, 131, 132, 132B, 135) to *80* 3L tLED
- Re-lamp *7,* 3LT8 in room 110 to *7,* 3L tLED
- Re-lamp *32*, 3LT8 in Band/Music rooms (107/108) to *32,* 3L tLED
- Re-lamp *6*, 2LT8 in rooms (108A, B, C, D, 121), to *6* 2L tLED
- Re-lamp *30*, 3LT8 in hallway/lobby to *30,* 2L tLED
- Re-lamp *37*, 2LT8 in Boys/Girls locker rooms (119pass, 121, 121A, 121B, 129, 129B), to *37*, 2L tLED
- Replace *23,* 2'x2' U-tube in reception/hallways, with *23,* 2L 2' tLED
- Re-lamp *19,* 3LT8 in Administrative Wing (137,138,139,140,142,144,146) to *19,* 3L tLED
- Replace *10* Exit signs with *10* LED Exit
- Replace *12* 2LT8 high output in Gymnasium, with *12*, 2L tLED and *12* 6LT8 HO with *12*, 150w (new LED fixture)

Second Floor:

- Re-lamp *220* 3LT8 in classrooms (201, 202, 203, 204, 205, 206, 207, 208, 210, 211, 217, 218, 219, 220, 221, 222, 223, 224) to *220*, 3L tLED
- Re-lamp *27*, 3LT8 in hallway to *30*, 2L tLED
- Re-lamp *62*, 3LT8 in Computer Room/Library (225, 226, 227, 2828, 200a) to *62,* 3LT8
- Re-lamp *8*, 2LT8 in bathrooms (214, 215, 216) to *8,* 2L tLED
- Re-Lamp *6,* 2LT8 in various rooms (203, 209, 213, 224A), to *6,* 2L tLED

Exterior:

- Re-lamp *6,* 400w parking light poles & building to 6, 200w pulse start
- Replace 3, 400w wall packs with 3, 200w pulse start
- Replace *1*, 100w wall packs with *1,* 30w pulse start
- Re-lamp *12,* 2L T8 4' to *12,* 2L tLED 4'

Gross Installed Cost	**$41,586**
Less Utility Grants	**$8,092**
Net Installed Cost	**$33,494**
Annual Electrical Savings	**$9,459**
Annual Maintenance Savings	**$3,222**
Total Annual Savings	**$12,681**
Ten Year Savings	**$140,661**
Payback, in Months	**32**
First Year Return on Investment	**38%**

Consolidated Savings Summary

Facility	Project	Gross Cost	Incentives	Net Cost	Annual Savings	Payback, in Months	First Year ROI
Evergreen	EMS Replacement	$136,012	$0	$136,012	$0	N/A	N/A
	EMS Efficiency	$92,412	($26,710)	$65,702	$49,146	16	75%
Trailside	EMS Integration	$46,391	$0	$46,391	$0	N/A	N/A
	EMS Efficiency	$56,896	($4,960)	$51,936	$21,843	29	42%
Woodfield	EMS Integration	$46,886	$0	$46,886	$0	N/A	N/A
	EMS Efficiency	$57,597	($4,960)	$52,637	$22,187	28	42%
Fox River	EMS Integration	$46,665	$0	$46,665	$0	N/A	N/A
	EMS Efficiency	$70,047	($13,454)	$56,593	$7,735	87	14%
Trailside	Lighting Upgrade	$47,935	($10,912)	$37,023	$18,875	24	51%
Woodfield	Lighting Upgrade	$53,086	($10,744)	$42,342	$20,256	25	48%
Fox River	Lighting Upgrade	$41,511	($8,092)	$33,419	$12,681	32	38%
	Totals	$695,438	($79,832)	$615,606	$152,723	48	25%

Three types of savings

- Energy Savings from efficiency – reduced consumption
- Incentives from Focus on Energy to subsidize the project cost
- Lowered infrastructure and maintenance costs

