2012

Youngstown Historical Center of Industry & Labor Energy Upgrade

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April 15th, 2012

151 W. Wood Street | Youngstown, OH 44504-1611

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EXECUTIVE SUMMARY

The Youngstown State University Green Energy Challenge Team (YSU GECT) was formed with the purpose of furthering the team's knowledge of energy efficiency by producing an innovative green design for the client's alternative energy demands. The client, Youngstown State University, is an urban research university that has high values of energy conservation and furthers these ideals by reducing campus-wide energy usage and incorporating renewable on-site power generation. The Youngstown Historical Center of Industry & Labor was selected to serve as a green model for future campus projects. The YSU team consists of six core students with different backgrounds and one common goal: to provide the owner with the most up-to-date energy efficient designs while keeping upfront installation costs and future utility costs at a minimum. By incorporating the most advanced engineering technologies into the design, YSU GECT is providing the owner with a financially comfortable, energy efficient base design featuring multiple alternate proposal items. These recommended alternates increase the mechanical, electrical, and plumbing efficiencies, thus reducing future utility costs and minimizing the overall carbon foot print of the facility. The YSU GECT holds client satisfaction in high regard and as a result, strives to be a gateway connecting the customer to sustainable design.

First, within most facilities, a reduction in lighting power consumption impacts utility costs more than any other system upgrade. As a result, lighting revisions are the most attainable means of sustainability and green design. Also, restructuring the power distribution network with a passive consumption plan will lessen peak demands. Combining both effective solutions makes energy reduction renovations financially attractive for the client.

Second, three-phase inductive motors will be retrofitted with a Variable Frequency Drive (VFD), allowing for slower starts, greater energy savings, and higher payback incentives.

Finally, the proposed energy upgrade integrates renewable power generation to offset energy consumption of utility-generated power required to operate the facility. Incorporating wind power systems, the alternative energy design proposes the installation of two "Blade Tip Power System" turbines with a combined maximum power rating of 4 kW, producing approximately 12 kWh per day.

The Youngstown Historical Center of Industry & Labor energy upgrade will cost **$103,877.54** and will be paid back within **2.10 years**.

Note: Because the energy upgrade proposal is specifically strong in the area of "Lighting Retrofit Analysis", a 1.4 multiplier is requested in this area. Therefore, a 0.6 multiplier is requested in the area of "Alternative Energy Design."

CLIENT SUMMARY

Ever since Youngstown State University's birth in 1908 as a law school division of the local YMCA, the school has been steadily expanding and evolving. Over the years, the university's name has changed to recognize the various phases in its existence, including: Youngstown Institute of Technology (1921), Youngstown College (1928), Youngstown University (1955), and finally Youngstown State University on September 1, 1967. Today, YSU has a sprawling 140-acre campus that houses seven different Colleges and is considered an urban research university. In addition to the recent construction of the Williamson College of Business and the Wattson and Tressel Training Center the university has expanded through various property acquisitions adjacent to the campus core.

Figure 1: 3D Rendering of the Youngstown Historical Center of Industry & Labor

Shown in **Figure 1**, the Youngstown Historical Center of Industry & Labor, designed by world-renowned Architect Michael Graves in 1986, is home to a multitude of historical archives and exhibits that depict the Youngstown and surrounding area's industrial history. The museum's permanent exhibit entitled "By the Sweat of Their Brow: Forging the Steel Valley" is the main attraction, which showcases the labor and immigration history of the Mahoning Valley. In 2012, the Labor Museum is celebrating 20 years of operation thanks in part to Youngstown State University, which began to manage the property in January 2010. Prior to this date, the museum had struggled with debilitating budget cuts and low attendance numbers that nearly forced the museum's closure. Today, the museum has strong ties to the YSU College of Liberal Arts and Social Sciences and provides hands-on experience for students interested in many fields, including museum management and historical preservation. After surveying the existing facility and systems in detail, the team concluded that the all proposed modifications to the museum must not detract from the architect's original vision. From the style of light fixtures to the smoke stacks incorporated into the rear of the structure, everything serves a specific aesthetic purpose to depict the unique history of the local community.

During the facility selection process, total building efficiency as well as potential for campus and community awareness were the primary criteria for evaluation. Being one of the few campus-controlled facilities not retrofitted with updated light fixtures and ballasts during a recent Johnson Controls campus-wide upgrade, the museum was a great candidate for a retrofit project. Another deciding factor, an energy upgrade at a public facility helps bring awareness about energy conservation and green technologies to the surrounding community.

MISSION STATEMENT

In collaboration with the local Mahoning Valley NECA Chapter and its executive director, Tom Travers, the YSU Green Energy Challenge Team's key goal is to use innovation and intelligent engineering as driving factors to ensure a design incorporating original thinking with standards of excellence. This goal provides great potential to create a site that will lessen negative environmental impacts and promote others to design with energy efficiency as the number one priority. It is necessary to focus on two key concepts: reduction of overall energy consumption and utilization of renewable energy sources. All energy efficient solutions incorporated in the museum's proposal were based on the main goal of conserving energy to produce a potential LEED-Silver-certified site. All main research areas of the proposed design have individualized goals that contribute to a more sustainable site in several unique ways.

1. ***Lighting Retrofit Analysis:***

It was the main goal of this research area to lessen energy consumption by using innovative LED options in addition to the standard T5 fluorescents while creating an environment with appropriate light levels in compliance with current NEC/ASHRAE standards.

2. ***Energy Use Analysis and Retrofit:***

Because the museum was built in 1986, the distribution equipment was determined to be efficient, making a complete overhaul unnecessary. Therefore, the main goal of this area was to evaluate existing distribution equipment to analyze energy consumption throughout the course of each day and create a passive way for the museum to reduce its consumption.

3. ***Alternative Energy Design:***

It was a strong desire of the client to be energy-conscious and "green". Therefore, the main goal of this area of research was to incorporate an energy efficient design that utilizes resources available on-site to account for the client's energy demands. To accomplish this goal, an off-grid energy source of wind power was considered, along with proposals for grey water and condensate recovery.

4. ***Schematic Estimate/Schedule and Financing:***

This section's main goal was to gather information from various experienced professionals to develop an accurate and realistic timeline, cost estimation, and financing plan for the entire energy upgrade.

5. ***LEED for Existing Buildings Review:***

An expectation of LEED Silver certification was set by the client and GEC team. This was also a driving factor in other research areas. It was the team's goal to analyze each LEED (Existing Building Version 2.0) credit and fulfill the 40 possible LEED points necessary for this certification.

YOUNGSTOWN STATE UNIVERSITY GREEN ENERGY CHALLENGE TEAM

The 2012 YSU GECT consists of six core members: Mike Currao (Electrical Engineering), Jason Nutt (Electrical Engineering Technology), Ethan Parks (Electrical Engineering Technology), Michael Sammartino (Electrical Engineering), Jarrett Scacchetti (Mathematics and Electrical Engineering), and David Wright (Electrical Engineering Technology). The core team is assisted by other students in the chapter. For lighting system design and analysis, Jason Nutt is assisted by Nicholas Gealy and Tyler Vitullu. For the mechanical and HVAC system analysis, Mike Sammartino is assisted by Robert Paige and Kalen Wallace. For LEED qualification and certification, Jarrett Scacchetti is assisted by Nick Brown. For the financial plan, Ethan Parks is assisted by Mathew Biedka and Drew Duraney. Finally, for the alternative energy systems, Mike Currao is assisted by Ryan Hicks and Jacob Tibbits. With a strong background in the electrical construction industry and having several team members working for local electrical contractors and engineering firms, the team is looking to utilize acquired knowledge to employ cost-efficient energy-saving solutions to a relatively new facility designed by a renowned architect. Through outreach and support from local contractors, engineers, architects, and peers, the YSU team looks forward to assembling a model for energy consciousness that the community can look to as template for the local green energy movement.

TEAM RESUMES

Michael Currao

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NECA Green Energy Challenge Duties: Conduct field visit for initial site assessment and research wind energy systems such as wind turbines, mounting, and inverters as well as solar panel options.

Objective: To practically apply skills and knowledge gained at Youngstown State University by obtaining a career in the field of Electrical Engineering.

Profile: Astute Engineering major who fosters team work in the presence of others.

Expertise in: Microsoft Office Suite (Excel, Word, PowerPoint), OrCAD PSpice software.
Experience with: AutoCAD, Solid Works, Visual Basic 6.0, LaTeX, Maple, Microsoft Windows XP/Vista/7.
Additional Skills: Ability to work with diverse groups

Education: YOUNGSTOWN STATE UNIVERSITY — Youngstown, OH
College of Science, Technology, Engineering and Mathematics — ABET Accreditation

Major: Electrical and Computer Engineering (Computer/Digital Option) — Expected May 2014
Minor: Mathematics
Overall GPA: 3.83/ 4.00 Major GPA: 4.00/ 4.00

Honors/ Achievements: Dean's List for the College of STEM, YSU STEM Leadership Society, Trustees' Scholarship

Relevant Coursework:

- Basic Circuit Theory I and II
- Statics / Dynamics
- Differential Equations
- Engineering Concepts
- Physics I and II
- Calculus I, II, and III
- Chemistry

Employment: Abercrombie and Fitch — Boardman, OH:
Impact Team Member (February 2011 — Present)
YSU Computer Lab Monitor — Youngstown, OH: (January 2011 — May 2011)

Affiliations/ Volunteer work:

- Institute of Electrical and Electronics Engineers Student Chapter Member (2011 — Present)
- National Electrical Contractors Association Student Chapter Member (2011-Present)
- Relay For Life (2011)

Jason A. Nutt
janutt01@student.ysu.edu
733 Lakeview Drive
Cortland, OH 44410
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NECA Green Energy Challenge Duties: Conduct field visit for initial site assessment, analyze existing lighting system with computer software for accurate proposal, and draft proposed lighting plans.

Objective: To practically apply skills and knowledge gained at Youngstown State University by obtaining a career in the field of Electrical Engineering.

Profile: Dynamic personality with artisan CAD abilities.

Expertise in: Microsoft Office Suite (Excel, Word, PowerPoint), PSpice software, ASCII.
Experience with: AutoCAD 2011, Revit MEP 2011, Microsoft Windows XP/Vista/7, MathCAD, Acuity Visual, COMcheck.
Additional Skills: Strong communication skills, experience in electrical design in construction field.

Education: YOUNGSTOWN STATE UNIVERSITY — Youngstown, OH
College of Science, Technology, Engineering and Mathematics — ABET Accreditation

- Associates of Electrical Engineering Technology, May 2011
- Bachelor of Electrical Engineering Technology, May 2013
  - Major: Electrical Engineering Technology (Traditional Option)

Relevant Coursework:

- Basic Circuit Theory I and II
- Digital and Analog Circuits I
- Electrical Machines
- Digital Systems I
- Electronics I and II
- Power Systems Protection
- Logic System Design
- Engineering Drawing/Drafting
- Engineering Concepts
- Microprocessors I
- Programmable Logic Controllers
- Electronic Communication systems
- Variable Speed Drives

Employment: CJL ENGINEERING — Youngstown, OH:
Electrical Engineering Intern, Electrical Designer (May 2008 — Present)
YSU FACILITIES — Youngstown, OH:
Drafting Assistant (March 2007 — May 2008)
Control Transformer — Cortland, OH:
Machinist (September 2006 — March 2007)
Guitar Center — Boardman, OH:
Pro Audio Department Manager (January 2006 — July 2006)
WEST — Niles, OH:
Technical Representative (January 2005 — January 2006)

Affiliations:

- Vice President of YSU NECA (2012)
- National Electrical Contractors Association Student Chapter Member (2010-2012)
  - Participant in 2011 Green Energy Challenge, placing 2nd nationally.

Ethan Parks
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Greenford Ohio 44422
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NECA Green Energy Challenge Duties: Conduct field visit for initial site assessment and outline financing plan for all aspects of proposed energy upgrade.

Objective: To practically apply skills and knowledge gained at Youngstown State University by obtaining a career in the field of Electrical Engineering.

Profile: Highly-motivated undergraduate student.

Expertise in: Knowledge of electrical construction components and materials.
Experience with: AutoCAD 2011, Visual Basic, Microsoft Windows XP/Vista/7.
Additional Skills: Ability to develop creative ways to efficiently accomplish tasks.

Education: YOUNGSTOWN STATE UNIVERSITY — Youngstown, OH
College of Science, Technology, Engineering and Mathematics — ABET Accreditation

Major: Electrical Engineering Technology — May 2014
Overall GPA: 3.8 / 4.00 Major GPA: 4.00 / 4.00

Honors/ Achievements: Dean's List for the College of STEM at YSU

Relevant Coursework:

- Basic Circuit Theory I
- AutoCAD

Employment: "JOE" DICKEY ELECTRIC INC. - North Lima, OH: (June 2010 - Present)

PARKS GARDEN CENTER AND LANDSCAPING - Canfield, OH: (November 2005 - June 2010)

Affiliations:

- National Electrical Contractors Association Student Chapter Member (2010-2012)
  - Participant in 2011 Green Energy Challenge, placing 2nd nationally.

Michael T. Sammartino
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NECA Green Energy Challenge Duties: Conduct field visit for initial site assessment and evaluate existing mechanical and distribution system with proposals for design improvements and additions.

Objective: Attain the opportunity to apply skills and knowledge gained at Youngstown State University by obtaining a career in the field of Electrical Engineering

Profile: Hard working and motivated undergraduate student who is a team player.

Expertise in: OrCAD PSpice, C++, UNIX, VHDL, Altera Quartus II, MATLAB, Python, MAPLE, NI LabVIEW, Microsoft Office Suite (Word, Excel, PowerPoint), AVR Microcontrollers.
Experience with: AutoCAD, SolidWorks, C# .NET, superconductors, high voltage/high current power supplies, testing and measurement equipment (DMM, oscilloscopes, etc).
Additional Skills: Strong communication skills and ability to work with diverse groups.

Education: YOUNGSTOWN STATE UNIVERSITY — Youngstown, OH
College of Science, Technology, Engineering and Mathematics — ABET Accreditation

Major: Electrical and Computer Engineering (Computer/Digital Option) — May 2012
Minor: Mathematics
Overall GPA: 3.13 / 4.00 Major GPA: 4.00 / 4.00

COMMUNITY COLLEGE OF THE AIR FORCE — Maxwell Air Force Base, AL
Associates Degree in Criminal Justice
Distinguished Graduate in both Basic Military Training and CATM School.

Relevant Coursework:

- Basic Circuit Theory I and II
- Digital and Analog Circuits
- Digital Circuit Design
- Computer Design
- Electromagnetic Fields I and II
- Electromagnetic Energy Conversion
- Embedded Systems
- Physics I and II
- Calculus I, II, and III,
- Differential Equations
- Linear Algebra and Matrix Theory
- Statics / Dynamics
- Electric Power Systems
- Linear Control Systems

Employment: YOUNGSTOWN STATE UNIVERSITY — Youngstown, OH:
Research Assistant (May 2011 — Present)
AKRON CHILDREN'S HOSPITAL — Boardman, OH:
Security Officer (July 2009 — Present)
UNITED STATES AIR FORCE: (January 2007 — Present)
Deployed in Operation Iraqi Freedom. Mobile Vehicle X-Ray operator (June 2008 — March 2009)
MARC'S GROCERY STORE — Austintown, OH: (Feb 2005 — May 2008)

Affiliations/ Certifications:

- Institute of Electrical and Electronics Engineers Student Chapter Vice President (2011 — 2012)
- National Electrical Contractors Association Student Chapter Member (2011 – Present)
- YSU IEEE Micromouse Competition lead hardware/controls designer (2011)
- Syncro Medical HTS Electromagnetic Coil Project — Undergraduate Research Assistant (2010 — 2011)
- Private Pilot License
- Amateur Radio License
- Air Force Reserve Command Airman of the Year (2009)

Jarrett M. Scacchetti
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24 Topaz Circle
Canfield, OH 44406
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NECA Green Energy Challenge Duties: Conduct field visit for initial site assessment, research LEED for certification, and typing/ formatting the proposals.

Objective: An Engineering internship that will provide a hands-on opportunity and challenge abilities.

Profile: Highly-motivated collegiate honors student with an acute attention to detail.

Expertise in: Microsoft Office Suite (Excel, Word, PowerPoint), OrCAD PSpice software, VHDL design with Quartus II software, C++.
Experience with: AutoCAD 2010, Solid Works 2008, Visual Basic 6.0, MS Windows XP/7, Linux, Mac OS X, Maple, LaTeX.
Additional Skills: Strong communication skills, interpersonal and social skills, and a team player.

Education: YOUNGSTOWN STATE UNIVERSITY — Youngstown, OH
College of Science, Technology, Engineering and Mathematics — ABET Accreditation

Major: Electrical and Computer Engineering (Computer/Digital Option) – May 2013
Major: Applied Mathematics — May 2013
Overall GPA: 3.92/ 4.00 Major GPA: 4.00 / 4.00

Honors/ Achievements: YSU Leslie H. Cochran University Scholar Award, Dean's List for the College of STEM at YSU, Tau Beta Pi Engineering Honor Society (Vice President 2011 — 2012), Pi Mu Epsilon Mathematics Honors Society, Honor Society of Phi Kappa Phi (Student Vice President), Honorable Mention in the 2010 & 2011 COMAP Competition.

Relevant Coursework:

- Basic Circuit Theory I, II
- Digital and Analog Circuits I
- Electromagnetic Theory I, II
- Digital Circuit Design I
- Partial Differential Equations
- Discrete Mathematics
- Statics / Dynamics
- Computer Design with VHDL
- Electromagnetic Energy Conversion
- Electric Power Systems

Employment: YSU DEAN — STEM — Youngstown, OH:
Teaching Assistant (January 2012 — Present)

YSU MEDIA & ACADEMIC COMPUTING – Youngstown, OH:
Software Assistant 1 "Student" (October 2010 — August 2011)

Affiliations/ Volunteer work:

- National Electrical Contractors Association Student Chapter Member (2011—2012); Vice President (2011), Secretary (2012)
- Institute of Electrical and Electronics Engineers Student Chapter Member (2009 — 2011); President (2011 — 2012)
- Honors Program (2009 — Present)
- Executive Board Member, NEOREP (Northeast Ohio Robotics Education Program)
- IEEE YSU SPAC Coordinator

David E. Wright

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583 Roxbury Ave.
Youngstown, Ohio 44502
(330) 402-5284

NECA Energy Green Challenge Duties: Conduct field visit for initial site assessment and develop proposals for construction schedule and overall cost estimates and take-offs.

Objective: To combine my practical field experience, knowledge of the electrical trades, and the knowledge acquired through the Youngstown State Electrical Engineering program to advance existing career in the electrical construction industry.

Profile: Knowledgeable individual with hands-on experience in the electrical trades and a commitment to continuing education.

Expertise in: Residential Electrical Construction, Commercial Electrical Estimating.
Experience with: AutoCAD, Small design-build projects.
Additional Skills: Excellent working knowledge of the construction process; experience in project coordination, employee training, and customer relations.

Education:

YOUNGSTOWN STATE UNIVERSITY — Youngstown, OH
College of Science, Technology, Engineering and Mathematics — ABET Accreditation
Major: Electrical Engineering Technology — Expected May 2013
Overall GPA: 3.48 / 4.00

YOUNGSTOWN STATE UNIVERSITY – Youngstown, OH
Williamson College of Business Administration
Associate of Technical Study — Obtained December 16, 2007
Major: Business Technology
Overall GPA: 3.23 / 4.00

IBEW/National Joint Apprenticeship and Training Committee — Youngstown, OH
Residential Wireman Certification, May 31, 2004

Honors/ Achievements: MLK Jr. Scholarship, YSU Leadership Scholarship, Penn-Ohio NECA scholarship, Deans List.

Relevant Coursework:

- NECA/IBEW Res. Wireman Courses
- AutoCAD 1
- Drafting and Plan Reading
- Microprocessors
- Basic Computer Digital Circuits
- Engineering Computing
- Electrical Machines
- Electronics

Employment:

"JOE" DICKEY ELECTRIC INC. – North Lima, Ohio:
- Electrical Estimator/ Engineering Intern (January 2008 — Present)
  - Perform commercial estimating duties and project coordination tasks.
- Residential Journeyman Electrician (May 2004 — January 2008)
  - Charged with the electrical construction of multiple new residential developments and provided on the job training for apprentices.
- Residential Electrical Apprentice (August 2002 — May 2004)
  - Received residential electrical on the job training.

GULU ELECTRICAL CONTRACTORS INC. — Youngstown, Ohio:
- Residential Electrical Apprentice: (January 2002 — August 2002)
  - Received residential electrical on the job training

Affiliations/ Volunteer work:

- National Electrical Contractors Association Student Chapter Member (2010 —Present) Chapter President (2011 – Present)
- Institute of Electrical and Electronics Engineers Member (2009 — Present)
- International Brotherhood of Electrical Workers Local 64 member (2001 — Present)
- Habitat For Humanity and "Extreme Makeover: My Home Town"

LIGHTING RETROFIT ANALYSIS

EXISTING LIGHTING SYSTEM

When examining the existing lighting in the building, the museum was broken down into three common lighting types: (I) 250 watt R38 Halogen track lamps, (II) 2'x2' and 2'x4' 4-lamp linear fluorescent fixtures, and (III) 26 watt triple-tube compact fluorescent down lights. Full lighting information from the energy audit can be seen in **Table 8.**

HALOGEN TRACK LAMPS

The first fixture types in need of improvement are track fixtures containing 250W Par38 Halogen lamps by Sylvania with a low life span of 3,000 hours and an uncomfortably high lumen output within the center focal point of the photometric spread, Model Description: 250PAR38HALSP1010. The prominent areas housing these lamps are the exhibition halls on the first floor and basement, as well as the lobby on the first floor. The current lamp type in this track fixture can be seen in **Figure 2**. The first floor contains the majority of the track fixtures with (16) fixtures in the lobby and (99) more in the exhibit hall, while the basement hall contains (57) fixtures.


Figure 2: 250 Watt Par38 Track Heads

The track fixtures are controlled by incandescent dimmer banks located in the mechanical rooms of their respective floors; some of these dimmer banks appear to be in disrepair or not working at all, resulting in hot spots in the exhibit halls. Due to the unnecessarily high foot candle levels present in the corresponding areas of concentration, the existing dimmer banks are currently adjusted to 20% capacity to decrease light levels. The dimming of the 250W Par38 Halogen lamps does not increase the lamp life of 3,000 hours typical with this Halogen lamp, and as a result the oversized lamping within the track fixtures increases maintenance and labor costs when repair is needed.


Figure 3: 2'x2' Linear Fluorescent Fixtures with T12 Lamps

LAY-IN LINEAR FLUORESCENT FIXTURES

The second fixture types in need of improvement throughout the building are (4) 96W T12 linear fluorescent fixtures containing T12 lamps by Sylvania, Model Description: 4 -F40 RS CW, shown in **Figure 3**. Two classrooms contain (15) 2'x2' 2-lamp fixtures, while other miscellaneous rooms contain (6) 2'x4' 2-lamp fixtures. The 2'x4' 4-

lamp fixtures can be found throughout the second floor in the archives where (43) fixtures are located along with the (15) fixtures in the train display area. The 1'x4' 2-lamp linear fluorescent high bay fixtures can be found in storage areas on the first floor and basement, in addition to the mechanical rooms. In total, (211) linear fluorescent fixtures are installed throughout the history center.

COMPACT FLUORESCENT DOWN LIGHTS

The third lighting type, the 26 watt triple-tube compact fluorescent down lights are used for several purposes: up lighting, down lighting, dome fixtures, and wall sconces. Shown in **Figure 4,** these fixtures contain (1) 26 Watt triple-tube lamp. In total, (132) compact fluorescent down lights are installed throughout the center.

The remainder of the building's lighting consists of emergency lights and 2-lamp fluorescent can lights that are located in the classrooms. Due to the small quantity of these lights, they will remain unchanged.

Figure 4: Compact Fluorescent Down Lights and Dome Fixtures

Table 1: Existing Fixture Summary

Fixture Num.	Description	Lamps	MFR. Catalog Number
S -1	2-lamp, 4' industrial fluorescent strip with reflector [2]	(2) F40 RS CW	Williams 82222
S -2	4-lamp, 8' industrial fluorescent strip with reflector [2]	(4) F40 RS CW	Williams 8225
R -2	4-lamp, 2' x 4' recessed fluorescent troffer [2]	(4) F40 RS CW	Williams 4424-SWA110
R-4	2-lamp, double twin tube fluorescent	(2) F13DTT	Prescolite PBX –T095
R-5	1-lamp, 6" incandescent [3]	(1) A19	Prescolite 1224-362
TR- 1	1-lamp, 300W spot / flood track head [1]	(1) 300 PAR-56 MFL	Lite Lab L-156-7A-CF-BD70
TR- 2	1-lamp, 75W track head with canopy	(1) 75PAR/3FL	Lite Lab L-180-2
P-1	12' cast aluminum "villa" style post	(1) 250 W HPS	Spring City Villa 12-Villa
W-1	1-lamp, wall-mounted interior incandescent light fixture with globe and guard	(1) 100W A-19	Stonco VW-2GC

Notes: [1] Field surveyed as 250 PAR38 HALSP1010.
[2] Field surveyed as 96W with adjusted to include ballast.
[3] Incandescent lamp replaced with 26W compact fluorescent.

