Green Energy CHALLENGE
ELECTRI International NECA

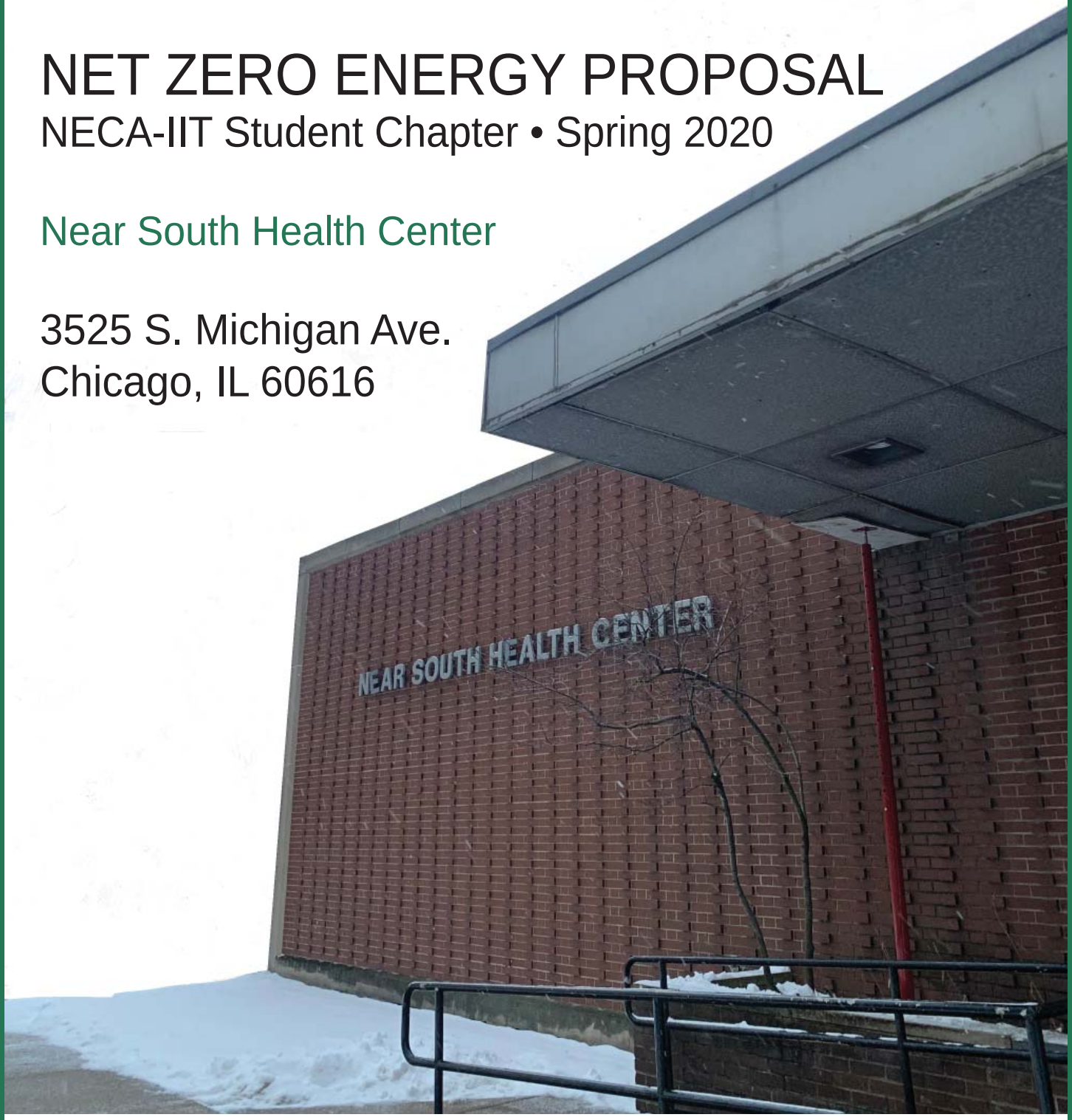
NECA

NET ZERO ENERGY PROPOSAL

NECA-IIT Student Chapter • Spring 2020

Near South Health Center

3525 S. Michigan Ave.
Chicago, IL 60616



ECA
Electrical Contractors' Association
of City of Chicago, Inc.

ILLINOIS INSTITUTE OF TECHNOLOGY

Project Summary

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1. Executive Summary of Proposal

The National Electrical Contractors Association-Illinois Institute of Technology Student Chapter (NECA-IIT) selected a building operating with low efficiency that serves an important role in the Bronzeville, Chicago community. The team audited Near South Health Center, which serves local community members in Cook County, and is located a mere 3 blocks from the Illinois Tech campus. With a purpose to bring health and wellbeing to the community, and a goal to become more modernized, Near South Health Clinic graciously gave NECA-IIT the opportunity to impact change in this facility.

Near South Health Center is over 40 years old and it has not received any known energy efficiency updates in its lifetime. Because of this, the building has poor air handling, uses inefficient office supplies and does not produce any of its own power. Because of these issues, the team proposes the following changes to Near South Health Center:

1. Replacement of old HVAC systems
2. Replacement of all fluorsecent bulbs to LED
3. Installation of a rooftop PV system
4. Installation of occupancy sensors

The total cost of these proposed updates to the Near South Health Center is $318,241.28 financed through private donations, grants, and city rebate opportunities. The total kWh energy saved per year is 74,319.25, and this is equivalent to 17.9 tons of waste recycled. The return of investment on these updates will be achieved in 3 years, and renovation will last approximately 4 months.

Mission Statement

The NECA student chapter at the Illinois Institute of Technology (See Figure 1) harnesses opportunities to engage engineers, designers, contractors, builders, and community members in energy conscious design through education of green energy and sustainable solutions. Implementation is an integrated design process used to conceive logical and feasible energy efficient solutions.

Figure 1: NECA-IIT Team

Project Summary

Team Roles

Core Team Members:

Kevin Dillon-Team Leader, Kevin coordinated meetings, client communication, partner communication, and served as the team moderator.

Samantha Blanchard-NECA-IIT Chapter President, Sam coordinated IIT-NECA events, and presentations for chapter members.

Massara Haseeb-NECA-IIT Chapter Vice President and video director, Massara assisted the chapter president as necessary, as well as managed and coordinated efforts toward the creation of the video.

Christina Hiotaky-NECA-IIT Chapter Secretary and Energy Efficiency Team Leader, Christina kept accurate records of all chapter meetings, formatted and compiled all components of the proposal, and managed the Energy Efficiency team.

Raymond Schroeders-NECA-IIT Chapter Treasurer and Solar Team leader, Raymond tracked all chapter finances as well as managed the solar team.

Supporting Team Members:

Tristan Meredith-Co-Team Leader

Virgilio Nunez-Lighting Team Leader

Jelena Mihajlovic-Klaric-Finance Team Leader, Volunteer Coordinator

2. Facility Role and Clientele

Facility Role

The Near South Health Center (See Figures 2 & 3) is operated by the Cook County Health System, which houses over 25 health centers across Cook County. Cook County Health strives to make an impact in their community by identifying and incorporating cutting edge technologies into their health centers. Cook County Health has operated for nearly 200 years, and strives to provide quality healthcare to all community members, even those who may not have the means to pay. The health centers follow three important tenants: Respect, Growth, and Diversity.

Near South Health Center is located in Bronzeville, a Chicago neighborhood 5 miles south of downtown. It was known as an epicenter for African American history in the early 20th century. This “Black Metropolis” was a stepping stone for African Americans to create business and commerce in a previously white owned area. Institutions grew strong, even in those repressive times, as Bronzeville had significantly less restrictions during this time.

Figure 2: Mike Hickey (left), Samantha Blanchard (middle), and Kevin Dillon (right) visit the center for an Energy Audit

History was made by Bronzeville’s dynamic community members. Jesse Binga founded Chicago’s first black owned insurance and financial institution, Binga Bank. Dale Hale Williams pioneered open-heart surgery in neighboring Provident Hospital. The YMCA on Wabash avenue developed the first Black History month. Many famous musicians and artists reigned from Bronzeville, including Louis Armstrong, Nat “King” Cole, Sam Cooke, Dinah Washington, Quincy Jones, Herbie Hancock, and Gwendolyn Brooks. Today’s Bronzeville is undergoing a revitalization driven by entrepreneurial African Americans who value its rich history and are dedicated to keeping that history and its lessons alive for generations to come. Renovated and restored historic homes complement new housing open to all income levels.

Project Summary

Architectural landmarks, many of which have been restored, include the original Chicago Defender Building, Unity Hall, The Chicago Bee Building, Overton Hygienic Building, Michigan Boulevard Garden Apartments, The Forum, the Wabash Avenue YMCA, and the Supreme Life Building. While restaurants, shops, and other local businesses are flourishing, it's Bronzeville's profound history that remains the primary draw for both locals and tourists.

Clientele

The Near South Health Center serves all members of the Bronzeville community and beyond, regardless of their financial situation. The Cook County Health system has also dedicated numerous research initiatives towards:

- Prehospital Airway Control Trials
- Flu Prevention
- Heart Disease
- Gun Violence
- Opioid Use
- Suicide Prevention
- Breast Cancer

The health system works with the media and researchers to raise awareness on issues that impact the Chicagoland area more than ever.

Community Service

The NECA-IIT Chapter discussed the vital role Near South Health Center plays in maintaining the health standards of local community members in the Bronzeville area. Our leadership discussed with maintenance workers, management, and doctors to discuss the impact they have made giving us a better understanding of their initiatives. Guests from the ECA, Gurtz Electric Company, Continental Electrical Construction Company, Maron Electric Company, Connelly Electric, and Build Smart Chicago gave feedback on the proposal as well as presented on topics such as achieving net-zero.

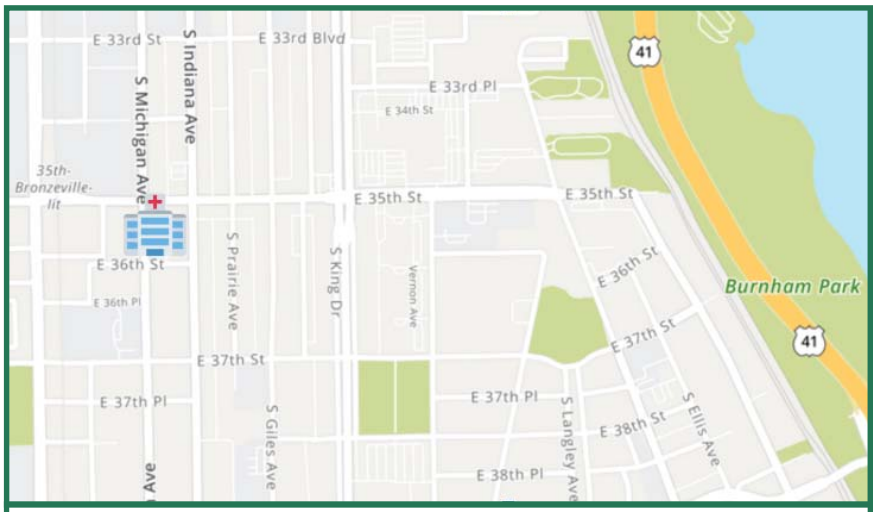

Figure 3: Location of Near South Health Center

3. Team Resumes

Kevin Dillon

Contact Information

(630)-373-0019
kdillon1@hawk.iit.edu

Education

Illinois Institute of Technology
Armour College of Engineering

Major: Computer & Cybersecurity Engineering

Expected Graduation:
Fall 2020

Skills

SPI	Java
I2C	Javascript
UART Serial Communication	MySQL
	Python & C
	AngularJS
HTML/CSS	TestNG/JUnit
Git	VHDL

Work Experience

Software Developer • Intuit AppConnect • September 2014-December 2017
Chicago, IL

- Designed unit tests for new and existing Java classes using TestNG framework
- Practiced agile working procedures managed by JIRA to divide tasks into actionable parts
- Constructed database tables and columns and modified existing tables using MySQL queries
- Programmed new Java data objects, functions for existing classes and some API request endpoints
- Built front-end pages designed for third-party developers Including Paypal and Square

Intern • itDuzzit • June 2013-August 2014
Chicago, IL

- Studied APIs from web applications to construct connections on the itDuzzit Cloud Integration platform
- Learned XML, JSON and csv file layouts and how to effectively parse and construct each
- Programmed Java functions and HTML/CSS/Javascript files for updating pages, adding new end-user
- callable methods and creating new available web application connections

Leadership

Team Leader • NECA-IIT • Spring 2020

- Responsible for coordinating all efforts towards the Green Energy Challenge project.

Project Leader • IIT-IPRO Program • Fall 2019

- Lead Watson Communication group to establish IoT publish/subscribe communication for IBM Remote Telescopes IPRO class in Fall 2019

Member • IIT Esports Event Planning Team • Fall 2018

Project Summary

Samantha Blanchard

Contact Information

(661)-317-0910
sblanchard@hawk.iit.edu

Education

Illinois Institute of Technology
Armour College of Engineering

Major: Mechanical Engineering

Expected Graduation: Spring 2022

Skills

MATLAB	Javascript
Python	MovieMaker
GSAS	Event Planning
Expugui	Public Speaking
TGA	Conversational Spanish
Excel	
AutoCAD	

Work Experience

Undergraduate Researcher • Illinois Tech • July 2019-Present
Chicago, Illinois

- Work with Northwestern Post Doctorate to conduct research on Lithium Ion Batteries, with Manganese Dioxide as a cathode material

Campus Manager • Fresh Prints Company • August 2018-August 2019

- Establish a client base on campus by networking with campus organizations
- Mentored by CEO of Fresh Prints Company
- Work with online databases and outside distributors to find apparel specific to each client

Lifeguard • City of Palmdale • July 2016-July 2019
Palmdale, California

- Responsible for light facility maintenance work, active surveillance of all patrons, and regulating and enforcing all facility rules

Leadership

Board Member • Chicago Undergraduate Research Symposium

- Work with individuals from universities across Chicago to conduct the largest research symposium in the city, annually.

VP of Academic Affairs • SGA • Spring 2020

- Meet with campus administration to make changes to university policy

President • NECA-IIT • Spring 2020

- Conduct energy audits of local facilities and compete in Green Energy Challenge

Vice president • Electrochemical Association

Project Summary

Massara Haseeb

Contact Information

(708)-737-9923
mhaseeb1@hawk.iit.edu

Education

Illinois Institute of Technology
Armour College of Engineering

Major: Mechanical Engineering

Expected Graduation: Fall 2020

Moraine Valley Community College • Transferred Spring 2018

Skills

Revit
Fusion 360
Inventor
Microsoft Office
MATLAB
C++
Customer Service
Arabic
Laser Cutting
Sales

Work Experience

Mechanical Engineering Intern • dbHMS • January 2020-March 2020
Chicago, Illinois

- Developed a working knowledge of Revit MEP
- Gathered knowledge of the project in order to perform calculations and draw air flow diagram to prepare layouts of systems
- Designed components or portions of duct and piping systems while also modifying existing designs to improve upon them
- performed routine tasks under supervision using well-defined engineering standards and procedures
- Drafted plans, airflow diagrams, detail sheets, and equipment schedules

Manager/Painting Instructor • Art a la Carte • September 2016-November 2018

- Taught 70 children and 45 adults on average per week the process of completing a masterpiece in numerous steps
- Established and executed new plans on creative paintings for classes

Leadership

Vice President • NECA-IIT • Spring 2020

- Assisted the president in running chapter meetings and delegating important information

Executive Board Member • Muslim Student Association • Fall 2018-Present

- In charge of forming a community between members with monthly group events and biweekly discussion topics

Project Summary

Christina Hiotaky

Contact Information

(248)-506-2092
chiotaky@hawk.iit.edu

Education

Illinois Institute of Technology
Armour College of Engineering

Major: Architectural Engineering

Expected Graduation: Fall 2021

Skills

First Aid	Word
CPR	Excel
AED	Rhino
Lifeguarding	SketchUp
Communication	AutoCAD
	Revit
Photoshop	MATLAB
Illustrator	InDesign

Work Experience

Aquatics Coach • Midtown Athletic Club • May 2019-March 2020
Chicago, Illinois

- Coached children and adults of various ages in order to develop and refine their technique while continually enforcing water safety practices
- Communicated directly with clients for scheduling.
- Implemented sales techniques to gain and retain clients.

Lifeguard • Keating Sports Center • August 2017-March 2020
Chicago, Illinois

- Responsible for light facility maintenance work, active surveillance of all patrons, and regulating and enforcing all facility rules.

Assistant Manager • Cranbrook Swim Club • May 2017-April 2019
Southfield, Michigan

- In charge of daily operations including employee management, facility maintenance, customer service, and crisis management as necessary.

Leadership

Member • IIT Varsity Swimming • Fall 2017-Current

- Devote 20+ hours/week towards training
- Attend various team functions/meetings
- Travel for competitions

Secretary • NECA-IIT • Spring 2020

- Responsible for keeping accurate notes during all chapter meetings.

Floor Representative • IIT RHA • Fall 2017-Spring 2018

- Responsible for issues in the residence halls for respective floor in biweekly meetings.

College of Architecture Senator • IIT SGA • Fall 2017

- Responsible for voting on new student organizations and worked on the Communications Committee to provide awareness of SGA to the student body.

Project Summary

Raymond Schroeders

Contact Information

(941)-894-8285
rschroeders@hawk.iit.edu

Education

Illinois Institute of Technology
Armour College of Engineering

Major: Aerospace Engineering

Expected Graduation: Spring 2021

Skills

Autodesk
Inventor
Word
Excel
OSHA 30-Hr
Construction
NFPA 70E
Fusion 360
MATLAB
Python
XFLR5

Work Experience

Engineering Intern • Blue Sky Homes • May 2019-Present
Tampa, Florida

- Headed the creation of the company website in order for contractors to submit bids and customers to see progression of their home and make selections
- Responsible for troubleshooting and adding multiple features to the current company software in order to make company processes smoother and faster
- Headed the creation of multiple company software features including one that used the company's scheduling data to show when capital would need to be withdrawn as well as deposited

Engineering Intern • Blue Sky Construction Management • June 2018-August 2018
Tampa, Florida

- Worked on electronics, wiring, and systems within a 77 mega-watt solar array
- Responsible for communications between weather stations and trackers on site
- Responsible for set up of the communication network on site between all inverters and the power station

Leadership

Captain • IIT Varsity Swimming • Fall 2019-Current

- Organize, schedule, and manage offseason practices, meetings, and events held on and off campus.
- Relay messages and send reminders to keep events running smoothly.
- Provide recruiting assistance through campus tours, phone calls, and scheduling to potential and new swimmers.

Treasurer • NECA-IIT • Spring 2020

- Responsible for organizing and tracking all chapter finances

1. Electrical Systems Assessment

The NECA-IIT Student Chapter organized an energy analysis on the Near South Health Center to develop energy saving measures and incorporate distributed energy resources to obtain a Net Zero Energy facility. The 8,855 ft^2 center used 215,320 kWh of electricity and required 11,098 therms of natural gas per year. Converted to energy use intensity (EUI), the center required 225.47 $kBtu/ft^2$.

Lighting Fixtures

The current lighting fixtures (See Figure 4) are mainly fluorescent, rather than the more efficient Light Emitting Diode (LED) bulbs. The fixtures are primarily recessed ceiling and wall mounted. The patient/exam rooms and the office spaces utilize ceiling mounted 2 ballast F32 T8 3 or 4-bulb-fixtures, and the washrooms use wall mounted single ballast F25 T8 2-bulb-fixtures. The hallways use recessed ceiling FB32 2-bulb-fixtures which house U shaped fluorescent lamps. Overall, the center contains approximately 11,713 bulbs, leading to a lot of energy savings potential in a lighting retrofit.

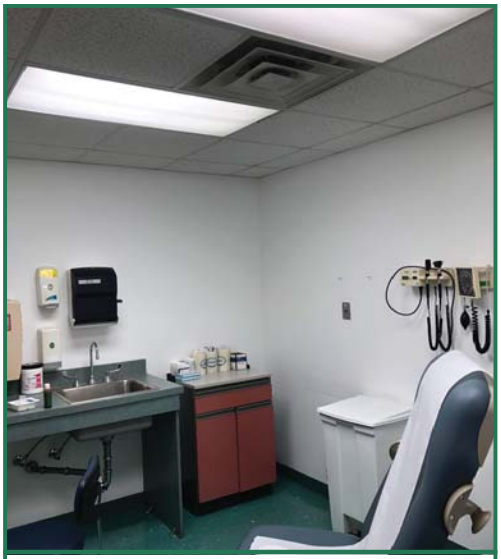

Figure 4: Patient Room

Figure 5: New Controls

Lighting Controls

The lighting in the center is controlled manually through switches. Energy improvements are possible by decreasing the amount of time that the bulbs are on, such as by installing occupancy sensors as shown in Figure 5. Without the use of lighting controls, workers may leave rooms with the lights on which increases the amount of electricity consumed. Occupancy sensors at their greatest potential have the capacity to reduce electrical consumption by 60%.

HVAC Motor Controls

Currently, the center's HVAC system is centered around 6 Air Handling Units (AHU). An audit revealed the entire system needs to be replaced. The recommendation is to install high efficiency units with Variable Air Volume boxes (VAV) and a Smart Thermostat (See Figure 6). By upgrading the motor controls, the system will be able to quickly adapt to the changing environment, display the temperature in each room, notify the user when something is wrong with the system, runs less often when away, and keeps all occupants comfortable, all while staying energy efficient (See Appendix, page 1-1). All of these features, when used at their fullest potential can reduce energy costs by up to 30%.

