IPRO 338: The Effects of Green Technology on Electrical Contractors.

Sponsor:

Electrical Contractors´ Association | City of Chicago

Submitted December 8, 2008

Team Members:

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Abstract

Background
Environmentally friendly products continue to become more reliable and inexpensive. More developers demand these products and building techniques be used in construction. However, information on these products is often confusing and incomplete. There is high demand for a tool that can help assist in bringing about a well informed transition from industry standard building practices and products, to green alternatives, as well as cut down on miscommunication between architects and contractors.

Goals
- Develop a website to host a user-friendly online database of green technology information for the Electrical Contractors' Association (ECA) of the City of Chicago.
- Develop a template for the website was the primary focus for the first semester, due to the time constraint.
- Provide data on green electrical products with cut sheets, pricing and distributor information, return on investment projections, and Leadership in Energy and Environmental Design (LEED) certification facts.

Methodology
There were three major components involved with completing the goals for this semester. The first was accumulation of data, the second was organizing the data into a workable template for a website, the third was integrating the database into the website. The team accomplished the task of accumulating the needed information by dividing into three teams. These teams were IT, Deliverables, and Research. From there the research team was divided even further into seven sub-teams. They were Power Distribution, HVAC, Lighting, Water Efficiency, LEED, ROI, and Grants. In order to design the database structure we had to decide on how the web site itself was going to run. We decided that we wanted to be able to search for products by price, power requirements, applicable LEED point, manufacturer, manufacturer's location, percentage of post-consumer recycled content, and percentage of pre-consumer recycled content. In addition to that we wanted to include a section that had information on recent advances in technology and studies done in the electrical contractor field, we called it our "white papers" section.

Obstacles
- Determining specific goal that would benefit the electrical contractors in the process of going green.
- Establishing scope of work for timeframe established.
- Grasping the terminology and the concept of the project by individuals not familiar with the construction industry.
- Obtaining pricing and return on investment for products because so much of the industry uses job specific bidding.

In order to resolve these issues, research was done on LEED and on green technology. Discussions during team meetings with group sponsors and members helped the team establish a clear goal.

Accomplishments & Recommendations
This team has successfully created a website and database from which future teams can expand. At this time a number of important industry contacts have been made and a template for future research is available. The ECA is already fully involved, but it is recommended that future teams attempt to gain the support of other industry players such as architects and general contractors. This will make the website more comprehensive and improve a tool to help the entire construction industry move to more environmentally friendly practices.

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1 Introduction

The following is a description of the methodologies and achievements of IPRO 338 at Illinois Institute of Technology during the fall 2008 semester. A research team was organized to focus on the effects that green technologies have had on electrical contractors in the city of Chicago, and create a tool to help them transition from traditional construction practices to environmentally friendly ones.

1.1 Background

The environment has become one of the most prominent topics in our society. Every business and politician expresses how important it is to protect our planet and the construction industry is no exception.

In April of 2000 the United States Green Building Council (USGBC) introduced the Leadership in Energy and Environmental Design (LEED) system. The LEED rating system quickly became the nationally accepted method of evaluating the impact that the construction and operation of a building would have on the environment. Today, the majority of building owners are familiar with LEED, and as this familiarity grows, the system becomes more accepted. At the same time, the reliability of green technologies has increased while up-front costs for these technologies are decreasing. This has caused the demand for green buildings, and LEED certification in construction, to increase dramatically. Construction firms who do not possess the know how to carry out green projects will soon be at a dramatic competitive disadvantage in an industry that has always been very competitive.

1.2 Purpose

Green technologies have grown in popularity very quickly but the market for these products is still only in its infancy. This has created a situation in which LEED certification is often required by building owners and developers, but contractors lack the knowledge to deliver on this requirement. Data on green products and methods are scattered, incomplete and confusing. Also, there is a growing disconnect between architects, general contractors, and other sub-contractors in relation to the best methods for achieving LEED standards.

Realizing the potential problems, the Electrical Contractors Association of the City of Chicago (ECA) sponsored this project. It is a primary goal of this undertaking to create a competitive advantage for the ECA in the market. Another goal is to help create a well informed transition from standard to green building practices and reduce miscommunication and redundancies in the green construction process.