Assumptions and Benefits

- 10-year savings assumes a 3% increase in cost of power per year
- Hours of operation are estimated at 1,215-4,000 per year, depending on the area
- Cost of power is estimated at $ 0.129 per kilowatt-hour and $ 0.52 per therm

Warranty

- Mechanical and controls systems carry (1) year labor and (1) year general parts through Tower Energy
- Variable frequency drives are warrantied for (18) months through Schneider Electric
- All existing control wiring warranted for (1) year
- Lighting warranted for (10) years, parts and labor

Savings Verification

- Focus on Energy grants are pre-verified by in-house engineering and are contingent on meeting strict quality control with certified equipment and applicators. Tower Energy is a certified Trade Ally for Focus on Energy.
- Tower Energy will track and document energy savings on a monthly basis for 24 months after completion. Full access of the EMS is required during this period. EMS management services will continue after this period, for a management fee.

Project Contingencies

- Savings assume proper operation and maintenance of all mechanical components.

Optional Performance Guarantee

The savings projections in this proposal are largely objective, but it is important to plan the approach needed for a successfully energy reduction initiative. The following points must be considered:

- Technological improvements
    - Implementation of technological improvements including Variable Speed Drive installation, among others, are widely accepted in the industry as energy savings measures that offer substantial benefits. Modeling software is used to objectively predict associated opportunities to reduce energy. Actual behavior is observed to set a baseline case for each proposed measure. Then software is utilized to model savings possibilities based on our experience.
- Advanced control strategies
    - Programming strategies including Discharge Air Temperature Reset, Duct Static Pressure Reset, and Demand Controlled Ventilation, are recognized by Focus on Energy, along with the rest of the industry, to significantly reduce energy consumption, with proper implementation and oversight of systems' performance.
- Performance tuning and optimization
    - The most critical component of capitalizing on technological and programming improvements is observation of systems *after* implementation. Generally, systems like the ones included in this proposal are installed and then set to generic parameters. However, every facility has a unique set of characteristics. Routine supervision of the system is required to match dynamic environmental needs with system behavior. This is not a quick nor simple process. Retrofits are particularly involved because the system is asked to compensate for known and unknown mechanical deficiencies, along with mechanical system design shortfalls (i.e. a 2-pipe system like the one in Evergreen or sensors originally installed in the incorrect location, like the examples cited at Woodfield). Efficiency must be balanced with occupant comfort. Communication between facility staff and optimization technicians is critical.

Any project like the one proposed includes risk due to a number of variables:

- Mechanical or control deficiencies
    - Energy Management Systems will automatically compensate for defects that may go unnoticed without system supervision. This can be very costly. For instance, a stuck hot water heating valve can cause the boilers to run harder to try to satisfy that space. An example of this is a defective Outdoor Air Temperature sensor failed on a project of Tower Energy's, so the system defaulted to -40°F, which caused a huge spike in gas an electrical consumption. Monitoring is critical to react quickly. Gas and electric consumption should be checked daily for anomalies. A platform like Eniscope mitigates much of the risk by providing threshold alarming and daily report generation.

- Manual Overrides
    - Failed components are often overridden as a temporary means to achieve comfort until a proper repair can be made. Often, these overrides are accidentally left in place. Scheduling overrides are another common issue. A space might be subject to unusual usage for several days so the weekly schedule is adjusted. These also, are sometimes forgotten about, and cause substantial increases in energy.
- Weather Anomalies
    - The projections included in this proposals are based on decades of average temperature patterns. Seasonal anomalies, like the Polar Vortex of a few years ago, create uncertainty.
- Changes in Usage
    - Physical additions to the building or changes in specialty services, like Daycare, will impact consumption that could not be accounted for during baseline analysis.