Figure 6: Smart Thermostat

2. EPA Portfolio Manager Tool

The EPA (See Figure 7) Portfolio Manager Tool was utilized to measure and track energy consumption. This software compares and ranks a building's energy performance based on building size, function, and geographical location. Buildings receive a score between 1-100, with a higher score indicating high efficiency, and is compared to other buildings nationwide. According to historical energy data provided, the health center received a rating of 3. This indicates that the center has poor performance compared to other similar properties. The Near South Health Center will need to implement lots of energy efficient improvements to raise their EPA score.

Figure 7: EPA Logo

3. DOE Building Asset Score Analysis

The Department of Energy's (DOE) Asset Score Analysis Tool evaluated the energy consumption of the Near South Health Center. The DOE Asset Score allowed the NECA-IIT Student Chapter to construct and simulate a model (See Figure 8) of the current building and its mechanical systems. The score is a range from 0 – 10, with a higher number indicating higher efficiency and this tool makes recommendations for the building envelope, and mechanical and lighting systems.

The current building design received a score of 4.0. This is a low score for a building aiming to become a Net Zero Energy facility.

The DOE tool determined that the building has the potential to score a 9.0 with a total estimated savings of 52%. The score improvement comes from upgrading all lighting fixtures to LEDs, adding occupancy sensors, installing continuous insulation in the roof and walls, proper sealing of windows and doors, and a full renovation of the mechanical system of the building.

Figure 8: Building Model

4. Building Recommendations

Long-Term Improvements

Long-term improvements for the center include replacements to the air handling system and motor controls, a new water heater, as well as a replacement in their current windows. The new air handling units would provide accurate, digital temperature control, energy and GHG emissions reductions, and an overall system renewal to modernize the center's HVAC equipment and serve the building for the next 20 years and beyond. The new water heater will signicantly reduce the natural gas consumption and better suit the needs of the center.The new windows would be a simple but highly efficient replacement to their current system.

Air Handling Unit Replacement

When choosing the new equipment several things were considered. First, Carrier was selected as the brand to ensure the existing cavity will align properly. Second, the combination of new units would be able to handle the appropriate amount of heating and cooling necessary. Third, since the existing equipment was last implemented in 2004, the electrical branch loads for the units are considered to be up to code standards. Finally, the highest Energy Efficiency Ratio (EER) determined the replacement. Table 1 shows the savings at maximum output for each unit (See Appendix, page 1-2).

AHU #	Existing EER	New EER	Improvement
1-4	11	20.5	46.3%
5	11.3	16	29.3%
6	11.2	16	30%
Average			42.7%

Table 1: Energy Efficiency Ratio Improvements in HVAC System

Water Heater

The center currently utilizes one Rheem Universal Heavy-Duty 75 Gal. 125K BTU Commercial Natural Gas Tank Water Heater (See Appendix, page 1-3). The tank operates on 80% efficiency and the boiler requires 8 hours of usage per day. On average, this heater consumes 431,999,984 BTU of energy and 4,320 Therms per year which costs about $4,708.80 per year.

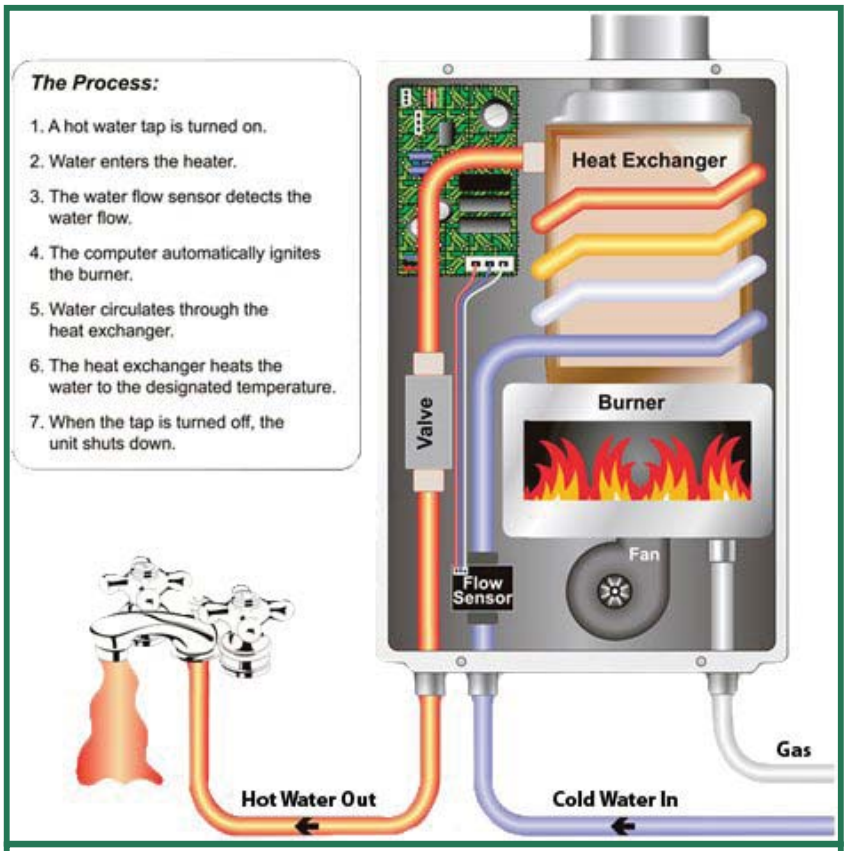

Figure 9: Tankless Water Heater Diagram

Replacing the current water heater with a tankless water heater (See Figure 9) decreases yearly operating cost, is more efficient and requires less time for hot water to reach its destination. The Rheem Commercial 9.5 GPM Natural Gas High Efficiency Indoor Tankless Water Heater (See Appendix, page 1-4) runs on 96% efficiency and does not require a specific time of usage per day. One tankless water heater uses approx. 182 therms/year and two of these units satisfy the usage requirements of the center which leads to a savings of 3,956 Therms per year which is a 92% improvement. The upfront cost of the tankless water heaters is $3,056.00 and the installation cost is around $1,000.00-$2,000.00 depending upon the contractor. The reduction in natural gas consumption saves about $4,312.04 per year. Even with two of these tankless water heaters installed, it would be far more efficient than the tank heater they currently use, and would greatly increase their overall energy efficiency.

Window Replacement

The windows in the lobby are all single-pane windows that are not energy efficient and are poorly insulated. The recommendation for the center is to switch over to double pane windows as shown in Figure 10. The replacement of the single pane windows to the ENERGY STAR double pane windows will result in a 22% average cost savings for each window. There are 24 windows in the center, with an estimated $323.00 saved per window per year, the center would save $7,752.00.

Short-Term Improvements

Refrigerators

Two of the refrigerators in the facility are not EnergyStar rated and therefore require more energy than necessary for functionality. The facility runs the refrigerators 24/7 for the staff room and office room. Each refrigerator currently uses approximately 1,539 kWh of energy per year for a total of 3,078 kWh per year; combined, the two refrigerators cost $221.60 per year. To convert to a GE applicance, the Energy Guide estimated kWh per year for both appliances is 800 kWh, and the estimated price is $57.60. This leads to a savings of $164.02, and an energy savings of 2,278 kWh per year.

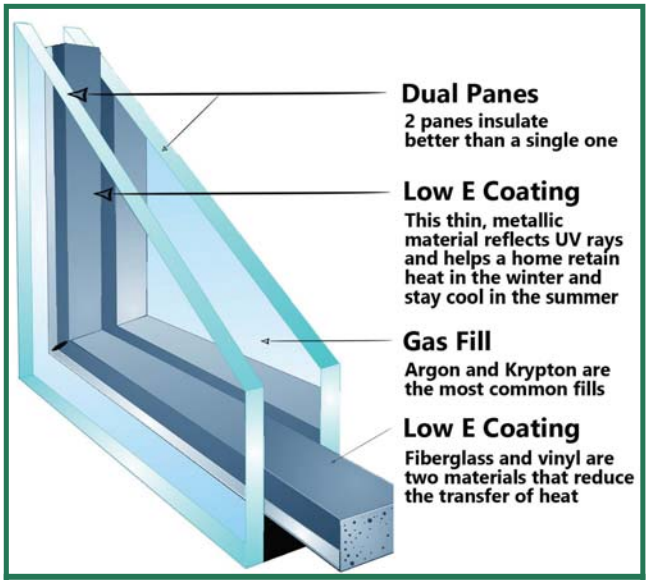

Figure 10: Double Pane Window Diagram

Printers

The center utilizes 10 large all-in-one office printers. Half of them are older models that consume substantial amount of power in general and 95W of power consumption in standby mode (See Appendix page 1-5). The other half are EPEAT Gold-Certified with only 1W of power consumption in standby mode (See Appendix, page 1-6). Recommendation for the center is to implement a printer consolidation strategy called “Workgroup printers”.

Most organizations can achieve a ratio of one device (typically a networked multifunction device) per ten or more users. Based on the number of employees at the center, this would remove the five older models. Benefits include lower costs for hardware, consumables (paper, ink, and toner), electricity, and maintenance. Representative savings run between 30 and 40 percent per year and can range as high as 60 percent of total printing costs, according to various vendors. Each old equipment uses approximately 1,720 kWh of energy per year with the cost of $192.70, which leads to a possible savings of $963.50.

5. Net Zero Recommendations

Near South Health Center has the potential to drastically decrease energy consumption in the building. With the improvements, the center can reduce its energy consumption by 75% including the photovoltaic (PV) system. As shown in Figure 11, the existing EUI of the center is 225.47 kBtu/ft^2, and with the improvements made, the new EUI is 54.6 kBtu/ft^2.

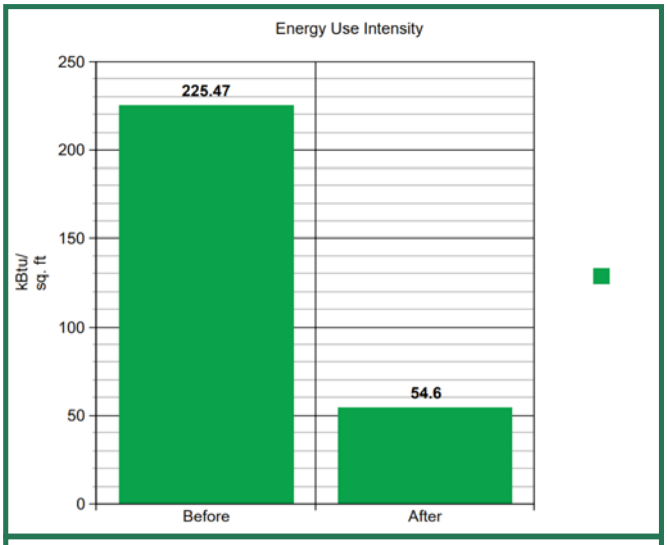

Figure 11: Old EUI vs. New EUI

Figure 12 shows that about 391,228.1 kBTU/year is needed to achieve net zero status, and is possible with some other techniques. This includes: researching ways to implement new renewable energy sources, adding roof insulation, and reflective windows. Currently, the natural gas consumption is responsible for 1,109,800 kBTU/year. After the recommendations to the heating system, natural gas consumption went down by 44%. This reduction in natural gas leads to an estimated $5,389.56 saved per year in heating and cooling costs.

If the center incorporates renewable energy sources, such as geothermal technology, the center would then be able to achieve net zero. In order to achieve this, the center will require a complete overhaul to their current heating system, including replacing the existing ductwork, and new wall and door insulation. A complete overhaul to the heating system requires the center to close for at least 2 to 4 months and costs anywhere from 30 to 50 thousand dollars to install.

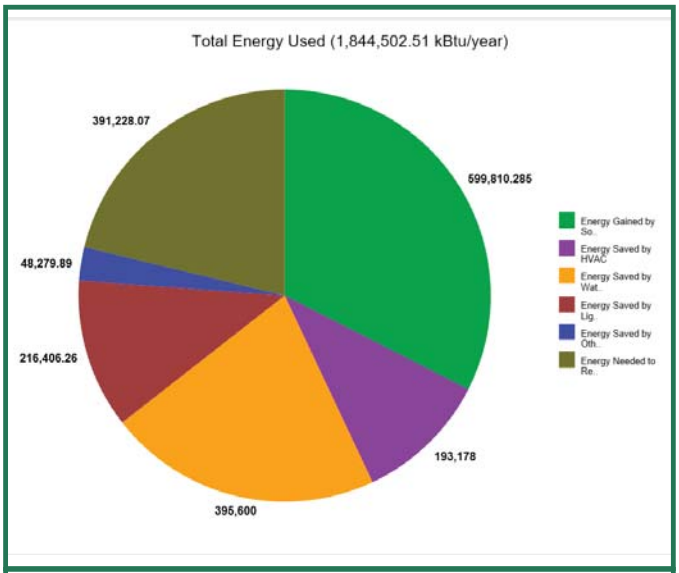

Figure 12: Total Energy Used

1. Lighting System Recommendation

A lighting audit of the Near South Health Center was conducted and revealed the current lighting situation. There are eighty seven 2' by 4' drop ceiling lights with varying bulbs per fixture located on the first and only floor of the facility. There are an additional twenty 2' by 2' that house a U style bulb. These types of light fixtures utilize T8 fluorescent bulbs which provide approximately 2,300 lumens and each consume roughly 25 to 32 watts per bulb. There are currently no dimmer switches or daylight sensors. Some of the areas of the building do not receive necessary luminosity levels or achieve ideal color temperature for this workplace environment. It has also been noted that the heat distribution in this facility is inefficient and would greatly benefit from a more energy efficient lighting solution.

As seen in Figure 13, there are a total of 54 rooms. The spaces consist of fifteen office like spaces, eighteen exam rooms, one mechanical room, four storage rooms, five bathrooms, and ten miscellaneous use rooms such as lobby and reception areas. Drop ceiling lights are the only type of lights used and are thus able to be retrofitted with LEDs. Although there are windows in the building, they are only present on the south wall of the reception area. The windows span the top 2' of the south wall but are under the roof's overhang thus limiting the direct sunlight entering the reception area.

Figure 13: Floor Plan of Near South Health Clinic

The NECA-IIT Chapter has detailed several changes to the current lighting system that will not only be code-compliant but also cost and energy efficient.

Negative Attributes of the Existing System

As seen in Figures 14 and 15, some of the ceiling lights are spaced too close to one another, leading to an inefficient use of the available lighting; however, the placement is necessary in many areas due to lux requirements for specific medical rooms. It was also observed that the lights remained on even outside of the regular business hours despite not offering overnight services.

Figure 14: Exam Room

Figure 15: Conference Room

Positive Impact of the New System

The replacement of the original system with LEDs can have a positive impact on energy consumption and cost. LEDs light up in nanoseconds, which means that the bulbs remain operational for exceedingly small times, increasing their lifespan tremendously. It is estimated they can last two-to-four times longer than most fluorescent, metal halide, and sodium vapor lights. This is over 40 times as long as the lifespan of an average incandescent bulb. It is believed that the LED bulb lighting retrofit project will result in a 30% reduction in its energy consumptions for lighting purposes. LEDs are dimmable, which is a feature that not only decreases the cost more, but it is also essential in order to imitate natural daylight cycles, which is the most beneficial pattern of lighting to the center's patients, since it helps modulate their circadian rhythm. They do not produce UV rays, they work well in a wide range of operating temperatures with very small levels of degradation. Finally, they are a lot more environmentally friendly than the other lighting systems because of the lower energy consumption and they do not contain toxic elements, such as mercury. Figures 16 and 17 demonstrate the impact of the proposed lighting system change.

Figure 16: Proposed Lobby Lighting

2. Product Selection

Figure 17: Proposed Hallway Lighting

Customer's Needs

The recommendation is to replace the existing fluorescent light bulbs with LED equivalents while keeping with the current lighting troffers. The lighting troffers that are placed too close to one another will either be moved further apart or removed if unnecessary. These changes will lower operating costs while fixing the lighting distribution.

The installation of occupancy sensors in all rooms is also recommended since currently there are none in place. This will also help in reducing the energy consumption for lighting to achieve the net zero rating for the whole building. Figure 18 displays the proposed occupancy sensors.

3. Reflected Ceiling Drawings

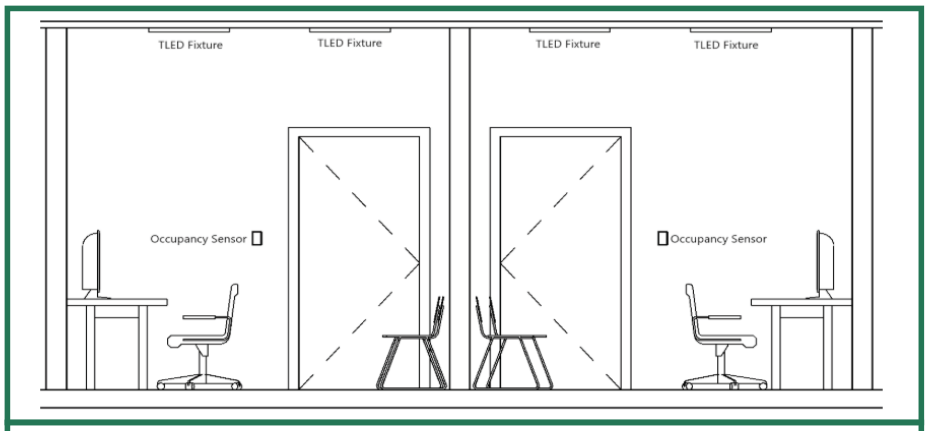

Figure 18: Occupancy Sensor Diagram

Figure 19 and Table 2 highlight the troffer placements in the Near South Health Center.The larger rectangles in the drawing represent the 2'x4' lay-in troffers with 4 lamps per troffer. Due to the functionality of certain rooms, such as the triage room or clinical exam rooms, it is recommended that those areas meet or exceed lux readings of 1,000 lumens/m^2. The squares represent the 2'x2' troffers with 2 U shaped lamps. These are only found in the hallways or small storage areas where it is recommended lux readings only exceed 100 lumens/m^2. Finally, the long rectangular boxes represent the 1'x4' troffers with 2 lamps per troffer. These only appear in the maintenance room and janitor's room where lighting is recommended to exceed 200 lumens/m^2. The current placement of the troffers is conducive to the recommended lumens/m^2 in each room.

Technical Analysis 2: Lighting Retrofit

Figure 19: Reflected Ceiling Drawing

Count	Manufacturer	Catalog Number	Fixture Description	Lamp Type	Input Watts	Luminosity	Initial Color Temperature
20	PL & T	LEDT-10069CS	2'x2' Troffer (2 U-lamp)	U-TLED	18 W	2200 lm	4000 K
87	TCP	88LT8000021	2'x4' Troffer (4 Lamp)	TLED	22 W	2800 lm	4100 K

Table 2: Lighting Fixture Schedule List

4. Photometric Analysis Drawing

See Figure 20 for the photometric Analysis Drawing of the Near South Health Center.

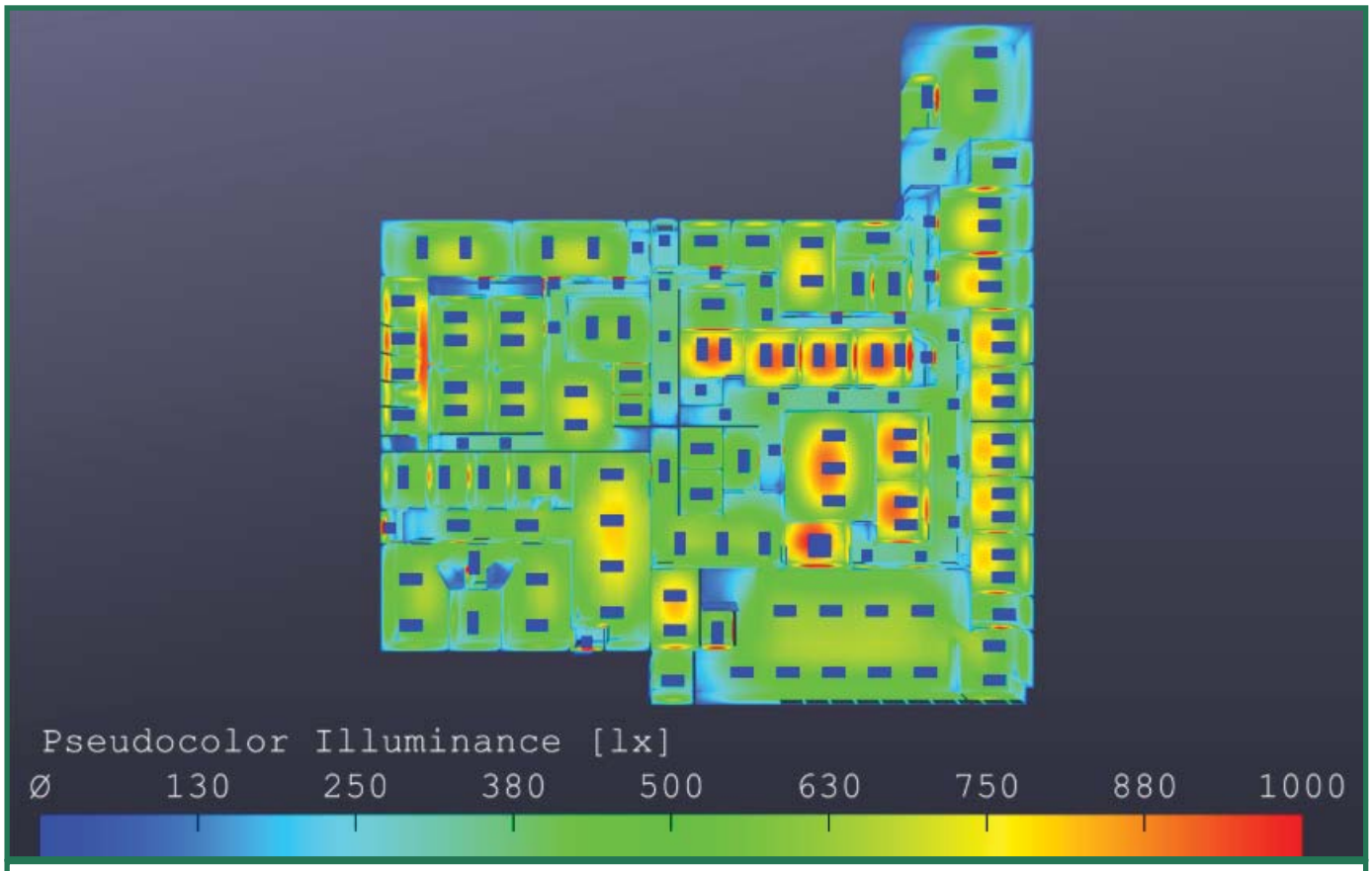

Figure 20: Photometric Analysis Drawing

IES Illuminance Recommendations

The Illuminating Engineering society publishes a handbook listing specific standards that guide lighting professionals. These standards propose certain levels of light intensity, measured in footcandles (fc), a unit measuring illuminance on a one square foot surface from a uniform source of light. Table 3 is the recommended illuminance values, as well as the illuminance values for the existing and the proposed lighting systems, which show how the proposal is aligned with the recommendations of the Illuminating Engineering Society:

Room Type	(IES) Suggested Illuminance, fc	(Current) Actual Illuminance, fc	(New) Actual Illuminance, fc
Warehouses	150	150	150
Patient Room	1000	800-1000*	800-1000*
Normal Office	500	800	600-900*
Lab	750-1200	900	800
Corridors	100	50-700*	100-500*
Locker Room	100-300	500	400*
Restrom	100-300	300-500*	300-400*
Waiting Rooms	200-300	400-700*	550-1000*
Conference Room	300-500	300-450*	300-650*

Table 3: Suggested vs. Actual Illuminance
*= range of values, varying with specific rooms or segments of larger space

Negative Impact of Poor Lighting Levels

If lighting is implemented in the specific pattern that imitates day cycles, which has been proven to be the most beneficial to patients by modulating the body's circadian rhythm, most benefits come from using brighter settings. However, there are a few potential negative outcomes that might occur as a result of overexposure to light in health-care settings. Another issue that correlates to excessive brightness is potential retinal damage in preterm infants, since they have thinner eyelids and have not yet developed the ability to constrict their pupils in response to light exposure. As seen in Figure 21, color temperature can have very specific effects on the work environment when the lighting levels are inadequate, resulting in the rise of staff-related errors, like medication dispensing error rates in pharmacies, which can be life-threatening to patients.