PROPOSED LIGHTING SYSTEM

After the field survey, a complete analysis of existing conditions at the historical center included, but was not limited to: complete lighting and fixture count, actual illumination meter readings, lighting fixture analysis, existing lamp Mercury (Hg) content calculations (picogram per lumen hour, pg/lm-h), and compliance with current area-specific IES recommendations. The GECT composed a lighting upgrade proposal that concentrates on key factors that affect overall energy consumption within the building. This proposal includes factors to provide an environmentally conscious design in an attempt to maximize energy efficiency within the center.

In order to provide an environmentally conscious lighting design, the GECT focused on mercury content reduction in lamps and reducing overall waste produced from replacing lamps with short life-spans. Careful measures were taken to: (1) reduce existing lamp usage by suggesting longer-life lamps, (2) decrease mercury content throughout the building by proposing fixtures with lamps that eliminate mercury or significantly reduce the pg/lm-h value, (3) increase or match existing foot-candle levels in upgraded areas, and (4) limit the number of lamps kept in owner-stock for replacement. These measures were applied to three lighting types in the building: (I) 250 watt Par38 Halogen track lamps, (II) 2'x2' and 2'x4' 4- lamp linear fluorescent fixtures, and (III) 26 watt triple-tube compact fluorescent down lights. Break down for the cost and energy analysis can be found in **Table 9** and **Table 10**.

ACCULAMP PAR38 LED

The existing 250 watt halogen lamps are to be replaced with Acculamp Par38 LED screw-in lamps. These LED lamps will provide the building with large amounts of energy savings by decreasing the lamp wattage per lamp from 250 watts to 20 watts; these LED lamps will be installed in all track heads throughout the building. Also, by only changing the lamps, and not the fixtures or tracks, labor costs are kept low for this portion of the renovation. The next issue to be addressed with the existing track heads is the dimmer banks that are used to control the fixtures. These dimmer banks, located in the machine rooms of their respective floors, appeared to be in a state of disrepair. Each dimmer switch will be replaced with an equivalent, modern version and the panels will be rewired accordingly.

LINEAR FLUORESCENT LIGHTS

The 2'x2' 2-lamp and 2'x4' 2-lamp and 4-lamp lay-in fixtures will be replaced with Focal Point Equation two lamp fixtures. All three variances of these fixtures will contain T5 high output lamps. The 2-lamp high bay fixtures located in the basement of the museum will be replaced with Lithonia IBZ I-beam 4-lamp fixtures containing T5 high output lamps. Along with replacing the high bay fixtures, the total amount of installed fixtures will be reduced from the (116) existing fixtures to (58) of the four lamp Lithonia fixtures, a 50% reduction. Both the Focal Point and Lithonia fixtures are higher priced than other fixtures on the market; however, the higher quality fixture will improve aesthetics in the museum and will produce more energy savings, providing the customer with greater satisfaction overall. A total of (8) occupancy sensors are also proposed in the mechanical, storage, and classroom areas on each floor since these areas are rarely occupied but the lights are constantly left on. These sensors, for the most part, can be implemented in existing switching locations.

COMPACT FLUORESCENT FIXTURES

These fixtures contained 26 watt triple-tube lamps and could be found in several different fixture styles. It was decided that these lamps would remain unchanged as the CFLs provides an acceptable level of energy savings along with easy maintenance; they have been installed in all possible areas.

MERCURY CONTENT ANALYSIS

Comparing the existing and proposed lighting systems, mercury content calculations were made to show the major environmental impact that the new fixtures would have on the building. As per LEED guidelines, an acceptable level of mercury from light fixtures in a building is 90 pg/lm-h. The total mercury content from the existing fixtures was calculated to be 84.21 pg/lm-h (as shown **Table 2**). With the GECT proposed system, the total mercury levels was calculated at 17.47 pg/lm-h (as shown in

Table 3), which is one-fifth of the existing mercury content. This significant difference marks a large step toward preserving the environment and provides significant advancement towards green design.

Table 2: Existing Lamp Mercury Levels

LEED EB Mercury Content Calculator: Actual Mercury Containing Lamps (during performance period)							
Type of Lamp	Number of Existing Lamps for Building and Grounds (during performance period)	One Lamp Hg Content (milligrams)	PicoGrams per lumen hour for each type of Lamp	One Lamp Mean (at 40% of lamp life) Light Output (Lumens)	One Lamp Life (Hours)	Total Hg Content for All Lamps of this Type (grams)	Total Lumen Hours that will be Delivered by All Lamps of this Type (Hours)
PHILLIPS 96W T12	540	1.7	77	2945	7,500	0.918	11927250000
GE 26W TRIPLE TUBE CFL	132	1.8	132	1700	8,000	0.2376	1795200000
TOTALS						**1.1556**	**13,722,450,000**
Total Mercury Content of Existing Lamps (during performance period)							**1.16**
Total Lumen-Hours of Existing Lamps (during performance period)							**13,722,450,000**
Average Mercury Content of Existing Lamps in Picograms per Lumen Hour (during performance period)							**84.21**

Table 3: New Lamp Mercury Levels

LEED EB Mercury Content Calculator: Actual Mercury Containing Lamps (during performance period)							
Type of Lamp	Number of Proposed Lamps for Building and Grounds (during performance period)	One Lamp Hg Content (milligrams)	PicoGrams per lumen hour for each type of Lamp	One Lamp Mean (at 40% of lamp life) Light Output (Lumens)	One Lamp Life (Hours)	Total Hg Content for All Lamps of this Type (grams)	Total Lumen Hours that will be Delivered by All Lamps of this Type (Hours)
PHILLIPS F49T5HO/835	306	1.4	12	4750	25,000	.4284	36,337,500,000
GE 26W TRIPLE TUBE CFL	132	1.8	132	1700	8,000	0.2376	1,795,200,000
TOTALS						**0.666**	**38,132,700,000**
Total Mercury Content of Proposed Lamps (during performance period)							**0.67**
Total Lumen-Hours of Existing Lamps (during performance period)							**38,132,700,000**
Average Mercury Content of Proposed Lamps in Picograms per Lumen Hour (during performance period)							**17.47**

COMPUTER MODELING OF PROPOSED SYSTEM

Based on the proposed lighting retrofit, computer models of the historical center were created in AutoCAD 2011 for 2-D lighting layouts. These models were constructed based on as-built drawings of the existing system, with substitutions made for proposed energy-efficient fixtures. Also, Visual 2.0 and Autodesk Revit MEP 2011 were used to create 3-D photometric calculations and 3-D renderings of the new lighting layout, respectively. Equivalent luminaire models were imported into the software from IES files describing the lighting characteristics of proposed fixtures. Note that no IES files existed for the LED fixtures; they were created manually from design specifications on cut sheets. **Figure 6 - Figure 5** are 3D renderings of the proposed lighting systems while **Figure 10 - Figure 12** shows the new ceiling plans for each floor of the building and lighting levels in typical areas.

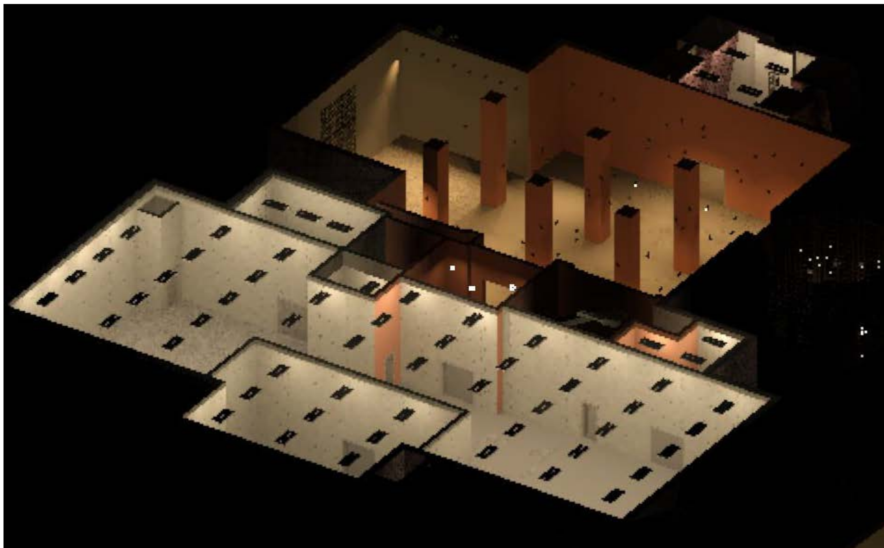


Figure 7: Basement Lighting Rendering

Figure 6: 1st Floor Lighting Rendering

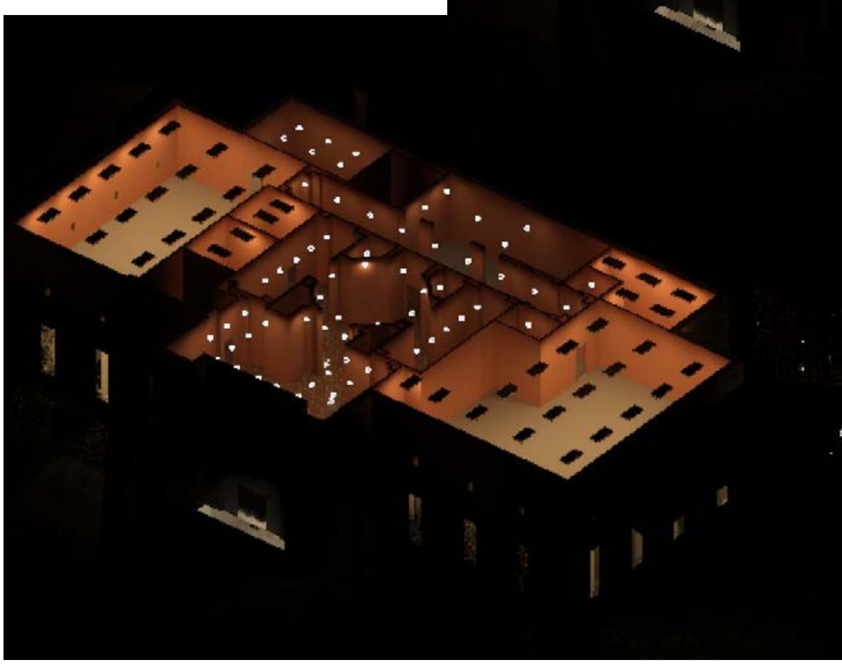


Figure 5: 2nd Floor Lighting Rendering

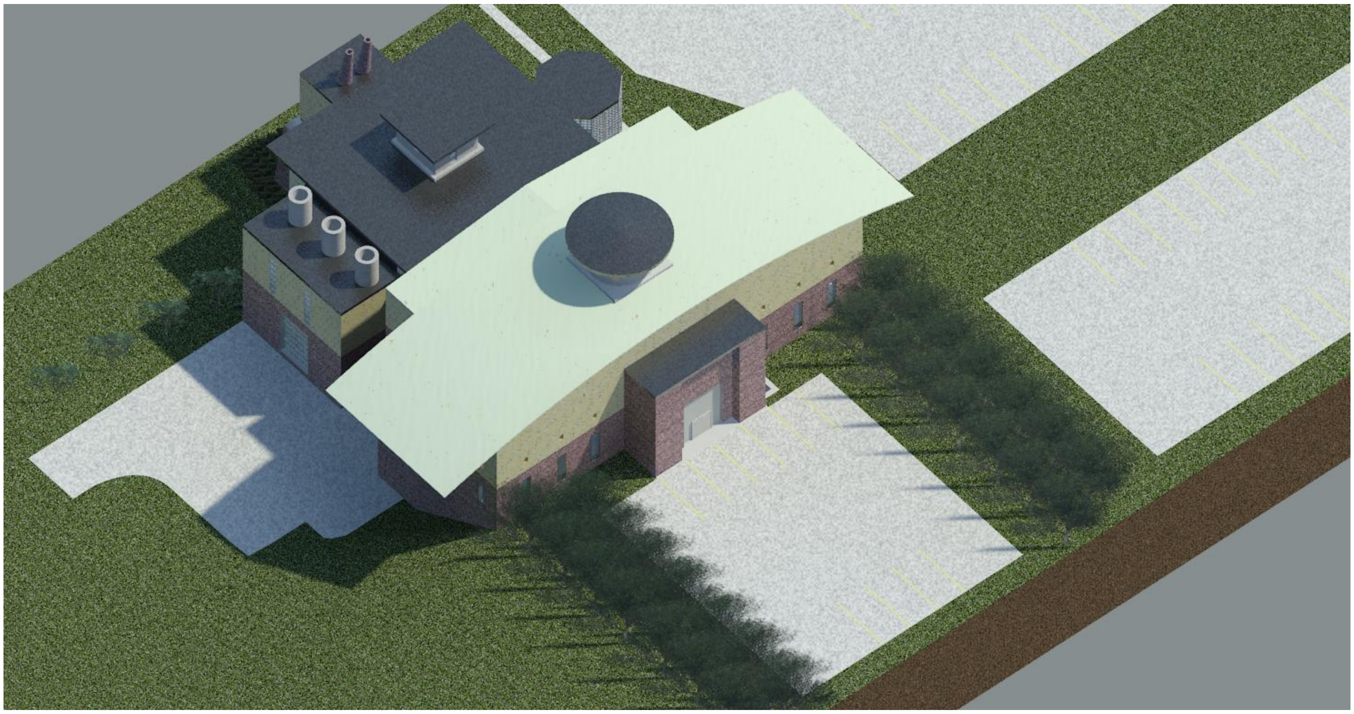


Figure 9: 3D Rendering of the Historical Center

LIGHT FIXTURE SCHEDULE

SYMBOL	MARK	DESCRIPTION	LAMPS	MOUNTING	NOTES
	F1	LITHONIA IBZ-454-L-MVOLT-GEB10PS90	F49T5/HO	PENDANT	
	F2	FOCAL POINT EQUATION FEQ-22-B-1-T5HO-S-MVOLT-G1-WH	F49T5/HO	LAY-IN	
	F3	FOCAL POINT EQUATION FEQ-24-B-1-T5HO-S-MVOLT-G1-WH	F49T5/HO	LAY-IN	
▽	L1	ACCULAMP ALSP38-1200L-45-40K-DIM	LED	TRACK	

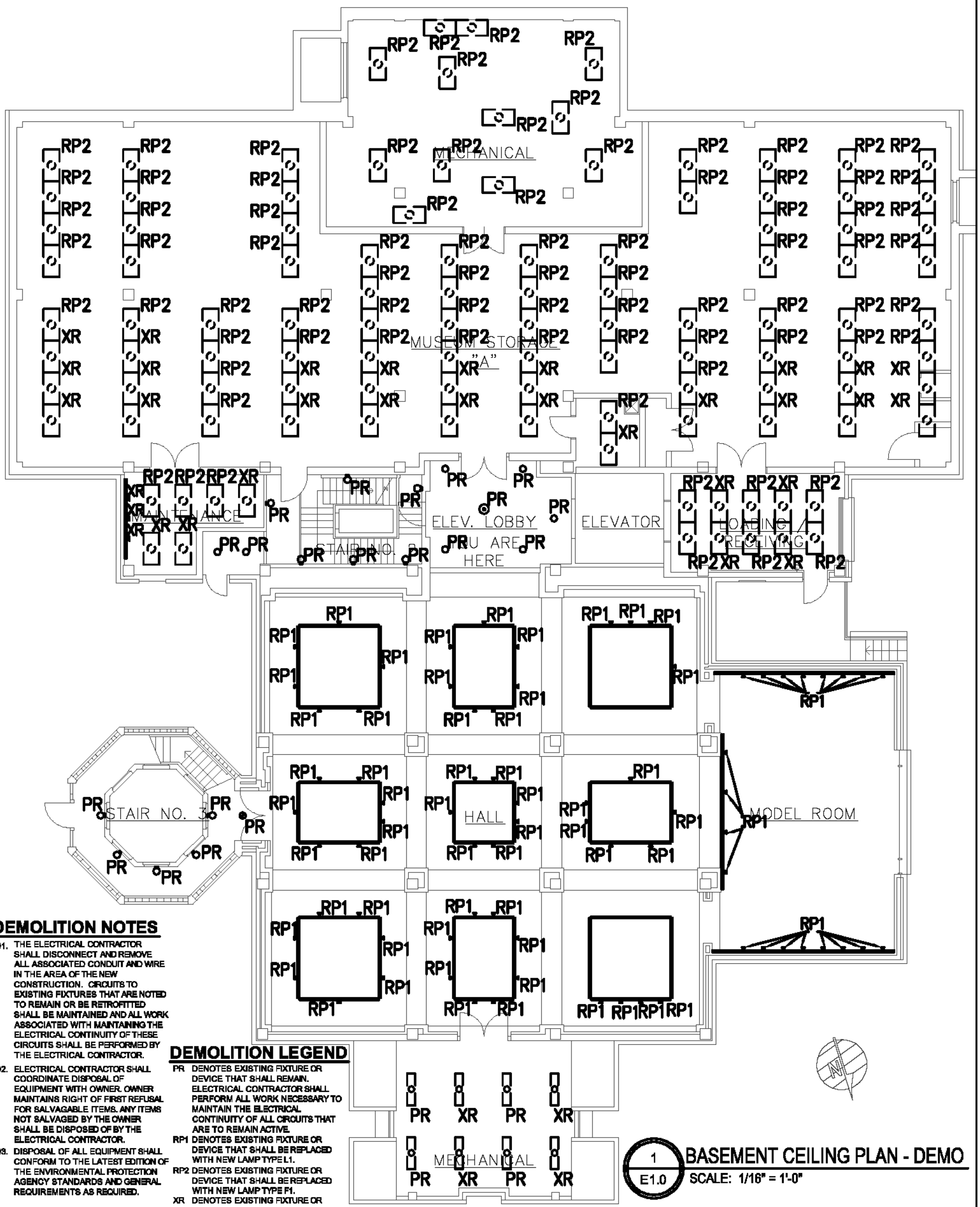
ELECTRICAL LEGEND:

ACCEPTABLE MANUFACTURERS ARE HUBBELL AND PASS & SEYMOUR

EXISTING WALL SCONCE.

FUTURE ENGINEERS: MIKW CURRAO, DAVE WRIGHT, JARRETT SCACCHETTI, JASON NUTT, ETHAN PARKS, MICHAEL SAMMARTINO	YSU GREEN ENERGY CHALLENGE TEAM **PROPOSED LIGHTING UPGRADE** **CAFARO HOUSE** **YOUNGSTOWN, OHIO**	CHECKED BY:	SCALE: AS NOTED
YSU		DATE: 04-12-12	DRAWN BY: JAN
		DRAWING TITLE: SCHEDULES	SHEET # E0.1

Figure 8: Fixture Schedule and Legend



DEMOLITION NOTES

D1. THE ELECTRICAL CONTRACTOR SHALL DISCONNECT AND REMOVE ALL ASSOCIATED CONDUIT AND WIRE IN THE AREA OF THE NEW CONSTRUCTION. CIRCUITS TO EXISTING FIXTURES THAT ARE NOTED TO REMAIN OR BE RETROFITTED SHALL BE MAINTAINED AND ALL WORK ASSOCIATED WITH MAINTAINING THE ELECTRICAL CONTINUITY OF THESE CIRCUITS SHALL BE PERFORMED BY THE ELECTRICAL CONTRACTOR.

D2. ELECTRICAL CONTRACTOR SHALL COORDINATE DISPOSAL OF EQUIPMENT WITH OWNER. OWNER MAINTAINS RIGHT OF FIRST REFUSAL FOR SALVAGABLE ITEMS. ANY ITEMS NOT SALVAGED BY THE OWNER SHALL BE DISPOSED OF BY THE ELECTRICAL CONTRACTOR.

D3. DISPOSAL OF ALL EQUIPMENT SHALL CONFORM TO THE LATEST EDITION OF THE ENVIRONMENTAL PROTECTION AGENCY STANDARDS AND GENERAL REQUIREMENTS AS REQUIRED.

DEMOLITION LEGEND

PR DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL REMAIN. ELECTRICAL CONTRACTOR SHALL PERFORM ALL WORK NECESSARY TO MAINTAIN THE ELECTRICAL CONTINUITY OF ALL CIRCUITS THAT ARE TO REMAIN ACTIVE.

RP1 DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE REPLACED WITH NEW LAMP TYPE L1.

RP2 DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE REPLACED WITH NEW LAMP TYPE F1.

XR DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE DEMOLISHED.

1 / E1.0 BASEMENT CEILING PLAN - DEMO
SCALE: 1/16" = 1'-0"

FUTURE ENGINEERS:

MIKE CURRAO, DAVE WRIGHT, JARRETT SCACCHETTI, JASON NUTT, ETHAN PARKS, MICHAEL SAMMARTINO

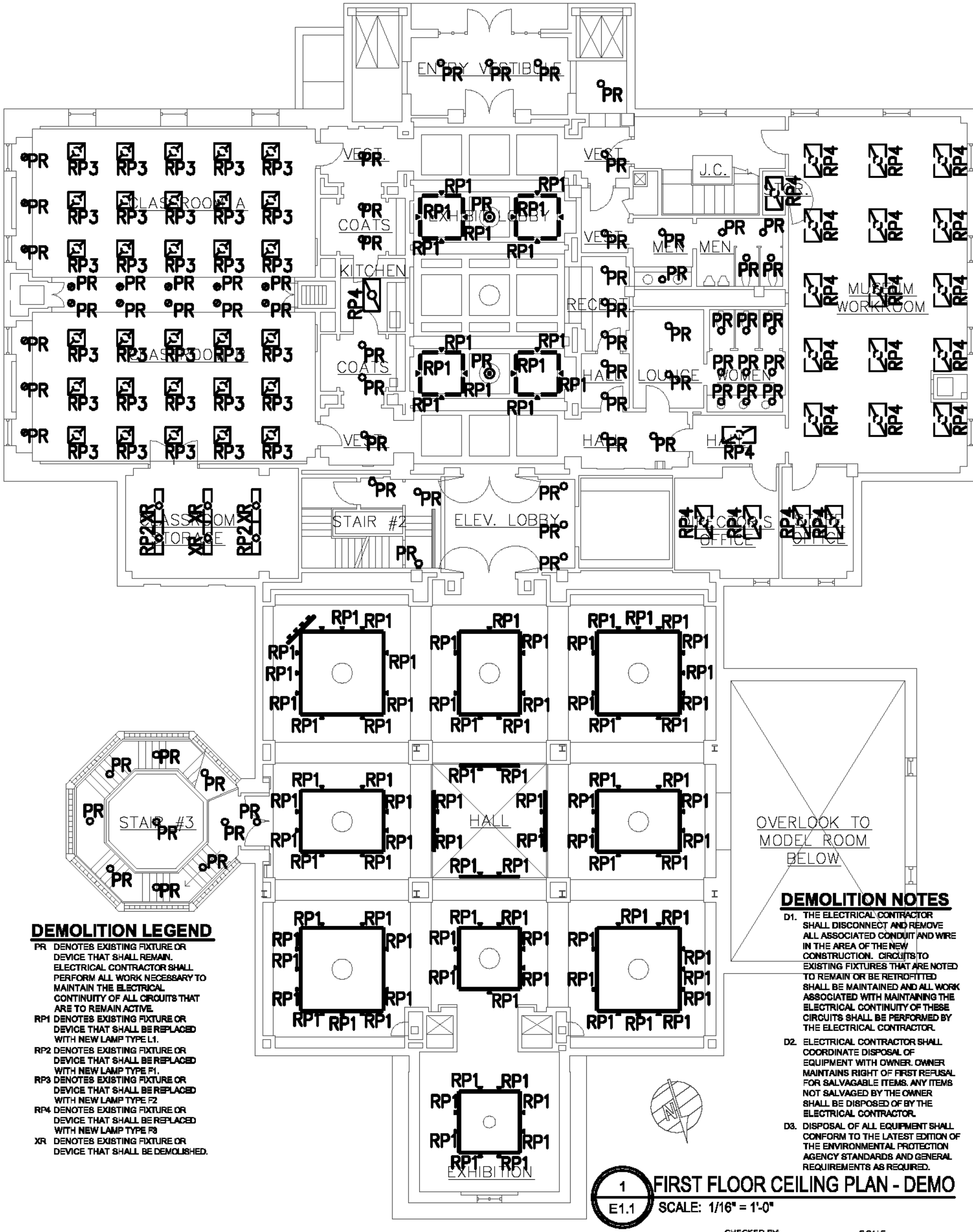
YSU

YSU GREEN ENERGY CHALLENGE TEAM

PROPOSED LIGHTING UPGRADE
MUSEUM OF LABOR AND INDUSTRY
YOUNGSTOWN, OHIO

CHECKED BY:	SCALE: AS NOTED
DATE: 04-12-12	DRAWN BY: JAN
DRAWING TITLE: BASEMENT CEILING PLAN - DEMO	SHEET # E1.0

Figure 10: Basement Ceiling Plan - Demo



DEMOLITION LEGEND

- PR DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL REMAIN. ELECTRICAL CONTRACTOR SHALL PERFORM ALL WORK NECESSARY TO MAINTAIN THE ELECTRICAL CONTINUITY OF ALL CIRCUITS THAT ARE TO REMAIN ACTIVE.
- RP1 DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE REPLACED WITH NEW LAMP TYPE L1.
- RP2 DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE REPLACED WITH NEW LAMP TYPE F1.
- RP3 DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE REPLACED WITH NEW LAMP TYPE F2
- RP4 DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE REPLACED WITH NEW LAMP TYPE F3
- XR DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE DEMOLISHED.