The best method to reach these goals was determined to be the development of a website to host a user-friendly on-line database of green technology for the ECA. This website will provide a great deal of information in one place. This information includes:

- Data on products with cut sheets
- Pricing
- Suppliers/Distributors
- Return on investment (ROI)
- LEED facts and certification assistance

1.3 Scope of Work

This will be an ongoing project. In the first few weeks we determined it would be impossible to compile a list of every product and manufacturer that would apply to our project so we decided to get a limited number to get the database started. This allowed us to at least have a finished product, test our website and allow for future expansion next semester. The ECA has already committed to future support for the project, and efforts have been made to gain support from other building trade organizations, as well as from architectural associations and environmental groups.

The first phase in development had these specific goals:

- Establish the scope and usefulness of the project
- Collect research and data
- Continue industry contacts
- Develop a template for the database
- Integrate the database into the website

2 Implementation

At inception, the team anticipated the project implementation would require a systematic approach. The execution of the project can be divided into four areas of consideration: The Methodology, Team Assignments, Obstacles Encountered, and Ethical Issues.

2.1 Methodology

The team started by creating a team charter so that they could see in plain English the standards we were setting for ourselves. This allowed them to police themselves to see if they were doing all that was required of them. This charter can be found in Appendix A.

The first step in the process was to establish the scope of the work. In order to accomplish this, the group spoke to representatives of the ECA to gain knowledge and understanding of industry and establish useful goals. This was important in order to ensure that the project was on course to create a valuable product for our sponsors.

Once the goals and timetable were established, the next step in the process was to create research teams. These teams were responsible for gathering all the information that would ultimately go on the website. The process of finding and disseminating all the information available on green products is the primary focus of this project. This process will need to continue next semester to improve upon the design of the website and add products to the database. With the speed at which new technologies are developed this will most certainly be a continuing effort, throughout the lifespan of the website.

The initial seven research teams and their primary area of concern are as follows:

Lighting

- Find product and manufacturer information for lighting systems that contribute to meeting LEED standards
- Discover how these systems contribute to meeting LEED standards
- Investigate price of systems

Heating, Ventilation and Air Conditioning (HVAC)

- Find product and manufacturer information for HVAC equipment and systems that contribute to meeting LEED standards
- Discover how the products and systems contribute to meeting LEED standards
- Investigate price of products and systems

Power Distribution

- Find methods of reducing power consumption
- Find any products that contribute to lower power consumption in power distribution systems, and include manufacturer information
- Discover how specific products contribute to meeting LEED standards
- Investigate pricing of systems and methods

Water Efficiency

- Investigate how water efficiency in and around a building is effected by products powered by electricity
- Investigate pricing of related products and methods

LEED

- Investigate the LEED system
- Determine which points are achievable by electrical systems and related areas
- Effectively communicate the LEED principles and requirements

Return on Investment

- Investigate return on investment of these products and systems

Grants

- Investigate public and private sector incentive programs for using energy efficient products

The results of the team research were compiled and saved in an organized database. This database can be expanded by future teams to create a more complete final product.

The final focus for this phase of the project was to integrate the database into the website. This website would be fully functioning and a useful tool to electrical contractors. The website needed to be user friendly and intuitive. Much of the information on the site is available throughout the internet. This site will make finding and understanding all the information quick and simple.

2.2 Assignments

The team assigned each member with certain roles early in the process. These assignments were based upon each team member's abilities, and where they felt that they could make the greatest contribution to the project.

- Ross Johnson was the Project Leader, he prepared the meeting agendas presided over every meeting and ensured that the deadlines set by the group were met on time and were up to the standards described in the charter. He was also in charge of writing the final project and presentation.
- Jason Mitchell was the co-team leader. He assisted Ross with leadership responsibilities and brought a great deal of knowledge from the previous IPRO 338 team. Jason also served on the grants team, and assisted the deliverables team.
- Wing Hong Wong served as the team secretary. He created detailed and accurate minutes of the team meetings, discussions and decisions.
- Josh Horwath was the IT team leader, he oversaw the website and database progress.
- Soren Haurberg was on the IT team. He was in charge of programming and setting up all of the server side software. He also wrote the website and setup the database.
- Frank Malawski was on the IT team working on the logos and overall design of the site. He was also the head of the LEED research team. He was mostly in touch with contractors from around the area finding out how they met LEED standards.
- Kunal Patel was on the IT team. He focused most of his work on making sure the website was exactly what the sponsors wanted. He was also in charge of staying in contact with the USGBC.
- Yongdoo Lee was in charge of Water Efficiency research. He also worked in the ROI team.
- Edumaregbemiro Odunaiya was on the IT team and assisted in the website overall design. He also worked under the deliverables team in designing our abstract.
- LaLuce Mitchell was head of the research team and also headed up Power Distribution research. He also worked on the LEED research team. He brought a wealth of information about LEED to the group because he is already LEED accredited.