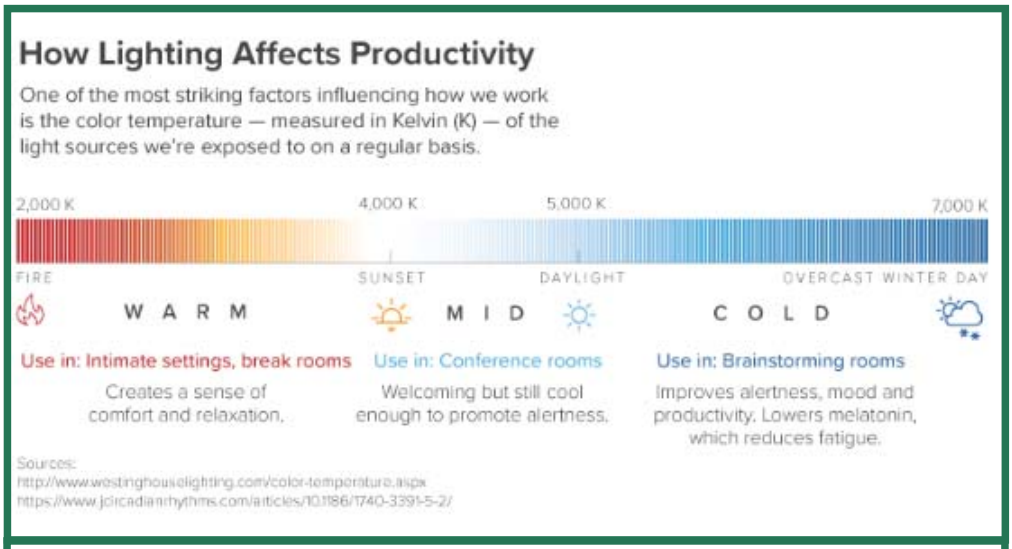

Figure 21: Effects of Color Temperature on Mood

5. Return on Investment Report

The retrofit expects a return on investment in 10 years. The initial cost of installation is estimated at $26,000 without additional funding factors.The comprehensive lighting project will result in a 20% reduction in energy usage. Cost over time in years for the lighting installation is shown in Figure 22.

According to the Energy Information Administration, lighting in commercial buildings makes up between 17% and 38% of the total energy cost. The health center currently uses 668 4ft F32T8 lamps and 40 2ft FB32T8 U-lamps. These are connected electrically to a combined fluorescent ballast count of 124 per based on the audit. The first segment of Table 4 displays monthly costs of each product including replacement per ballast.

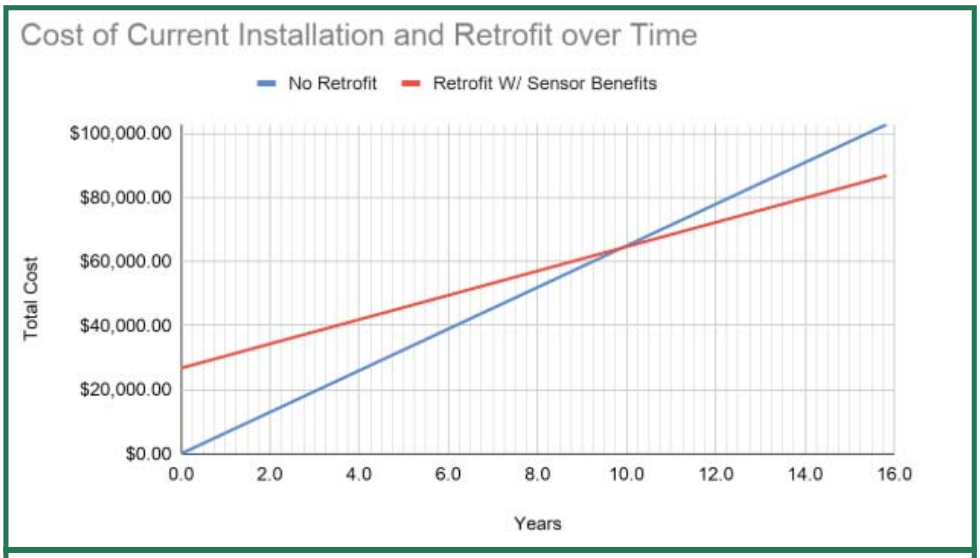

Figure 22: Installation and Retrofit Cost over time

Some speed of electricians are assumed per new installations: about 3 ballasts removed and re-wired fixtures per hour, 10 minutes to rewire existing lighting controls to utilize occupancy sensors, 10 minutes to replace and test bulbs per fixture. The wage package for electricians working this job is $85.79 according to calculations from the finance section of the report. The second segment of Table 4 contains more detail on the calculations for how many labor hours and the installation total cost. Lamp and sensor pricings come from current bulk pricing related to the selected products (See Appendix, page 1-7). The total cost of the initial installation with parts and labor is shown below as $26,722.60.

The monthly cost of the retrofit installation shows the effect of lowering the wattage of lights throughout an entire facility. The electrical cost lowers by over $200/mo when factoring the occupancy sensors and LED lamps together. With parts and labor, the monthly rate drops by 29% between the old and new lighting system.

Technical Analysis 2: Lighting Retrofit

(a) Current Cost per month									
Lighting Units	Lifetime (hrs)	Watts	Cost/ each	Count	$/mo. Units	Man hrs/ each	Wage Rate	Labor cost/ month	Total/month
F32T8 tube	24,000	32	$1.77	668	$15.34	0	$0.00	0	$15.34
F32T8-U	20,000	32	$4.93	40	$3.08	0	$0.00	0	$3.08
T8 4-Line Ballast	75,000	--	$14.27	87	$5.16	0.17	$85.79	$5.17	$10.34
T8 2-Line Ballast	75,000	--	$7.87	37	$1.21	0.17	$85.79	$2.20	$3.41
Electrical Cost	kW (total)	kWh/ month	$/kWh	Electric $/month	Total Month of Current Installation				$541.11
Lamp Con-sumption	22.656	7,068.7	0.072	$508.94	Total/Year of Current Installation				$6,493.37
(b) Retrofit Installation Costs									
Item Type	Qty.	Units	Hours/ unit	Labor Hours	Wage Rate	Labor Cost	Unit Cost	Mat. Cost	Total Cost
Labor--Bal-last Bypass + Lamp	124	EA	0.33	40.92	$85.79	$3,510.50	--	--	$3,510.53
Occupancy Sensors	54	EA	0.17	9.18	$85.79	$787.55	$70.00	$3,780.00	$4,567.55
LED Tube Lamps	668	EA	0.17	113.56	$85.79	$9,742.31	$5.00	$3,340.00	$13,082.31
U-LED Lamps	40	EA	0.17	6.8	$85.79	583.37	4.00	$160.00	$743.37
								Subtotal	$21,903.77
								Overhead (10%)	$2,190.38
								Contractor Profit (12%)	$2,628.45
								Retrofit Upfront Cost	$26,722.60
(c) Retrofit Monthly Costs									
Lighting Units	Lifetime (hrs)	Watts	Cost/ each	Count	$/mo Units	Man hrs/ each	Wage Rate	Labor Cost/ month	Total/month
LED T8 Tube	50,000	22	$8.57	668	$35.73	0	$0.00	0	$35.73
LED T8-U	50,000	18	$13.00	40	$3.24	0	$0.00	0	$3.24
Electrical Cost	kW	kWh/mo	$/kWh	Electric Cost/mo				Sensor	No Sensors
Lamp Consumption	15.416	4,809.8	0.072	$346.31		Total/month of New Installation		$316.02	$385.28
Sensor Adjusted Power	15.416	3,847.8	0.072	277.04		Total/year of New installation		$3,792.22	$4,623.35

Table 4: Lighting Retrofit Cost Analysis

1. Photovoltaic Solar Energy System Evaluation

The Near South Health Center currently doesn't have a PV system, therefore, the set up is designed from the ground up. The first step is to evaluate the possible locations to place the system. Then, evaluate the advantages and disadvantages of Grid-Direct, Grid interactive or Off-Grid for energy storage and decide on a system that fits the needs of the center. A scaled plan view of the system and shading analysis will be provided as a detail to determine the maximum amount of sunlight capturable. Then a 3-line diagram of the PV system, including PV panel array, inverters, batteries among others will be included to demonstrate the connections between the center and other sources. Finally, a summary of all proposed changes will be provided that will list all the costs and benefits for the center to install a PV system.

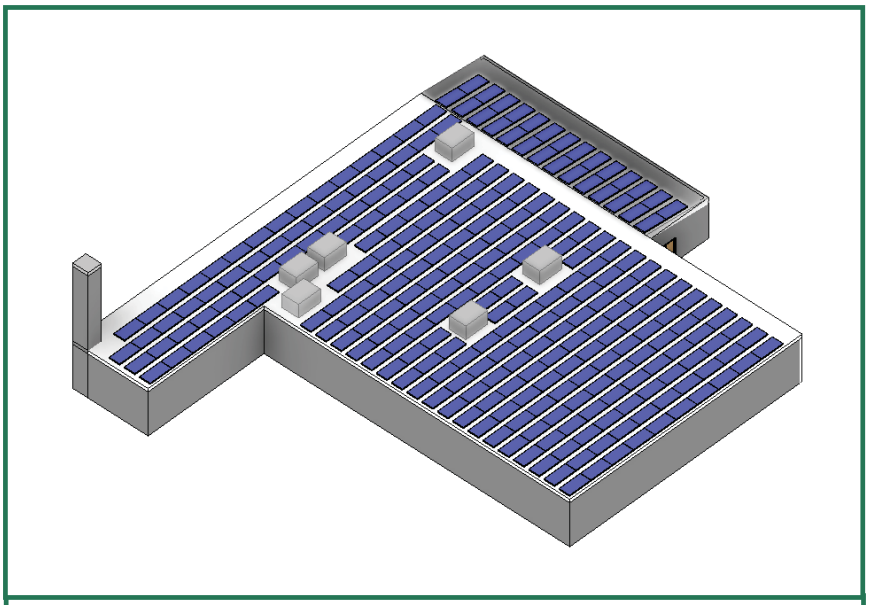

Figure 23: PV Array Location

Location Evaluation

The solar panels can only be placed is on top of the 6900 ft^2 rooftop (See Figure 23). The center is a compact building on a very small piece of land. The optimal tilt angle for the PV panels in Chicago is 40° with respect to the Sun's Azimuth. The optimal tilt angle is found when the sun rays hit the PV panels directly, and is based on 2 factors: where the panels are located and the time of year.

The formula to calculate the angle for the building's latitude is:

$$Intensity = 1.35\ x\ \left(\frac{1}{1.35}\right)^{\sec(angle\ of\ Sun\ from\ Zenith)}\ \frac{KW}{m^2}$$

Nevertheless, the sun is not in a fixed location and thus there are different optimal angles depending on the season; for summer it would be 18 degrees and for winter 66 degrees. Thus, the maximum efficiency throughout the year can be achieved by having a tracker, single or dual axis. However, it is not recommended to have any mechanical parts located outdoors at such heights in an area like Chicago. Due to the high uplift wind loads, wind deflectors, here would be a high maintenance cost and a higher risk for malfunctions. Therefore, the NECA-IIT Student Chapter suggests using a fixed setup with a 20 degree angle for best cost-efficiency.

2. Photovoltaic Grid System

Grid-Direct:

A grid direct (or grid tied) solar system is connected to the utility power grid and doesn't make use of a battery. The panels generate direct current (DC) electricity which is sent through an inverter to convert the power to grid-compatible alternating current (AC) electricity. The advantages of grid direct systems are they provide the most stable and efficient usage of the solar panels, and it is the most economical one through the use of net metering. These installations and the equipment are lower in cost, since they don't require extra batteries or stand-alone equipment. A grid-tied system also stores excess electricity onto the utility grid that can be sold to companies committed to buying energy from individuals with solar panels. With the power grid serving as a battery, there is no need for maintenance or replacements, no energy is wasted, and the system is more efficient compared to battery storage and uses the grid as backup power in case the PV system stops generating power. However, using grid-tied solar panels leaves the users still at the mercy of the electric companies, which are adding more fees in many areas and reducing the buying prices, making the solar users responsible for all the extra strain placed on the grid. In case of a blackout of the local electric substation, a grid-tied system is rendered useless and the user has no electric power, since the panels are automatically shut off to protect the electrical workers.

Grid-Interactive:

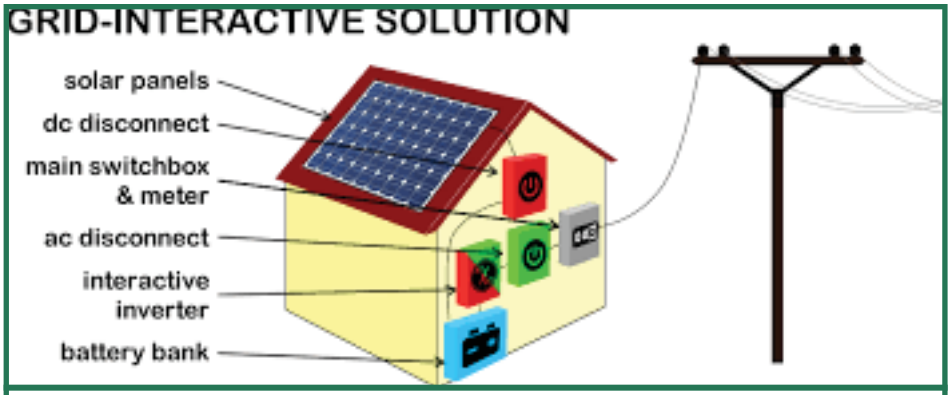

Figure 24: Grid-Interactive System Diagram

A hybrid solar system combines aspects of off-grid and on-grid systems (See Figure 24). This system connects solar panels to a battery and the grid at the same time. The advantages of this system are that it is cheaper than off-grid systems. There is no need for a backup generator with this system. The battery capacity can be downsized, and the electricity from the utility company is cheaper than diesel. With this system, the solar battery is used as a backup in case the grid goes down, and the owner can sell power to the electric company. This system allows the user to have maintenance support from the electric company and saves them the cost of a backup generator. The system has also a lot of potential, since the new inverters take advantage of changes in the utility electricity rates throughout the day, meaning solar energy can be programmed to be used during peak hours, and the grid power during off-peak hours. The excess electricity stored in the batteries can be put on the utility grid

when the user gets paid the most per kWh. Finally, since the battery is being used as a backup instead of a full-time dependence, it discharges less frequently, which adds to the battery's life. This means that, since the battery's life is extended, it needs to be replaced less often. The disadvantage of this system is that it is still more expensive than a grid-tied system (but cheaper than an off-grid, since there is no need for a backup generator). Also, the battery bank doesn't charge during a power outage, since the grid-tied solar panels are designed to stop producing electricity during an outage. This is to protect the electrical workers working on the live power lines, therefore, the same battery capacity necessary with this system.

Off-Grid:

An Off-Grid system (See Figure 25) is not connected to the utility power grid. This system uses the DC power that the PV panels generate and feeds it into a charge controller, then a battery bank for storage. A power inverter is still necessary to convert the battery power from DC to the 120V AC power that outlets use, and an optional backup generator. The advantages of an off-grid system are that by using these panels, the user can become energy self-sufficient and avoid power failures on the grid.This system can also be cheaper than extending power lines in certain remote areas (more than 100 yards from the grid), and it offers almost the same reliability as the grid-tied system. The disadvantages of this system are that it needs to have enough battery capacity to store excess energy, and it often requires a backup gas generator in cases of emergency, which adds an extra cost to the system. Furthermore, the batteries can be quite expensive, difficult to use, and may decrease the efficiency of the system. The batteries need to be replaced every 10 years, and can store only a certain amount of energy. This can be risky during cloudy times, and may call for a backup generator. Finally, in many areas, during the summer, an Off-Grid solar system generates a surplus of energy, and a lot of the solar electricity produced during this time goes to waste, contrary to a grid-tied system, which distributes it to the electric company's substation.

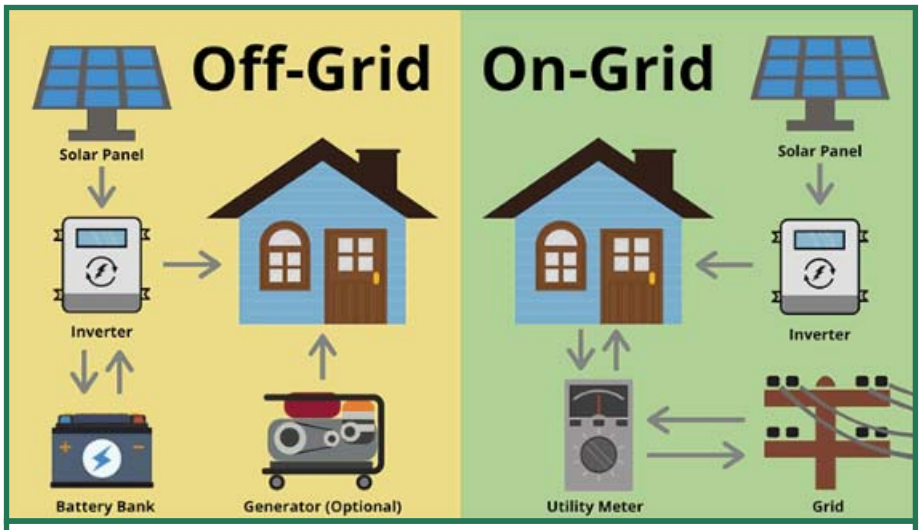

Figure 25: Off-Grid vs. On-Grid System

Technical Analysis 3: Solar Energy System

The recommendation for Near South Health Center is the grid-tied solar system. For this building, it is more economical (to install and sustain), it is stable, and it is easier to install. This system also has the highest ROI (Return On Investment). This is because the panels do not produce enough energy for the needs of the center, therefore the facility won't have a surplus of energy for a battery bank, which renders the expense of one redundant.

3. Scaled Plan View

Based on the information given, NECA-IIT decided the best location for the PV panels are represented in the scaled plan view. Reference back to Figure 26, if needed.