DEMOLITION NOTES

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D2. ELECTRICAL CONTRACTOR SHALL COORDINATE DISPOSAL OF EQUIPMENT WITH OWNER. OWNER MAINTAINS RIGHT OF FIRST REFUSAL FOR SALVAGABLE ITEMS. ANY ITEMS NOT SALVAGED BY THE OWNER SHALL BE DISPOSED OF BY THE ELECTRICAL CONTRACTOR.

D3. DISPOSAL OF ALL EQUIPMENT SHALL CONFORM TO THE LATEST EDITION OF THE ENVIRONMENTAL PROTECTION AGENCY STANDARDS AND GENERAL REQUIREMENTS AS REQUIRED.

1 / E1.1 FIRST FLOOR CEILING PLAN - DEMO
SCALE: 1/16" = 1'-0"

FUTURE ENGINEERS:

MIKE CURRAO, DAVE WRIGHT, JARRETT SCACCHETTI, JASON NUTT, ETHAN PARKS, MICHAEL SAMMARTINO

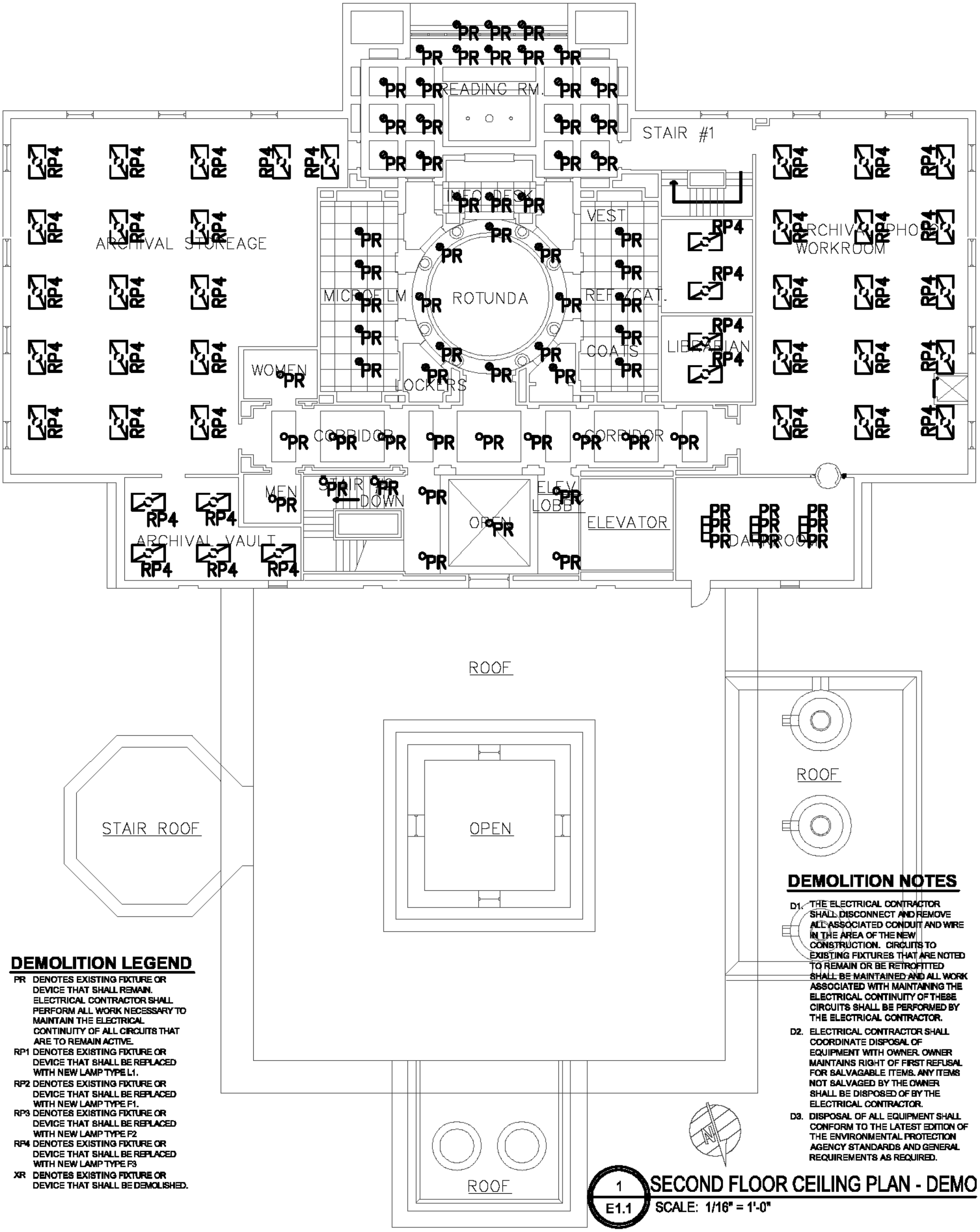
YSU

YSU GREEN ENERGY CHALLENGE TEAM

PROPOSED LIGHTING UPGRADE
MUSEUM OF LABOR AND INDUSTRY
YOUNGSTOWN, OHIO

CHECKED BY:	SCALE: AS NOTED
DATE: 04-12-12	DRAWN BY: JAN
DRAWING TITLE: FIRST FLOOR CEILING PLAN - DEMO	SHEET # E1.1

Figure 11: First Floor Ceiling Plan - Demo



DEMOLITION LEGEND

PR DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL REMAIN. ELECTRICAL CONTRACTOR SHALL PERFORM ALL WORK NECESSARY TO MAINTAIN THE ELECTRICAL CONTINUITY OF ALL CIRCUITS THAT ARE TO REMAIN ACTIVE.

RP1 DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE REPLACED WITH NEW LAMP TYPE L1.

RP2 DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE REPLACED WITH NEW LAMP TYPE F1.

RP3 DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE REPLACED WITH NEW LAMP TYPE F2

RP4 DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE REPLACED WITH NEW LAMP TYPE F3

XR DENOTES EXISTING FIXTURE OR DEVICE THAT SHALL BE DEMOLISHED.

DEMOLITION NOTES

D1. THE ELECTRICAL CONTRACTOR SHALL DISCONNECT AND REMOVE ALL ASSOCIATED CONDUIT AND WIRE IN THE AREA OF THE NEW CONSTRUCTION. CIRCUITS TO EXISTING FIXTURES THAT ARE NOTED TO REMAIN OR BE RETROFITTED SHALL BE MAINTAINED AND ALL WORK ASSOCIATED WITH MAINTAINING THE ELECTRICAL CONTINUITY OF THESE CIRCUITS SHALL BE PERFORMED BY THE ELECTRICAL CONTRACTOR.

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D3. DISPOSAL OF ALL EQUIPMENT SHALL CONFORM TO THE LATEST EDITION OF THE ENVIRONMENTAL PROTECTION AGENCY STANDARDS AND GENERAL REQUIREMENTS AS REQUIRED.

1 / E1.1 SECOND FLOOR CEILING PLAN - DEMO
SCALE: 1/16" = 1'-0"

FUTURE ENGINEERS: MIKE CURRAO, DAVE WRIGHT, JARRETT SCACCHETTI, JASON NUTT, ETHAN PARKS, MICHAEL SAMMARTINO	YSU GREEN ENERGY CHALLENGE TEAM PROPOSED LIGHTING UPGRADE MUSEUM OF LABOR AND INDUSTRY YOUNGSTOWN, OHIO	CHECKED BY:	SCALE: AS NOTED
YSU		DATE: 04-12-12	DRAWN BY: JAN
		DRAWING TITLE: SECOND FLOOR CEILING PLAN - DEMO	SHEET # E1.2

Figure 12: Second Floor Ceiling Plan - Demo

ENERGY USE ANALYSIS AND RETROFIT

SUMMARY OF ENERGY USE

Currently, the distribution system at the historical center is energy-efficient and does not need significant improvements. Mounted on the building exterior, the center is being fed from a 225 kVA 3-phase pad-mounted transformer with a 4160 V primary that is stepped down to 277/480 V on the secondary side. This transformer feeds a 625 A distribution panel located in the basement of the building, shown in **Figure 13**. The distribution panel feeds various lighting panels, mechanical panels, and mechanical equipment throughout the building. A power demand meter monitored by First Energy is located on the exterior and gives real-time power consumption information including kW, kVAR, and kW-h. This allowed us to compute a power factor of 0.905 for the facility. But, since the university buys their power at a wholesale, they are not penalized for power factor; hence, this topic was not pursued since an upgrade would not be beneficial to the client.

Figure 13: Transfer Switches in Mechanical Room

The major mechanical loads of the building consist of an elevator, three air-handling units, cooling tower, and a chiller. Most electrical motors over 2 HP utilize starting capacitors to offset power requirements, and all air handlers currently have Variable Speed Control Devices installed. Combined, these loads are fused for a maximum load of 582.5 Amps at 480 Volts. **Figure 14** below shows actual energy consumption for 2011 provided by First Energy.

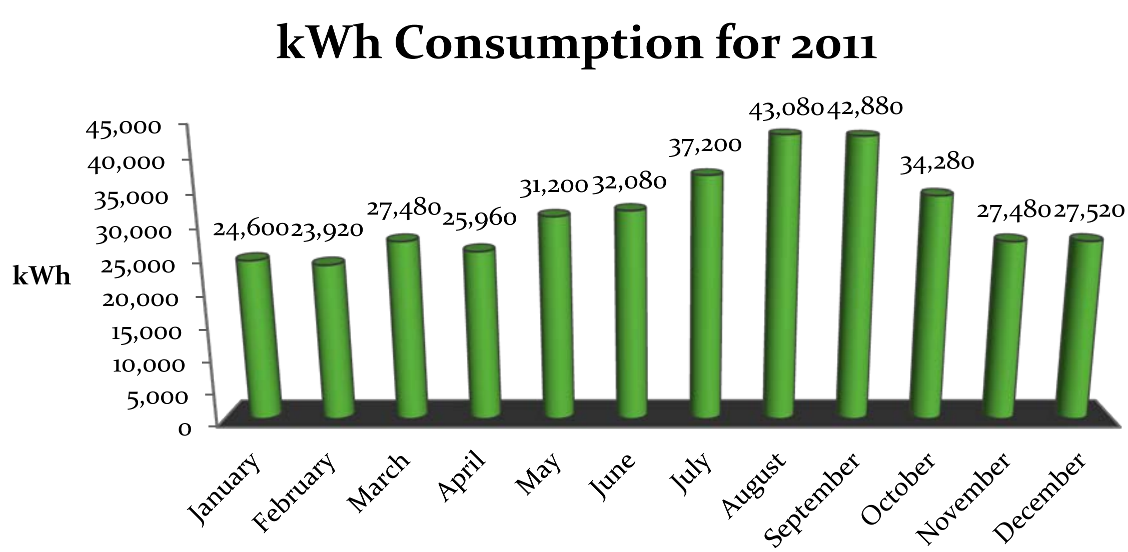


Figure 14: Energy Consumption for 2011

The HVAC system for the building primarily consists of a central heating and cooling system utilizing two air handler units (AHU). Heat is received from boilers circulating hot water via hot water pumps to the AHU's, and air conditioning through cold water chillers transferred by a central chilled water pump. All units operate off 480V/3P and are located inside the basement mechanical room and building exterior respectively. Seasonal Energy Efficiency Ratio (SEER) is a measure of heating/cooling output (in BTU's) to energy input (in watt-hours). The U.S. Department of Energy set forth the SEER 10 regulation in 1992, which was increased to SEER 13 requirement in 2006. Since the building was constructed in 1986, the historical center could benefit from a HVAC upgrade to SEER 13, which is a minimum of 60% more efficient then the requirements set forth during the building's construction in 1986.

PROPOSED IMPROVEMENTS

VARIABLE FREQUENCY DRIVES

Since a large portion of the historical center's energy consumption comes from mechanical equipment, Variable Frequency Drives should be incorporated into existing machinery to save energy. Variable frequency drives (VFDs) on fans and motors save energy by matching the system demand with actual volume (of air, water, etc.) needed. Retrofitting VFDs to existing equipment is simple; however, it must be matched to the motor rating. Energy consumption in centrifugal devices, such as pumps and motors, follow The Affinity Laws (shown in **Figure 15**). Therefore, when only 80% of system demand is needed, the device only needs to run at 80% of the rated speed which requires only 50% of the rated power, instantly cutting the power consumption in half. It should be considered to limit all equipment to 80% of its rated output in order to guarantee the 50% power savings. In this application, it would only be practical to apply VFDs to three phase equipment (shown in **Table 4**) as the pay-back of single phase equipment would exceed the life of the building.

Another advantage of VFDs is the ability to "soft start" connected equipment. When connected at full supply voltage, induction motors instantaneously draw a large initial current several times greater than the rated current. VFDs have the ability to control initial current, start the motor far below the rated current, and then gradually raise the speed to the required level. Without VFDs, it would be impossible to run equipment at 80% of the rated speed as stated above, and the ability of soft-starting equipment could greatly increase the remaining lifespan of equipment. VFDs also increase the power factor to about 0.95; with much more control than a capacitor bank could provide.

1) Flow is proportional to shaft speed

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

2) Pressure is proportional to the square of the shaft speed

$$\frac{H_1}{H_2} = \left(\frac{N_1}{N_2}\right)^2$$

3) Power is proportional to the cube of the shaft speed

$$\frac{P_1}{P_2} = \left(\frac{N_1}{N_2}\right)^3$$

V = volumetric flow rate
N = shaft rotational speed
H = pressure developed by the pump
P = shaft power

Figure 15: The Affinity Laws

Table 4: Three-phase Induction Motors at Historical Center

Device	Volts [V] / PH	Rating	FLA [1]	Power [W]
Fire Pump	480/3	25 HP	74.8	46675
Jockey Pump	480/3	2 HP	7.5	4680
Chiller	480/3	170 FLA	170	106080
Cooling Tower	480/3	10 HP	30.8	19219
Air Handler (1S)	480/3	25 HP	74.8	46675
Air Handler (FR)	480/3	15 HP	46.2	28829
Hot Water Pump	480/3	7.5 HP	24.2	15101
Cold Water Pump 1	480/3	7.5 HP	24.2	15101
Cold Water Pump 2	480/3	7.5 HP	24.2	15101
Cond. Water Pump	480/3	5 HP	16.7	10421
VF-1 (vent fan)	480/3	0.75 HP	3.5	2184
Compressor	480/3	1.5 HP	6.6	4118
Air Handler 2	480/3	15 HP	46.2	28829
RF-1 (return fan)	480/3	5 HP	16.7	10421
Elevator	480/3	175 FLA	175	109200
VF-2 (vent fan)	480/3	0.5 HP	2.4	1498
		Total:		464.1 [kW]
		Total Adjusted[2]:		**33.35 [kW]**

[1] FLA conversions were found using the 2011 National Electrical Code Handbook.

[2] This number accounts for winter and summer months, and no modifications to fire equipment or elevators.

FUTURE RECOMMENDATIONS FOR IMPROVEMENT

STEAM TRAPS

The historical center utilizes steam provided offsite by Youngstown Thermal. An elaborate piping system throughout the downtown Youngstown area allows for numerous businesses, including the historical center, to benefit from a continuous local energy source. The building uses steam for almost every mechanical function in the building. To insure that the maximum amount of steam is supplied to the system and none is lost, various steam traps are placed within the pipe systems. A steam trap filters out condensed steam, or condensate, which can harm a systems overall efficiency. A Fluke thermal camera was used to locate steam traps that were not properly operating. Shown in **Figure 17**, it was determined that an inverted bucket type steam trap, located at the steam source, was not properly functioning. When a steam trap properly operates, the condensate is removed from the steam and this filtered steam is then released back into the system, shown in **Figure 16**.

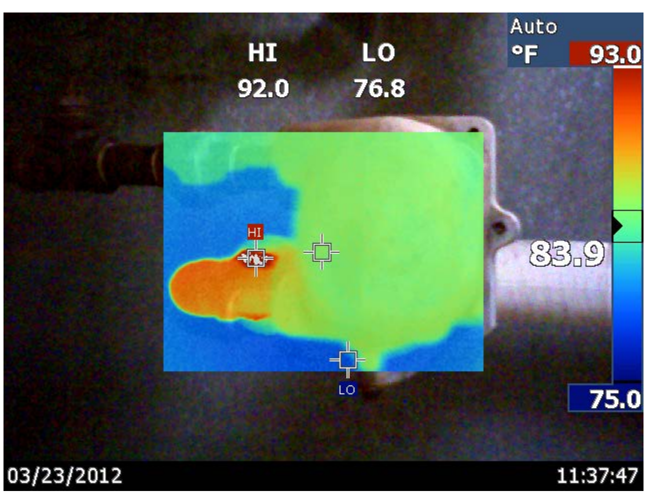


Figure 16: Thermal Image of a Good Steam Trap

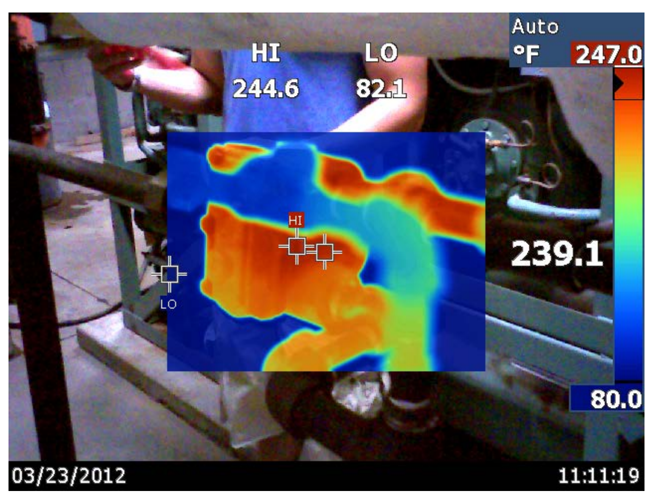


Figure 17: Thermal Image of a Bad Steam Trap

Condensate will affect the rate at which the filtered steam is provided to the system. The thermal imagery camera recorded 200°F heat coming from the condensate removal line; evidence that the steam trap is allowing for large amounts of steam to be removed into the condensate line. It is proposed that either the steam track is repaired or a new steam trap is installed to correct this minor inefficiency. Further neglect of this malfunction will only lead to lost energy and degraded system efficiency.

CHILLER

Another area for improvement involves the chiller used in the mechanical room that was installed during building construction. A chiller works by removing heat from a liquid and then circulating the liquid to equipment; in this building, the chiller is essential in the operation of the air handling units. The chiller currently in use is a Carrier 30HR 120 D600 that is no longer made or available by the manufacturer. It was calculated that this device uses on average .9kW/ton. Due to technological advancements and the equipment's age, this is no longer an acceptable range of operation for a modern chiller. It is proposed that a newer, more advanced model (Carrier 30HX Evergreen chiller with an average of .756kW/ton) be installed to replace what is currently in use. This will allow for a .144kW/ton decrease in electrical demand, lowering utility costs.

RETURN ON INVESTMENT CALCULATIONS

VFDS

Combined, the three phase mechanical motors at full load consume 464.1 kW, calculated as follows for motors with full load amps (FLA) ratings: $|S_{3\emptyset}| = 3V_P I_P$. It should be noted that some motors, including Air Handlers 1S, FR, and 2; VF-1 and 2; and RF-1 will be programmed via VFD to run at 50% speed at night. This will result in only 12.5% of the rated power being consumed according to the affinity laws: ${}^{100}/_{P_2} = \left({}^{100}/_{50}\right)^3 \therefore P_2 = 12.5\%$. However, both cooling and heating devices do not run concurrently; thus for calculations, the power usage will be adjusted as follows:

I. The power utilized by the following devices must be averaged using the arithmetic mean in order to allow for 6 months of heating and 6 months of cooling: Chiller, Cooling Tower, Hot Water Pump, and Cold Water Pump 1 & 2.
II. Since the motors do not run at full load, a 20% load value is used for all calculations. No adjustments will be performed on Fire Equipment or Elevators for safety purposes.
III. The compressor will be assumed to be running for 2 hours per day.

Summing all of the power consumptions and adjusting the constant power usage calculation, consumption would be **33.35kW**. This would bring the total energy consumption to 33.35[kW] * 24 [h] = **800.4 [kWh]** and 800.4 [kWh] * $0.25/kWh = **$200.10/day.** Combined, all improvements will reduce energy by **247.13 kWh/day** and **$61.78/day** respectively. The summary of these results is shown in **Table 5**.

Table 5: Summary of Devices and VFDs

Device	Original Adjusted Power [W]	Adjustment Reasoning	Power with Recommended Improvements [W]	Improvement Reasoning
Fire Pump	0	Not Applicable / Safety Device	0	No Change
Jockey Pump	0	Not Applicable / Safety Device	0	No Change
Chiller	53040	Six Months of operation	26520	VFD Savings = 0.50 * original
Cooling Tower	19219	Six Months of operation	9609	VFD Savings = 0.50 * original
Air Handler (1S)	23338	VFD previously installed / assume 50% savings	23338	No Change
Air Handler (FR)	14415	VFD previously installed / assume 50% savings	14415	No Change
Hot Water Pump	7550	Six Months of operation	3775	VFD Savings = 0.50 * original
Cold Water Pump 1	7550	Six Months of operation	3775	VFD Savings = 0.50 * original
Cold Water Pump 2	7550	Six Months of operation	3775	VFD Savings = 0.50 * original
Cond. Water Pump	5211	Six Months of operation	2606	VFD Savings = 0.50 * original
VF-1 (vent fan)	2184	No Adjustment	2184	VFD Savings = 0.50 * original
Compressor	343	Assume operating 2 hours per day = (1/12)*original	343	No Change
Air Handler 2	14415	VFD previously installed / assume 50% savings	14415	No Change
RF-1 (return fan)	10421	No Adjustment	5211	VFD Savings = 0.50 * original
Elevator	0	Not Applicable / Safety Device	0	No Change
VF-2 (vent fan)	1498	No Adjustment	749	VFD Savings = 0.50 * original

The type and cost of VFDs for the historical center are: Schneider Electric AC-Drive-6MVC2 (priced $772.50 each) for motors less than or equal to 5 HP; Schneider Electric AC-Drive-6MVC5 (priced $1353.00 each) for motors up to 15 HP; and Schneider Electric AC-Drive-6MVC7 (priced $2014.00 each) for remaining motors. Since motors cannot share VFDs due to the location of devices, the proposal requires (3) MVC2's, (5) MVC5's, and (1) MVC7. Therefore, the total price for VFD modifications with installation and labor costs is $22,376.94, detailed in **Figure 24**. A daily savings of $61.78 and total equipment cost of $22,376.94 would yield an equipment payoff in only **362.2 days** including installation, mark-ups, and overhead. (This payback does not include savings gathered from prolonging equipment life via soft starts; or incentives found by the finance team.)