- Jae Lee was head of ROI research and lighting research.
- Alexandra Manke was on the deliverables team and worked on the midterm presentation as well as the exhibit poster. She also served on the Grants team.
- Hyeon Im was on the deliverables team, was in charge of HVAC research and served on the ROI research team.
- Ludmila Georieva was the head of our deliverables team and served on the grants team.

2.3 Obstacles

As with any task, there were a number of problems encountered while completing the task. The team had anticipated problems and was well equipped to deal with them.

A stated goal of the project is to provide pricing and ROI information for a wide variety of green products and systems. This proved difficult due to the tendency for many items to be job specific. Often, these products are designed and specified according to the job and then submitted for bid to many possible suppliers. To combat this the group gathered as much information as they could on products that weren't job specific. The IT team left room for expansion of the website for next semester. The main idea is that the next group would design a way to submit job parameters to multiple manufacturers for bid as well as update the website to comply with the soon to be update LEED program.

Another obstacle was to balance the compilation of all of the requirements needed to present the project, while still working on the project itself. These barriers were overcome by working together as a team. Solutions were found together during meetings, much in the same way previous obstacles were overcome. The team members also took responsibility for completing specific tasks thoroughly and efficiently throughout the timeframe of the project.

2.4 Ethical Behavior

Overarching standard

To facilitate environmental stewardship by providing a resource to help Chicagoland electrical contractors meet Leadership in Energy and Environmental Design (LEED) and United States Green Building Council (USGBC) standards.

Ethical issues faced during project

In order to help electrical contractors in the Chicago area, the team researched LEED requirements and USGBC standards. It was found that in some cases, requirements were too complex and would require extra costs. This resulted in pressure to rearrange the information. The team avoided ethical pitfalls by following LEED and Chicago building guidelines, and by establishing new methods and standards that were as appealing as, or more desirable than the old standards.

Also, in the process of carrying out the project, every team member had different backgrounds and experience. Some members were not familiar with electrical systems or LEED requirements. This lack of experience caused some pressure to understand the project and complete tasks in a timely manner. Therefore, in the initial stages some individuals felt that they had an unjustly heavy work load and were not appreciated. This problem was overcome through strong teamwork and appropriate distribution of tasks to maximize each individual's strong points.

3 Conclusions

The team has had a successful first semester. There have been a number of notable achievements made and the basic groundwork has been done for future teams to continue the progress. The team has assembled a list of recommendations for future teams to consider.

3.1 Results

A graphic representation of the basic model for the website can be seen in the flow chart below.