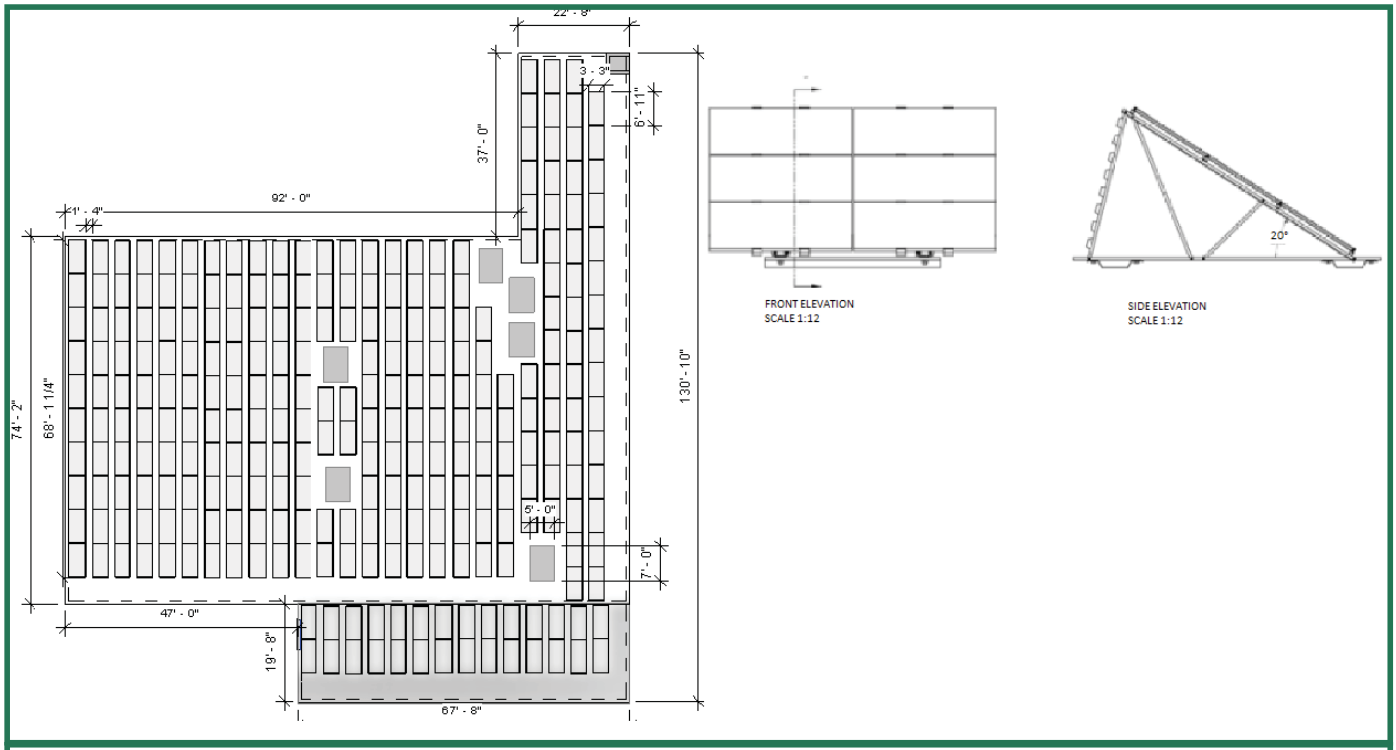

Figure 26: Roof Plan

Shading Analysis

Currently, the center is one of the shorter buildings in the area. Thus, the surrouding objects and buildings affect shading.

To reveal how the PV panels are affected by shadows, Figures 27-38 demonstrate the shading effects during each season at various times of the day.

Technical Analysis 3: Solar Energy System

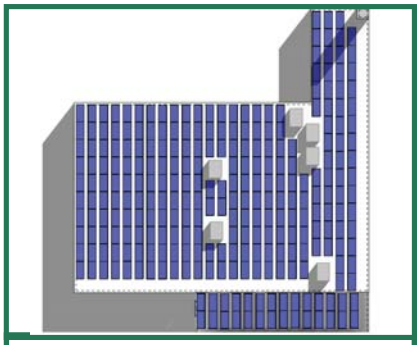

Figure 27: Fall 09:00 AM

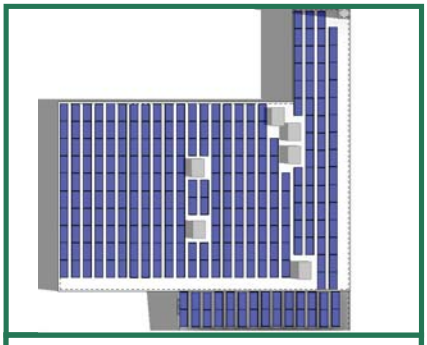

Figure 28: Fall 12:00 PM

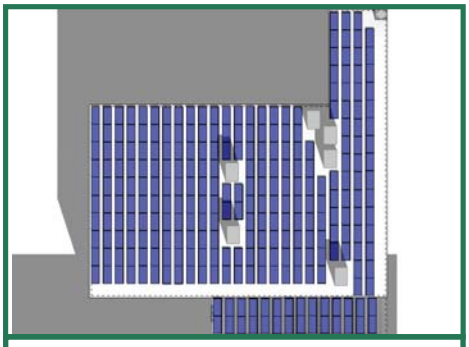

Figure 29: Fall 04:00 PM

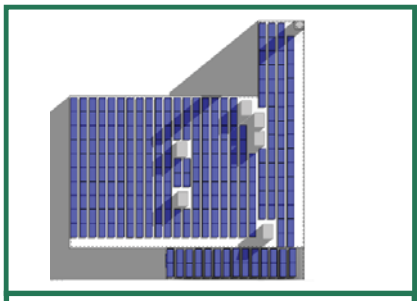

Figure 30: Winter 09:00 AM

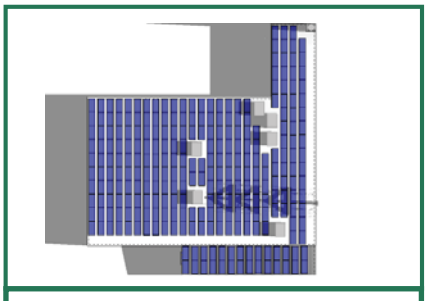

Figure 31: Winter 12:00 PM

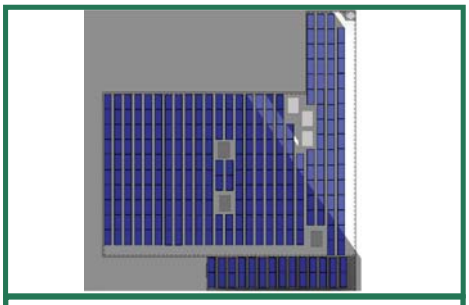

Figure 32: Winter 12:00 PM

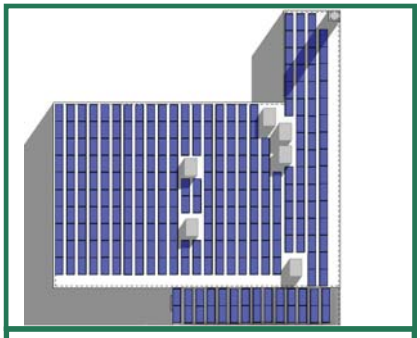

Figure 33: Spring 09:00 AM

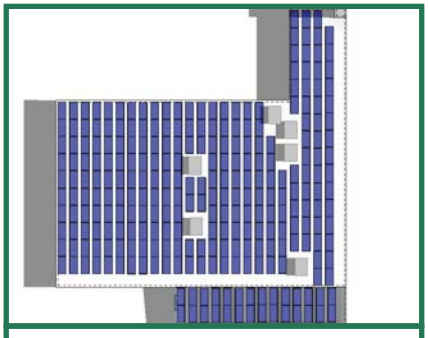

Figure 34: Spring 12:00 PM

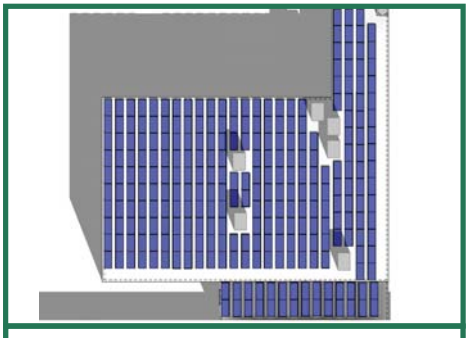

Figure 35: Spring 04:00 PM

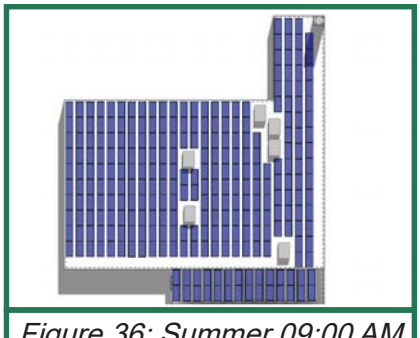

Figure 36: Summer 09:00 AM

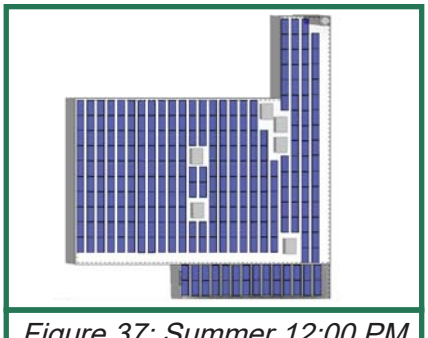

Figure 37: Summer 12:00 PM

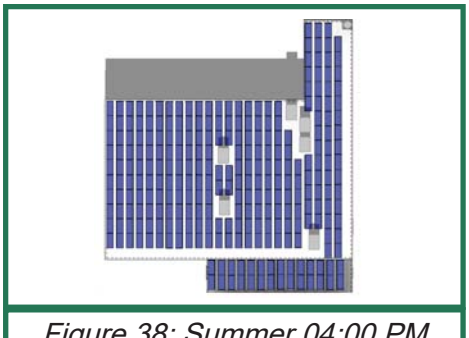

Figure 38: Summer 04:00 PM

4. 3-Line Diagram

See Figure 39 for the 3-Line Diagram of the proposed PV system

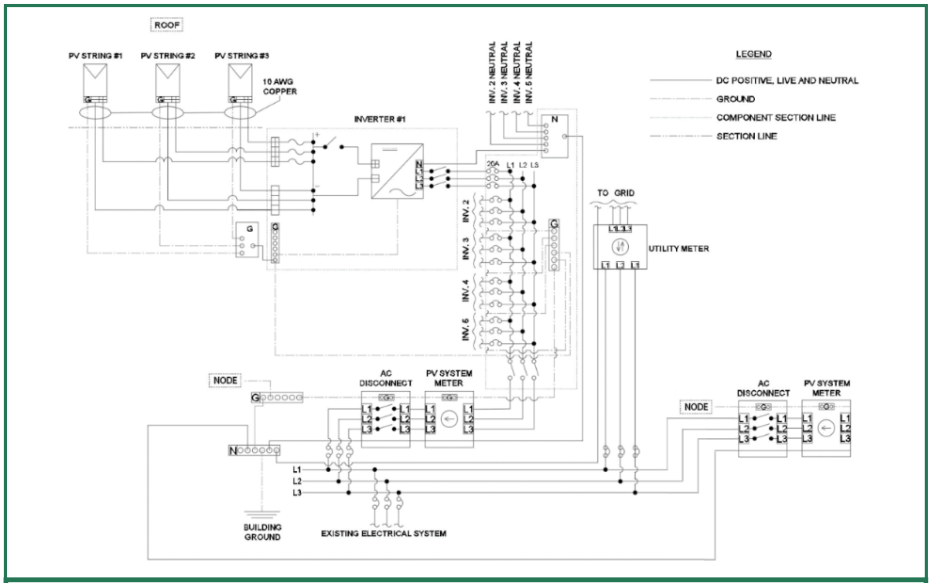

Figure 39: Proposed Schematic 3-Line Diagram

5. Equipment Selection

PV Panels

Solar panels are the main components that produce the electricity through PV cells. Light from the sun is converted into energy making it most efficient to use these solar panels during the day when the sky is clear. The solar panels need to be elevated and adjusted perpendicular to the sunlight to absorb the maximum amount while avoiding shadows. The panels we selected for this project are the HiKu_CS3W-MS 435W.

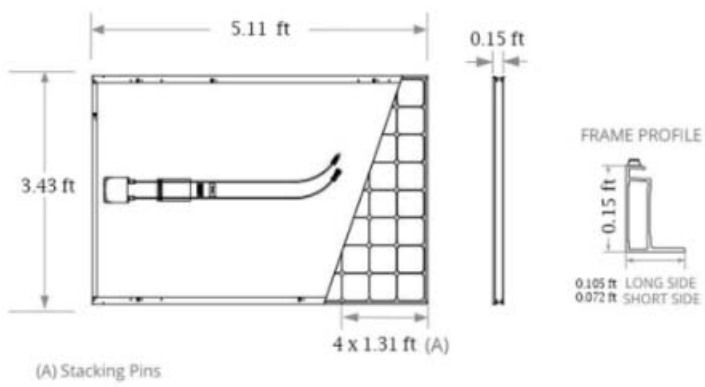

Figure 40: Solar panel

These panels were selected because they provide 26% more energy than most conventional panels. They are also cheaper in upfront cost and in the lifetime of the system, with a 4.5% lower LCOE and up to 2.7% lower system cost (See Figure 40).

Solar Inverter

Solar panels generate DC electricity which needs to be converted to AC electricity for use in buildings. In a string inverter system, solar panels are linked together in series and the DC electricity is brought to a single inverter which converts it to AC power. In a micro inverter system, each panel has its own microinverter attached to the backside of the panel. The panel produces DC, but is converted to AC on the roof and is fed straight to the electrical switchboard. There are more advanced string inverter systems which use small power optimizers attached to the back of each solar panel. Power optimizers are able to monitor and control each panel individually and ensure every panel is operating at maximum efficiency under all conditions.

Summary of Electrical Components

The following is a list of proposed components from the panels to the existing building system:

- Canadian Solar HiKu_CS3W-MS 435W solar panels
- Canadian Solar CSI-60KTL-GS/GI Inverter
- Aluminium (AL6005-T5) 20 degree Tilt Mounting
- 2 Pfg 1169 PV1- F 1x4mm2, Black/ Red, TUV certification cabling

More information about the solar panels and solar inverter selected are available for reference (See Appendix, page 1-8).

6. Summary Report

Upfront Cost

The complete installation of the solar energy system costs about $212,885.00. This estimate includes the equipment required for the solar energy system as well as the labor required to install them. Structural testing of the roof must be included for the mounting components used for the solar panels. Due to the age of the building, the structural integrity of the building must be taken into account when installing the mounts and racks for the solar panels. The weight and embedding plays a significant factor when designing the system. See Figure 41 for energy produced per month by the system.

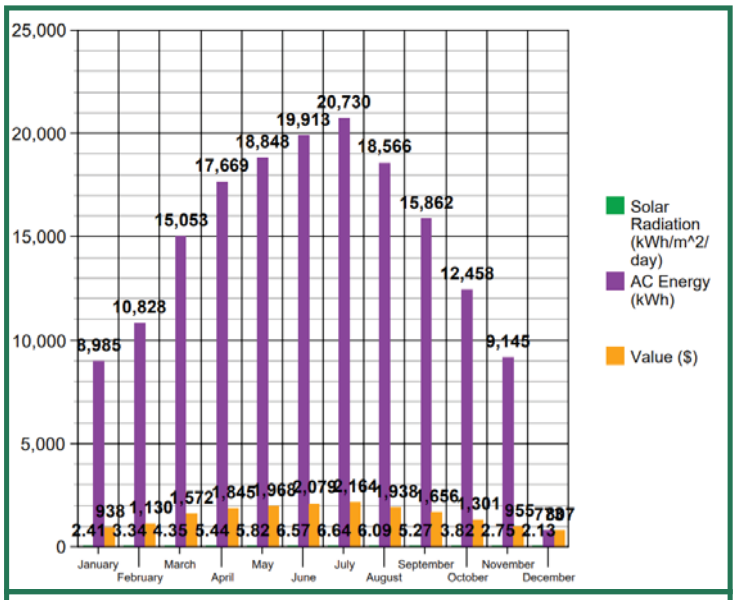

Figure 41: Solar Energy Produced per month

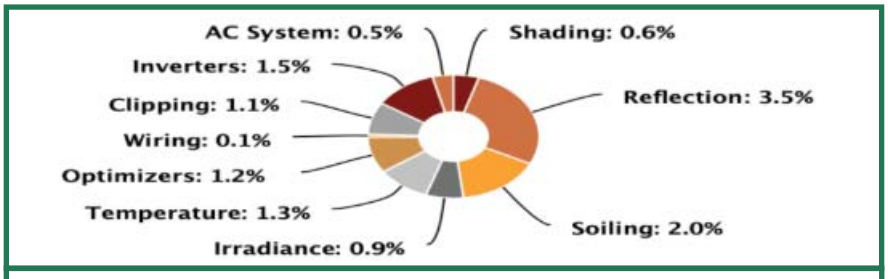

Figure 42: Solar Loss Percentage

Life Cycle & Maintenance

Little maintenance is usually required for solar panels. Aside from washing off dirt and dust two to four times a year with water, to help achieve maximum light absorption. The specific panels suggested for the center last for about 25 years, and have a 12-year warranty on materials and workmanship. This guarantees that the solar panel output won't fall below a certain level (about 80.2%) during this time. The output decline over one year is 2.0% and from years 2-25, it is 0.7%. Figure 42 shows the percentage these losses affect the system.

Grant/Tax Incentives

Solar Renewable Energy Certificates (SRECs) are solar incentives that allow homeowners to sell certificates for energy to their utility (See Figure 43). A homeowner earns one SREC for every 1,000 kilowatt hours (kWhs) produced by a solar panel system. A SREC is worth $103.55 per 1,000 kWhs in Illinois. In addition to the Illinois solar incentive, the center could also benefit from a federal solar tax credit. Section 25D of the Internal Revenue Code provides for a tax credit equal to 26% of the cost of the system installed through 2020. Moreover, the Smart Inverter Rebate has a value set at $250.00 per kW of the project's direct current capacity. The program is available only to projects in MidAmerican, Ameren, and ComEd utility territories, according to the law. FEJA mandates that only utilities that serve more than 200,000 customers in Illinois are required to offer the rebate.

Figure 43: SRECs

Energy Generated

Table 5 displays the comparison of kWh used by the center during the different seasons to the production of kilowatt hours that the solar energy system will produce. Table 6 provides the approximate kWh produced throughout the year. The solar energy system produces more energy during the warmer months peaking in July at 20,730 kWh. During the colder months of the year (October-February), the system is producing 7,730 kWh. The kWh produced per year shown in

Table 6 and Figure 41, this includes the potential losses of the solar energy system. Shading and soiling are two common occurrences that affect the production of the solar panels. Increased maintenance can help reduce these effects to achieve maximum efficiency. Before taking into account the losses shown in Figure 42. The production output of the system is calculated at 152.25 kWh, which is 75.29% efficiency.

Month	kWh Produced
January	8,985
February	10,828
March	15,053
April	17,669
May	18,848
June	19,913
July	20,730
August	18,566
September	15,862
October	12,458
November	12,160
December	7,730

Table 6: kWh per Month

kWh Used in Colder months	kWh Used in warmer months	kWh Used per year	kWh Produced in Colder months	kWh Produced in Warmer Months	kWh Produced per year
125,600	65,400	191,000	97,730	78,057	175,787

Table 5: kWh Produced vs. Used

Positive Cash Flow

The proposed solar energy system will result in positive cash flow over the course of 70 months. This is based solely on the savings the solar panels generate over the course of the year and the SREC certificates that are awarded per megawatt hour produced. The 2020 solar investment tax credit accumulates to $18,202.74. However this value only applies to the taxes which the center must pay annually. This remaining credit cannot be refunded, but can be rolled-over into the following year. Table 7 details these credits.

Cost of Project	kWh Produced per year	Savings per month on energy production	SREC Certification	Total Amount of Savings per year	Payback Period (Months)
$212,885.00	175,787	$18,353.00	$18,202.7	$36,555.74	70

Table 7: Payback Period

CO2 Pollution Reduction

The EPA estimated that the energy generated by the panels is equivalent to 174,030 pounds of CO2. With an estimated a minimum life cycle of 25 years, the PV system will offset over 3,481 kilopounds in its lifetime. This is the same as 3,153,773 miles driven by a passenger vehicle.

Schematic Estimate, Schedule, and Finance Plan

1. Cost Estimate

The NECA-IIT Student Chapter has calculated estimated costs of parts and labor required for this project as shown in Table 8. For Technical Analysis 1, the estimated cost before overhead and contractor profit comes to $29,565.24. Including overhead and contractor profit, the estimated cost is $36,069.59. For Technical Analysis 2, the estimated cost before overhead and contractor profit comes to $18,403.77. Including overhead and contractor profit, the estimated cost for the lighting retrofit is $22,452.60. For Technical Analysis 3, the estimated cost before overhead and contractor profit comes to $212,884.76. Including overhead and contractor profit, the estimated cost for the solar energy system is $259,719.09. This brings the total cost of the project to $318,241.28.