STEAM TRAPS (FUTURE RECCOMENDATION)

The malfunctioning steam trap losses were measured by the amount of condensate escaping into the removal line. It was estimated that 140 drops per minute of condensate were leaving the system. This estimate was converted into more useful units as follows:

$$140\left(\frac{\text{drops}}{\text{min}}\right) \text{ x } \left(\frac{60\text{ min}}{1\text{ hr}}\right) \text{ x } \left(\frac{5\text{ mL}}{120\text{ drops}}\right) \text{ x } \left(\frac{1\text{ gallon}}{3785\text{ mL}}\right) \text{ x } \left(\frac{8.333\text{ lb}}{1\text{ gallon}}\right) = 0.75\text{lb/hr}$$

To calculate the monetary loss from the malfunctioning steam trap, Example 8.3 from *Guide to Energy Management* was used as a reference. First, the total amount of enthalpy between the steam and the condensate had to be calculated. At 240^{o}F, the enthalpy of steam is 1160.6 Btu/lb, and the enthalpy of the condensate at 80^{o}F is 48.04 Btu/lb; values for enthalpy were taken from various tables in *Guide to Energy Management*. Subtract these two values for a total enthalpy of 1113 Btu/lb. The values for total enthalpy, loss of condensate, and cost of steam are then multiplied as follows, where 8760 hrs/year is the estimated hours of operation for one year:

$$\left(1113\,\frac{\text{Btu}}{\text{lb}}\right)\text{ x }\left(.75\,\frac{\text{lb}}{\text{hr}}\right)\text{ x }\left(\frac{\$6.00}{\text{million Btu}}\right)=\$.005/\text{hr in fuel cost}$$

$$\left(\frac{\$0.005}{\text{hr}}\right)\text{ x }\left(\frac{8760\text{ hrs}}{\text{year}}\right)=\$\mathbf{43.8/year}$$

The replacement steam trap, a Hoffman Specialty Bucket Steam Trap Model B1015A, would be an initial cost of $135.00. With an annual savings of $43.80 and equipment cost of $135.00, this would yield a payoff of less than **4 years**, not including installation and labor costs.

CHILLER (FUTURE RECOMMENDATION)

Based on previous calculations, an overall decrease of .144kW/ton was calculated for the installation of the 30HX Evergreen chiller. On average, the chiller will operate at a cooling capacity of 122.5 tons. This information can then be used to calculate the decrease in operating cost as follows:

$$\left(\frac{.114\text{kW}}{\text{ton}}\right)\text{ x }122.5\text{ tons}=13.97\text{kW}$$

This number can now be used to derive a yearly savings of $15,255, where 4,368 hours/year is the estimated annual hours of operation:

$$13.97\text{kW x }\left(\frac{4368\text{ hr}}{\text{year}}\right)\text{ x }\$0.25\text{ kWh}=\mathbf{\$15{,}255/year}$$

Obtained from Carrier, an equipment quote for the 30HX Evergreen series placed the overall cost of the unit at $40,755 excluding sales tax. Adding an estimated installation cost of $20,000, the total installed cost of replacing the existing chiller is $60,755. Producing an annual savings of $15,255, the chiller replacement will be paid off in less than **4 years** including installation cost.

ALTERNATIVE ENERGY DESIGN

After analyzing the current power consumption and proposing viable solutions for energy reduction, the implementation of on-site alternative energies can further reduce electricity demands. When considering the location size, and region; wind energy has been determined to be the most efficient and economical system.

Due to the location of the historical center and cost issues, some of the initial alternative energy systems were deemed impractical for the upgrade. Hydropower, tidal power, and wave power are not an option as the building is in an urban area, not near a river or body of water. Geothermal energy would be impractical as more mechanical rooms would be required to house the necessary pumps and heat exchanger. Although biofuels can be renewable and are not hazardous to the environment, it is highly resource intensive. Dense agriculture and animal supply would be required, which are not present in downtown Youngstown. Finally, ground-mounted and roof-mounted photovoltaic arrays were considered but deemed not applicable for this project due the exterior building aesthetics and unique roof design, neither of which allowed for proper system placement.

WIND TURBINE SYSTEM

Figure 18: Google Satellite View of the Historical Center

Wind is a form of renewable energy that can be found in any part of the world making it a prime option for saving energy at the historical center. Due to the relatively small acreage of the historical center property, locating a safe, energy-productive location for the wind turbines that does not affect the appearance of the building proved to be a difficult task for the design team.

The original proposal installed the wind turbines on the west hill on the west side of the building. This would be an ideal spot for the turbines for energy production, being on a south-facing hill with few nearby obstructions. However, safety was a concern since a 150% turbine-height fall radius would be required in this location. Using a 6-foot diameter turbine on a 15-foot pole would require an uninhabited 31.5-foot fall radius, which could not occur in this location. Therefore, the final proposed location installs (2) turbines on the south side of the building near decorative smoke stacks, shown as yellow dots in **Figure 18**.


Figure 19: Honeywell WT6500 Wind Turbine

For the proposed turbine, the YSU GECT chose the Honeywell WT6500 which is one of the most advanced and energy efficient turbines being sold today. With a discrete footprint smaller than similar turbines and a matte black finish to match the building's roof, this model appropriately matches all design criteria and allows for easy installation via mounting brackets rather than poles. In the proposed location, the turbines will receive wind from various directions by facing south; also, the discrete location will not pose any safety or aesthetic concern for the property. Also, the building-mounted installation will cost significantly less than a ground-mounted setup which would require trenching a far distance from the building.

This turbine creates a maximum of 2 kW of electricity and has an ultra-low cut-in speed of 2 mph, a great feature for this application; with a cut-out speed of 40 mph, the turbines will properly operate throughout the year at the site. Proposing the installation of two turbines would yield a maximum of 4 kW or 96 kWh per day. With the wind average in the Youngstown area being 10.4 mph, shown in **Figure 20**, a more accurate prediction of power production would be 0.5 kW or 12 kWh per day, resulting in an estimated production of 4,383 kWh annually.

In addition to two wind turbines, two roof mounts, and two roof-mount bases, the Honeywell wind turbines will be tied into the property's electrical distribution system with an Aurora POGT6500US grid-tie inverter. Even with the limitations previously discussed, a future photovoltaic array is proposed to be installed on the hill to the west of the building. This is an optimum location for solar energy production due to the south-facing hillside.

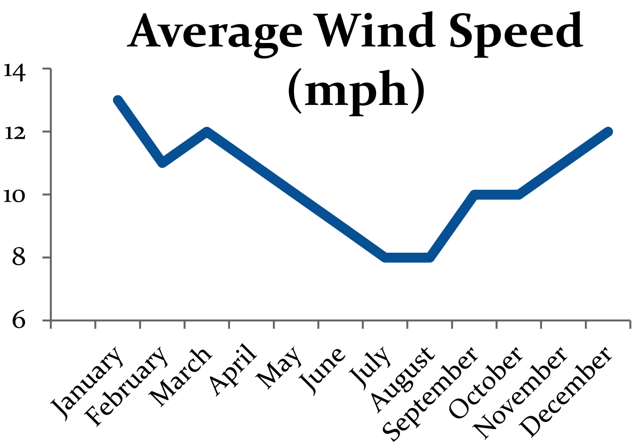


Figure 20: Graph of the Average Wind Speed

GREY WATER & CONDENSATE RECOVERY

As a future recommendation to conserve environmental resources, it is suggested that a rain water and condensate return harvesting system be installed. This system would collect runoff water from the roof tops and condensate water from the HVAC system that will be treated and held in a cistern holding tank. Toilets and urinals consume as much as 30% to 40% of water purchased for a typical commercial building. By eliminating this wasteful use of potable water, "green" buildings will not only reduce their municipal water bills, but also contribute to conserving a valuable limited environmental resource. However, due to the high initial cost to implement this type of system in an existing facility, the system payback would not be appealing and shall not be included as part of the current energy upgrade proposal.

SCHEMATIC ESTIMATE AND SCHEDULE

ENERGY UPGRADE COORDINATION SCHEDULE

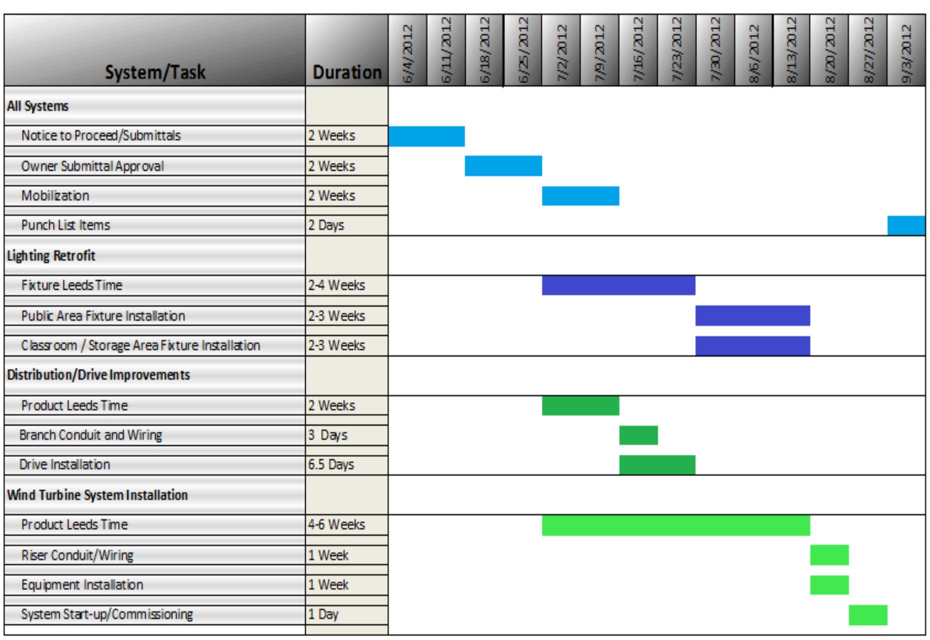


Figure 21: Coordination Schedule for Project Completion

Shown in **Figure 21**, a project timeline was created for each respective scope of work involved in the energy upgrade, broken down by system. The total construction period for the entire renovation project will encompass 14 weeks. Due to the variances in product lead times for the systems, the equipment installation will take place sequentially rather than concurrently, starting with the distribution system. This project will be treated like a typical contract-based renovation through the State of Ohio. Some factors taken into consideration were product lead times, product submittal process, mobilization, and punch list items.

Due to the nature of the project there will be minimal impact to facility operations during the retrofit process. All of the track lighting retrofits in the public areas can take place on the Monday and Tuesday of each week when the museum is closed to the public. The remainder of the light fixtures and other system components being installed are not in public areas. One other possible interruption that will be taken into consideration is the down time associated with the installation of the new variable frequency drives on the mechanical equipment. These switchovers can be done sequentially to minimize system interruptions. With these considerations in mind, it is proposed that all work at the facility be conducted Monday through Friday during standard first shift hours of 7:00am to 3:30pm. Maintaining this schedule will help keep labor expenses for the owner and contractor to a minimum.

COST ESTIMATES

The total price for all retrofits, system improvements, and on-site alternative power generation is **$117,399.60**. This figure represents the total upfront system costs without any incentives such as tax credits or power company incentives. As a moderately-sized retrofit project that was designed with total system payback period being the bottom line, the total project price breaks down as follows: (I) lighting retrofit at $66,565.88, (II) distribution and mechanical system upgrades at $22,376.94, and (II) wind generation system at $26,956.78. Finally, the $1,500.00 permit fee allowance is included in the total price, not in the system break downs.

LIGHTING RETROFIT

For the lighting retrofit at the historical center, a complete cost evaluation was performed using the Accubid bidding software. With one of the team member's working as an electrical estimator by trade, the bid proposal was produced with Accubid provided by a local contractor, Dickey Electric. This software generated accurate cost estimates for each portion of the design.

It was decided that competitive labor rates should be utilized on this project as YSU solicits bids from "open shop" (non-union) contractors as well as union contractors. To combat the encroachment of non-union shops on local projects, a new tool at the disposal of local union contractors is the 4th District Northern Ohio Recovery Agreement (NORA). In brief, this agreement allows union contractors to utilize a less expensive labor force comprising of electricians and laborers of various skill levels to complete projects once a variance from the local NECA office has been granted. And with a good portion of the work in the lighting retrofit being bulb replacements, it is economically intelligent from a cost standpoint to utilize this available labor force.

Lamp Maintenance Savings Summary	
Total Number of Bulbs	196
(X) Maintenance Factor	16
(=) Total Bulb Count	3,120
(X) Cost Per Bulb with Labor	18.24 (approx)
(=) Total Maintenance Savings	$56,914.23
(/) Total Lifespan	43.7 yrs
(=) Yearly Maintenance Savings	$1,302.38

Figure 22: Lamp Maintenance Savings Summary

Besides the competitive labor aspect, total system maintenance labor and materials savings were taken into consideration when preparing the cost estimates. Even though these savings cannot be deducted directly from the bottom line of the system installation cost, they can be subtracted as a yearly "value adder" similar to the proposed system energy savings. The new LED retrofit PAR38 lamps have a 50,000-hour rated lifespan, which is over 16 times the 3,000-hour lifespan of the existing 250W PAR38 lamps. This gives a maintenance factor of 16, representing paying a contractor to change the existing lamps 16 times over the lifespan of the proposed replacement lamps. After taking into consideration the additional cost of purchasing the 3,120 lamps and the labor to install them at current union service electrician rates, it translates to a total savings of $56,914.23 over the life of the proposed LED lamps (43.7 years). This lifespan in years is calculated by taking the bulb lifespan, 50,000 hours, and dividing it by the number of hours a year the bulbs will be operating (1,144 hours). Now to find the yearly maintenance savings, the $56,914.23 is divided by 43.7 years to give an annual maintenance savings of $1,302.38, summarized in **Figure 22**.

The same calculations were performed for the long-life T5HO lamps that will be replacing the existing T12 fluorescent lamps. The existing lamps have an average life span of 7,500 hours in comparison to the 36,000 hour lifespan of the T5HO lamps. This translates to maintenance factor of 4.8 and a total maintenance cost savings of $21,647.44 over the 31.46 year lifespan of the proposed lamps. When broken down to a yearly savings, that is $688.09 per year.

Figure 23 shows the breakdown of the costs associated with the lighting retrofit portion of the project. The relevant cost categories that appear in this table include: (A) the database material, (B) quoted materials, (C) direct labor costs, (D) general expenses, and (E) the contractor markup for labor and materials. Each of these categories includes different aspects that contribute to the overall cost estimate:

A. The database material consists of the miscellaneous parts and materials necessary to complete the project such as conduit, wire, and fasteners.

B. Quoted materials consist of quotes obtained through local factory representatives and supply houses. In the case of the lighting retrofit, this was all of the new fixtures and bulbs.

C. The direct labor is the labor force that is being utilized for the project. The historical center resides in IBEW local #64 territories, so their labor force will be utilized. In the case of the lighting retrofit, the "CE" and "CW" rates which were agreed upon by the local entity will be utilized.

D. The project's general expenses consist of permit costs, freight costs, and any temporary power costs. In the case of the lighting portion of the project, the freight was included in the lighting package pricing and there was no temporary power needed. All permit costs were added to the total project cost.

E. The contractor's markup for the project is taken into consideration. For this project, a markup of 20% on all labor and materials was used to compensate for overhead and desired profit margins.

OVERALL PRICE OF LIGHTING RETROFIT: $66,565.88

	Labor Type	Crew	Hours	Rate $	SubTotal	Brdn %	Frng $	Brdn Tot.	Frng Tot.	Total	Full Rate	Code	Type
19	#64 - CE-3		92.00	22.50	2,070.00		6.89		633.88	2,703.88	29.39		
20	#64 - CW-1		92.00	11.25	1,035.00		6.21		571.32	1,606.32	17.46		
	Totals		184.00	16.88	3,105.00		6.55		1,205.20	4,310.20	23.43		

	General Expenses	Alarm	Quantity	Field	Duration	Cost/Unit	Total Cost	Tax(%)	Overhead %	Markup %	Total	Notes	Code	Type
1	ELECTRICAL PERMIT	Alarm	1.00	<None>										
2	TEMPORARY ELECTRIC	Alarm		<None>					10.000	10.000				
3	FREIGHT ALLOWANCE	Alarm		<None>										
	Totals													

	Final Pricing	Calculated (%)	Calculated ($)	Variance (%)	Modified ($)	Modified (%)	Alarm	Code
	Database Material (Extension)		1,129.37		1,129.37			
	Quoted Material (Extension)		30,922.00		30,922.00			
	Quoted Material		19,110.00		19,110.00			
	Material Total		51,161.37		51,161.37			
	Direct Labor		4,310.20		4,310.20		On	
	Labor Total		4,310.20		4,310.20			
	General Expenses						On	
	Total Cost		55,471.57		55,471.57			
	Database Material Overhead	5.000	56.47	-100.00				
	Quoted Material Overhead	5.000	2,501.60	-100.00				
	Labor Overhead	10.000	431.02	-100.00				
	Total Overhead	5.389	2,989.09	-100.00				
	Database Material Markup	10.000	118.58	-100.00				
	Quoted Material Markup	5.000	2,626.68	-100.00				
	Labor Markup	10.000	474.12	-100.00				
	Adjustment Markup				11,094.31	20.000		
	Total Markup	5.507	3,219.38	244.61	11,094.31	20.000		
	Selling Price		61,680.04	7.92	66,565.88			
	Final Price		61,680.04	7.92	66,565.88			

Figure 23: Lighting Retrofit Cost Estimate

DISTRIBUTION UPGRADES AND ADDITIONS

For the mechanical systems upgrade, the same software was utilized to compose the cost estimate, shown in **Figure 24**. Even though only a total of nine VFDs are proposed, there is a projected 112 hours of labor allotted for this portion of the project. This extra labor is associated with the installation of conduit from the existing distribution panel to place the VFDs in line with the controlled motor loads and the time associated with the programming of the VFDs. For this retrofit, all of the drive parts were quoted through Granger, including the programmer and conduit entry kits. It should be noted that apprentice labor is utilized alongside journeyman labor to keep project costs down.

ESTIMATED DISTRIBUTION UPGRADE AND ADDITIONS TOTAL COST: $22,376.94

	Labor Type	Crew	Hours	Rate $	SubTotal	Brdn %	Frng $	Brdn Tot.	Frng Tot.	Total	Full Rate	Code	Type
5	#64C - JOURNEYMAN		52.00	30.10	1,565.20		21.32		1,108.64	2,673.84	51.42		
10	#64C - APPRENTICE (6TH PERIOD)		52.00	18.06	939.12		15.00		780.00	1,719.12	33.06		
	Totals		104.00	24.08	2,504.32		18.16		1,888.64	4,392.96	42.24		

	General Expenses	Alarm	Quantity	Field	Duration	Cost/Unit	Total Cost	Tax(%)	Overhead %	Markup %	Total	Notes	Code	Type
1	ELECTRICAL PERMIT	Alarm	1.00	<None>										
2	TEMPORARY ELECTRIC	Alarm		<None>					10.000	10.000				
3	FREICHT ALLOWANCE	Alarm		<None>										
	Totals													

	Final Pricing	Calculated (%)	Calculated ($)	Variance (%)	Modified ($)	Modified (%)	Alarm	Code
	Database Material (Extension)		2,352.14		2,352.14			
	Quoted Material		11,902.35		11,902.35			
	Material Total		14,254.49		14,254.49			
	Direct Labor		4,392.96		4,392.96		On	
	Labor Total		4,392.96		4,392.96			
	General Expenses						On	
	Total Cost		18,647.45		18,647.45			
	Database Material Overhead	5.000	117.61	-100.00				
	Quoted Material Overhead	5.000	595.12	-100.00				
	Labor Overhead	10.000	439.30	-100.00				
	Total Overhead	6.178	1,152.03	-100.00				
	Database Material Markup	10.000	246.98	-100.00				
	Quoted Material Markup	5.000	624.87	-100.00				
	Labor Markup	10.000	483.23	-100.00				
	Adjustment Markup				3,729.49	20.000		
	Total Markup	6.844	1,355.08	175.22	3,729.49	20.000		
	Selling Price		21,154.56	5.78	22,376.94			
	Final Price		21,154.56	5.78	22,376.94			

Figure 24: Distribution Upgrade and Additions Cost Estimate

For this portion of the project, apprentice labor was utilized since local apprentices are trained in these technologies at the NJATC training facilities. The system that is being proposed for the facility is fairly "installer-friendly." However, there were some extra considerations taken into account when quantifying the costs for this portion of the project. The first of which, shown under the equipment breakout in **Figure 25**, is the necessity of an aerial lift to get the turbines up to the roof level where they will be installed. The somewhat bulky "sled style" roof mounts and CMU blocks to weigh down the mount would also have to be lifted to the roof level. With that obstacle aside, the remainder of the project consists of the materials portrayed on the one-line diagram of the system. The other consideration made was the shipping costs, not a part of the quoted materials package through Honeywell.

ESTIMATED ALTERNATIVE ENERGY SYSTEMS COST: $26,956.78

	Labor Type	Crew	Hours	Rate $	SubTotal	Brdn %	Frng $	Brdn Tot.	Frng Tot.	Total	Full Rate	Code	Type
5	#64C - JOURNEYMAN		40.00	30.10	1,204.00		21.32		852.80	2,056.80	51.42		
10	#64C - APPRENTICE (6TH PERIOD)		40.00	18.06	722.40		15.00		600.00	1,322.40	33.06		
	Totals		80.00	24.08	1,926.40		18.16		1,452.80	3,379.20	42.24		

	General Expenses	Alarm	Quantity	Field	Duration	Cost/Unit	Total Cost	Tax(%)	Overhead %	Markup %	Total	Notes	Code	Type
3	FREIGHT ALLOWANCE	Off	1.00	<None>		250.00	250.00				250.00			
	Totals						250.00				250.00			

	Equipment	Alarm	Quantity	Field	Duration	Cost/Unit	Total Cost	Tax(%)	Overhead %	Markup %	Total	Notes	Code	Type
5	JLG AERIAL LIFT - 40' (PER W	Off	1.00	<None>		880.00	880.00				880.00			
	Totals						880.00				880.00			

	Final Pricing	Calculated (%)	Calculated ($)	Variance (%)	Modified ($)	Modified (%)	Alarm	Code
	Database Material (Extension)		989.78		989.78			
	Quoted Material		16,965.00		16,965.00			
	Material Total		17,954.78		17,954.78			
	Direct Labor		3,379.20		3,379.20		On	
	Labor Total		3,379.20		3,379.20			
	General Expenses		250.00		250.00			
	Equipment		880.00		880.00			
	Total Cost		22,463.98		22,463.98			
	Database Material Overhead	5.000	49.49	-100.00				
	Quoted Material Overhead	5.000	848.25	-100.00				
	Labor Overhead	10.000	337.92	-100.00				
	Total Overhead	5.501	1,235.66	-100.00				
	Database Material Markup	10.000	103.93	-100.00				
	Quoted Material Markup	5.000	890.66	-100.00				
	Labor Markup	10.000	371.71	-100.00				
	Adjustment Markup				4,492.80	20.000		
	Total Markup	5.765	1,366.30	228.83	4,402.80	20.000		
	Selling Price		25,065.94	7.54	26,956.78			
	Final Price		25,065.94	7.54	26,956.78			

Figure 25: Alternative Energy Systems Cost Estimate

FINANCING PLAN

Since YSU is a state university, the funding for this energy upgrade will come mainly from government incentives through Ohio Edison (the local power company). YSU will continue to pursue other green energy rebates and renewable resource credits through other utility companies. The Youngstown Historical Center of Industry & Labor purchases its power from First Energy, the parent company of Ohio Edison. The museum pays $0.25 per kWh, which was used in all calculations. The proposed system payback periods are shown in **Table 6**.

LIGHTING RETROFIT

The museum is open for approximately 1,144 hours annually. This was used in the calculations of the following figures. The total power consumption for the existing fixtures is 104,022 W and 118,993.2 kWh annually. Further calculations reveal that the museum will consume a total of 22,326 W or 15,993.2 kWh annually with the upgrades. The energy savings from the upgrades is 81,696 W, or approximately 103,000 kWh per year. From the standard lighting incentives for business program by Ohio Edison, total lighting incentives of $12,655 were calculated using a downloadable form available on First Energy's website. The various incentives that are currently being offered include a $25 credit for the implementation of an occupancy sensor in a space not currently controlled by such a device. This project also qualifies for the various "per fixture type" credits that are being offered through the current lighting incentive program. Based on energy cost savings and utility incentives, the individual payback for the lighting system is 2.09 years.