Understanding these risk factors, Tower Energy offers to mitigate a portion of risk pursuant to the following criteria:

a. Tower Energy guarantees a minimum annual savings equal to 75% of the projected savings of each ~~EMS~~ project in this proposal
    i. Guaranteed amount escalates 3% per year
b. Tower Energy will receive, from WGSD, 75% of the savings exceeding the guaranteed amount
c. Calculations will be made using the last (3) years' average of consumption data as a baseline
d. Tower and WGSD will agree, in advance, on utility rates used to calculate savings figures- with 3% annual escalator
e. Disbursements made by either party will be made at the anniversary of project completion once the data is available for calculations
f. WGSD agrees to repair any deficiencies that occur as soon as practical
g. Both parties agree to notify the other of changes made to control points
h. This savings guarantee will be in place for Year 1 and Year 2 after the project is complete
i. Options for Year 3 and Year 4 will be available, but WGSD will agree to hire Tower for monitoring service for those years
    i. Monthly fees will be 10% of projected monthly savings with a 3% annual escalator, based on the annual projections included in this proposal
j. Monitoring service is included with the project for Years 1 & 2

Contract Execution and Terms

Terms: Down payment is 50% of Gross Installed Cost; Guaranteed utility incentives assigned to Tower Energy as payment; Balance due upon completion. Pricing is valid for 90 days.

Project #1: Evergreen EMS Replacement

Gross Installed Cost	$136,012
Less Utility Grants	($0)
Net Installed Cost	$136,012

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Project #2: Evergreen EMS Optimization

Gross Installed Cost	$92,412
Less Utility Grants	($26,710)
Net Installed Cost	$65,702

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Project #3(a): Trailside EMS Integration

Gross Installed Cost	$56,896
Less Utility Grants	($4,960)
Net Installed Cost	$51,936

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Project #3(b): Woodfield EMS Integration

Gross Installed Cost	$57,597
Less Utility Grants	($4,960)
Net Installed Cost	$52,637

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Project #3(c): Fox River EMS Integration

Gross Installed Cost	$70,047
Less Utility Grants	($13,454)
Net Installed Cost	$56,593

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Project #4(a): Trailside EMS Optimization

Gross Installed Cost	$56,896
Less Utility Grants	($4,960)
Net Installed Cost	$51,936

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Project #4(b): Woodfield EMS Optimization

Gross Installed Cost	$57,597
Less Utility Grants	($4,960)
Net Installed Cost	$52,637

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Project #4(c): Fox River EMS Optimization

Gross Installed Cost	$70,047
Less Utility Grants	($13,454)
Net Installed Cost	$56,593

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Project #5: Trailside Lighting Upgrade

Gross Installed Cost	$47,935
Less Utility Grants	($10,912)
Net Installed Cost	$37,023

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Project #6: Woodfield Lighting Upgrade

Gross Installed Cost	$53,086
Less Utility Grants	($10,744)
Net Installed Cost	$42,343

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Project #7: Fox River Lighting Upgrade

Gross Installed Cost	$41,511
Less Utility Grants	($8,092)
Net Installed Cost	$33,419

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Accepted By:

_____

Waterford Graded School District

Its: _____

Date: _____

Countersigned:

_____

John Plouff, VP- Mechanical Services

Tower Energy International, LLC

Date: _____

Evergreen Exterior Lighting Upgrade Additive-Alternate

Exterior:

- Re-lamp *7*- 400W HID *poles to* 200W *pulse start and twin arc technology*
- Replace *8*- 100W wall packs with 30W LED wall pack
- Replace *4*- soffit fixtures under canopy with 36W LED-new fixture
- Replace *3*- ground based floods with 60W LED spot
- Re-lamp *1*- 400W building based flood to 200W pulse start and twin arc.

Gross Installed Cost	**$6,183**
Less Utility Grants	**$1,980**
Net Installed Cost	**$4,203**
Annual Electrical Savings	**$2,010**
Annual Maintenance Savings	**$840**
Total Annual Savings	**$2,850**
Ten Year Savings	**$31,438**
Payback, in Months	**18**
First Year Return on Investment	**68%**