Technical Analysis 1: Energy Efficiency Analysis									
Item	Qty.	Units	Man Hours/ Unit	Labor Hours	Wage Rate	Labor Cost	Unit Cost	Total Material Cost	Labor + Materials
Refrigerator-GE	2	EA	1	2	$20.12	$40.24	$96.00	$192.00	$232.24
JELD-WEN V-4500 White Vinyl Sliding Window	24	EA	1	24	$40.00	$960.00	$280.00	$6,720.00	$7,680.00
Carrier WeatherExpert AC, 6 ton	4	EA	6	24	$40.00	$960.00	$3,706.00	$12,304.00	$13,264.00
Carrier WeatherExpert AC, 4 ton	1	EA	5	5	$40.00	$200.00	$2,498.00	$2,498.00	$2,698.00
Carrier Weather Expert AC, 3 ton	1	EA	4	4	$40.00	$160.00	$2,235.00	$2,235.00	$2,395.00
Rheem Commercial Natural Gas High Efficiency Tankless Water Heater	2	EA	3	6	$40.00	$240.00	$1,528.00	$3,056.00	$3,296.00
								Subtotal	$29,565.24
								Overhead (10%)	$2,956.52
								Contractor Profit (12%)	$3,547.83
								Total	$36,069.59
Technical Analysis 2: Lighting Retrofit									
Item	Qty.	Units	Man Hours/ Unit	Labor Hours	Wage Rate	Labor Cost	Unit Cost	Total Material Cost	Labor + Materials
Labor--Ballast Bypass + Lamp	124	EA	0.33	40.92	$85.79	$3,510.53	--	--	$3,510.53
Occupancy Sensors	54	EA	0.17	9.18	$85.79	$787.55	$70.00	$3,780.00	$4,567.55
LED Tube Lamps	668	EA	0.17	113.56	$85.79	$9,742.31	$0.00	$0.00	$9,742.31
U-LED Lamps	40	EA	0.17	6.8	$85.79	$583.37	$0.00	$0.00	$583.37
								Subtotal	$18,403.77
								Overhead (10%)	$1,840.38
								Contractor Profit (12%)	$2,208.45
								Total	$22,452.60
Technical Analysis 3: Solar Energy System									
Item	Qty.	Units	Man Hours/ Unit	Labor Hours	Wage Rate	Labor Hours	Unit Cost	Total Material Cost	Labor + Materials
Panels	350	EA	0.67	228	$25.00	$5,700.00	$339.00	$118,650.00	$124,350.00
Inverter	3	EA	76	228	$25	$5,700.00	$3,499.00	$10,497.00	$16,197.00
Mounting	1	EA	609	609	$25.00	$15,225.00	$33,495.00	$33,495.00	$48,720.00
Wiriing	1	EA	457.5	457.5	$25	$11,437.50	$12,180.00	$12,180.00	$23,617.50
								Subtotal	$212,884.50
								Overhead (10%)	$21,288.45
								Contractor Profit (12%)	$25,546.14
								Total	$259,719.09

Table 8: Cost Estimate

Summary of Schedule

Lighting will be installed between August 17th, 2020 and August, 24th, 2020. A crew of four will work on lighting installation, dividing the clinic into manageable segments so as to work efficiently but also to maximize the usable space within the clinic. While lighting is being installed, the new refrigerators will be brought into the clinic. The windows will be installed on the weekend of August 22nd so that windows can be installed on a Saturday in patient rooms that are not being used and on Sunday when there are no patients in the clinic. A crew of two will work on the window installations. This will allow for a more speedy installation process. The AC units will be installed on Sundays, beginning August 22nd, 2020, each unit with its own particular Sunday. This is so that the clinic has working AC during its operational days of the week. It will take a total of six weeks to finish the installation of all of the units, finishing on September 26th. The water heater will also be installed on September 26th. The installation of the solar system will begin on September 7th with a crew of four, starting off with wiring which will take 21 days. Next, mounting will be installed beginning September 29th, 2020, taking 28 days. Then, panels will be installed

beginning October 28, 2020, taking 8 days. Lastly, inverters will be installed beginning November 6, 2020, taking 8 days. The project end date for the entire project will be November 16th, 2020. The Gannt chart in Table 9 displays this progression of work. It is worth noting that this schedule takes into account both work and allotted break time for workers.

The spread of dates ensures minimal disruption of current operation. Lighting and window installation has the most potential for disruption, but splitting the center into smaller and more manageable segments will minimize or eliminate disruption. The installation of AC units, the water heater, refrigerator, and solar panels are predicted to have very little to no impact on the way the clinic is running its day to day activities.

2. Gantt Chart Schedule

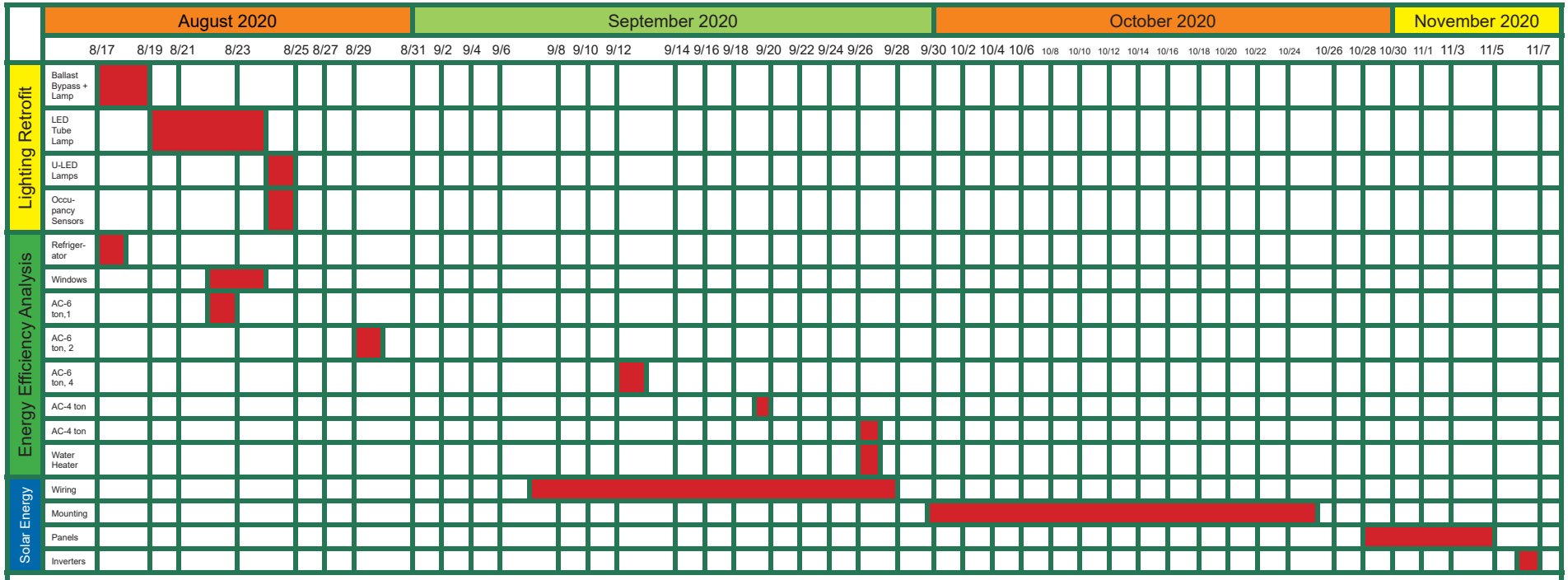

Table 9: Gantt Chart Schedule

3. Financing Plan

Table 10 shows that the changes in the Technical Analysis 1 section will result in a savings of $16,361.66 per year. With a total project cost of $35,923.00, the projected return on investment is three years. This is a conservative estimate, rounded up from 2.20 years projected return on investment. Positive net cash flow will occur in the third year of operation. The implementation of solar energy would greatly reduce the cost of electricity used for lighting. The projected returns on investment for the upgraded lighting with and without solar power to display the positive impact solar power would have on the ability of the Near South Health Center to pay back the investment and begin generating positive cash flow. The lower estimate on projected ROI would achieve a positive cash flow after 4 years, rounded up from the raw calculation of 3.14 years.

Energy Efficiency Analysis	
Total Cost of Project: $35,923.00	
Itemized Savings per Year	
Water Heater	$4,312.04
Windows	$7,752.00
Refrigerator	$249.00
Printers	$963.50
HVAC	$2,085.12
Total Savings per Year: $16,361.66	
Projected Return on Investment: 3 years	
Lighting Retrofit	
Total Cost of Project: $22,452.60	
Yearly cost of New vs. Old Installations	
Type	Cost
Old	$6,493.37
New-Without Solar Power	$3,434.68
New-With Solar Power	$595.92
Projected ROI without Solar Power: 8 years	
Projected ROI with Solar Power: 4 years	
Solar Energy System	
Total Cost of Project: $259,719.09	
Financing Opportunites	
Incentive	Cash Gain
ComEd Rebate	$38,000.00
Federal Tax Credit	$55,350.00
SREC	$273,041.00
Total Finances: $366,391.00	
Savings per Year: $18,353.00	
Projected Return on Investment: 3 years	

Table 10: Projected ROI per Analysis Section

The SREC will be paid out over five years to the Near South Health Clinic, bringing in a cash flow of $54,608.23 per year over the five year period. Thus, the solar system will have paid for itself by the third year of operation, and will produce a net positive cash flow in the third year of operation. This is a conservative estimate rounded up from 2.36 years.

4. Positive Cash Flow

The total project cost is $318,241.28 and is represented in blue in Figure 44. The cash influx is determined by the piecewise equations in Figure 43. The equation for cash influx was determined to be the amount of savings per year and funding received from grants or other sources as a function of time in years. Cash influx is represented in red in Figure 44. The point at which the red and blue lines intersect, marked 'Intercept' in Figure 44, is the breakeven point. Thus, the Near South Health Center will achieve a positive cash flow in 2.39 years after the beginning of the project. Assuming the project begins on August 17th, 2020, then the date on which the Near South Health Center achieves a positive cash flow is January 8th, 2023.

Cash Flow in Dollars per Year

$$\begin{cases} f_0(x) = 187241.46x & \text{if } 0 \le x \le 1 \\ f_0(x) = 93990.8(x-1) + 187241.46 & \text{if } 1 \le x \le 5 \\ f_0(x) = 42047(x-5) + 563944.8 & \text{if } x \ge 5 \\ f_1(x) = 318094.00 & \text{as project cost} \end{cases}$$

Figure 43: Cash Flow Equation

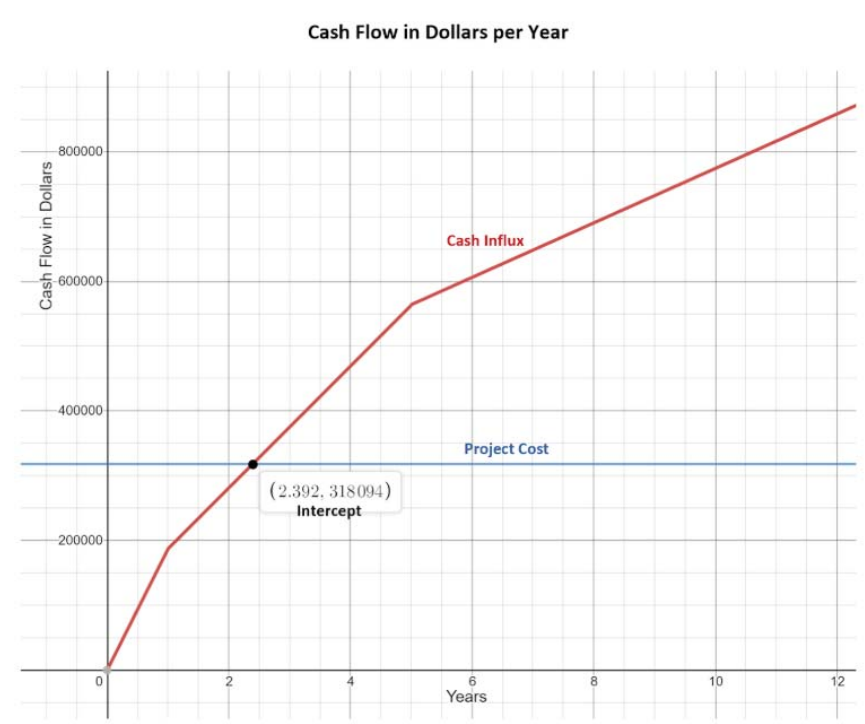

Figure 44: Cash Flow Chart

Energy Awareness Campaign

Summary of Campaign

The NECA-IIT Student Chapter created an Energy Awareness campaign (See Figure 45) that would benefit the campus community and surrounding neighborhood. First, the student newspaper provided a platform to inform fellow students, faculty, and staff of the efforts of the chapter. This action spread the meaning of net zero and described the resulting positive environmental impact, as well as increased participation throughout the campus community.

Figure 45: Campaign Flyer

Workshops were held to inform the organization on the benefits of solar and lighting. In collaboration with the campus Citizens Climate Lobby group, the NECA-IIT Student Chapter learned the basics of climate change and energy audit calculations. The use of various social media platforms encouraged students to speak to their local representatives about the Energy Innovation and Carbon Dividend Act. The combination of these efforts reached nearly 3,000 student body members, who believe in being better educated on their role as environmental activists as a result of our efforts.

The next step in this process involved engaging with Near South Health Center to produce fliers for distribution to patients on ways to reduce energy consumption at home and work. The fliers are educational and informative of simple practices that can be done with minimal effort but create a large impact on our societal energy consumption. Reaching nearly 300 Bronzeville families, this campaign can reduce the community's carbon footprint tremendously.

The NECA-IIT Student Chapter has always been committed to educating people about the challenges the world faces in regards to green energy and what can be done to combat this change on a personal and societal level, as this is the first step in the existence and growth of green energy design.

Summary of Volunteer Service

Though constrained by the COVID-19 pandemic, the NECA-IIT Student Chapter worked with the Near South Health Center to create fliers and distribute information on reducing energy consumption. The fliers catered towards each group: Doctors, Nurses, and other medical staff; building and office managers; and facility and security personnel. The main contact for distributing these fliers was Keyander Baldwin. In making these fliers, the joint goal is to help reduce the community's carbon footprint through better information and mindful practices. See Figure 46 for the letter of performance from the Near South Health Center.

April 24, 2020

To Whom It May Concern:

The Illinois Tech Spring 2020 IPRO: Energy Efficiency Strategies Student Team has partnered with the Near South Health Center to bring awareness to the community about our efforts for environmental sustainability as we serve our local Bronzeville community. Providing efficient, affordable and friendly service to our patients is our utmost priority, and we appreciate our local university tech students' efforts in guiding us on how to keep our energy costs down.

The student team has visited the site on multiple occasions, demonstrating teamwork, an appreciation for our facility, and a keen interest in our energy operations. They collected light flow measurements, examined our floorplan and the occupancy pattern of our rooms, analyzed and took photographs of our lighting and energy equipment, and consulted with our facilities staff to gather more information from a primary source.

As part of their project, the IPRO Team launched a local marketing campaign to bring awareness of our efforts to engage and promote sustainability not only within our clinic, but also within Bronzeville. The students wrote a letter to the community and promoted their partnership with the Near South Health and our sustainability efforts on social media.

In closing, I endorse this team's application and proposal for your competition, and hope that their work will continue to inspire our communities to support and increase participation in environmental sustainability.

Sincerely,

Keyander Baldwin
Clinic Manager
Near South Health Center

Figure 46: Letter of Performance

A log of the IIT-NECA Chapter's Volunteer Service can be found in the appendix (See Appendix, page 1-9).

Local NECA Chapter Interaction

Summary of Interaction

The team consulted various times with Tim Taylor, Assistant Manager of the Chicago and Cook County Chapter, NECA. Tim presented his NECA involvement and career early in the project. Then Jack Smith and Steve Awe from Kelso-Burnett Co. gave a presentation on Project Management and PV solar systems (See Figure 47). Tim helped immensely by answering questions about the competition and reviewing the proposal for accuracy. Working alongside contractors from Cook County Health, the team obtained data from ComEd and drawings from the center. See Figure 48 for the letter of performance from Tim Taylor.

Figure 47: Jack Smith and Steve Awe visit NECA-IIT Student Chapter Meeting

Log of Interaction

- Face-to-face visit with Tim Taylor-Assistant Manager ECA (January 23rd)
- Presentation from Jack Smith-Senior Division Manager Kelso-Burnett Co. (January 30th)
- Site Visit with Keyander Baldwin-Manager Cook County Health Clinic (February 6th)
- Site Visit with Jack Smith-Senior Division Manager Kelso-Burnett Co.(February 10th)
- Planning for Next Chapter Meeting with Tim Taylor-Assistant Manager ECA (February 11th)
- Plan for Site Visit with Mike Hickey-Site Contractor Coordinator Cook County Health Clinic (February 19th)
- Discuss energy costs with Tim Taylor-Assistant Manager ECA (February 27th)
- Preparation for COVID-19 Changes with Tim Taylor-Assistant Manager ECA (March 13th)

A log of interaction detailing the IIT-NECA Chapter's interaction with various local NECA members can be found in the Appendix (See Appendix, page 1-10).

Local NECA Chapter Interaction

ECA Electrical Contractors' Association of City of Chicago, Inc.

April 28, 2020

Ms. Laura Holmes
ELECTRI Administrator
ELECTRI International
3 Bethesda Metro Center, Suite 1100
Bethesda, MD 20814

Dear Laura:

I am writing to fulfill the 2020 NECA Green Energy Challenge requirement in the Local NECA Chapter Interaction section: Items #1 & #2. On behalf of the Chicago & Cook County Chapter, NECA, we are pleased to support the NECA IIT Student Chapter for the *Green Energy Challenge* competition by providing examples of interaction with the Chapter. As the sponsor of the IIT chapter, our Student Committee and overall membership continues to be regularly involved with the students in a variety of activities.

Listed below are a number of those activities from this school year:

- NECA presentation/Introduction. T. Taylor, 1/23/2020;
- Discussion of NECA Green Energy Challenge, submittal of ELECTRI applicable Research Projects for review, appropriate ASHRAE materials for review, contact with Chapter office in regard to wage scale, scope of work of Local 134 electricians, among other areas throughout the semester 1/24/2020 through 4/17/2020;
- "Project Management & Solar Energy" – Presentation by Jack Smith and Steve Awe, Kelso-Burnett Co. for NECA IIT Student Chapter meeting at IIT, 3/5/2020.
- Discussion of NECA Green Energy Challenge with member contractors of the Association Executive Committee, 4/8/2020.

In addition to the above listed activities, our office has had many telephone and e-mail conversations with the student chapter members, students have contacted several of our member contractor companies, general contractor(s) and related industry professionals regarding topics for meetings, as well. We are pleased to sponsor and work with this NECA Student Chapter.

Sincerely,

Timothy A. Taylor

Tim Taylor
Assistant Manger

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Figure 48: Letter of Participation from Tim Taylor

Campus/Local Media Engagement

University Newsletter

See Figure 49 for the news release on the NECA-IIT Chapter.

TechNews Latest News Archive Contact Us About

IIT National Electrical Contractors Association (NECA) reinstated for the Spring 2020 semester

Christina Hiotaky
NECA Secretary
Pronouns: (She/Her)
Mon Feb 03, 2020

The Illinois Tech National Electrical Contractors Association (NECA) chapter has officially been reinstated as a club for the Spring 2020 semester. During the first week of classes, four officers were selected to run the chapter: Samantha Blanchard (President), Messara Haseeb (Vice President), Christina Hiotaky (Secretary), and Raymond Schroeders (Treasurer). Every semester the NECA chapter investigates the electrical and energy efficiency of a nearby public building and proposes various changes in an effort to achieve a net zero energy outcome. A net zero energy outcome means the total amount of energy used by the building on an annual basis is equal to the amount of renewable energy created on the site. "NECA Student Chapter teams (will) demonstrate their ability to analyze particular electrical construction management "problems" and create a comprehensive plan and budget for an appropriate retrofit. Students are challenged to develop technical skills that are vital to careers in electrical construction and professional skills including time management, written communication, and oral presentation" (NECA website). This project takes place throughout the Spring 2020 semester, and will be entered to compete at the 2020 NECA Green Energy Challenge in October, set to take place right here in Chicago. The project leads for the 2020 competition are Kevin Dillon (Team Leader) and Tristan Meredith (Co-Leader). The team plans to conduct an energy audit of Near South Health Center, located on 35th Street, under the advising of Dr. Dan Tomal. Email sblanchard@hawk.iit.edu if you would like additional information on how to get involved!

Figure 49: TechNews Article

A copy of the articles published detailing the overview of the project work the NECA-IIT Student Chapter has completed throughout the semester can be found in the Appendix (See Appendix, page 1-11).

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Home comfort is easily accessible online and with the free, downloadable mobile app. In your family room, at the office, or anywhere in the world, you can't beat the convenience.

*Based on a 2012 third party study comparing Carrier® Cor™ technology to the estimated cost of a non-programmable thermostat set at 72°F at all times.

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Nominal Cooling Ton Size	Cooling Stages	AHRI Efficiency (SEER) IEER	Dimensions (in) L x W x H	Gas Heat - Heating Input (Btuh)			Approx. Unit Weight (lbs)
				Low	Medium	High	
3	1	(14.0)	74 x 47 x 33	67	110	–	482
4	1	(14.0)	74 x 47 x 33	67	110	150	543
5	1	(14.0)	74 x 47 x 33	67	110	150	556
6	2	15.0	74 x 47 x 41	67	110	150	607

Electric Heat / Electric Cooling & Cooling Only Models – 50FC

Nominal Cooling Ton Size	Cooling Stages	AHRI Efficiency (SEER) IEER	Dimensions (in) L x W x H	Electrical Heat Nominal kW Range	Approx. Unit Weight (lbs)
3	1	(14.0)	74 x 47 x 33	4.0 to 15.0	437
4	1	(14.0)	74 x 47 x 33	4.0 to 21.0	498
5	1	(14.0)	74 x 47 x 33	6.5 to 24.0	511
6	2	15.2	74 x 47 x 41	6.5 to 24.0	562

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Nominal Cooling Ton Size	Cooling Stages	AHRI Efficiency SEER	Dimensions (in) L x W x H	Gas Heat - Heating Input (Btuh)			Approx. Unit Weight (lbs)
				Low	Medium	High	
3	2	16.0	74 x 47 x 33	67	110	-	513
4	2	16.0	74 x 47 x 33	67	110	150	555
5	2	16.0	74 x 47 x 41	67	110	150	600

Electric Heat / Electric Cooling & Cooling Only Models – High Efficient 50GC

Nominal Cooling Ton Size	Cooling Stages	AHRI Efficiency SEER	Dimensions (in) L x W x H	Electrical Heat Nominal kW Range	Approx. Unit Weight (lbs)
3	2	16.0	74 x 47 x 33	4.0 to 15.0	468
4	2	16.0	74 x 47 x 33	4.0 to 21.0	510
5	2	16.0	74 x 47 x 41	6.5 to 24.0	555

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- CO_2 Sensor
- Condensate Overflow Protection
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- Phase Monitor/Protection
- Thru-The-Base Utility Connections
- Louvered Hail Guards
- Non-Fused Disconnect Switch
- HACR Breaker (GC models)
- Electric Heaters (GC Models)
- Low Ambient Controls (GC Models)
- Foil Face Insulation (GC Models)
- MERV-8 Return Air Filters
- Hinged Access Panels
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- Powered Convenience Outlet
- Coated Coils:
  - Pre-Coat
  - E-Coat
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Low profile damper minimizes overall product height. Heavy duty vent hood supports are designed to withstand the rigors of installation.