TOTAL SYSTEM COSTS		
LIGHTING	$66,565.88	
POWER	$22,376.94	
WIND	$26,956.78	
PERMIT FEE ALLOWANCE	$1,500.00	
TOTAL PROJECT COST		$117,399.60

INCENTIVES		
LIGHTING	$12,655	
POWER (VFDs)	$867	
TOTAL INCENTIVES		$13,522.00

TOTAL PROJECT ADJUSTED COST	**$103,877.54**

ANNUAL kWh SAVINGS		
AT 1,144 HOURS/YEAR		
LIGHTING	103,058	
POWER	90,264.23	
WIND	4,383	
TOTAL kWh SAVINGS		197,705.23

YSU'S COST / kWh	$0.25
TOTAL YEARLY SAVINGS	**$49,426.31**

TOTAL PAYBACK PERIOD	**2.10166 YEARS**

INDIVIDUAL PAYBACK	
LIGHTING	2.09 YEARS
DISTRIBUTION	0.95 YEARS
WIND/SOLAR	24.6 YEARS

Table 6: Proposed System Payback Period

DISTRIBUTION UPGRADES AND ADDITIONS

Along with energy savings from the lighting retrofit, the installation of VFDs on mechanical equipment will greatly reduce energy consumption and allow for related incentives. The chiller and the steam trap will be left as alternate options, and recommended as upgrades. The Youngstown Historical Center of Industry & Labor will be eligible for $867 in incentives. These incentives are from the "Motors and Drives Incentives for Business" program through First Energy. With the current incentives of $30 per connected horsepower of motor load being controlled by VSD's the above total credit amount of $867 was established. The distribution upgrade, which costs $22,376.94, will save 90,264.23 kWh per year. With a price of $0.25/kWh at Youngstown State University, this upgrade has an individual payback of 0.95 years.

ALTERNATIVE ENERGY SYSTEMS

Costing $26,956.78, the alternative energy upgrade will produce energy savings of 4,383 kWh per year without utility incentives being applicable. Although there are currently many public utility incentives for wind projects available in the state of Ohio, this project does not qualify for them due to geographical location. Also, because of the tax exempt status of Youngstown State University, there were also many government based tax incentives for which this project cannot qualify. These considerations were taken into account when scaling this portion of the design. With a price of $0.25/kWh at Youngstown State University, this upgrade has an individual payback of 24.6 years. Similar to the instillation of the existing solar array on Moser Hall, Youngstown State University could have the contractor purchase and lease the equipment to avoid paying for the system upfront. This option would also benefit the contractor as they would be able to receive tax incentives for leasing the equipment.

PAYBACK ANALYSIS

According to incentives listed in **Table 6**, the overall energy upgrade with an adjusted cost of $103,877.54 can be paid back in **2.10 years**. Although renewable energy does not have immediate paybacks, the long-term benefits of reducing reliance on fossil fuels significantly outweighs return on investment as well as creating the image of being green.

LEED FOR EXISTING BUILDINGS (VERSION 2.0) REVIEW

OVERVIEW OF EVALUATION

For the energy upgrade proposed at the Youngstown Historical Center, the design solutions represent unique opportunities for the application of U.S. Green Building Council standards. According to the client's long-term goals, the historical center should meet LEED certification, a goal promoted across the campus of YSU. To meet Silver certification, the post-approval points from LEED for Existing Buildings (Version 2.0) must total at least 40 out of 85 possible points.

Table 7: LEED Existing Buildings Proposed Credit Summary

Category	Proposed Points	Maximum Possible Points
Sustainable Sites	6	14
Water Efficiency	2	5
Energy and Atmosphere	10	23
Materials and Resources	6	16
Indoor Environmental Air Quality	14	22
Innovation and Design Process	2	5
PROJECT TOTALS:	**40/85 POINTS**	**(LEED SILVER CERTIFICATION)**

From **Table 7**, after analyzing all six categories, **FOURTY points** can be obtained, thus receiving potential **LEED Silver** certification at the historical center. Although all credits below will count toward the desired certification, only some of the credits and implementations (marked with an *) directly correlate to the energy upgrades proposed in this audit.

EXPLANATION OF PROPOSED LEED CREDITS

I. Sustainable Sites (SIX proposed points)

For this section of LEED for Existing Buildings (Version 2.0), the following SIX credits can be satisfied: 1.1, 3.1-3, 4.1, and 7*. The prerequisites for Sustainable Sites are: (1) implementation of an erosion/sedimentation control plan and (2) age of building is at least 2 years. These LEED credits can be obtained at the historical center by:

- Developing a plan for a green site/building exterior,
- Promoting alternative transportation with: public transportation access, bicycle storage and changing rooms, and preferential parking spaces for alternative fuel vehicles,

- Protecting and restoring natural spaces on 50% of site area, and
- Decreasing light pollution from site lighting*.

II. *Water Efficiency* (TWO proposed points)

For this section of LEED E.B. 2.0, the following TWO credits can be satisfied: 3.1-2. The prerequisites for Water Efficiency are: (1) maintaining minimum water efficiency and (2) meeting discharge water compliance. These LEED credits can be obtained at the historical center by:

- Reducing overall water usage by 20%.

III. *Energy and Atmosphere* (TEN proposed points)

For this section of LEED E.B. 2.0, the following TEN credits can be satisfied: 1*, 3.1-3*, 4, 5.4, and 6*. The prerequisites for Energy and Atmosphere are: (1) ensuring existing building commissioning, (2) documenting minimum energy performance, and (3) applying ozone protection. These LEED credits can be obtained at the historical center by:

- Optimizing energy performance (Energy Star Rating of 75)*,
- Educating staff on maintenance and monitoring*,
- Additional Ozone Protection*,
- Providing emission reduction reporting, and
- Documenting sustainable building cost impacts*.

IV. *Materials and Resources* (SIX proposed points)

For this section of LEED E.B. 2.0, the following SIX credits can be satisfied: 1.1, 2.1*, 3.1, 4.1, 5.1, and 6*. The prerequisites for Materials and Resources are: (1) implementing a waste management policy, (2) storing and collecting recyclables, and (3) reducing mercury content of light bulbs. These LEED credits can be obtained at the historical center by:

- Diverting Construction, Demolition & Renovation Waste Materials by 50%,
- Optimizing use of alternative materials for 10% of total purchases*,
- Using sustainable cleaning products and materials for 30% of annual purchases,
- Ensuring occupant recycling by diverting 30% of waste stream, and
- Reducing mercury content of light bulbs even more*.

V. *Indoor Environmental Quality* (FOURTEEN proposed points)

For this section of LEED for Existing Buildings (Version 2.0), the following FOURTEEN credits can be satisfied: 1, 2, 3, 4.1-2, 5.1, 6.1-2*, 7.1-2*, 8.1*, 8.3*, 10.3, and 10.6. The prerequisites for Indoor Environmental Quality are: (1) ensuring functionality of air intake/exhaust systems, (2) providing environmental tobacco smoke control, (3) removing or encapsulating asbestos, and (4) removing PCBs. These LEED credits can be obtained at the historical center by:

- Monitoring outside air delivery and Increasing ventilation,

- Constructing an indoor air quality management program,
- Documenting productivity impacts of employee absenteeism, costs, and other factors,
- Controlling lighting, temperature, and ventilation systems*,
- Providing thermal comfort compliance and monitoring*,
- Utilizing daylight in 50% of high-occupancy spaces while providing direct line-of-sight-to-vision glazing on 45% of outdoor views*, and
- Implementing low environmental impact cleaning policy.

VI. Innovation and Design Process (TWO proposed points)

For this section of LEED E.B. 2.0, the TWO credits can be satisfied: 1.1* and 2*. There are no prerequisites for Innovation and Design Process. Credit 1.1 can be obtained at the historical center by implementing various innovations in operations and upgrades that (1) are not covered elsewhere in the LEED criteria or (2) substantially exceed existing criteria. Credit 2 can be obtained by using a LEED Accredited Professional (LEED AP). Collaborating with the YSU GECT, Ralph Morrone of YSU Facilities Maintenance is both a Professional Engineer (PE) and a LEED AP.

OUTREACH APPENDIX

CAMPUS ENERGY AWARENESS ADVANCEMENT

Every two years the Sustainable Endowments Institute releases its "Report Card" for campuses across the nation assigning grades for the various categories listed in **Figure 26**. The most recent assessments were released in 2011, and Youngstown State was ranked near the bottom of the list of 17 universities evaluated in the state of Ohio. The grade of C- that was received was an improvement from the F received in 2009.

Sustainability Report Card	
Administration	C
Climate Change and energy	D
Food and Recycling	A
Green Building	D
Student Involvement	B
Transportation	D
Endowment Transparency	F
Investment Priorities	C
Shareholder Engagement	D
OVERALL GRADE	C-

Figure 26: YSU SEI Score

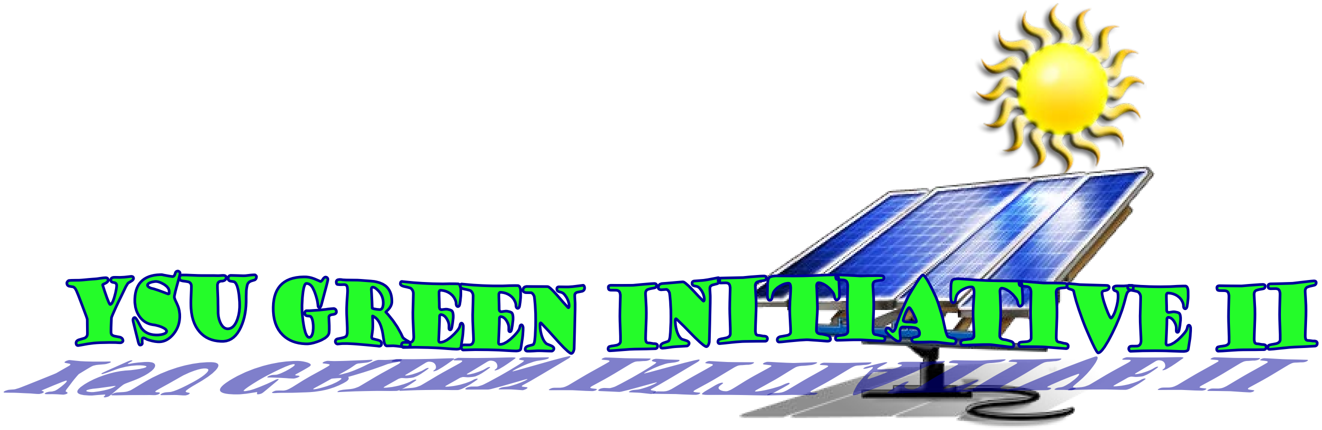
Despite receiving this mediocre overall grade of C-, Youngstown State University is making improvements on green energy programs. For the Climate Change and Energy category, YSU is evaluating potential auditors to conduct a greenhouse gas emissions inventory and has committed to investing $10 million in energy efficiency upgrades. The university has installed high-efficiency lighting and chillers, upgraded steam traps and insulation, and plans to install over 10,000 square feet of solar panels. Even though the university scored a D in this category, within the next few years there should be some major improvements. Food and Recycling received an A since Campus Dining Services spends 10% of its food budget on local or organic items and serves almost exclusively cage-free eggs, as well as fair trade coffee and chocolate. To reduce waste, reusable mugs and to-go containers are encouraged, and all meals are tray-less. The YSU Recycling Program composts all postconsumer and most pre-consumer food waste. The university diverts over 30 percent of its waste from landfills and recycles electronics in addition to traditional materials. Building on these green programs and initiatives, the YSU GECT's goal was to implement a plan that would not only foster green thinking in terms of alternative energy and energy efficient design, but also make students aware of the "green" that is all around them at YSU.

YSU GREEN INITIATIVE II

In addition to making various classroom appearances and speaking about green projects, the YSU GECT developed a contest to further promote green energy and student awareness. As a continuation to last year's Green Initiative, this year's contest asked students to submit their ideas about incorporating green energy and awareness at YSU (shown in **Figure 27**). A "*myYSU Personal Announcement"* email and notification banner on their personal webpage was sent to reach out to the entire student body. Beginning in mid-March, the competition concluded on April 6th, 2012. Here are some of the key features of the contest:

- This is the 2nd year of this event, and will continue to be an annual event every spring sponsored by the YSU NECA student chapter.
- The top three ideas (as determined by the YSU NECA student chapter) will be rewarded monetarily.
- The winning ideas will be submitted to *The Jambar* (YSU'S student newspaper) along with the chapter's feedback for publication, shown in **Figure 33**.

The invitation for submittals was well received. In fact, dozens of qualifying ideas were received before the deadline. Shown in **Figure 28**, the excerpts of the winning ideas illustrate the fact that the student body is aware of current green technologies and are capable of proposing creative ways to implement various energy-efficient designs across campus. This year's First Place winner of the Youngstown State University's Green Initiative II is Mark Meffan for the proposed LED parking deck retrofit idea. In Second Place, Jessica Valsi, discussed the use of a cutting-edge campus monitoring system. Finally, in Third Place, Mike Wittenauer discussed how the campus should have an energy monitoring system as well as the incorporating of a rating system around campus to determine who is more efficient.



Sponsored by: **YSU National Electrical Contractors Association (NECA) Student Chapter**

The **Youngstown State University NECA Student Chapter** is once again sponsoring a contest to promote the awareness of green energy across campus. Enter now for your chance to win one of three prizes for the email competition!

- **How the competition works**: Students are asked to submit their ideas on the incorporation of green energy and awareness at YSU. Those who submit ideas will be entered for a chance to win several prizes. The ideas can be as diverse as the student population. For example, energy-efficient lighting, integration of alternative energy (wind, solar, etc.), or any other creative idea that comes to mind. The YSU team would like to encourage all ideas. Nothing will be disregarded.

- **Deadline**: All suggestions and ideas must be submitted by **8 PM** on **Friday, April 6th, 2012**via email to David Wright at dewright@student.ysu.edu.

- **Prizes**: The top three ideas, as judged by the YSU team, will be rewarded with VISA gift cards (**$100** for first place, **$50** for second place, and **$25** for third place). The winners will be contacted by email. Their ideas and feedback from the YSU NECA Student Chapter will be submitted to *The Jambar* for publication and distribution at YSU.

- **Additional Prizes**: Stop by our information table on the lower level of Kilcawley Center on April 5th or 6th from 8am-5pm and fill out a simple 3 question survey for a chance to win local coffee shop gift cards. While you are there, talk to one of our student chapter members about how to get involved and do your part to make our campus and your home greener.

The Youngstown State University NECA Student Chapter is looking forward to reading your creative ideas on green energy!

Figure 27: 2012 Green Initiative

"The parking decks are massive electricity consumers. Depending on where the electricity is purchased, programs are available to offset some of the materials and labor cost of the retrofit… First Energy has a lighting program available now that can offer 80 cents per watt saved. This can be used up to and including 100% of parts and labor if the savings is sufficient. Titan LED is a company based in Youngstown who could provide additional expertise as well as the materials needed to accomplish massive savings as well as better lit facilities."

Mark Meffan

#1

"Visualized Energy, a Youngstown Business Incubator success story, operates on Federal Street in Downtown Youngstown, OH. The company…developed a device that records energy use of utilities. The device measures energy use in 15-minute intervals, and allows clients to monitor energy use in order to identify cost-saving adjustments. The company has succeeded in saving its clients a substantial amount of money, and expects to save millions for its clients in the future. The service cuts costs for companies, and encourages energy conservation. In 2005, Oberlin College implemented a campus resource monitoring system with real-time web-based feedback on electricity feedback. The effectiveness of real-time feedback as a strategy to encourage energy consumption by consumers has been proven by an extensive amount of research."

Jessica Valsi

#2

"Each building on campus will hold an achievement level for how environmentally friendly they are. This could be as simple as a color system starting with green being the most eco-friendly on campus, all the way down to black being the least environmentally friendly building on campus. This might encourage the administrators, and heads of each building to actively seek new creative ways to make their buildings more eco-friendly. These statuses will be handed out either annually, or semi-annually. This will give buildings a chance to increase their rank on campus. Hopefully this encourages the use of more environmentally conscious practices."

Mike Wittenauer

#3

Figure 28: Excerpts from Green Initiative Winners

STUDENT AWARENESS SURVEY

New this year is the Student Awareness Survey, **Figure 29**, which is an extension of last year's Green Initiative. This survey contained three questions that are used to display the Green Energy Awareness of the students and faculty on campus. It also spread some green energy consumption ideas to students while filling out the survey. Shown below are the survey and summary of results.

QUESTION 1:

For the first survey question, the students were asked to list any campus energy or green conscious programs. **Figure 30** demonstrates the results of the first survey question. 54 students who participated in the survey either answered with zero groups or simply submitted without a response. 13 students stated one energy conscious program, and 2 students answered knowing of two groups.

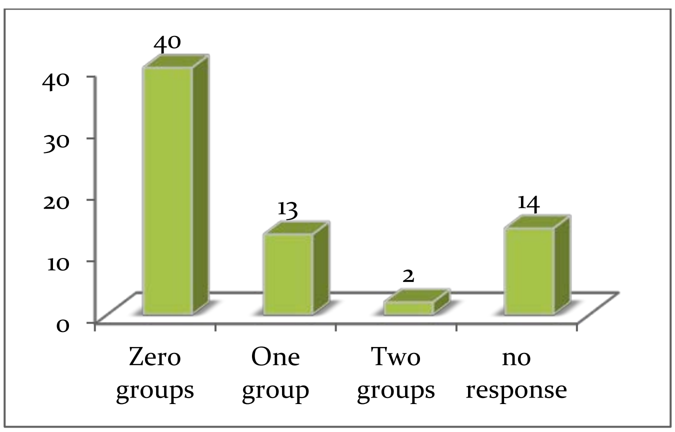
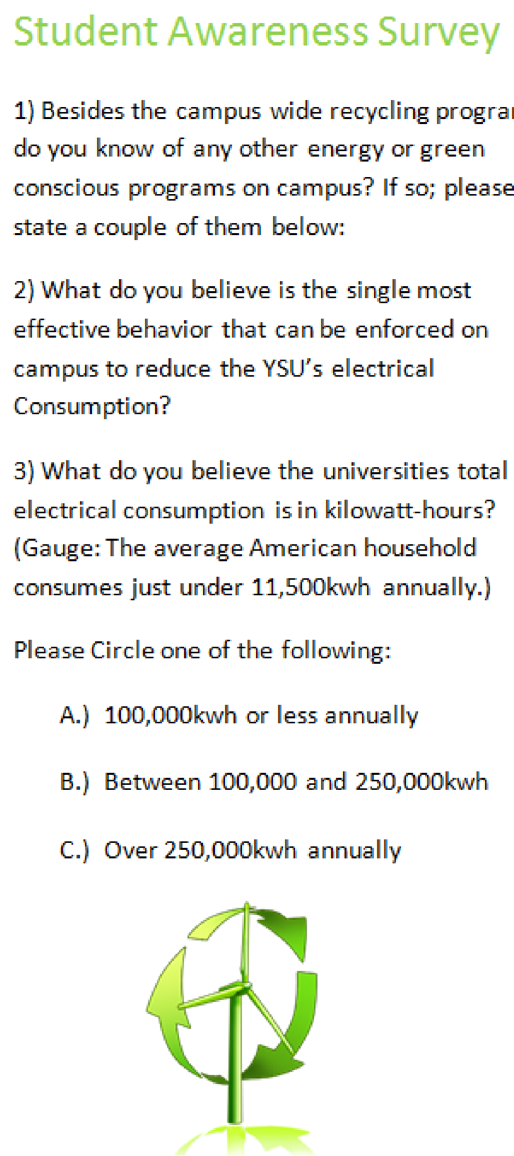


Figure 30: Green Initiative Survey Responses



Student Awareness Survey

1) Besides the campus wide recycling program; do you know of any other energy or green conscious programs on campus? If so; please state a couple of them below:

2) What do you believe is the single most effective behavior that can be enforced on campus to reduce the YSU's electrical Consumption?

3) What do you believe the universities total electrical consumption is in kilowatt-hours? (Gauge: The average American household consumes just under 11,500kwh annually.)

Please Circle one of the following:

A.) 100,000kwh or less annually

B.) Between 100,000 and 250,000kwh

C.) Over 250,000kwh annually

Figure 29: Green Initiative Survey

QUESTION 2:

For the second question, those surveyed were asked to describe what they believed was the most effective behavior that can be enforced on campus to reduce the Youngstown State University's electrical consumption. There was a wide variety of responses as listed in **Figure 31**, the most popular answers consisted of fifteen people who said to install occupancy sensors, and thirteen people who suggested that the electrical components, such as lights, would be turned off when not in use.

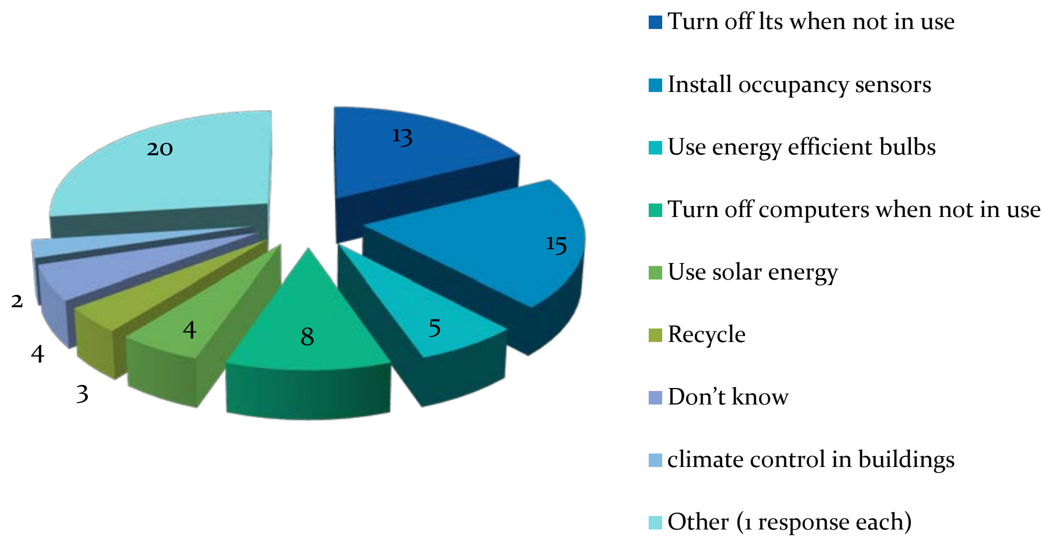


Figure 31: Green Initiative Survey "Effective Behaviors"

QUESTION 3:

Questions 3 asked the participants what they believed YSU's total electrical consumption is in kilowatt-hours with the options of: (A) 100,000 kWh or less annually, (B) between 100,000 and 250,000 kWh, and (C) over 250,000 kWh annually. A large majority of the participants chose "over 250,000kwh annually." In fact, out of the 69 answers received from the survey, 50 of them Answer C which is the correct answer. Eighteen participants chose B and one participant chose A. The results are displayed below in **Figure 32**.

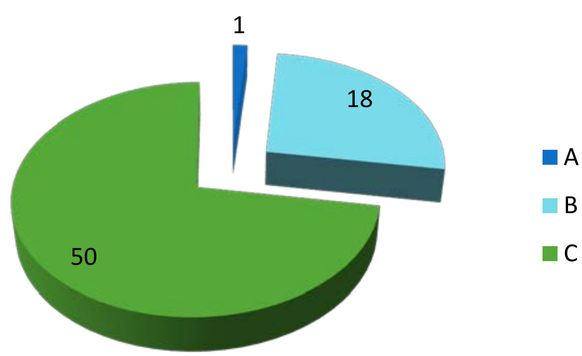


Figure 32: Breakdown of Energy Consumption Question

In conclusion, we as a student chapter have developed a plan to improve energy conservation awareness at Youngstown State University that is complimentary and built upon the existing efforts and programs. Taking feedback from students, we are in the process of implementing a green energy feedback system that will rate different buildings and areas depending on their green efforts; the suggestion from Mike Wittenauer.

FEEDBACK LETTER FROM CLIENT

Youngstown State University
One University Plaza,
Youngstown, OH 44555
April 13th, 2012

2012 YSU Green Energy Challenge Team
Youngstown State University
One University Plaza,
Youngstown, OH 44555

Dear Team:

I would like to express my gratitude for your leadership in the energy audit and energy upgrade proposal for the Youngstown Historical Center of Industry & Labor at Youngstown State University. The level of professionalism of yourself and your team members was expressed throughout all aspects of the project.