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Warranty

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See Commercial Warranty Certificate for complete information.

Efficiency | All models tested according to ANSI test procedures, and meet or exceed the thermal efficiency and standby loss requirements of ASHRAE standard (EPact). Also exceeds energy efficiency codes of all states including California Energy Commission (CEC).

Safety and Construction | Design certified by CSA: For operation at 180 degrees; meets all safety and construction requirement of ANSI Z21.10.3; as an automatic storage or instantaneous water heater; as an automatic circulating tank water heater; and for operation on combustible floors and in alcove installations. **Certified for 150 PSI maximum working pressure (160 PSI for ASME models).**

Optional Construction | ASME construction is available on designated models. UL Sanitation (NSF5) compliant models are available when equipped with optional seal kit (Part No. AM35450).

Continued on page 5

Rheem Universal

35 to 100-Gallon Capacities
98,000-399,900 Btu/h
Natural and LP Gas
Top-Front-Rear Inlet/Outlet
Water Connections

(On Selected Models)

(With Optional Kit)

PRINTED IN U.S.A. 06/17 WP FORM NO. RR102C-1 Rev. 24

The new degree of comfort.™

Rheem Commercial Condensing Tankless Water Heaters

Commercial Tankless Models

RTGH-C95DVL

RTGH-C95XL

Commercial Tankless Models with Manifold Control

RTGH-CM95DVL

RTGH-CM95XL

LEED Points = 2

Rheem Model Number	RTGH-C95DVLN / RTGH-CM95DVLN	RTGH-C95DVLP / RTGH-CM95DVLP	RTGH-C95XLN / RTGH-CM95XLN	RTGH-C95XLP / RTGH-CM95XLP
Operation / Installation	Forced Combustion / Indoor Only		Forced Combustion / Outdoor Only	
Minimum/Maximum Gas Rate (Input)	11,000 / 199,000			
Approved Gas Types	Natural Gas	Liquid Propane	Natural Gas	Liquid Propane
Thermal Efficiency	96%		95%	
Dimensions (Inches)	Height: 27-1/2 / Width: 18-1/2 / Depth: 9-3/4 / Weight: 82 Lbs.			
Electrical				
– Appliance	(120 VAC/60 Hz)			
– Temperature Controler	12 V DC			
Ignition System	Direct Ignition			
Hot Water Capacity				
– Min Flow Rate (Gpm)	0.4			
– Minimum Activation Flow Rate	0.26			
– Maximum Flow Rate	9.5			
Temperature				
– Factory Default Range	100°-120°F			
– Optional Range	85°-185°F			
Temperature (without Remote)	120°F			
Freeze Protection To (Ambient Temp.)	-30°F			
Service Connections				
– Gas Supply	3/4" (19mm) MNPT			
– Cold Water Inlet	3/4" (19mm) MNPT			
– Hot Water Outlet	3/4" (19mm) MNPT			
Controller	UMC-117			
Controller Cable	18 AWG			

Chart continued on reverse

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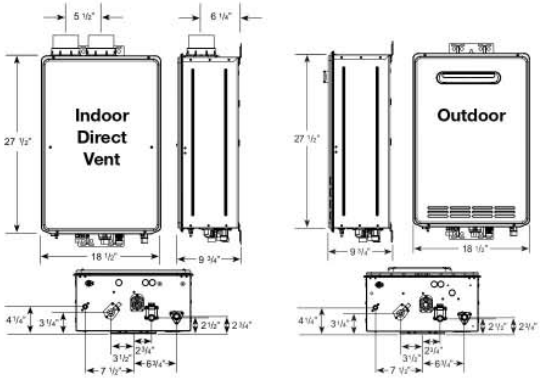
Rheem Commercial Condensing Tankless Water Heaters Continued

Rheem Model Number	RTGH-C95DVLN / RTGH-CM95DVLN	RTGH-C95DVLP / RTGH-CM95DVLP	RTGH-C95XLN / RTGH-CM95XLN	RTGH-C95XLP / RTGH-CM95XLP
Safety Devices				
Clearances Combustible and Noncombustable	*24 inches (610mm) reccomended for service			
– Top of Heater	12" (30cm)			
– Front of Heater	12" (30cm)			
– Sides of Heater	0.5" (1.3cm)			
– Back of Heater	0"			
– Bottom of Heater	12" (30cm)			
– From Vent Pipe	0"			
Min/Max Gas Supply Pressure	4" wc (1.0kPa) / 10.5" wc (2.6kPa)	8" wc (2.0kPa) / 13" wc (3.2kPa)	4" wc (1.0kPa) / 10.5" wc (2.6kPa)	8" wc (2.0kPa) / 13" wc (3.2kPa)
Min/Max Water Supply Pressure	14 psi (97kPa) / 150 psi (1035kPa)			
NOx	Complies with South Coast Air Quality Management District 14 ng/J or 20 ppm NOx emission levels			
Venting				
	Centrotherm PPs (polypropelene solid)		N/A	
	PVC (Schedule 40, ASTM D-1785)		N/A	
	CPVC (Schedule 40, ASTM)		N/A	
	ABS (Schedule 40, ASTM D-2661)		N/A	
Common Venting	Centrotherm PPs (polypropelene solid)	N/A	N/A	
Power Venting (Room Air Intake)	Individual or Common Vent	Individual	N/A	
Warranty	5 Year Heat Exchanger / 5 Year Parts / 1 Year Labor			



Maximum Common Vent Length

MAXIMUM VENT LENGTH (EQ. FT.)				
Number of Units	Direct Vent		Power Vent (Room Air)	
	Air Intake	Exhaust	Air Intake	Exhaust
2	100	100	N/A	100
3	100	100		100
4	100	100		100
5	100	100		100
6	82	82		82
7	55	55		55
8	43	43		43

To Determine Equivalent Vent Lengths, Add:

	8" Common Vent
87 Degree Elbow	5.0' (1.5m)
45 Degree Elbow	2.5' (0.8m)

- The vent termination does not count as part of the straight pipe equivalent when determining the total vent length.
- The system may be vented horizontally through a wall or vertically through the roof.
- Header kits have already been counted and do not need to be added.

Tankless Multi-Unit Flow Rates

Manifold QTY	Total System BTU based on 199,900 Btu per Unit	Total System Gallons Per Minute (GPM) - Per Temperature Rise (ΔT)											
		35	45	50	60	70	77	80	90	100	110	120	140
1	199,900	9.5	8.4	7.5	6.3	5.4	4.9	4.7	4.2	3.8	3.4	3.1	2.7
2	399,800	19.0	16.7	15.0	12.5	10.7	9.8	9.4	8.4	7.5	6.8	6.3	5.4
3	599,700	28.5	25.1	22.5	18.8	16.1	14.6	14.1	12.5	11.3	10.2	9.4	8.1
4	799,600	38.0	33.4	30.1	25.1	21.5	19.5	18.8	16.7	15.0	13.7	12.5	10.7
5	999,500	47.5	41.8	37.6	31.3	26.8	24.4	23.5	20.9	18.8	17.1	15.7	13.4
6	1,199,400	57.0	50.1	45.1	37.6	32.2	29.3	28.2	25.1	22.5	20.5	18.8	16.1
7	1,399,300	66.5	58.5	52.6	43.8	37.6	34.2	32.9	29.2	26.3	23.9	21.9	18.8
8	1,599,200	76.0	66.8	60.1	50.1	42.9	39.0	37.6	33.4	30.1	27.3	25.1	21.5
9	1,799,100	85.5	75.2	67.6	56.4	48.3	43.9	42.3	37.6	33.8	30.7	28.2	24.2
10	1,999,000	95.0	83.5	75.2	62.6	53.7	48.8	47.0	41.8	37.6	34.2	31.3	26.8
11	2,198,900	104.5	91.9	82.7	68.9	59.1	53.7	51.7	45.9	41.3	37.6	34.4	29.5
12	2,398,800	114.0	100.2	90.2	75.2	64.4	58.6	56.4	50.1	45.1	41.0	37.6	32.2
13	2,598,700	123.5	108.6	97.7	81.4	69.8	63.4	61.1	54.3	48.9	44.4	40.7	34.9
14	2,798,600	133.0	116.9	105.2	87.7	75.2	68.3	65.8	58.5	52.6	47.8	43.8	37.6
15	2,998,500	142.5	125.3	112.7	94.0	80.5	73.2	70.5	62.6	56.4	51.2	47.0	40.3
16	3,198,400	152.0	133.6	120.3	100.2	85.9	78.1	75.2	66.8	60.1	54.7	50.1	42.9
17	3,398,300	161.5	142.0	127.8	106.5	91.3	83.0	79.9	71.0	63.9	58.1	53.2	45.6
18	3,598,200	171.0	150.3	135.3	112.7	96.6	87.9	84.6	75.2	67.6	61.5	56.4	48.3
19	3,798,100	180.5	158.7	142.8	119.0	102.0	92.7	89.3	79.3	71.4	64.9	59.5	51.0
20	3,998,000	190.0	167.0	150.3	125.3	107.4	97.6	94.0	83.5	75.2	68.3	62.6	53.7

Maximum Single Unit Vent Length (intake/outlet):

NUMBER OF 90° ELBOWS	MAX. LENGTH OF 2" STRAIGHT PIPE	MAX. LENGTH OF 3" STRAIGHT PIPE	MAX. LENGTH OF 4" STRAIGHT PIPE
0 or 1	5.0 ft. (1.5 m)	38.0 ft. (11.6 m)	94.0 ft. (28.6 m)
2	3.5 ft. (1.0 m)	36.5 ft. (11.1 m)	88.0 ft. (26.8 m)
3	2.0 ft. (0.6 m)	35.0 ft. (10.6 m)	82.0 ft. (25.0 m)
4	N/A	33.5 ft. (10.2 m)	76.0 ft. (23.2 m)
5	N/A	32.0 ft. (9.8 m)	70.0 ft. (21.3 m)
6	N/A	30.5 ft. (9.3 m)	64.0 ft. (19.5 m)

(ULC-S636 pipe must be used for Canada.)

In keeping with its policy of continuous progress and product improvement, Rheem reserves the right to make changes without notice.

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Roswell, Georgia 30076 • www.rheem.com

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PRINTED IN U.S.A. 06/17 WP FORM NO. TK-601RH

The new degree of comfort.™

Suggested Specifications
RTGH-C95DVLN, RTGH-C95DVLP, RTGH-C95XLN, or RTGH-C95XLP

The fully modulating, on-demand, condensing gas fired tankless water heater(s) shall be Rheem models RTGH-C95DVLN, RTGH-C95DVLP, RTGH-C95XLN, or RTGH-C95XLP, having an input rating of 11,000 Btu/h through 199,000 Btu/h and available in NG or LP. The heater(s) shall have ¾ in. male NPT water and gas connections. The heater(s) shall have a minimum flow rate of 0.26 GPM and an activation rate of 0.40 GPM. An integrated condensate neutralizer will be included with every unit. The inlet gas supply pressures shall be 4.0 in. WC (min.) up to 10.5 in. WC (max) for NG and 8.0 in. WC (min.) up to 13 in. WC (max.) for LP. The heater(s) shall be factory supplied with a manual gas shutoff valve, a pressure relief valve, 2 water service valves and a temperature remote, RTG20006, that can be installed up to 195 ft. from the heater using 18 gauge (minimum) control wire. The temperature remote shall provide diagnostic information, fault history, and heater set temperature with a minimum set water temperature of 85°F and maximum set water temperature of 185°F. The heater(s) shall operate using 120 V / 60 Hz power source. The heater(s) will incorporate a factory installed power cord (indoor models only).

The indoor heater(s) shall be vented with 2", 3" or 4" diameter PVC schedule 40, CPVC schedule 40, CentroTherm PPs or ABS (U. S. only) with a length not to exceed 5 ft. (equivalent) for 2", 38 ft. (equivalent) for 3" vent or 94 ft. (equivalent) for 4" vent, terminating horizontally or vertically. The intake pipe may use material such as PVC, ABS, PP, or aluminum and cannot exceed 5 ft. (equivalent) for 2", 38 ft. (equivalent) for 3" vent or 94 ft. (equivalent) for 4" vent. For single vent applications the heater can use room make up air. RTGH-C95DVLN or RTGH-CM95DVLN can be common vented with up to 8 units in-line with an 8" diameter trunk line. The outdoor heater(s) shall be constructed with an integral exhaust vent on the front of the heater.

The water heater(s) shall use a copper, fin tube primary heat exchanger. The secondary heat exchanger shall be constructed from stainless steel 316L. The heater(s) shall be controlled by an on-board solid-state printed circuit board which uses the following factory installed components: thermistors to monitor water inlet and outlet temperatures and heat exchanger temperature; a flow sensor to measure flow rate; flame rods to monitor flame is on or off and if oxygen level is appropriate. The heater shall include in-line fusing for electrical surge protection, an electronic igniter coil, aluminized stainless steel burners, Guardian OFW overheat film wrap, heat exchanger thermistor and outlet thermistor to work as high limit switch, modulating gas valve, an ambient thermistor and freeze protection to -30°F.

The heaters can manifold controls to EZ-Link up to 2 heaters to provide additional capacity. The EZ-Link controls shall be built onto the on-board solid-state printed circuit board and does not require external controls. The heaters can use a MIC-6 controller, RTG20213A, to manifold 2-6 heaters or a MIC-185 controller, RTG20126A & RTG20126B, to manifold 2-20 heaters. The EZ-Link, MIC-6, or MIC-185 controls shall modulate the system for the most efficient performance and rotate the initial heater for balanced duty/cycle operation. The heater(s) shall be CSA approved for sale in the United States and Canada, ENERGY STAR® qualified with a Thermal Efficiency of 96% for Indoor and 95% for Outdoor units, meets the energy efficiency requirements of the U.S. Department of Energy and ASHRAE 90.1-2007, and complies with Ultra-Low NOx emissions of 14 ng/J or 20 ppm.

Suggested Specifications
RTGH-CM95DVLN, RTGH-CM95DVLP, RTGH-CM95XLN, or RTGH-CM95XLP

The fully modulating, on-demand, condensing gas fired tankless water heater(s) shall be Rheem models RTGH-CM95DVLN, RTGH-CM95DVLP, RTGH-CM95XLN, or RTGH-CM95XLP

Same as non-manifold ready (see above) until 4th paragraph

The manifold ready heaters can manifold controls to EZ-link up to 20 heaters to provide additional capacity. Each manifold ready heater shall include a factory installed control module and the control cable shall be included with the units. The heaters controls shall modulate the system for the most efficient performance and rotate the initial heater for balanced duty/cycle operation. The heater(s) shall be CSA approved for sale in the United States and Canada, ENERGY STAR® qualified with a minimum Thermal Efficiency of 96% for Indoor and 95% for Outdoor units, meets the energy efficiency requirements of the U. S. Department of Energy and ASHRAE 90.1-2007, and complies with Ultra-Low NOx emissions of 14 ng/J or 20 ppm.

WorkCentre™ 7425/7428/7435
Specifications

Model	< WC7435 >
Standard functions	Copy, Print, Scan to email, Scan to folder
Optional functions	Fax, Internet fax, LAN fax, Network print connectivity, Network scan, Walkup fax
Print speed	Color: up to 35 ppm Black: up to 35 ppm
First-page-out time, copying	As fast as 5 seconds black and white / 6.4 seconds color
Print memory (standard)	1.5 GB standard
Hard drive	40 GB (min)
Duty cycle	Up to 105,000 images/month
Maximum paper capacity	5,140 sheets
Two-sided output	Standard
Productivity features	Build Job, Collation, Consumable life reporting, Job interrupt, Job queue, Sample set, Separator pages, SmartKits™, Transparency separators, Watermarks
Productivity features (optional)	Annotation, Bates Stamping, Output tray selection
Network protocols	EtherTalk ®, FTP, HTTP, HTTPs, LPR, SNMPv1, SNMPv2, SNMPv3, TCP/IP, UDP

Document handler	Duplex Automatic Document Feeder Capacity: 75 sheets Size: 5.5 x 8.3 in. to 11.7 x 17 in.
Maximum paper capacity	5,140 sheets
Output capacity	600 sheets

Electrical requirements	120 V, 50/60 Hz
Power consumption	Operating: 615 W Standby: 95 W
ENERGY STAR	ENERGY STAR® qualified
Sound pressure levels	56 dB (operating), 22 dB (standby)

Device management features (optional)	SNMP v.1, SNMP v.2, SNMP v.3, Xerox CentreWare® Internet Services Embedded Web Server
Standard security features	Image overwrite security, Network authentication, Secure Print
Optional security features	Audit log, Fax security, Lock printing of received faxes, Xerox Secure Access Unified ID System

Dimensions (WxDxH)	41.2 x 26.6 x 44.3 in. (1,046 x 678 x 1,125 mm)

KONICA MINOLTA

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** Not available at time of launch. Options required.

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bizhub 364e

MONOCHROME PRINTER/COPIER/SCANNER/FAX

COUNT ON KONICA MINOLTA

SPECIFICATIONS	
Type / Toner System / Print Method	Printer/Copier/Scanner with Stationary Platen / Simitri HD Toner with Biomass / Tandem Process
Monthly Duty Cycle (pages)	150,000
Print / Copy Speed (Letter, portrait)	36ppm
• DF-701 Dual Scanner Document Feeder	Full Color/B&W Duplex Speed: 160 opm, Full Color/B&W Simplex Speed: 80 opm, Paper Capacity: 100 Sheets, Paper Size: 5.5" x 8.5" to 11" x 17"
• DF-624 Single Rev. Scanner Document Feeder	Full Color/B&W Duplex Speed: 37 opm, Full Color/B&W Simplex Speed: 80 opm, Paper Capacity: 100 Sheets, Paper Size: 5.5" x 8.5" to 11" x 17"
Power Requirements / Consumption	120V 12A (60 Hz) / 1500W or less
Dimensions / Weight	24.2"(W) x 27" (D) x 36.3" (H) / 168.7 lbs
COPY	
Warm-up Time / First Copy Time	Less than 20 seconds / 5.3 seconds or less
Copy Resolution / Quantity	600 x 600 dpi / 1-9,999
Magnification	Zoom range: 25% - 400%, 0.1% increments, Preset reduction: 78.5%, 73.3%, 64.7%, 50.0%, Preset enlargement: 121.4%, 129.4%, 154.5%, 200%
Copy Exposure Modes	Text (legible text), Text/Photo (clear text and halftones), Photo (optimized for gradations), Map (fine edges and legible text), Dot Matrix (dot matrix or pencil originals), Copied Paper
PRINT: Emperon Print System with bizhub Extended Solution Technology	
Processor / Memory / Hard Disk Drive	800 MHz / 2GB / 250GB (Shared with the copier)
Print Resolution	600 x 600 dpi (1800 equivalent x 600 dpi) or 1200 x 1200 dpi / Grayscale Gradations: 256 shades per pixel
Page Description Language / Fonts	PCL5e/c, PCL6 (XL v.3.0) Emulation, PS3 (v.3016) Emulation, XPS v. 1.0 (XML Paper Specification) / PCL: 80 Roman fonts, PostScript 3 Emulation: 137 Roman fonts
Operating System Compatibility	**PCL6/PS3:** Windows XP Home (SP1), Windows XP Professional (x32, x64), Windows Vista (x32, x64), Windows 7 (x32, x64), Windows 8 (x32, x64), Windows Server 2003 Standard/Enterprise (x32, x64), Windows Server 2003 Standard/Enterprise R2 (x32, x64), Windows Server 2008 Standard/Enterprise (x32, x64), Windows Server 2008 Standard/Enterprise R2, Windows Server 2012 (Datacenter/Standard); **XPS:** Windows Vista (x32, x64), Windows 7 (x32, x64), Windows 8 (x32, x64), Windows Server 2008 Standard/Enterprise (x32, x64), Windows Server 2008 Standard/Enterprise R2, Windows Server 2012 Datacenter/Standard; **Mac (PS-PPD):** OS 9.2 or later, OS X 10.2 or later, OS X 10.4 (Intel) or later / **Linux:** Red Hat Enterprise
Interface	10 Base-T/100 Base-TX/1000 Base-T, USB 1.1, USB 2.0, USB Host
Network Protocols	TCP/IP (IPv4/IPv6), BOOTP, ARP, ICMP, DHCP, DHCP v6, AutoIP, SLP, SNMP, FTP, LPR/LPD, RAW Socket, SMB, IPP, HTTP, POP, SMTP, LDAP, NTP, SSL, IPX, AppleTalk, Bonjour, NetBEUI, WebDAV, DPWS, S/MIME, IPSec, DNS, DynamicDNS, LLMNR, LLTD, SSDP, SOAP
COPY / PRINT FUNCTIONS	
Features	Account Track (1,000 accounts), Administration Mode, Auto Duplex, Auto Tray Switching, Card Shot, Copy Guard, Encrypted Network Password Printing, Energy Save Mode, Enlarge Display, Erase (Border, Frame, Edge) Mode, Finishing (Group, Sort, Staple, Punch, Half-Fold, Tri-Fold, Center Staple and Fold), Form Overlay, Glossy Mode, Image Adjustments, Image Preview (Job Finishing Image Display, Engine Configuration Display), Interrupt, Job List, Job Reserve, Job Skip, Mixplex, Mix-Media, MyTab, Non-Image Area Erase, OHP Interleaving, Password Copy, Program/Recall Jobs, Print from USB, Proof Copy, Secure Printing, Separate Scan, Tab Printing, Text Enhancement, User Authentication (Up to 20 Authentication Servers) (Synchronize w/Account Track), HDD Encryption, HDD Job Overwrite, HDD Sanitizing, User Box Function, Utility (Meter Count, Environment Settings, Default Settings, One-Touch Settings, Check Consumable Life), Watermark, Zoom Selection
SCAN	
Scan Resolutions	200 dpi, 300 dpi, 400 dpi, 600 dpi
Scan File Formats / Color Modes	TIFF, PDF, Compact PDF, JPEG, XPS, Compact XPS, PPTX / Auto Color, Full Color, Black & White, 2-Color, Single Color
Scan Functions	Scan-to-Email, Scan-to-FTP, Scan-to-HDD (Scan-to-User Box), Scan-to-Me/Scan-to-Home, Scan-to-SMB (Scan-to-Desktop), Scan-to-USB, Scan-to-WebDAV, Distributed Scan Management, Network TWAIN, WS-Scan, Color Internet Fax
• FK-508 / FK-511 FAX KIT (OPTIONAL)	
Compatibility / Compression	Super G3 compatibility, 33.6 Kbps modem speed / MH, MR, MMR, JBIG data compression
Fax Transmission Speed / Fax Memory	Less than 3 seconds per page (JBIG, standard resolution) / 2 GB (shared print, copy, scan, fax memory)
Fax Line Mode / Fax Exposure Mode	PSTN, PBX, G3 / Text, Text/Photo, Photo, Dot Matrix
Fax Functions	Autodialing (2,000 addresses), Auto Memory Reception, Broadcasting (maximum 600 locations), Duplex Transmission/Reception, F-Code Support, Group Dialing (up to 500 addresses per group / up to 100 groups), Password Transmission/Reception, PC-Fax, IP Address Fax, Polling Transmission/Reception, Program Dialing (400 programs), Timer Transmission, TSI Routing
• Fax Options	Spare TX-Marker Stamp 2, SP-501 Fax Stamp Unit
PAPER HANDLING	
Original Size	Up to 11" x 17" (scanning/copying), Up to 11" x 17" full bleed on 12" x 18" paper (printing)
Paper Trays	**Tray 1:** 500-sheet (universal cassette) / 5.5" x 8.5" to 11" x 17" / 14 lb. bond to 140 lb. index; **Tray 2:** 500-sheet (universal cassette) / 5.5" x 8.5" to 12" x 18" / 14 lb. bond to 140 lb. index Bypass Tray: 150-sheet bypass / 4" x 6" to 12" x 18", 8" x 13" / Banner Paper / 16 lb. bond to 100 lb. cover up to 300 gsm
• PC-110 Paper Feed Cabinet	500-sheets / 8.5" x 11", 8.5" x 14", 11" x 17" / 14 lb. bond to 140 lb. index / Foolscap: 8.5" x 13.5", 220mm x 330mm , 8.5" x 13", 8.25" x 13", 8.12" x 13.25", 8" x 13"
• PC-210 Paper Feed Cabinet	500-sheets (x2) / 8.5" x 11", 8.5" x 14", 11" x 17" / 14 lb. bond to 140 lb. index / Foolscap: 8.5" x 13.5", 220mm x 330mm , 8.5" x 13", 8.25" x 13", 8.12" x 13.25", 8" x 13"
• PC-410 Paper Feed Cabinet	2,500-sheets / 8.5" x 11" / 14 lb. bond to 140 lb. index
Maximum Paper Capacity	3,650-sheets (total with options)
APPLICATIONS	
Network & Device Management	PageScope Data Administrator, Driver Packaging Utility, HDD Back-Up Utility, Download Manager, Log Management Utility
User Tools	PageScope Web Connection, PageScope Direct Print, PageScope Box Operator, PageScope Print Status Notifier, Copy Protect Utility, Print Utility for Unix
Management Tools	bizhub vCare support
• PageScope Enterprise Suite	PageScope Account Manager, PageScope Authentication Manager, PageScope MyPrint Manager, PageScope MyPanel Manager, PageScope Net Care Device Manager (standard)
• ADDITIONAL OPTIONS	
• Authentication / Security Options	AU-102 Biometric Authentication Unit, AU -201H HID Proximity Card Authentication Unit, AU-202H HID iClass Card Authentication Unit, AU-204H Magnetic Stripe Card Reader, AU-205H IC Card Reader*, AU-211P CAC/PIV Solution*, SC-508 Copy Guard Kit, WT-506 Working Table to support Authentication Devices, MK-735 Internal Mount Kit
• External Keyboard	KH-102 Keyboard Mount Kit, KP-101 10-Key Pad, EK-606 USB Interface for External Keyboard and Voice Guidance, EK-607 USB Interface for External Keyboard, Bluetooth Support and Voice Guidance
• i-Option	LK-101 v3 i-Option, LK-102 v3 i-Option, LK-104 v3 i-Option, LK-105 v3 i-Option, LK-106 i-Option, LK-107 i-Option, LK-108 i-Option, LK-110 i-Option, LK-111 i-Option, UK-204 i-Option Memory Upgrade Kit
• Finishing	FS-534 50-Sheet Staple Finisher, PK-520 Punch Kit (FS-534), FS-534 + SD-511 50-Sheet Staple Finisher + Saddle Stitcher Kit, FS-533 50-Sheet Inner Staple Finisher, PK-519 Punch Kit (FS-533), JS-506 Job Separator
• Others	DK-510 Copy Desk, MK-730 Banner Paper Guide, OC-511 Original Cover

● OPTIONAL ● STANDARD

*Anticipated availability Winter 2014.

KONICA MINOLTA

Konica Minolta Optimized Print Services offers a full suite of device output services and workflow solutions that increase efficiency and control costs. Please contact your authorized Konica Minolta sales representative for details.

Printed on a: bizhub PRESS C8000

KONICA MINOLTA BUSINESS SOLUTIONS U.S.A., INC.
100 Williams Drive
Ramsey, NJ 07446

www.CountOnKonicaMinolta.com
www.kmbs.konicaminolta.us

bizhub Simitri bizhub vCare bizhub MarketPlace

Item #: 364ESS
11/13

LED
U-Bend T8 Tube

PL&T

FEATURES

- Meets DLC performance and efficiency criteria
- Equivalent to a 32-Watt fluorescent U-Bend
- Frosted glass lens evenly diffuses light
- DLC® No. PLTSP14214
- UL listed for use in damp locations
- 4000 Kelvin cool white color
- Bi-Pin G13 base

APPLICATIONS

- Office spaces and conference rooms
- Classrooms and hallways
- Hospitals and lobbies

❖ For use with non-shunted sockets only

c UL us LISTED

DLC QPL DLC LISTED ™

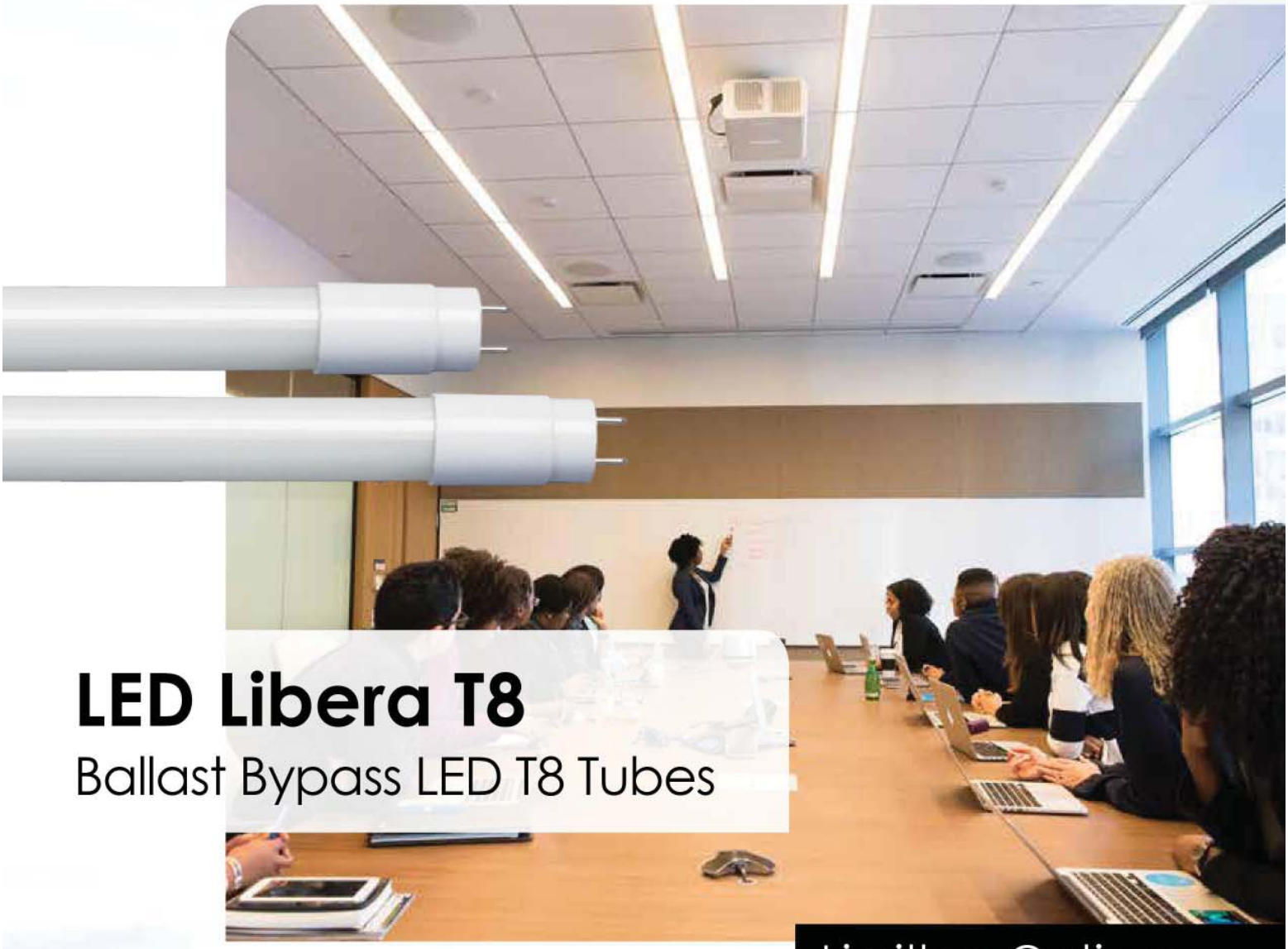
SKU#	Kelvin	Lumens	CRI	Wattage	Voltage	DLC?	Base	Life Hours	Warranty
LEDT-10069CS	4000	2200	82	18	120-277	YES	Bi-Pin	50,000	5 Year

SPECIFICATIONS

DIMMABLE ..... NO
DLC LISTED ..... YES
SAFETY RATING ..... UL DAMP
CRI 82
COLOR ..... COOL WHITE
COLOR TEMPERATURE 4000K
LIFE HOURS 50,000
WATTAGE ..... 18 WATTS
LUMENS 2,200
VOLTAGE 120-277
LENS ..... FROSTED GLASS
LEG SPACING ..... 6 INCH
BALLAST TYPE ..... BALLAST BYPASS
DIAMETER ..... 8.02 IN.
LENGTH ..... 22.425 IN.
FLUORESCENT EQUAL ..... 32 WATT

TCP

Libera T8™ LED



LED Libera T8

Ballast Bypass LED T8 Tubes

LED compatible replacement for linear fixtures that operate independently of ballasts.

Limitless Options

for the following applications:

- Offices
- Restaurants
- Retail Stores
- Lobbies
- Schools
- Hospitals

CLASSIFIED c UL us

5 YEAR WARRANTY

ENERGY STAR PARTNER

c ETL us

we know light.™

TCP

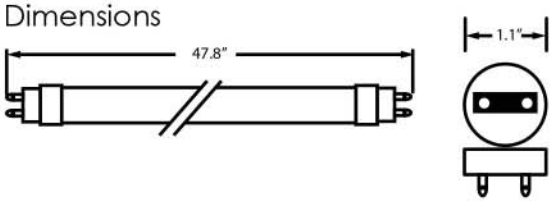
Liberal 8™ LED

Features and Benefits

- >40% energy savings;
- Long 50,000 hour rated life— minimizes replacements and labor costs;
- Instant on/off;
- No mercury— great for all environments;
- Rated for enclosed fixtures;
- Damp location rated;
- G-13 Bi-pin contacts.

LED T8 Tube
4 foot

Dimensions



Specifications

Item#	TCP Part#	UL / DLC Listed Model	Voltage	Actual Power Consumption	Lumens	CRI	Power Factor	Color Temp.	DIM/ND	Lens	Length	Lifespan	Cert
TCP-10300	88LT800017	T8048941E	120-277V	14W	1800lm	>80	>0.9	4100K	ND	Frosted Glass	1,213.6mm	50,000 hrs	UL/DLC
TCP-10301	88LT800018	T8048950E	120-277V	14W	1800lm	>80	>0.9	5000K	ND	Frosted Glass	1,213.6mm	50,000 hrs	UL/DLC
TCP-10302	88LT800019	T8045441E	120-277V	19W	2400lm	>80	>0.9	4100K	ND	Frosted Glass	1,213.6mm	50,000 hrs	ETL/DLC
TCP-10303	88LT800020	T8045450E	120-277V	19W	2400lm	>80	>0.9	5000K	ND	Frosted Glass	1,213.6mm	50,000 hrs	ETL/DLC
TCP-10304	88LT800021	T8041741E	120-277V	22W	2800lm	>80	>0.9	4100K	ND	Frosted Glass	1,213.6mm	50,000 hrs	ETL/DLC
TCP-10305	88LT800022	T8041750E	120-277V	22W	2800lm	>80	>0.9	5000K	ND	Frosted Glass	1,213.6mm	50,000 hrs	ETL/DLC

Listing

- UL/ETL/DLC Listed – damp location rated
- Approved for open and enclosed fixtures

Warranty

- Five years against defects in manufacturing

To view our DLC qualified products, please consult the DLC Qualified Products List at www.designlights.org/qpl.

5 YEAR WARRANTY

TCP® | 325 Campus Dr. | Aurora, Ohio 44202 | P: 800-324-1496 | tcpi.com

AcuityControls

Sensor Switch™

WSX Family

WSX
WSX PDT
Single Relay

WSX 2P
WSX PDT 2P
Dual Relay

WSX NL
WSX PDT NL
Night Light

OVERVIEW

The WSX Family of wall switch occupancy sensors provides simple and cost effective solutions for commercial and residential lighting control applications. All WSX Family sensors have a stylish low profile appearance, soft-click buttons, and provide small motion detection up to 20 ft (6.10 m), making them perfect for private offices, private rest rooms, closets, copy rooms, or any other small enclosed space. Additionally, all WSX Family sensors have a patent-pending wiring method that enables them to function either with or without a neutral connection. WSX units come pre-configured for wiring without a neutral, however if connection to neutral is required by code, contractors can convert the unit in seconds.

With optional flash programming via the Sensor Switch VLP mobile device application, users can easily change time delay, on mode and photocontrol settings.

FEATURES

- Programmable with Sensor Switch VLP app or traditional push button, refer to ordering information for availability
- Compatible w/LEDs, electronic & magnetic ballasts, CFLs, & incandescents
- 100% passive detection, no potential for interference with other building systems
- Small motion detection to 20 ft
- Push-button programmable without removing cover plate - adjustable time delays & operating modes
- Dual technology (PDT) utilizes PIR/Microphonics™ detection (patented)
- Self-grounding mounting strap
- Device accomodates powering over ground or neutral connection (patent pending)
- Ultra low current leakage (<0.5 mA) when connected via ground
- Fully meets NEC 2017 Section 404.2C neutral requirements - no current leakage to ground when connected to neutral
- Line power and load wires are interchangeable - impossible to wire backwards (patented)
- Integrated Photocell (disabled by default) prevents light from turning on if sufficient daylight is present – not available in Nightlight versions
- Vandal resistant lens

Warranty

Five-year limited warranty. Complete warranty terms located at:
www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

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

Specifications subject to change without notice.

Available on the App Store
ANDROID APP ON Google play
VLP
c UL us LISTED

WSX SINGLE RELAY					Example: WSX PDT WH
Series	**Operating Mode[1]**	**Voltage**	**Visible Light Programming[5]**	**Color[4]**	**Temp / Humidity**
WSX Passive infrared (PIR) WSX PDT Dual Technology (PIR/Microphonics™)	[blank] Auto-on (default) or vacancy SA Vacancy (default) or auto-on VA Vacancy only NL[2] Nightlight	[blank] 120-277 VAC 347[3] 347VAC	[blank] None VLP Visible Light Programming	WH White IV Ivory GY Gray AL Almond BK Black RD Red	[blank] Standard LT Low Temp/ High Humidity

WSX DUAL RELAY				Example: WSX 2P NL WH
Series	**Operating Mode[1]**	**Voltage**	**Color[4]**	**Temp / Humidity**
WSX 2P Passive infrared (PIR) WSX PDT 2P Dual Technology (PIR/Microphonics™)	[blank] Pole 1 auto-on Pole 2 vacancy 2SA Both poles vacancy (default) 2VA Both poles vacancy (only) NL[2] Nightlight	[blank] 120-277 VAC 347[3] 347VAC	WH White AL Lt. Almond IV Ivory BK Black GY Gray RD Red	[blank] Standard LT Low Temp/ High Humidity

Notes:

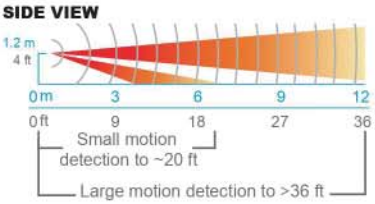
1. Operating Modes reprogrammable via push-button except for VA version
2. Default set to Manual On, not available with VLP
3. Wall plates included in white or ivory only for 347 VAC units
4. Matching wall plate provided for 120/277 VAC units
5. Available only on WSX PDT Series.

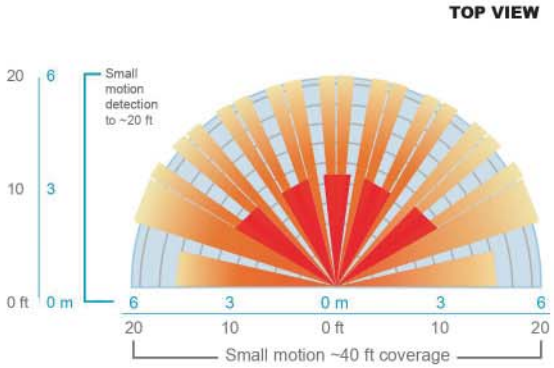
SPECIFICATIONS

Size:	2.74"H x 1.68"W x 1.63"D (not including ground strap)
Weight:	5 oz
Mounting:	Single gang switch box
Mounting Height:	30-48 in
Maximum Load/Pole:	(Relay) 800W @ 120VAC, 1200W @ 277VAC, 1500W @ 347VAC
Minimum Load:	None
Motor Load:	1/4 HP
Frequency:	50/60 Hz (timers are 1.2x for 50Hz)
Temperature Rating:	0°C-60°C

COVERAGE PATTERNS

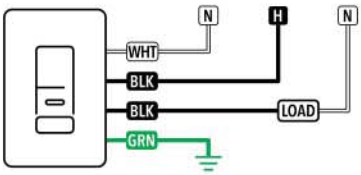
- Small motion (e.g., hand movements) detection up to 20 ft (6.10 m), ~625 ft²
- Large motion (e.g., walking) detection greater than 36 ft (10.97 m), ~2025 ft²
- Wall-to-Wall coverage
- Passive Dual Technology (Microphonics) provides overlapping detection of human activity over the complete PIR coverage area. Advanced filtering is utilized to prevent non-occupant noises from keeping the lights on.
- Tested to NEMA WD 7-2011



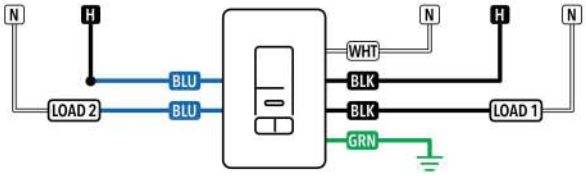


CONVERTIBLE NEUTRAL

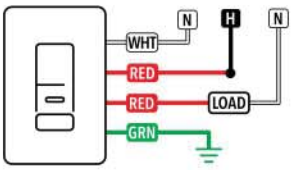
SINGLE RELAY, 120/277 VAC



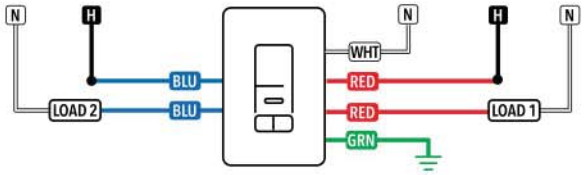
DUAL RELAY, 120/277 VAC



SINGLE RELAY, 347 VAC

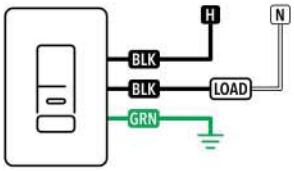


DUAL RELAY, 347 VAC

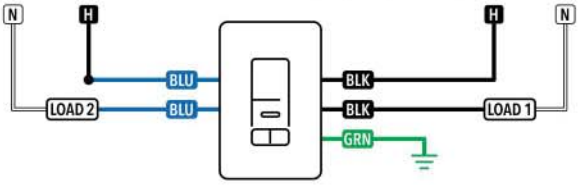


GROUND ONLY

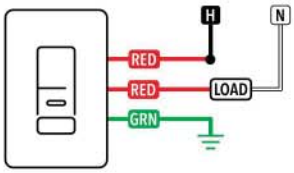
SINGLE RELAY, 120/277 VAC



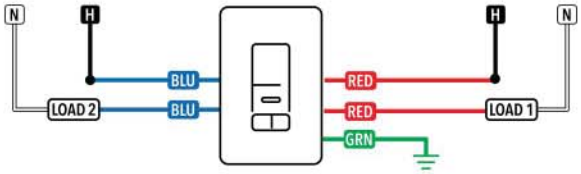
DUAL RELAY, 120/277 VAC



SINGLE RELAY, 347 VAC



DUAL RELAY, 347 VAC



Notes:

- Unit will draw power from either line connection.
- When switching 277 VAC or 347 VAC on both relays, the line inputs must be of the same phase.
- For dual relay, both relays must be fed from the same circuit.