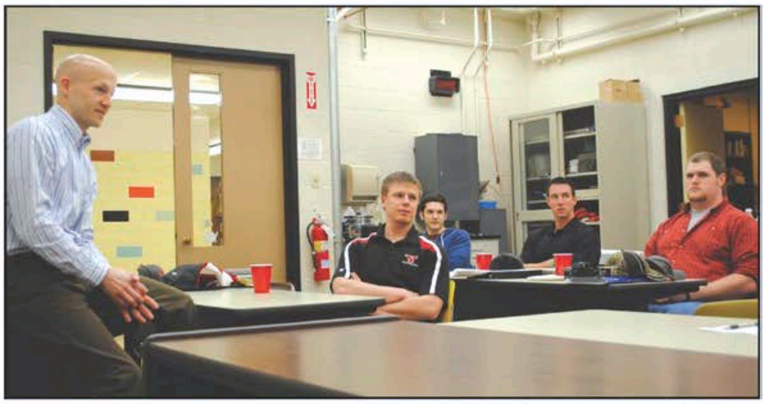
Your team established a single point of contact, a mission, a set of supporting goals and objectives then began a paced non-intrusive assessment of the historical center's current energy use and equipment conditions. This team made several site visits and thoroughly documented the electrical systems at the facility. The YSU team then prepared a draft report, solicited and integrated comments, and then finalized their proposal. The way the YSU team managed the project shows the level of professionalism employers and contractors require from engineering professionals. Your submittal provides an excellent example of what is to be seen from the team when they progress into industry.

Thank you again for your hard work. Sincerely,

Ralph C. Morrone, PE, LEED AP
Facilities Engineer, Youngstown State University

PUBLISHED ARTICLE IN UNIVERSITY NEWSLETTER

Shown below in **Figure 33**, the following article was published in *The Jambar* (the Youngstown State University student newspaper) on April 10th, 2012 on the front page. The article details the YSU GECT Green Initiative II and participation in the 2012 NECA/EI Green Energy Challenge.



Members of the Youngstown State University National Electrical Contractors Association listen to the advice of YSU alumnus Chris Jaskiewicz regarding their entry for the Green Initiative Contest. Photo by Marissa McIntyre/The Jambar.

NECA announces Green Initiative Contest winners

Marissa McIntyre
ASSISTANT NEWS EDITOR

Junior Mark Meffan's proposal, which suggested that campus buildings should be properly ventilated and equipped with LED and energy efficient lighting, won first place in the Green Initiative Contest on Saturday.

The National Electrical Contractors Association at Youngstown State University has run the contest for two consecutive years. This year, 44 students submitted their greenest ideas.

The initiative challenged students to find energy conserving alternatives on campus.

"The purpose is to spur a little bit of thought and to get feedback, and to make sure students are aware that there are things that can be done," said Dave Wright, YSU NECA president.

Wright said the time and effort Meffan spent on the project contributed to his win.

Meffan suggested that YSU use his idea to improve parking decks and other facilities. He also entered a small audit of the M-2 parking deck on Lincoln Avenue and provided figures to determine how much energy could be saved.

According to Meffan's research, the university could conserve energy and save more than $17,000 by switching to LED lighting in the parking decks.

He determined this by comparing the costs and longevity of different lighting fixtures.

Danny O'Connell, director of support services, said an idea like Meffan's would be taken into consideration, especially because the second phase of the M-2 parking deck renovation will involve replacing the lighting.

"We're working with a consultant to find out what lighting fixtures will give us more bang for our buck," O'Connell said.

He said lighting is the biggest expense in the second phase, so YSU is looking into lighting that would save money and be more energy efficient.

In his contest entry, Meffan said he aspires to open a green consulting firm, and he's interested in a greener future.

Senior Jessica Valsi won second place for her campus energy monitoring system.

Valsi's research found that the installation of Visualized Energy's software, which records energy use in 15-minute intervals, saved energy and money at other facilities. It de-

GREEN PAGE 4

GREEN PAGE 1

livers an electronic feed of energy usage.

Valsi researched the Youngstown Business Incubator's installation of this device, and she discovered that the YBI saved its clients money by pinpointing areas where they could be more energy efficient.

Other colleges and universities that have adopted energy monitoring systems have saved upwards of $7,000 a year, according to Valsi's research.

She began her research as a part of the sustainability and society course she's enrolled in this semester. When she heard of the contest, she decided to enter.

Promoting energy efficiency is important to Valsi. She said that if people saw the effects of wasting energy, they would be more likely to take steps to save it.

Third-place winner and senior Mike Wittenauer had an idea similar to Valsi's. He also suggested incorporating an achievement level for the buildings on campus.

Wittenauer proposed a color-coding system to illustrate the green-friendly buildings on campus and buildings that need to improve. In it, the color green would represent maximum energy efficiency, while black would indicate the least energy efficient buildings.

"The purpose of our group is to promote [green] awareness and to also give students the chance to have a better understanding of the industry," said Jason Nutt, YSU NECA vice president.

While overseeing the Green Initiative Contest, YSU NECA has been involved with a similar contest on a national level.

The Green Energy Challenge takes students from colleges across the country to comprise a theoretical plan of action to make their campuses more energy efficient.

After winning second place in the nation last year, YSU NECA members said they hope their evaluation of the Youngstown Historical Center of Industry and Labor will bring them a first-place prize.

Theodore Bosela, professor of engineering technology, has advised YSU NECA since January.

He said the group's variety would help in the competition; YSU NECA is made up of electrical, mechanical, and civil and environmental engineering majors.

"We have a lot of students that have experience working with this competition in the past," Bosela said. "I just let them do their thing. If they have any technical questions, I'm here to answer them."

Figure 33: YSU *Jambar* Article

LOCAL NECA CHAPTER INTERACTION

The NECA student chapter at Youngstown State University has a continuous and growing interaction with the local NECA chapter and NECA contractors. Building relationships and contacts with those in the industry in order to learn from experience is one of the student chapter's most important goals. This interaction has largely been facilitated through the Mahoning Valley NECA Chapter Executive Director, Tom Travers, who has been very instrumental and supportive of the group's activities and proved to be a vital link between the group and local contractors. Because of this interaction, the chapter can provide group members with learning opportunities, chances to interact with local contractors, and opportunities to learn the practical application of theory taught in the classroom.

Figure 34: NEC Seminar at the Warren JATC Training Center.

This year, one such opportunity was the annual National Electrical Code (NEC) update seminar that was held on March 1st, 2012, at the Warren JATC Training center. Shown in **Figure 34**, Tom Travers is introducing local Mahoning County Electrical Inspector, John Grivensky, and First Energy representative, Mike Ziegler. During the seminar, Mr. Ziegler spoke of the new service regulations in affect in the area. The 2012 code changes were presented and explained by Mr. Grivensky to the local union members, contractor representatives, and student chapter members in attendance. This seminar was not only a learning experience for the student chapter members that have not had exposure to the NEC in the classroom environment, but also proved to be a great opportunity for members to interact with the contractors. There were several contractors attending the meeting that provided the members with information on internship opportunities and industry contact information.

With two of the team members working for a local NECA signatory contractor ("Joe" Dickey Electric), the opportunity for hands on experience and advisement was also utilized throughout the competition. Pictured in **Figure 35**, estimator and team member Dave Wright (left) discusses the cost estimates produced using the Accubid bidding software with colleague and company President Dave Dickey (center). Ethan Parks (right), also of "Joe" Dickey Electric, listens to the conversation to incorporate the ideas into the project financing plan.

Figure 35: Schematic Estimation Discussion with Dave Dickey

The student chapter meetings are also open to local contractors and representatives. Shown in **Figure 36**, Chris Jaskiewicz of Valley Electrical Consolidated was a keynote speaker for one of the monthly meetings. At this meeting, Mr. Jaskiewicz gives an enthusiastic speech to the chapter members in attendance. He provided the group an account of his experiences as a former YSU student and alumni making the transition into the electrical construction industry. MV NEVA Executive Director Tom Travers and former student chapter president and 2011 YSU GECT captain, Justin Hosseininejad, also attend monthly meetings on a regular basis to provide the current team with vital input and suggestions.

Other chapter interaction included the consultation of Eric Carlson of "Joe" Dickey Electric for suggestions on system design and feedback. Many face-to-face, telephone, and email communications between the local NECA chapter and YSU's student chapter were necessary to make these opportunities possible. Because communications with the local NECA chapter are frequent, it is a mutual feeling that the level of interaction is a very healthy and beneficial relationship.

Figure 36: Chris Jaskiewicz Speaking at Chapter's Monthly Meeting

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ACKNOWLEDGEMENTS

The Youngstown State University Green Energy Challenge Team would like to express its greatest appreciation to the following individuals and their affiliated companies for their time, effort, and assistance with the formation of this proposal for the 2012 NECA/ELECTRI International Green Energy Challenge:

- **Youngstown Historical Center of Industry & Labor**
- **Dr. Theodore R. Bosela, PE** of Youngstown State University
- **Tom Travers** of the NECA Mahoning Valley Chapter
- **Ralph Morrone, PE, LEED AP** of Youngstown State University
- **Eric Carlson** of “Joe” Dickey Electric
- **Justin Hosseininejad, EI** of Phillip J. Jaminet Engineering
- **Eric Davis** of Warren Electrical JATC
- **Paul Repko** of Control System Manufacturing
- **Rex Ferry**, NECA President and CEO of Valley Electrical Consolidated

Through the knowledge gained by participating in the 2012 NECA/ELECTRI International Green Energy Challenge, the engineers involved in this energy audit and upgrade proposal have obtained valuable knowledge on renewable energy, green building, and environmental impacts. With the experience and professional connections gained in this effort, the Youngstown State University Green Energy Challenge Team members have become more energy-conscious engineers. After graduating and continuing through their careers, team members will continue to design using innovative building practices that adhere to energy-efficient standards throughout all phases of the proposed project. The team has acquired valuable lessons and looks forward to competing in next year’s challenge.

ENERGY AUDIT APPENDIX

EXISTING LIGHTING AUDIT

Table 8: Existing Lighting Audit

ROOM	QUANTITY	FIXTURE TYPE	LIGHT READING (FOOT CANDLES)	Special Notes
Basement				
Elevator Lobby	6	Compact Fluorescent Down light	3 FC center	
Exhibit Hall	57	250 w R38 Track heads	4 - 40 FC	
Stair 3	5	Wall sconce		Cornucopia of natural light
	1	Compact Fluorescent Down light		
Model Room	16	250 w R38 Track heads	10 - 80 FC	3 large sky lights
	1	Wall sconce		
Basement Storage	82	1'x4' Linear Fluorescent fixture (2-lamp)	30 FC	
Machine Room	12	1'x4' Linear Fluorescent fixture (2-lamp)	5 - 12 FC	
Electrical Room	6	1'x4' Linear Fluorescent fixture (2-lamp)	5 FC	
	3	250 w R38 Track heads		
Loading Dock	10	1'x4' Linear Fluorescent fixture (2-lamp)	3 FC	
Stairwell	6	Wall sconce	4 FC	
	2	Compact Fluorescent Down light		
1st Floor				
Classroom A	15	2'x2' Fluorescent Fixture (2-lamp)	27 FC perimeter	
	8	8" Compact fluorescent down cans (2-lamp)	42 FC center	
Vest A	1	Compact Fluorescent Down light	2 FC	
Coat A	2	6" Compact fluorescent down cans (2-lamp)	20 FC center	
Classroom B	15	2'x2' Fluorescent Fixture (2-lamp)	20 FC perimeter	
	8	8" Compact fluorescent down cans (2-lamp)	39 FC center	
Vest B	1	Compact Fluorescent Down light	2 FC	
Coat B	2	6" Compact fluorescent down cans (2-lamp)	20 FC center	
Classroom Storage	6	4'x1' Linear fluorescent (2-lamp)	30 FC center	
Kitchen	1	2'x4' Fluorescent Fixture (4-lamp)	100 FC center	
Entry Vest	3	Compact Fluorescent Down light	2 FC center	Lots of Natural Light
Exhibit Lobby	16	250 w R38 Track heads	90 FC under heads	
	2	Fluorescent up lights	12 FC center	
Men's Bathroom 1	5	Compact Fluorescent Down light	5 FC center	
	2	Compact Fluorescent Down light (2-lamp)		
Men's Vest	1	Compact Fluorescent Down light	2 FC	
Playroom	1	Compact Fluorescent Down light	2 FC	
Vest	1	Compact Fluorescent Down light	2 FC	
Reception Area	3	Compact Fluorescent Down light	8 FC	
Hall A	2	Compact Fluorescent Down light (2-lamp)	15 FC	
Hall B	2	Compact Fluorescent Down light	4 FC	
Women's Bathroom 1	8	Compact Fluorescent Down light	15 FC center	
	3	Compact Fluorescent Down light (2-lamp)	5 FC lounge	
Hall C	1	2'x4' Fluorescent Fixture (2-lamp)	44 FC center	
Director's Office	2	2'x4' Fluorescent Fixture (2-lamp)	60 FC center	
Staff Office	2	2'x4' Fluorescent Fixture (2-lamp)	60 FC center	
Train Room	15	2'x4' Fluorescent Fixture (4-lamp)	46 FC center	only 2 of 4 lamps on
Closet	1	1'x4' Linear Fluorescent fixture (2-lamp)		
Elevator Lobby	4	Compact Fluorescent Down light	3 FC center	some natural light
	2	Wall sconce		
Main Hall	2	Emergency light	20 - 100 FC	
	4	Track Lights 55 watt		
	99	250 w R38 Track heads		
Stair 3	10	Compact Fluorescent Down light		Cornucopia of natural light
Exhibit Locker room	1	Compact Fluorescent Down light	20 FC	
Second Floor				
Elevator Lobby	5	Compact Fluorescent Down light	12 FC	natural light
Hallway	9	Compact Fluorescent Down light	2 FC	
Women's Bathroom 2	1	Compact Fluorescent Down light	2 FC	
Men's Bathroom 2	1	Compact Fluorescent Down light	2 FC	
Stairwell	2	Wall sconce		

EXISTING AND PROPOSED FIXTURE ENERGY CONSUMPTION ANALYSIS

Table 9: Existing and Proposed Fixtures

Existing Fixtures	Lamp Quantity	Life Span (hrs)	Watts/lamp	Usage/year/lamp (kw/h)	Total Usage/year (kwh)	Cost/year
250 W Par 38 Track heads	195	3000	250	286	55,770.00	13,942.50
2'x2' T12 linear Flourescents (2-lamp)	60	7500	96	109.82	6,589.20	1,647.30
2'x4' T12 Linear Flourescents (2-lamp)	12	7500	96	109.82	1,317.84	329.46
2'x4' T12 Linear Flourescents (4-lamp)	236	7500	96	109.82	25,917.52	6,479.38
1'x4' T12 Linear Flourescent (high bay 2-lamp)	232	7500	96	109.82	25,478.24	6,369.56
26 W Triple tube Compact	132	8000	26	29.7	3,920.40	980.10
					Total cost/year	$29,748.30
Proposed Fixtures	**Lamp Quantity**	**Life Span (hrs)**	**Watts/lamp**	**Usage/year/lamp (kw/h)**	**Total Usage/year (kwh)**	**Cost/year**
AccuLampLED ALSP38	195	50,000	20	22.88	4461.60	1,115.40
FocalPoint Equation 2x2 (with T5HO lamps)	60	25,000	49	56.05	3363.00	840.75
FocalPoint Equation 2x4 (with T5HO lamps)	130	25,000	49	56.05	7286.50	1,821.63
Lithonia IBZ I-Beam (with T5HO lamps)	232	25,000	49	56.05	13003.60	3,250.90
26 w Triple tube Compact	132	8000	26	29.74	3925.68	981.42
(Wattage adjusted per lamp to reflect ballast load)					Total cost/year	$8,010.10

Table 10: Proposed Lighting Energy Consumption Costs

Replacement lamps with Occupancy sensor in operation			[1] Denotes lamps controlled by occupancy sensor		Calculations assumed that lights are off 75% of the time with occ. Sensor	
Replacement	**Lamp Quantity**	**Life Span**	**Watts/lamp**	**Usage/year/lamp (kw/h)**	**Total usage/year (kwh)**	**Cost/year**
AccuLampLED ALSP38	195	50,000	20	22.88	4461.60	1,115.40
[1] FocalPoint Equation 2x2 (with T5HO lamps)	60	25,000	49	14.01	840.60	210.15
FocalPoint Equation 2x4 (with T5HO lamps)	44	25,000	49	56.05	2466.20	616.55
[1] FocalPoint Equation 2x4 (with T5HO lamps)	86	25,000	49	14.01	1204.86	301.22
[1] Lithonia IBZ I-Beam (with T5HO lamps)	232	25,000	49	14.01	3250.32	812.58
[1] 26 w Triple tube Compact	7	8000	26	7.44	52.08	13.02
26 w Triple tube Compact	125	8000	26	29.74	3717.50	929.38
					Total cost per year	$3,998.29

acculamp

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE
Accent lighting applications where color, extended lamp life and efficacy are important.

CONSTRUCTION
Housing: High quality, cast aluminum, advanced thermal design for optimal cooling efficiency.
Optics: Optimally engineered specular faceted reflector for efficient distribution.

EXPECTED LIFE 50,000 hours.
Max. Luminous Intensity: 3200cd (600L); 5000cd (900L); 6800cd (1200L-25°); 2200cd (1200L-45°)

LUMEN OUTPUT
600 lumens (600L); 900 lumens (900L)1200 lumens (1200L)
Operating Temperature: -22°F to 113 °F (-30 °C to +45 °C)
Color Temperature (CRI): 600L/900L - 2800K (82CRI); 4000K (85CRI); High R9 (94CRI)
1200L - 2800K (82CRI); 4000K (85CRI)
High Spectral Content: R9=78

ELECTRICAL SYSTEM
Uses High Brightness LED mounted to efficient thermal transfer system.
15-watt (600L)/20-watt (900L/1200L) high efficiency integral driver 110-120VAC.
Actual wattage may differ by +10%/-15% when operating between 110-120V +/-10%.
Dimmable down to 10%. Contact factory for dimming compatibility.

LISTING
UL and C-UL Listed to U.S. and Canadian safety requirements. Wet location listed in base-up configuration. Tested in accordance with IESNA LM-79 standards.

WARRANTY
Five-year limited warranty. Complete warranty terms located at: http://www.acuitybrands.com/Customer-Resources/Terms_and_conditions.aspx

Note: Specifications subject to change without notice.
Actual performance may differ as a result of end-user environment and application.

ALSP38 — PAR 38 LED Lamp
SPECIFICATION (S-SERIES)

Dimensions
Diameter: 4-3/4"
Length: 5-1/8"
Weight: 1.0211 lbs (600L); 1.09 lbs (900L); 1.09 lbs (1200L)

All dimensions are inches.

ORDERING INFORMATION For shortest lead times, configure products using **bolded options.** **Example:** ALSP38 1200L

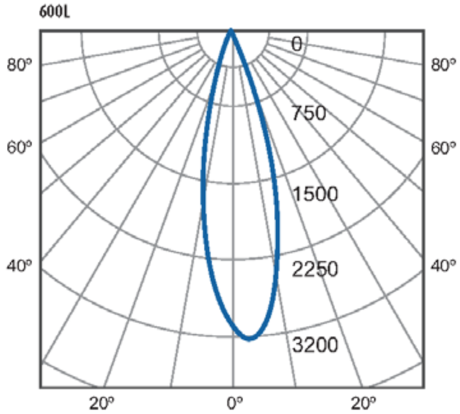
LED LAMP

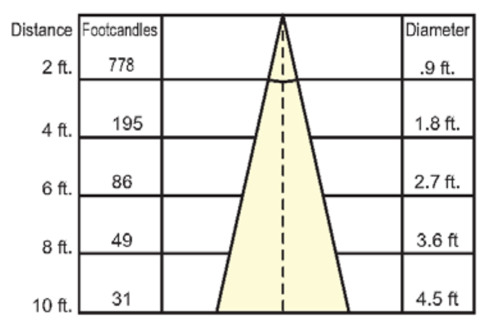
Series		Lumen output[1]		Beam Angle		Color temperature		Base		Options	
ALSP38	PAR 38 LED Lamp	600L	15W, 600 lumens	(blank)	25 degrees	(blank)	2800K	(blank)	E26 base	R9[4]	High R9 spectral content
		900L[2]	20W, 900 lumens	45	45 degrees[3]	40K	4000K	GU24	GU24 base	DIM[5]	Dimmable
		1200L	20W, 1200 lumens								

Notes
1 Total system delivered lumens.
2 Only available with High R9 option.
3 45° only available with 1200L.
4 Option available only with 900L.
5 DIM option available with 1200L only.

PHOTOMETRICS

600L



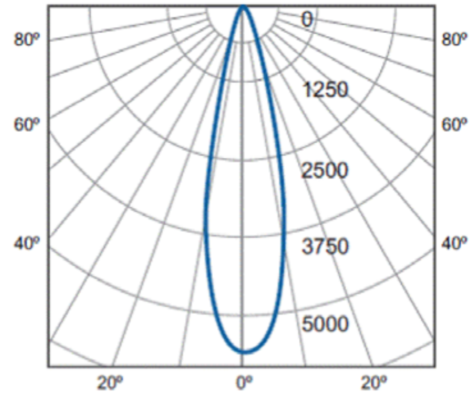


Beam angle = 25°

ALSSP38 — PAR 38 LED Lamp
SPECIFICATION (S-SERIES)

PHOTOMETRICS continued

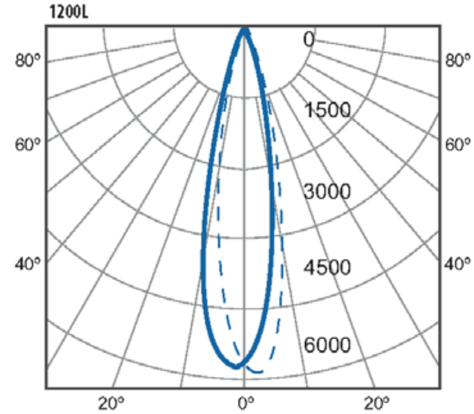
900L



Distance	Footcandles	Diameter
2 ft.	1227	.7 ft.
4 ft.	307	1.4 ft.
6 ft.	136	2.1 ft.
8 ft.	77	2.8 ft
10 ft.	49	3.5 ft

Beam angle = 25°

1200L



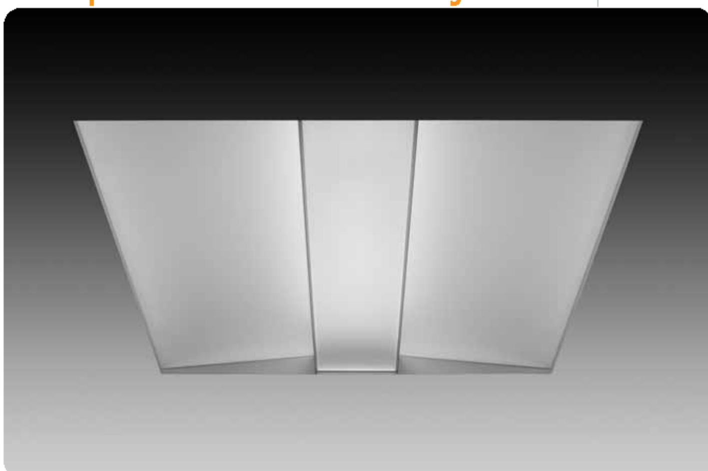
Distance	Footcandles	Diameter
2 ft.	1721	.7 ft.
4 ft.	430	1.5 ft.
6 ft.	191	2.2 ft.
8 ft.	108	3.0 ft
10 ft.	69	3.7 ft

Beam angle = 25°

acculamp

Armstrong® DC FlexZone™ Compatible

equation™ family



FOCAL POINT®

features

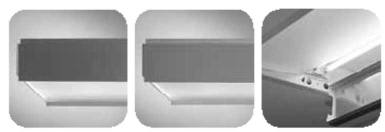
Equation blends sleek aesthetics and uniform diffuse illumination while delivering high fixture efficiencies.

Now with EMerge Alliance® Registered options compatible with Armstrong DC FlexZone ceilings for plug-and-play flexibility in DC power applications.

Center diffuser features MicroGlow™ prismatic lens technology. Precision molded conical prisms deliver 92% light transmission while controlling high angle brightness.

Patent pending QuickLatch™ hinged diffuser system makes relamping easy.

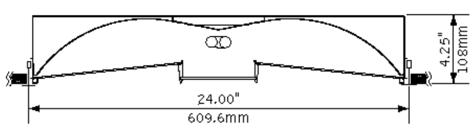
sheilding options & details



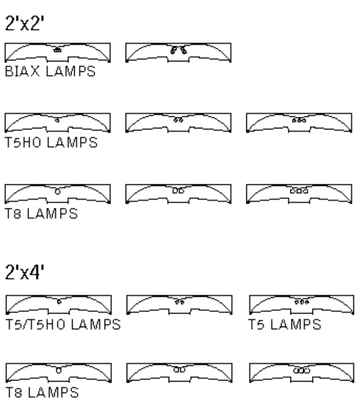
natural anodized side rails | white painted side rails | QuickLatch™

february 2012 E

dimensional data



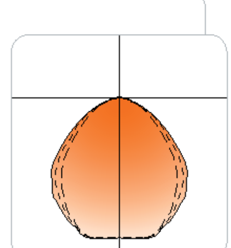
lamping options



performance

2'x4' luminaire
1-Lamp T5HO
83% Efficiency
1703 cd @ 10°

everGreen

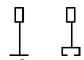


Visit focalpointlights.com for complete photometric data.

fixture:
project:

mounting information

Armstrong® DC FlexZone™ compatible



specifications

construction
One piece 20 Ga. Steel reflector and housing.
20 Ga. Steel ends form finishing housing.
Bottom access 20 Ga. Steel ballast compartment.
Earthquake brackets supplied as standard.

Weight:

2'x2':	17 lbs
2'x4':	29 lbs

optic
20 Ga. Steel reflectors finished in matte satin white powder coat.
.080" thick frosted white acrylic diffusers.
.125" thick MicroGlow™ miniature prism acrylic lens and .120" thick linear spread lens retained with side rails available in natural anodized aluminum or Matte Satin White.

electrical
Class 2 low voltage DC ballasts have a Class "P" rating.
UL Listed.
Ballast Factors
- 0.78 - 54W T5HO & 55W Biax
- 0.75 - 32W T8 (2 lamp)
- 1.00 - all others

0-10V dimming standard.
Load cable assembly connects fixture to low voltage bus bar.

finish
Polyester powder coat applied over a 5-stage pre-treatment.

eMerge ALLIANCE REGISTERED

ordering

luminaire series		FEQ
Equation	FEQ	
nominal size		
2' x 2'	22	
2' x 4'	24	
distribution		B
Bi-Directional	B	
lamp quantity		
One Lamp	1	
Two Lamp	2	
Three Lamp (2x2 - T8 & T5HO, 2x4 - T8 & T5 only)	3	
lamp type		
40 Watt Biax (2x2 only)	BX40	
55 Watt Biax (2x2 only)	BX55	
T5 (2x4 only)	T5	
T5HO (2x4 - 1-lamp only)	T5HO	
T8	T8	
ballast		DCF
DC 0-10V Dimming Ballast	DCF	
voltage		24
24 Volt	24	
mounting		
DC Suprafine® 9/16" Grid	G2	
DC Silhouette® 9/16" Slot Tee	G3	
shielding		
Natural Anodized Side Rails	AL	
White Painted Side Rails	WP	
factory options		
Air Return (Overall height with Air Return is 4.90")	AR	
Include 3000K Lamp*	L830	
Include 3500K Lamp*	L835	
Include 4100K Lamp*	L841	
finish		WH
Matte Satin White	WH	

* for more information see Reference section.

Focal Point LLC | 4141 S. Pulaski Rd Chicago, IL 60632 | T: 773.247.9494 | F: 773.247.8484 | info@focalpointlights.com | www.focalpointlights.com
Focal Point LLC reserves the right to change specifications for product improvement without notification.

recessed

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — The IBZ fluorescent high bay is ideal for new construction and renovation projects. It is a one-for-one replacement of common metal halide high bay systems. The unique Cool Running Plus™ technology provides industry-leading, trouble-free operation in ambient temperatures up to 155°F (68°C). Applications include manufacturing, warehousing, commercial and industrial facilities. The IBZ fixture performs well at mounting heights from 15'-40'. **Certain airborne contaminants can diminish integrity of acrylic. Click here for Acrylic Environmental Compatibility table for suitable uses.**

CONSTRUCTION — The highly configurable design of the IBZ high bay allows for a multitude of fixture options that can either be factory- or field-installed. The easy-access ballast channel houses the proprietary Cool Running Plus technology, which is the most advanced fluorescent ballast technology available for fluorescent high bay lighting. It has independent lamp operation to reduce lamp maintenance costs, is fast-starting to improve occupancy sensing, and a proprietary thermal-sensing processor that allows for reliable operation in environments where ambient temperatures can reach up to 155°F (68°C).

In addition to the reliable operation of IBZ fixtures, the reflectors tightly control the distribution of light and effectively manage lamp heat to increase the overall efficiency. The result is superior optics in either narrow distribution for aisles, or wide distribution for general lighting. Installation is made quick and easy with IBZ hanging accessories such as the aircraft cable and single-point mounting bracket. IBZ fixtures can be factory-wired to have both sensors and cord sets, further reducing installation time. The configurability, performance and ease of installation make IBZ fixtures the preferred choice for fluorescent high bay lighting.

Channel is formed of heavy-duty code-gauge (22-gauge) steel to stand up to the most demanding elements. Lamp holder assembly protects from incidental damage or movement of sockets during handling and installation. Sockets include secure positioning rotating collars with enclosed contacts. Access plate on the back of the channel housing allows quick and easy wiring.

Finish: Channel is high-gloss white baked enamel; five-stage iron phosphate pretreatment ensures superior paint adhesion and rust resistance.

OPTICS — Two optical systems are available. Narrow distribution is ideal for narrow or aisle lighting applications and features precision-formed segmented optics utilizing specular aluminum reflector. Provides 95% reflectivity and warranted for 25 years. Wide distribution includes high-reflectance white finish for general or open areas.

ELECTRICAL — Thermally protected, resetting, Class P, HPF, A sound-rated electronic ballast. AWM TFM or THHN wire used throughout rated for required temperatures. Ballast disconnect (BDP) is standard unless EL14 or cord set is requested.

INSTALLATION — Suitable for suspension by chain, cable, surface-mounting bracket, hook monopoint or single (pendant) monopoint. Surface mounting not recommended without optional surface mounting bracket. To maintain high ambient listing, fixture should be mounted at a minimum plenum height of 8".

LISTINGS — CSA Certified to U.S. and Canadian safety standards (UL1598 and CSA 250.0-08) for 55°C and 40°C lensed. Suitable for damp locations.

WARRANTY — 1-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Actual performance may differ as a result of end-user environment and application.

Note: Specifications subject to change without notice.

I-BEAM® IBZ
FLUORESCENT HIGH BAY

Fluorescent High Bay

IBZ

4-, 6- or 8-lamp T5HO

Patent Pending

COOL RUNNING TECHNOLOGY

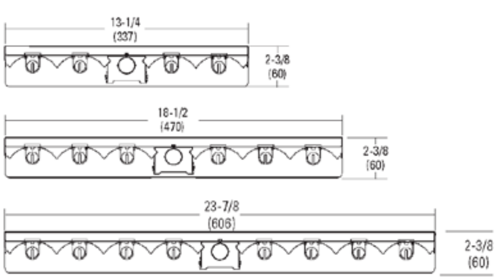
SPECIFICATIONS

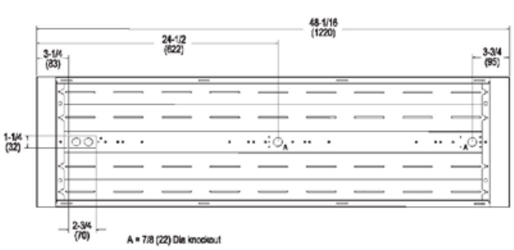
	Length	Width	Depth	Weight
4-lamp	48-1/16 (1221)	13-1/4 (337)	2-3/8 (60)	16 lbs. (7.3 kg)
6-lamp	48-1/16 (1221)	18-1/8 (460)	2-3/8 (60)	20 lbs (9.1 kg)
8-lamp	48-1/16 (1221)	23-7/8 (606)	2-3/8 (60)	25 lbs. (11.3 kg)

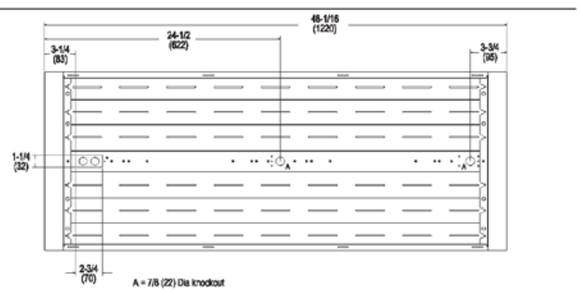
All dimensions are inches (millimeters) unless otherwise specified and may vary with options or accessories.

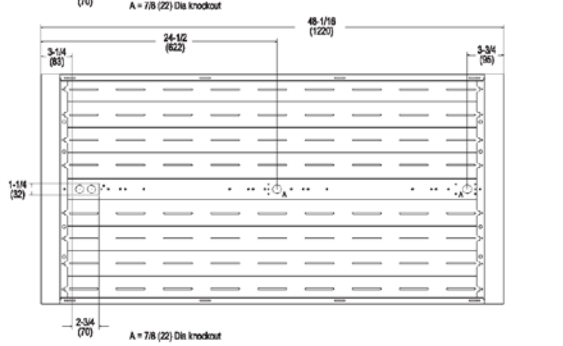
DIMENSIONS

Dimensions may vary with options or accessories.









IBZ Fluorescent High Bay, T5HO

ORDERING INFORMATION For shortest lead times, configure products using **standard options (shown in bold).**

Example: IBZ 454L

- **Series**
  - **IBZ**
  - *For tandem double-length unit, add prefix "T". Ex: TIBZ*
- **Lamp type**
  - Lamps installed[1]
    - **454L** 4-lamp 54W T5HO
    - **654L** 6-lamp 54W T5HO
    - **854L** 8-lamp 54W T5HO
  - Unlamped
    - **454** 4-lamp 54W T5HO
    - **654** 6-lamp 54W T5HO
    - **854** 8-lamp 54W T5HO
- **Distribution**
  - **(blank)** Narrow distribution, ≤5% uplight
  - NDU Narrow distribution, enhanced uplight, ≤13% uplight
  - **WD** Wide distribution, ≤5% uplight
  - WDU Wide distribution, enhanced uplight, ≤13% uplight
- **Shielding**[2,3]
  - **(blank)** No shielding
  - A12125 Pattern 12 acrylic, 0.125"[4]
  - ACL Clear acrylic, 0.125"[4]
  - PCL125 Clear polycarbonate, 0.125"[4]
  - NLWG No lens; wireguard in door frame
- **Voltage**
  - **(blank)** MVOLT; 120-277V
  - HVOLT 347V-480V[5]
- **Ballast configuration**
  - **(blank)** Standard configuration
  - *4-lamp = (1) 4-lamp ballast*
  - *6-lamp = (1) 2-lamp and (1) 4-lamp ballast*
  - *8-lamp = (2) 4-lamp ballasts*
- **Ballast**
  - **(blank)** Cool Running Plus T5 electronic, 1.0 BF, programmed rapid start
  - **GEB10PS90** T5 electronic, 1.0 BF, programmed rapid start

Lamp color

(blank)	F54T5HO/841
LP835	F54T5HO/835
LP850	F54T5HO/850
Amalgam lamps[6]	
LP841A	F54T5HO/841
LP835A	F54T5HO/835
LP850A	F54T5HO/850
Energy-saving 49W lamps	
P841E49	F54T5HO/841
P835E49	F54T5HO/835
P850E49	F54T5HO/850

Options

GLR	Internal fast-blow fuse[7,8]
GMF	Internal slow-blow fuse[7,8]
EL14	Emergency battery pack[7,9,10]
EL14SD	Emergency battery pack w/ self-diagnostics[7,9,10]
I162	1250 lumens per lamp battery[9,10,11]
OUTCTR	Wiring leads pulled through back center of fixture[3]
OCS	RELOC® OnePass® 5' installed[7]
IMP	Integrated modular plug[12,23]
FSP	Integral full side panels
PBTSKT	Polybutylene terephthalate sockets
Cord sets:	
CS1W	Straight plug, 120V[13,14]
CS3W	Twist-lock, 120V[13,14]
CS7W	Straight plug, 277V[13,14]
CS11W	Twist-lock, 277V[13,14]
CS25W	Twist-lock, 347V[13,14]
CS97W	Twist-lock, 480V[13,14]
CS93W	600 SO white cord, no plug (no voltage required)[13,14]
Motion sensors:	
MSI	Aisle motion sensor, pre-wired[15]
MSI360	360° motion sensor ,pre-wired[15]
MSE360	360° motion sensor ,embedded[7,16]
MSE360LB	360° motion sensor, embedded[7,17]
XP1	XPoint single relay[18]
XP2	XPoint double relay[18]
Wireguards:	
WGX	External wireguard installed
2WGX	External wireguard installed on bottom of fixture[19]

Accessories: *Order as separate catalog number.*

Mounting:	
IBAC120 M20	Aircraft cable 10' with hook (one pair)
IBAC240 M20	Aircraft cable 20' with hook (one pair)
IBHMP	Hook monopoint
IBZACVH	Aircraft 10' V hanger (one pair)
IBZTFC	Tandem coupler and side panel
IBZPMP	Pendant monopoint splice box, includes side covers[20]
IBZPMPHB	Pendant monopoint splice box, includes side covers (3/4" hub)[20]
HBBS36	Chain hanger, 36" (one pair)
IBZSMB	Surface-mounting bracket (one pair)
Field-installable door and lens assemblies:[21,22]	
DLIBZ14 A12125	4-lamp pattern 12 acrylic lens, 0.125"[21,22]
DLIBZ14 ACL	4-lamp clear acrylic lens[21,22]
DLIBZ14 PCL125	4-lamp clear polycarbonate lens, 0.125"[21,22]
DLIBZ19 A12125	6-lamp pattern 12 acrylic lens, 0.125"[21,22]
DLIBZ19 ACL	6-lamp clear acrylic lens[21,22]
DLIBZ19 PCL125	6-lamp clear polycarbonate lens, 0.125"[21,22]
DLIBZ24 ACL	8-lamp clear acrylic lens[21,22]
DLIBZ24 PCL125	8-lamp clear polycarbonate lens, 0.125"[21,22]
Cord sets and sensors for IMP option:	
CS1WIMP	Straight plug, 120V[7,13,14]
CS3WIMP	Twist-lock, 120V[7,13,14]
CS7WIMP	Straight plug, 277V[7,13,14]
CS11WIMP	Twist-lock, 277V[7,13,14]
CS25WIMP	Twist-lock 347V
CS93WIMP	600V SO white cord, no plug (no voltage required)[13]
CS97WIMP	Twist-lock 480V
MSIIMP	Aisle sensor[7,23]
MSI360IMP	360° sensor[7,23]
Wireguards:	
WGIBZ14	Standard 4-lamp wireguard
WGIBZ19	Standard 6-lamp wireguard
WGIBZ24	Standard 8-lamp wireguard

Notes

1 Lamps installed are F54T5HO/841 unless otherwise specified.
2 5/55°F warranty with open fixtures only.
3 Not available with MSE360 option.
4 For wireguard in door frame, add "WG" to shielding. Ex: A12125WG.
5 Not available with Cool Running Plus ballast.
6 Not for use with motion sensors.
7 Specify voltage. Consult factory for Canadian applications.
8 Not available with 347 voltage.
9 Battery options require a BACKPACK™ installed by the factory in order to accommodate the size of the battery. The BACKPACK is NOT field installable. May only be surface mounted using IBZSMB. Not available with pendant mount using IBZ PMP or IBZ PMPHB. Not available with IMP.
10 Certified to UL 1598 (approx. 1100 lumens at 25°C when using 49W lamps, and 911 lumens at 45°C). Single-lamp operation only. 120 or 277 voltage only.
11 Max 2500 lumens when used with 54W T5 lamps up to 55°C ambient temperature (120 or 277 voltage only).
12 Must be factory-installed. Not available on TIBZ 16-lamp configurations.
13 All cord sets are 18/3, 6', white.
14 Cord sets are voltage specific. Specify voltage. Other configurations available. Consult factory.
15 Specify voltage; 120, 208, 240, 277, 347 or 480.
16 Recommended for heights of 30-40'. Not available with lensed units. 120, 277 or 347 voltage only.
17 Embedded sensor. For mounting heights up to 20', not available with lensed units. 120, 277 or 347 voltage only.
18 Contact LC&D for additional system components required.
19 One wireguard shipped as separate line item for top installation in field. Not available with IBZPMP.
20 When ordering IBZPMP, two-ballast configurations are recommended. Ex: 2/2. Not available with tandem units.
Not available with any battery pack.
21 Not available with MSE360 or MSE360LB.
22 Add WG to nomenclature if wire guard is to be installed in door frame, ex: DLIBZ14 A12125WG.
23 Must have "IMP" power cord to power fixture.

IBZ_X54

LITHONIA LIGHTING®
An AcuityBrands Company

INDUSTRIAL: One Lithonia Way Conyers, GA 30012 Phone: 770-922-9000 Fax: 770-981-8141 www.lithonia.com

LEVITON

OSS10-IDI

Color: Ivory

UPC Code: 1

Country of Origin: Please Contact Customer Service

Occupancy Sensors

Item Description

Manual On Only (30min max Time Delay), 800W@120V INC 1200VA@120V 2700VA@277V FL, 120/277 Volt AC 60Hz, Single-Pole, 180 Degree, 1200 Sq. Ft. Coverage, LED Adjustable Night Light, Decora® Passive Infrared Wall Switch Occupancy Sensor, Commercial

Technical Information

Product Features

Product Line: OSS10
Technology: Passive Infrared
Switch Type: Single-Pole, LED NightLight
Mounting: Wall Switch
Device Type: Occupancy Sensor
Grade: Commercial
Coverage (Sq.Ft.): 1200 Sq. Ft.
Pattern: 180°
Mounting Height (Ft.): 4 Ft.
Adjustment: Manual
Time Delay: 30s-30m
Voltage: 120/277 Volt AC 60Hz
Load Rating: 800W@120V INC 1200VA@120V 2700VA@277V FL
Motor: 1/8 HP @ 120V
Power Pack: External Power Pack Not Required
Consumption (mA): N/A
Photocell: Internal
HVAC Relay: N/A
Operating Temperature: 0°C to 40°C
Storage Temperature Range: -10°C to 85°C
Relative Humidity: 20% to 90% non-condensing
Neutral Wire Connection: Required
Color: Ivory
LED Color: Red
Wallplate: Order Separately
Standards and Certifications: UL/cUL
Code Compliance: California Title 24
Size: 4.06" H x 1.75" W x 1.85" D (103.2mm x 44.4mm x 47.2mm)
Warranty: 5-Year Limited

Features and Benefits

- Manual On Only (30min max Time Delay).
- Exclusive dual PIR design provides unmatched range and small motion detection.
- Manual-ON/Auto-OFF operation
- Convenient push-button provides manual ON/OFF light switching at any time
- LED NightLight offers "Guide Light" functionality
- Adjustable NightLight illumination

AC Drives

AC Adjustable-Frequency Drives, Altivar® 212 and 61

Schneider Electric

Altivar 212

Altivar 61

Suitable for variable-torque applications such as air-handling supply and return fans, ventilation fans, exhaust fans, cooling tower fans and pumps, hot water and chilled water pumps, domestic water supply pumping, and fountain pumps. See Grainger.com® for additional or higher HP ratings.

Max. HP	Max. Output Amps	H (in.)	W (in.)	D (in.)	Mfr. Model	Item No.		$ Each
Altivar 212, 3-Phase 200-240VAC 50/60 Hz Input, 3-Phase 200-240VAC Output								
1	4.6	5.60	4.20	5.90	ATV212H075M3X	6MUZ6	✓	365.00
2	7.5	5.60	4.20	5.90	ATV212HU15M3X	6MUZ7	✓	472.50
3	10.6	5.60	4.20	5.90	ATV212HU22M3X	6MUZ8	✓	536.50
4	13.7	7.20	5.60	5.90	ATV212HU30M3X	6MUZ9	✓	656.00
5	16.7	7.20	5.60	5.90	ATV212HU40M3X	6MVA0	✓	730.00
7.5	24.2	9.10	7.00	6.70	ATV212HU55M3X	6MVA1	✓	943.50
10	32	9.10	7.00	6.70	ATV212HU75M3X	6MVA2	✓	1,138.00
15	46.2	12.97	9.60	7.50	ATV212HD11M3X	6MVA3	✓	1,447.00
20	61	12.97	9.60	7.50	ATV212HD15M3X	6MVA4	✓	1,810.00
25	74.8	12.97	9.60	7.50	ATV212HD18M3X	6MVA5	✓	2,120.00
30	88	16.50	9.40	8.40	ATV212HD22M3X	6MVA6	✓	2,585.00
40	117	24.80	12.50	11.40	ATV212HD30M3X	6MVA7	✓	3,314.00
Altivar 212, 3-Phase 400-480VAC 50/60 Hz Input, 3-Phase 400-480VAC Output								
1	2.2	5.60	4.20	5.90	ATV212H075N4	6MVA8	✓	472.50
2	3.7	5.60	4.20	5.90	ATV212HU15N4	6MVA9	✓	558.00
3	5.1	5.60	4.20	5.90	ATV212HU22N4	6MVC0	✓	644.00
4	7.2	7.20	5.60	5.90	ATV212HU30N4	6MVC1	✓	730.00
5	8.2	7.20	5.60	5.90	ATV212HU40N4	6MVC2	✓	772.50
7.5	12	7.20	5.60	5.90	ATV212HU55N4	6MVC3	✓	942.50
10	16	9.10	7.00	6.70	ATV212HU75N4	6MVC4	✓	1,118.00
15	22.5	9.10	7.00	6.70	ATV212HD11N4	6MVC5	✓	1,353.00
20	30.5	12.97	9.60	7.50	ATV212HD15N4	6MVC6	✓	1,684.00
25	37	12.97	9.60	7.50	ATV212HD18N4	6MVC7	✓	2,014.00
30	43.5	16.50	9.40	8.40	ATV212HD22N4	6MVC8	✓	2,192.00
40	58.5	16.50	9.40	8.40	ATV212HD30N4	6MVC9	✓	2,698.00
Altivar 61, 1 or 3-Phase 208-240VAC 50/60 Hz Input, 3-Phase 208-240VAC Output								
1, 2	4.8, 8	9.05	5.12	6.89	ATV61HU15M3	2HPT4	*✓	733.50
2, 3	8, 11	10.23	6.1	7.36	ATV61HU22M3	2HPT6	*✓	845.00
3, 4	11, 13.7	10.23	6.1	7.36	ATV61HU30M3	2HPT8	*✓	1,024.00
4, 5	13.7/17.5	10.23	6.1	7.36	ATV61HU40M3	2HPU1	*✓	1,146.00
5, 7½	17.5, 27.5	11.61	6.89	7.36	ATV61HU55M3	2HPU3	*✓	1,430.00
7½, 10	27.5, 33	11.61	8.27	8.39	ATV61HU75M3	2HPU5	*✓	1,755.00
Altivar 61, 3-Phase 208-240VAC 50/60 Hz Input, 3-Phase 208-240VAC Output								
15	54	15.75	9.05	8.39	ATV61HD11M3X	2HPP2	✓	2,106.00
20	66	15.75	9.05	8.39	ATV61HD15M3X	2HPP4	✓	2,641.00
25	75	16.54	9.45	9.29	ATV61HD18M3X	2HPP6	✓	3,078.00
30	88	16.54	9.45	9.29	ATV61HD22M3X	2HPP8	✓	3,749.00
40	120	21.65	12.6	10.47	ATV61HD30M3X	2HPR1	✓	4,806.00
50	144	21.65	12.6	10.47	ATV61HD37M3X	2HPR3	✓	5,582.00
60	176	21.65	12.6	10.47	ATV61HD45M3X	2HPR5	✓	6,611.00
75	221	36.22	12.6	9.84	ATV61HD55M3X	2HPR7	✓	8,439.00
100	285	36.22	12.6	9.84	ATV61HD75M3X	2HPR9	✓	10,139.00
125	359	40.23	14.17	11.73	ATV61HD90M3X	2HPT2	✓	12,924.00
Altivar 61, 3-Phase 400-480VAC 50/60 Hz Input, 3-Phase 400-480VAC Output								
2	4.1	9.05	5.12	6.89	ATV61HU15N4	2HPT5	✓	949.50
3	5.8	9.05	5.12	6.89	ATV61HU22N4	2HPT7	✓	1,107.00
4	7.8	10.23	6.1	7.36	ATV61HU30N4	2HPT9	✓	1,247.00
5	10.5	10.23	6.1	7.36	ATV61HU40N4	2HPU2	✓	1,284.00
7½	14.3	11.61	6.89	7.36	ATV61HU55N4	2HPU4	✓	1,441.00
10	17.6	11.61	6.89	7.36	ATV61HU75N4	2HPU6	✓	1,748.00
15	27.7	11.61	8.27	8.39	ATV61HD11N4	2HPP3	✓	1,956.00
20	33	15.75	9.05	8.39	ATV61HD15N4	2HPP5	✓	2,429.00
25	41	15.75	9.05	8.39	ATV61HD18N4	2HPP7	✓	2,923.00
30	48	16.54	9.45	9.29	ATV61HD22N4	2HPP9	✓	3,183.00
40	66	21.65	9.45	10.47	ATV61HD30N4	2HPR2	✓	3,914.00
50	79	21.65	9.45	10.47	ATV61HD37N4	2HPR4	✓	4,603.00
60	94	24.8	12.6	11.42	ATV61HD45N4	2HPR6	✓	5,778.00
75	116	24.8	12.6	11.42	ATV61HD55N4	2HPR8	✓	6,883.00
100	160	24.8	12.6	11.42	ATV61HD75N4	2HPT1	✓	7,859.00
125	179	36.22	12.6	9.84	ATV61HD90N4	2HPT3	✓	8,636.00

** Max. HP and output amps are listed for 1-phase first and 3-phase second.*

AC Adjustable-Frequency Drives, Altivar® 12 and 312

Schneider Electric

Altivar 12

Altivar 312

Ideal for constant-torque simple machines such as conveyors, mixers, gate control, machine movement, small pumps and fans, and positive displacement pumps. Perfect replacements for reversing motor controls and 2-speed motor controls.