WSX Family (IS-WSX-003)

NEW

CanadianSolar

HiKu

SUPER HIGH POWER MONO PERC MODULE

425 W ~ 450 W

CS3W-425|430|435|440|445|450MS

MORE POWER

- 26 % more power than conventional modules
- Up to 4.5 % lower LCOE
  Up to 2.7 % lower system cost
- Low NMOT: 42 ± 3 °C
  Low temperature coefficient (Pmax): -0.36 % / °C
- Better shading tolerance

MORE RELIABLE

- Lower internal current, lower hot spot temperature
- Cell crack risk limited in small region, enhance the module reliability
- Heavy snow load up to 5400 Pa, wind load up to 3600 Pa*

25 years linear power output warranty*

12 years enhanced product warranty on materials and workmanship*

*According to the applicable Canadian Solar Limited Warranty Statement.

MANAGEMENT SYSTEM CERTIFICATES*

ISO 9001:2015 / Quality management system
ISO 14001:2015 / Standards for environmental management system
OHSAS 18001:2007 / International standards for occupational health & safety

PRODUCT CERTIFICATES*

IEC 61215 / IEC 61730: VDE / CE
UL 1703: CSA / Take-e-way

* As there are different certification requirements in different markets, please contact your local Canadian Solar sales representative for the specific certificates applicable to the products in the region in which the products are to be used.

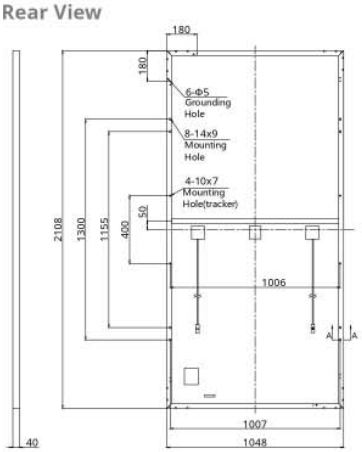
CANADIAN SOLAR INC. is committed to providing high quality solar products, solar system solutions and services to customers around the world. No. 1 module supplier for quality and performance/price ratio in IHS Module Customer Insight Survey. As a leading PV project developer and manufacturer of solar modules with over 36 GW deployed around the world since 2001.

* For detail information, please refer to Installation Manual.

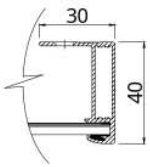
CANADIAN SOLAR INC.
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

ENGINEERING DRAWING (mm)

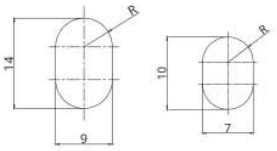
Rear View



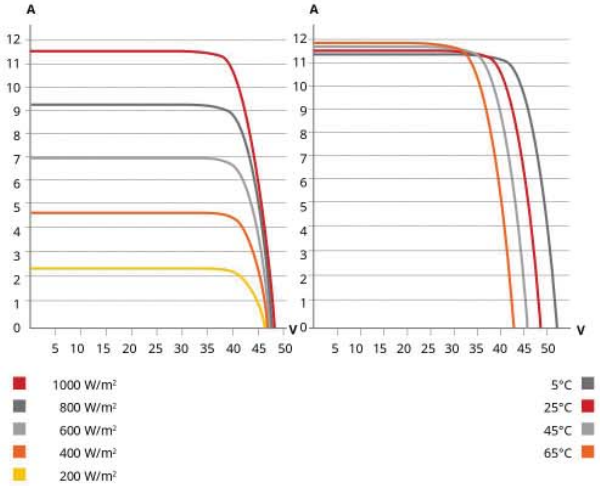
Frame Cross Section A-A



Mounting Hole



CS3W-435MS / I-V CURVES



ELECTRICAL DATA | STC*

CS3W	425MS	430MS	435MS	440MS	445MS	450MS
Nominal Max. Power (Pmax)	425 W	430 W	435 W	440 W	445 W	450 W
Opt. Operating Voltage (Vmp)	39.5 V	39.7 V	39.9 V	40.1 V	40.3 V	40.5 V
Opt. Operating Current (Imp)	10.76 A	10.84 A	10.91 A	10.98 A	11.05 A	11.12 A
Open Circuit Voltage (Voc)	47.7 V	47.9 V	48.1 V	48.3 V	48.5 V	48.7 V
Short Circuit Current (Isc)	11.37 A	11.42 A	11.47 A	11.53 A	11.59 A	11.65 A
Module Efficiency	19.24%	19.46%	19.69%	19.92%	20.14%	20.37%
Operating Temperature	-40°C ~ +85°C					
Max. System Voltage	1500V (IEC/UL) or 1000V (IEC/UL)					
Module Fire Performance	TYPE 1 (UL 1703) or CLASS C (IEC 61730)					
Max. Series Fuse Rating	20 A					
Application Classification	Class A					
Power Tolerance	0 ~ + 5 W					

* Under Standard Test Conditions (STC) of irradiance of 1000 W/m², spectrum AM 1.5 and cell temperature of 25°C.

ELECTRICAL DATA | NMOT*

CS3W	425MS	430MS	435MS	440MS	445MS	450MS
Nominal Max. Power (Pmax)	316 W	320 W	324 W	328 W	331 W	335 W
Opt. Operating Voltage (Vmp)	36.8 V	36.9 V	37.1 V	37.3 V	37.5 V	37.7 V
Opt. Operating Current (Imp)	8.60 A	8.67 A	8.73 A	8.79 A	8.84 A	8.89 A
Open Circuit Voltage (Voc)	44.7 V	44.9 V	45.1 V	45.3 V	45.5 V	45.6 V
Short Circuit Current (Isc)	9.17 A	9.21 A	9.25 A	9.30 A	9.35 A	9.40 A

* Under Nominal Module Operating Temperature (NMOT), irradiance of 800 W/m², spectrum AM 1.5, ambient temperature 20°C, wind speed 1 m/s.

MECHANICAL DATA

Specification	Data
Cell Type	Mono-crystalline
Cell Arrangement	144 [2 X (12 X 6)]
Dimensions	2108 X 1048 X 40 mm (83.0 X 41.3 X 1.57 in)
Weight	24.9 kg (54.9 lbs)
Front Cover	3.2 mm tempered glass
Frame	Anodized aluminium alloy, crossbar enhanced
J-Box	IP68, 3 bypass diodes
Cable	4 mm² (IEC), 12 AWG (UL)
Cable Length (Including Connector)	Portrait: 500 mm (19.7 in) (+) / 350 mm (13.8 in) (-); landscape: 1400 mm (55.1 in); leap-frog connection: 1670 mm (65.7 in)*
Connector	T4 series or H4 UTX or MC4-EVO2
Per Pallet	27 pieces
Per Container (40' HQ)	594 pieces

* For detailed information, please contact your local Canadian Solar sales and technical representatives.

TEMPERATURE CHARACTERISTICS

Specification	Data
Temperature Coefficient (Pmax)	-0.36 % / °C
Temperature Coefficient (Voc)	-0.29 % / °C
Temperature Coefficient (Isc)	0.05 % / °C
Nominal Module Operating Temperature	42 ± 3°C

PARTNER SECTION

* The specifications and key features contained in this datasheet may deviate slightly from our actual products due to the on-going innovation and product enhancement. Canadian Solar Inc. reserves the right to make necessary adjustment to the information described herein at any time without further notice.
Please be kindly advised that PV modules should be handled and installed by qualified people who have professional skills and please carefully read the safety and installation instructions before using our PV modules.

CANADIAN SOLAR INC.
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

NEW

CanadianSolar

THREE PHASE STRING INVERTER 50-66 KW

CSI-50KTL-GS-FL | CSI-50KTL-GS | CSI-60KTL-GS | CSI-66KTL-GS

Canadian Solar's grid-tied, transformer-less string inverters help accelerate the use of three-phase string architecture for commercial rooftop and small ground-mount applications. An NRTL approved, cost-effective alternative to central inverters, these inverters are modular design building blocks that provide high yield and enable significant BoS cost savings. They provide up to 98.8% conversion efficiency, a wide operating range of 200-850 V_{DC}, and four MPPTs for maximum energy harvest.

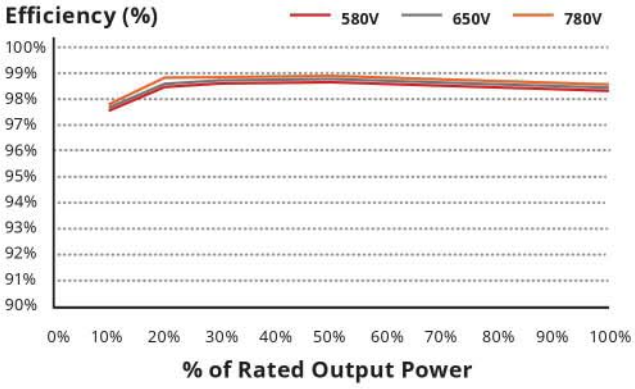
10 years **Standard warranty, extension up to 20 years**

KEY FEATURES

- Maximum efficiency of 98.8%, CEC efficiency of 98.4%
- 4 MPPTs to achieve higher system efficiency
- Transformerless design
- High switching frequency and ultra fast MPPT (<5 sec.) for maximum efficiency over a wide load range

EFFICIENCY CURVE

CSI-66KTL-GS@480 V



*For detailed information, please refer to the Installation Manual.

HIGH RELIABILITY

- Advanced thermal design with fan assisted cooling
- Ground-fault detection and interruption circuit
- AFCI Integrated (per UL1699B, factory enabled option)

BROAD ADAPTIBILITY

- NEMA 4X (IP65), outdoor application
- Utility interactive controls: active power derating, reactive power control and over frequency derating
- Integrated wiring box design
- Integrated DC and AC load rated disconnects
- Wide MPPT range for flexible string sizing
- 15-90 degree installation angle
- AC terminals compatible with copper and aluminum conductors (Al with bimetallic terminal)
- Supports up to 12 or 16 DC string inputs (3 or 4 per MPPT)

CANADIAN SOLAR (USA), INC. is committed to providing high quality solar products, solar system solutions and services to customers around the world. As a leading PV project developer and manufacturer of solar modules with over 21 GW deployed around the world since 2001, Canadian Solar Inc. (NASDAQ: CSIQ) is one of the most bankable solar companies worldwide.

CANADIAN SOLAR (USA), INC.

3000 Oak Road, Suite 400, Walnut Creek, CA 94597, USA | www.canadiansolar.com/na | sales.us@canadiansolar.com

SYSTEM/TECHNICAL DATA

MODEL NAME	CSI-50KTL-GS-FL	CSI-50KTL-GS	CSI-60KTL-GS	CSI-66KTL-GS
DC INPUT				
Max. PV Power	64 kW (16 kW/MPPT)	75 kW (22.5 kW/MPPT)	90 kW (22.5 kW/MPPT)	90 kW (22.5 kW/MPPT)
Max. DC Input Voltage	1000 V_{DC}			
Operating DC Input Voltage Range	200-850 V_{DC}			
Start-up DC Input Voltage/Power	200 V			
Number of MPP Trackers	4			
MPPT Voltage Range	568-850 V_{DC}		526-850 V_{DC}	579-850 V_{DC}
Operating Current (Imp)	88 A (22 A per MPPT)	114 A (28.5 A per MPPT)		
Max. Input Current (Isc)	137.2 A (34.3 A per MPPT)	178 A (44.5 A per MPPT)		
Number of DC Imputs	12 (3 per MPPT)	16 (4 per MPPT)		
DC Disconnection Type	Load rated DC switch			
AC OUTPUT				
Rated AC Output Power	50 kW	50 kW	60 kW	66 kW
Max. AC Output Power	50 kW	50 kW	60 kW	66 kW
Rated Output Voltage	480 V_{AC}			
Output Voltage Range*	422.4 - 528 V_{AC}			
Grid Connection Type	3 Φ/PE			
Nominal AC Output Current @480 Vac	60.2 A		72.2 A	79.4 A
Rated Output Frequency	60 Hz			
Output Frequency Range*	59.5 - 60.5 Hz			
Power Factor	1 default (±0.8 adjustable)			
Current THD	< 3 %			
DC Disconnection Type	Load rated AC switch			
SYSTEM				
Topology	Transformerless			
Max. Efficiency	98.8 %	98.8 %	98.7 %	98.8 %
CEC Efficiency	98.4 %			
Night Consumption	< 1 W			
ENVIRONMENT				
Protection Degree	NEMA 4X			
Cooling	Natural Convection Cooling	Intelligent Redundant Cooling		
Operating Temperature Range	-13 ° F to + 140 ° F / -25 ° C to +60 ° C			
Storage Temperature Range	-40 ° F to + 158 ° F / -40 ° C to +70 ° C			
Operating Humidity	0 - 100 %			
Operating Altitude	13,123.4 ft / 4000 m			
Audible Noise	<60 dBA @ 1 m			
DISPLAY AND COMMUNICATION				
Display	LCD + LED			
Communication	Standard: RS485 (Modbus)			
MECHANICAL DATA				
Dimensions (W / H / D)	24.8 x 40.7 x 13.9 in / 630 x 1034 x 354 mm			
Weight	165 lb / 74.8 kg	172 lb / 78 kg		
Installation Angle	90 degrees from horizontal	15-90 degrees from horizontal		
DC Inputs	15 A standard			
SAFETY				
Safety and EMC Standard	UL1741, UL1699B, CSA-C22.2 No. 107.1-01, IEEE1547; FCC PART 15			
Grid Standard	IEEE1547, Rule 21			
Smart-Grid Features	Voltage-Ride Thru, Frequency-Ride Thru, Soft-Start, Volt-Var, Frequency-Watt, Volt-Watt			

*The "Output Voltage Range" and "Output Frequency Range" may differ according to specific grid standard.

The specification and key features described in this datasheet may deviate slightly and are not guaranteed. Due to on-going innovation, research and product enhancement, Canadian Solar Inc. reserves the right to make any adjustment to the information described herein at any time without notice. Please always obtain the most recent version of the datasheet which shall be duly incorporated into the binding contract made by the parties governing all transactions related to the purchase and sale of the products described herein.

Caution: For professional use only. The installation and handling of PV equipment requires professional skills and should only be performed by qualified professionals. Please read the safety and installation instructions before using the product.

Volunteer Log of Interaction

Student Name	What they did	Volunteer Category	Source/Evidence	Hours
Jelena	Researched how healthcare workers can safely, yet more efficiently during a pandemic	Research	Wrote a short summer with tips	2
Jelena	Research regarding best practices for Doctors, Nurses, and other medical staff	Research	http://www.healthcarebusinesstech.com/best-practices-for-enhancing-doctornurse-relationships/. https://www.ama-assn.org/practice-management/physician-health/how-doctors-can-keep-their-families-safe-after-providing-covid. https://www.ncbi.nlm.nih.gov/books/NBK2637/. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4949805/	3
Adriana	Researched technology grants	Grants/Finance	https://freshwaterfuture.org/technology-grant-funders/	1
Brian	Research improving energy efficient behavior	Energy Awareness-Household	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5579831/	1
Dharmendra	Research on Energy Conservation Techniques	Conserving Energy	https://www.energysage.com/energy-efficiency/101/ways-to-save-energy/	1
Massara	Research for work life practices	Work Life Energy Awareness Practices	https://dl.acm.org/doi/abs/10.1145/1899475.1899495 http://oro.open.ac.uk/40884/1/IHC2014_camera_Ready.pdf	2
Daniel	Research on Pervasive Energy Awareness for Households	Energy Awareness Strategies-Daily Life Practices	https://dl.acm.org/doi/abs/10.1145/1864431.1864436	1
Miro	Internet Search posted on Energy Awareness	Energy Awareness Strategies-Daily Life Practices	https://dl.acm.org/doi/abs/10.1145/1864431.1864436	1.5

Volunteer Log of Interaction Continued

Peng	Researched solar panel design considerations and drew the 3-Line Diagram for the solar panel system connected to old electrical system	Solar Panel Design	https://academics.uccs.edu/rtirado/PES_1600_SolarEnergy/GevorkianCH3.pdf	3
Sam	Overall Energy Awareness & Conservation Techniques	Energy Awareness	https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/communicate-your-success/energy-star-communications-toolkit/bring-your-green-work-1	2
Tristan	Online research for facilities staff	Security & facilities upkeep staff	https://www.environmentalleader.com/2019/10/three-ways-facility-managers-can-improve-energy-efficiency-of-building-systems/ https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-13890.pdf	1
Kevin	Research Clinic Best Practices & Summary	Clinic Best Practices	https://www.ncbi.nlm.nih.gov/books/NBK316131/	1
Virgilio	Research ways to work while staying safe with COVID-19	Research	https://www.nationalnursesunited.org/covid-19	2
Christina	Research for Work Life Best Practices	Energy Awareness	http://www.srpnet.com/energy/biztips.aspx.	1
Sonia	Research Energy-Efficiency in low income communities	Social/Economic	https://www.edf.org/sites/default/files/documents/liee_national_summary.pdf	1
Sonia	On-Site Research at the health center	Research	Visited site on Feb. 20 from 3-5 pm	2

NECA Interaction Log

Date	Interaction	NECA Contact	Position	Company
1/23/20	Spoke in class, general NECA overview	Tim Taylor	Assitant Manager	ECA
1/29/20	Presentation Topic	Jack Smith	Senior Division manager	Kelson-Burret
2/6/20	Site Visit	K. Baldwin	Manager	Cook County Health Clinic
2/10/20	Site Visit	Jack Smith	Sr. Div Manager	Kelson-Burret
2/11/20	Presentation Topic Preperation	Jack Smith	Sr. Div Manager	Kelson-Burret
2/11/20	Planning for next chapter meeting	Tim Taylor	Assitant Manager	ECA
2/12/20	Speaker Planning	Tim Taylor	Assitant Manager	ECA
2/19/20	Plan for Site Visit	Mike Hickey	Site Contractor Coordina	Cook County Health Clinic
2/27/2020	Discuss energy costs	Mike Hickey	Site Contractor Coordina	Cook County Health Clinic
3/13/2020	Preparation for COVID-19 Changes	Tim Taylor	Assitant Manager	ECA
3/13/2020	Preparation for COVID-19 Changes	Mike Hickey	Site Contractor Coordina	Cook County Health Clinic

ECA Electrical Contractors' Association of City of Chicago, Inc.

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03/06/2020

NECA IIT Student Chapter Update

We thank the two presenters from Kelso-Burnett Co. for their assistance with the session!

NECA IIT Student Chapter Activity

The Electrical Contractors' Association of City of Chicago (ECA) Student Committee sponsored a NECA IIT Student Chapter meeting at the IIT Smart Tech Lab on March 5, 2020. The meeting was highlighted by two presentations from representatives from Kelso-Burnett Co. - Jack Smith and Steve Awe. Mr. Smith discussed "Project Management" issues and Mr. Awe focused on solar / photovoltaic issues. The students appreciated the discussions, as they are currently working on the NECA 2020 Green Energy Challenge. They are in the process of auditing a nearby Cook County healthcare facility. The submittal to NECA is due June 1, 2020. We thank Jack and Steve for their time at the meeting! Good luck to the students!

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IIT National Electrical Contractors Association (NECA) reinstated for the Spring 2020 semester

Christina Hiotaky
NECA Secretary
Pronouns: (She/Her)
Mon Feb 03, 2020

The Illinois Tech National Electrical Contractors Association (NECA) chapter has officially been reinstated as a club for the Spring 2020 semester. During the first week of classes, four officers were selected to run the chapter: Samantha Blanchard (President), Messara Haseeb (Vice President), Christina Hiotaky (Secretary), and Raymond Schroeders (Treasurer). Every semester the NECA chapter investigates the electrical and energy efficiency of a nearby public building and proposes various changes in an effort to achieve a net zero energy outcome. A net zero energy outcome means the total amount of energy used by the building on an annual basis is equal to the amount of renewable energy created on the site. "NECA Student Chapter teams (will) demonstrate their ability to analyze particular electrical construction management "problems" and create a comprehensive plan and budget for an appropriate retrofit. Students are challenged to develop technical skills that are vital to careers in electrical construction and professional skills including time management, written communication, and oral presentation" (NECA website). This project takes place throughout the Spring 2020 semester, and will be entered to compete at the 2020 NECA Green Energy Challenge in October, set to take place right here in Chicago. The project leads for the 2020 competition are Kevin Dillon (Team Leader) and Tristan Meredith (Co-Leader). The team plans to conduct an energy audit of Near South Health Center, located on 35th Street, under the advising of Dr. Dan Tomal. Email sblanchard@hawk.iit.edu if you would like additional information on how to get involved!

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