Max. HP	Max. Output Amps	H (in.)	W (in.)	D (in.)	Mfr. Model	Item No.	$ Each
1-Phase 120VAC 50/60 Hz Input, 3-Phase 230VAC Output							
0.25	1.4	5.59	2.83	4.02	ATV12H018F1	5WJJ5 ✓	214.00
0.5	2.4	5.12	2.83	4.77	ATV12H037F1	5WJJ8 ✓	222.25
1	4.2	5.12	4.13	6.15	ATV12H075F1	5WJK2 ✓	260.00
1-Phase 230VAC 50/60 Hz Input, 3-Phase 230VAC Output							
0.25	1.4	5.59	2.83	4.02	ATV12H018M2	5WJJ6 ✓	214.00
0.5	2.4	5.12	2.83	4.77	ATV12H037M2	5WJJ9 ✓	222.25
0.75	3.5	5.12	2.83	5.17	ATV12H055M2	5WJK1 ✓	237.75
1	4.2	5.12	2.83	5.17	ATV12H075M2	5WJK3 ✓	260.00
2	7.5	5.12	4.13	6.15	ATV12HU15M2	5WJK5 ✓	336.75
3	10	5.12	4.13	6.15	ATV12HU22M2	5WJK7 ✓	404.00
3-Phase 230VAC 50/60 Hz Input, 3-Phase 230VAC Output							
0.25	1.4	5.59	2.83	4.02	ATV12H018M3	5WJJ7 ✓	196.25
0.5	2.4	5.12	2.83	4.77	ATV12H037M3	5WJK0 ✓	204.50
1	4.2	5.12	2.83	5.17	ATV12H075M3	5WJK4 ✓	238.75
2	7.5	5.12	4.13	5.17	ATV12HU15M3	5WJK6 ✓	309.50
3	10	5.12	4.13	5.17	ATV12HU22M3	5WJK8 ✓	371.00
4	12.2	6.69	5.51	5.56	ATV12HU30M3	5WJK9 ✓	430.00
5	16.7	6.69	5.51	5.56	ATV12HU40M3	5WJL0 ✓	504.50
1-Phase 230VAC 50/60 Hz Input, 3-Phase 200-240VAC Output							
0.25	1.5	5.7	2.83	5.19	ATV312H018M2	6DWX2 ✓	316.75
0.5	3.3	5.7	2.83	5.19	ATV312H037M2	6DWX4 ✓	339.00
0.75	3.7	5.7	2.83	5.59	ATV312H055M2	6DWX7 ✓	361.50
1	4.8	5.7	2.83	5.59	ATV312H075M2	6DWY0 ✓	395.75
1.5	6.9	5.63	4.21	5.98	ATV312HU11M2	6DWY7 ✓	428.75
2	8	5.63	4.21	5.98	ATV312HU15M2	6DWZ0 ✓	475.00
3	11	7.24	5.59	5.98	ATV312HU22M2	6DWZ3 ✓	553.00
3-Phase 230VAC 50/60 Hz Input, 3-Phase 200-240VAC Output							
0.25	1.5	5.7	2.83	4.8	ATV312H018M3	6DWX3 ✓	305.00
0.5	3.3	5.7	2.83	4.8	ATV312H037M3	6DWX5 ✓	339.00
0.75	3.7	5.7	2.83	5.19	ATV312H055M3	6DWX8 ✓	361.50
1	4.8	5.7	2.83	5.19	ATV312H075M3	6DWY1 ✓	384.00
1.5	6.9	5.63	4.13	5.19	ATV312HU11M3	6DWY8 ✓	428.75
2	8	5.63	4.13	5.19	ATV312HU15M3	6DWZ1 ✓	497.25
3	11	5.63	4.21	5.98	ATV312HU22M3	6DWZ4 ✓	564.50
4	13.7	5.63	4.21	5.98	ATV312HU30M3	6DWZ6 ✓	654.50
5	17.5	7.24	5.59	5.98	ATV312HU40M3	6DWZ8 ✓	768.00
7.5	27.5	9.13	7.09	6.77	ATV312HU55M3	6DXA0 ✓	993.50
10	33	9.13	7.09	6.77	ATV312HU75M3	6DXA2 ✓	1,197.00
15	54	12.97	9.65	7.56	ATV312HD11M3	6DWY3 ✓	1,581.00
20	66	12.97	9.65	7.56	ATV312HD15M3	6DWY5 ✓	2,033.00
3-Phase 480VAC 50/60 Hz Input, 3-Phase 380-500VAC Output							
0.5	1.5	5.63	4.21	5.98	ATV312H037N4	6DWX6 ✓	428.75
0.75	1.9	5.63	4.21	5.98	ATV312H055N4	6DWX9 ✓	463.25
1	2.3	5.63	4.21	5.98	ATV312H075N4	6DWY2 ✓	497.25
1.5	3	5.63	4.21	5.98	ATV312HU11N4	6DWY9 ✓	530.50
2	4.1	5.63	4.21	5.98	ATV312HU15N4	6DWZ2 ✓	587.00
3	5.5	5.63	4.21	5.98	ATV312HU22N4	6DWZ5 ✓	678.00
4	7.1	7.24	5.59	5.98	ATV312HU30N4	6DWZ7 ✓	768.00
5	9.5	7.24	5.59	5.98	ATV312HU40N4	6DWZ9 ✓	813.00
7.5	14.3	9.13	7.09	6.77	ATV312HU55N4	6DXA1 ✓	1,016.00
10	17	9.13	7.09	6.77	ATV312HU75N4	6DXA3 ✓	1,243.00
15	27.7	12.97	9.65	7.56	ATV312HD11N4	6DWY4 ✓	1,637.00
20	33	12.97	9.65	7.56	ATV312HD15N4	6DWY6 ✓	2,033.00

Description	Mfr. Model	Item No.	$ Each
Accessories			
Connecting Cable for ATV12 Drives	TCSMCNAM3M002P	5WJL1 ✓	61.45
Remote Keypad, IP54 for ATV12 Drives	VW3A1006	5WJL2 ✓	66.15
Remote Keypad, IP65 for ATV12 Drives	VW3A1007	5WJL3 ✓	66.15
EMC Filter for ATV12 Drives H018F1 to H037F1, H018M2 to H075M2	VW3A4416	5WJL4 ✓	153.75
EMC Filter for ATV12 Drives H075F1, HU15M2, to HU22M2	VW3A4417	5WJL5 ✓	147.65
EMC Filter for ATV12 Drives H018M3 to H075M3	VW3A4418	5WJL6 ✓	259.00
EMC Filter for ATV12 Drives HU15M3, HU22M3	VW3A4419	5WJL7 ✓	275.50
Bluetooth Adapter for ATV12 and ATV312 Drives	VW3A8114	5WJL8 ✓	100.40
Program Loader for ATV12 Drives	VW3A8120	5WJL9 ✓	207.00
Program Multiloader for ATV12 and ATV312 Drives	VW3A8121	5WJN0 ✓	413.50
Connecting Cable for ATV12, ATV312, and Multiloader	VW3A8126	5WJN1	35.45
Voltage Converter for ATV12 Drives	VW3A9317	5WJN2 ✓	103.90
Connection Kit for ATV12 Drives H018F1, H037F1, H018M2 to H075M2, H018M3 to H075M3	VW3A9523	5WJN3	29.60
Connection Kit for ATV12 Drives H075F1, HU15M2, HU22M2, HU15M3, HU22M3	VW3A9524	5WJN4	29.60
Mounting Plate for ATV12 Drives H018F1, H037F1, H018M2 to H075M2, H018M3 to H075M3	VW3A9804	5WJN6 ✓	75.60
Mounting Plate for ATV12 Drives H075F1, HU15M2, HU22M2, HU15M3, HU22M3	VW3A9805	5WJN7 ✓	85.05

✓ = Repair & Replacement Coverage Available

WT6500 Wind Turbine

Honeywell

A WIND TURBINE LIKE NO OTHER –
ALWAYS TURNING

Blade Tip Power System

Today's wind energy...

Introducing a breakthrough wind energy system for home and business

The Honeywell Wind Turbine is a gearless wind turbine that measures just 6 feet (1.8 m) in diameter, weighs 241 lbs (110 kgs) and produces on average up to1500 kWh per year depending on height and location. The Honeywell Wind Turbine's BTPS perimeter power system and unique design of multi-stage blades allows the system to react quickly to changes in wind speed. This ensures that the maximum wind energy is captured without the typical noise and vibration associated with traditional wind turbines. The Honeywell Wind Turbine has an increased operating span over traditional turbines with a start-up speed as low as 0.5 mph (0.2 m/s), with an auto shut off at 38 mph (17.0 m/s), traditional gearbox turbines require minimum wind speeds of 7.5 mph (3.5 m/s) to cut in and start generating power. The Honeywell Wind Turbine is designed to be installed by a licensed electrician wherever energy is consumed, turning homes and businesses from points of total consumption to distributed energy sources, in a cost effective and efficient manner.

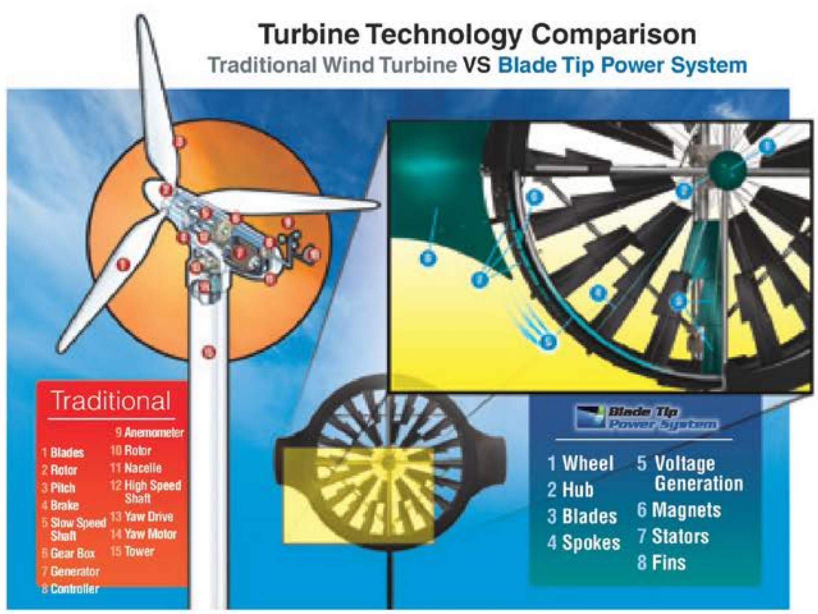
Blade Tip Power System

Gearless Blade Tip Power System – the future of wind power

The innovative Blade Tip Power System (BTPS) is the patented technology created by WindTronics™. The Honeywell Wind Turbine utilizes a system of magnets and stators surrounding its outer ring capturing power at the blade tips where speed is greatest, practically eliminating mechanical resistance and drag. Rather than forcing the available wind to turn a generator, the perimeter power system becomes the generator by swiftly passing the blade tip magnets through the copper coil banks mounted onto the enclosed perimeter frame. The Blade Tip Power System addresses past constraints such as size, noise, vibration and output. The enclosed perimeter shrouds the system and is more distinguishable to wildlife. WindTronics' proprietary systems are breaking traditional technological barriers across multiple markets, for homes and businesses, for both energy generation and energy recapture even in moderate winds.

Turbine Technology Comparison

Traditional Wind Turbine VS Blade Tip Power System



Turning a wind turbine into a wind generator by eliminating the gear box.

like no other.

Turbine Mounting Options: At 241 lbs (110 kgs) and 6 feet (1.8 m) versatile – like no other.

Flat Roof (Commercial)
QuadPod and Ballast Mount

Pitched Roof
QuadPod and Roof Box

Pole Mount (Commercial or Residential)

Cell Tower Mount (Commercial)

Directional Fins & Braking

The directional fins continuously guide the turbine for maximum wind exposure. The system starts turning at 0.5 mph (0.2 m/s), automatically shuts down in high winds (+38 mph [+17.0 m/s]) through its electromagnetic braking system and is designed to withstand winds up to 140 mph (62.6 m/s).

FAQ's

Many factors will affect the output of the turbine at each location depending on placement. Your location can be affected by trees, terrain and obstructions.

- Always seek the highest elevation and lowest obstruction field as possible (33 feet (10.0 m) minimum, the higher the better).
- You may advise your city, town or neighbors that you're installing a new generation wind turbine, but at 241 lbs (110 kgs), 6 feet (1.8 m), 35 dB at 10 feet (3.1 m), it may be not necessary. We're here to help you.
- An average annual wind rating of 12 mph (5.4 m/s) is recommended as a good minimum wind speed to keep in mind, off grid locations might consider less.
- The Honeywell Wind Turbine is designed for all environments from hot to cold temperatures and from coastal locations to mountaintops.
- Electrical connection is very similar to a backup generator connected to the building or solar power to the grid. Refer to connection options A through D.
- The system is designed to be installed by a licensed electrical contractor.
- Our Smart Swap warranty program allows contractors to replace components easily.
- The roof box QuadPod system is designed for pitched or flat roof tops. As roof construction and roof lines vary, pole mounted installations are recommended for residential environments for optimal cost, flexibility and performance.

WindTronics™ has created a range of tools to assist in identifying proper site selection based on wind, rates and rebates.

www.windknowledge.com
Easy look up of US and Canada wind rates, electrical rates, rebates and incentives.

www.windestimator.com
Global wind statistic, predominant wind direction and wind strength analysis.

Award Winning Technology

2010 EDISON AWARDS

Edison Awards Gold Winner in the Energy & Sustainability category

Popular Mechanics

One of the Most Brilliant Products of 2009 by Popular Mechanics Magazine

UNIDO Blue Sky Award

2009 UNIDO Top Ten New Technologies for Renewable Energy Utilization

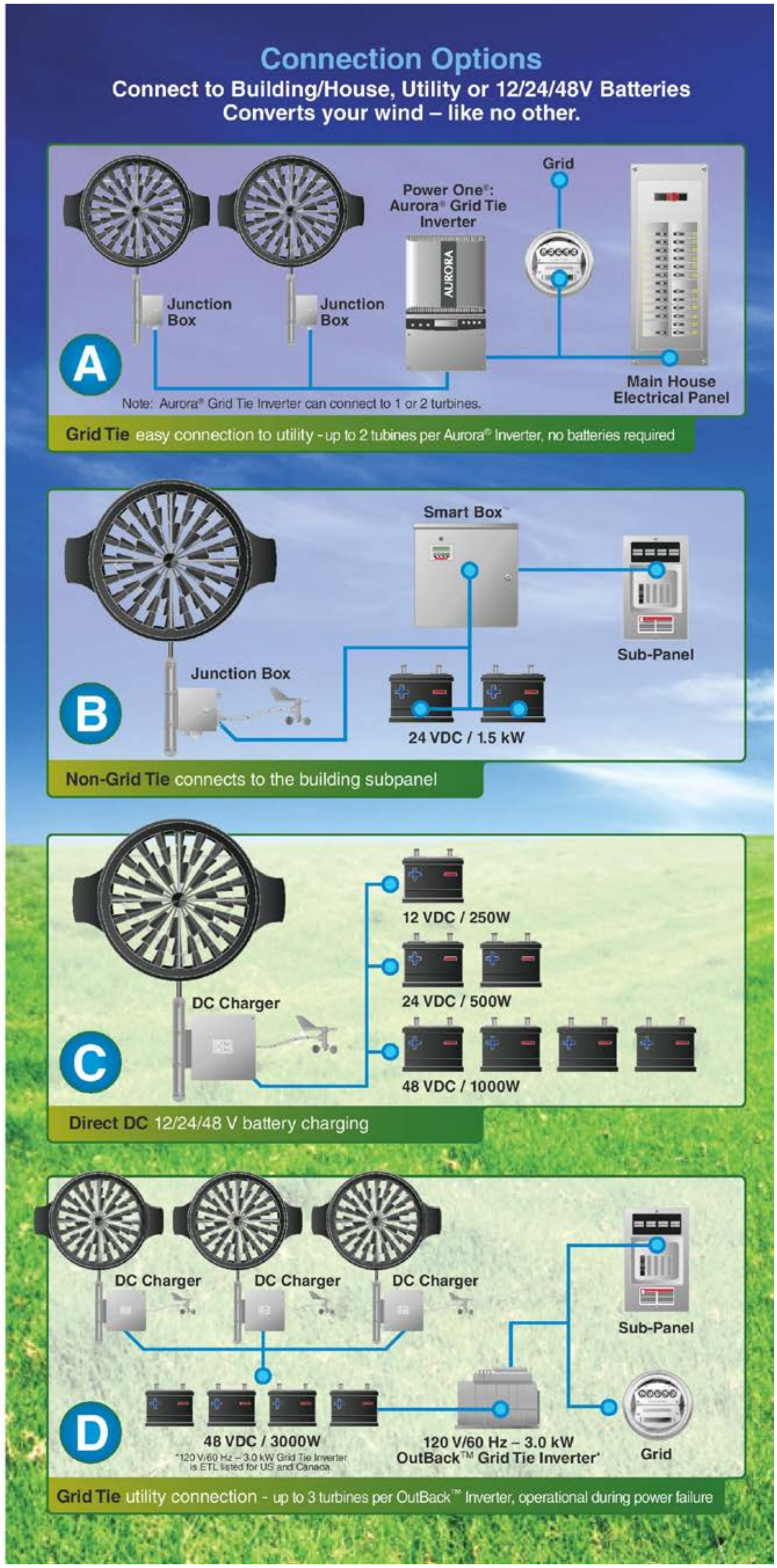
Built like no other - Automated assembly lines.

Product Certification

Honeywell Wind Turbine
North American Recognition – UL 6140, UL 508, UL 1004-1, UL 50E, UL 61010-1, CSA 22.2

SmartBox™ Control System
UL 1741, CAN/CSA C22.2 #107.1

Intertek



Energy Management System

The SmartBox Control System incorporates a proprietary control system that is specifically designed to capture the most efficient power from wind at its unpredictable patterns and dynamics. It functions as a sophisticated energy management system and also provides a simple and seamless interconnection to the grid. The Honeywell Wind Turbine and the SmartBox offers cutting-edge turbine technology to the individual, enabling each to harness, utilize and manage the energy at their local wind zone. The SmartBox is the control system that consists of a charge controller and a non-grid tie 1.5 kW inverter. Included within the charge controller is an automatic AC transfer switch that will automatically switch between your AC grid and power generated via the turbine. The Honeywell Wind Turbine works seamlessly with grid tie or DC Charge controllers.
Refer to items A through D on prior page under Connection Options.

SMART BOX

SmartBox Control System incorporates:

- Optimal Power Transfer Controller
- True Sine Wave Inverter
- Battery Power Management System
- Wind Direction & Speed Measurement Control System

Utility Grid Tie System

The Honeywell Wind Turbine can also be configured with the Aurora® grid tie inverter for simple connectivity to any utility or building (F.I.T. or net metering).

Aurora® inverters operate at 96% efficiency and comply with standards set for grid tied operation, safety, and electromagnetic compatibility including: UL1741/IEEE1547 & CSA-C22.2 N.107.1-01, VDEO126, CEI 11-20, DK5940, CEI64-8, IEC 61683, IEC 61727, EN50081, EN61000, CE certification, El Real Decreto RD1663/2000 de España.

A Wind Turbine Like No Other In...

- Residential
- Commercial
- Agricultural
- Remote
- Towers
- Energy Recovery
- Education
- Design
- Size
- Startup speed
- Ease of Permitting
- Efficiency
- Quiet Operation

Honeywell Model WT6500 Specifications		
Enclosed Blade Tip Power System (BTPS)	Wide Wind Acceptance – Auto Directional	Connects to building, utility or battery charge controller
BTPS Permanent Magnet Electric Generator	Cut in wind speed 2 mph (.89 m/s)	Optional Controllers included: Aurora®, OutBack™, SmartBox or DC Charger
ETL Listed, Conforming to UL 1741 & CAN/CSA C22.2 N0. 107.1	Acoustic Noise Emissions < 35dB at 10 feet (3.1 m)	
North American Recognition – UL 6140, UL 508, UL 1004-1, UL 50E, UL 61010-1, CSA 22.2		Designed to withstand winds up to 140 mph (62.6 m/s)
Blades – Glass Filled Nylon Composite	Shut down wind speed 38 mph (17.0 m/s)	5 Year Limited Warranty
Tip to Tip Blade Dimension 5.7' (1.7 m)	Electromagnetic Braking System	Annual CO2 Displacement 2.2 Tons

Description	Product Dimensions					
	Part Number	GTIN / UPC (Sellable Unit)	Weight (All Weights in lbs)		Dimensions (All in Inches)	
			Unit	Shipping	Unit	Shipping
Honeywell WT6500 Wind Turbine	WT6500	824309100014	241	400	78.7 W x 85 H x 19.5 Deep	85 W x 89 H x 21 Deep
SmartBox™ 120V/50Hz NGT (Non-Grid Tie)	SB650012050NGT	824309200127	58	66	20 L x 20.125 W x 9.0 Depth	25 L x 25 W x 23.76 H
SmartBox™ 120V/60Hz NGT (Non-Grid Tie)	SB650012060NGT	824309200028	58	66	20 Lx 20.125 W x 9.0 Depth	25 L x 25 W x 23.76 H
SmartBox™ 230V/50Hz NGT (Non-Grid Tie)	SB650023050NGT	824309200073	58	66	20 L x 20.125 W x 9.0 Depth	25 L x 25 W x 23.76 H
SmartBox™ 230V/60Hz NGT (Non-Grid Tie)	SB650023060NGT	824309200097	58	66	20 L x 20.125 W x 9.0 Depth	25 L x 25 W x 23.76 H
Aurora® Inverter 3.0kW (Grid Tie)	POGT6500***	824309500***	38	45	28.5 L x 15.5 W x 15 H	24.5 L x 12.75 W x 8.25 H
OutBack™ Inverter 3000W 120/60Hz w/ Battery Backup (Grid Tie)	OBGTFX3048	824309400022	62	69	16.25 L x 8.25 W x 14 H	22 L x 13 W x 22 H
DC Charge Controller 12/24/48V	DCCC6500	824309400015	13.2	14.96	14.7 L x 11.9 W x 6.6 H	18.15 L x 12.441 W x 12.441 H
QuadPod™ Fixed Mount	MQP6500	824309300049	165	170	72 L x 46 W x 12 H	74 L x 48 W x 12 H
QuadPod™ Ballast Attachment	MQP6500B	824309300056	374	374	46 L x 45 W x 6 H	46 L x 45 W x 6 H
Pole Coupler	MPT6500	824309******	100	105	31 L x 33 W x 19 H	32 L x 34 W x 20 H

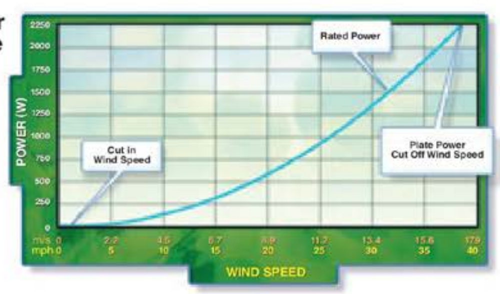
***Part number for Aurora® Grid Tie Inverter and Pole Coupler are dependent on model selection.

Turbine Package

Dimension in inches:
85 W
89 H
21 Deep

Gross weight:
400 lbs

Power Curve



Power Output

- 1,500 Watts at 31 mph
- 2,200 Watts at 38 mph Peak Rating

Energy Output

- 2752 kWh/yr maximum output constant wind (Class 4 DOE)

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