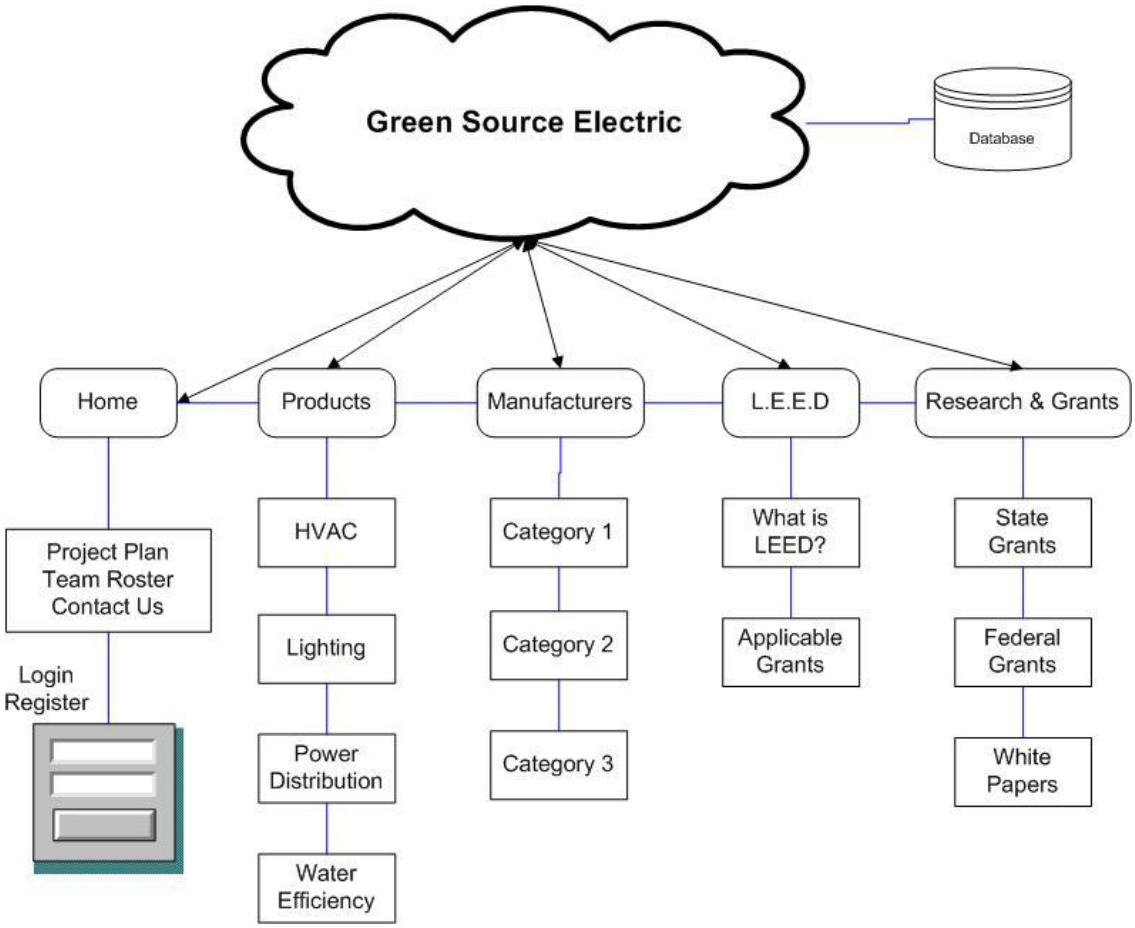

Chart 3: Website Flowchart.

This flow chart was developed based on the web design for the project. The site will walk first time users or those unfamiliar with LEED certification and green products through a tutorial on how to use the site. Information on what LEED is and how certification is achieved is the primary focus. After the introduction and tutorial the user can begin searching the site for products and vendors.

For those users who have experience with LEED and have specific needs already in mind, the site can be used directly as a search tool. The site makes it possible to find products and the theoretical LEED point value of each product. The points are accumulated and a running total is kept.

~~Picture~~ Figure 1: Screen Shot of Web Site.

In addition to LEED research and contacts, each sub-team also assembled a large amount of material. Again, some of this research is summarized in Appendix B. All of the completed research will be stored and made available to future IPRO groups as well as searchable on the website.

3.2 Recommendations

The following is a suggested list of goals for future teams to address:

- Attempt to gain the support of other industry players such as architects, general contractors, other trade organizations, and environmental advocacy groups. This will make the website more comprehensive and create a tool to help the entire construction industry make the transition to more environmentally friendly practices.
- Research the application process for LEED certification further, and add standard forms that would aid in the LEED application process.
- Continue the effort to find competitive pricing and ROI information on green products.
- Continue to expand on the current database of products and vendors and update the data already available as new products are introduced.

4 Acknowledgements

IPRO 338 would like to give special recognition to a few who played a particularly helpful role in bringing about this project.

- The Electrical Contractors' Association of the City of Chicago, specifically Mr. Tim Taylor who was a tremendous help throughout the semester.
- Bill Majeski at Kreoschell Inc.
- The Chicago Center for Green Technology

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Appendix A. Team Charter

Team Member Roster

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Team Member Experience and Expectations

Ross Johnson

I am a 3rd year EE, Last summer I worked at an MEP firm in their mission critical group. I took a 2 month seminar on LEED for new construction and I am taking the accreditation exam this September. I have held many leadership positions in the past including assistant chief engineer of an AM radio station on the south side and Chief engineer of a small FM radio station in the suburbs. I would like to become more familiar with the different forms of green energy and practices. at the end of the project I hope to have accomplished my personal goals and to have contributed something to the ECA and their industry.

LaLuce Mitchell

My goals for this IPRO are to expand my knowledge of LEED as it applies to real-life applications as different professions would really apply it to buildings, and to gain exposure by talking to, learning from,

and reacting to the perspectives of various individuals, such as the ECA, that are interested in how LEED applies to their specific profession and the construction industry in general. My previous experience/skills as they apply to this IPRO are that I have, in the past, gained knowledge of computer programming languages Java and C++ and have done web building in the past. I also know, to some extent, Flash. I am a LEED Accredited Professional, as of this summer, and so I have a decent knowledge of the LEED system and its requirements. Also, I am a 5th year Architecture student, with a minor in Structural Engineering.

Frank Malawski

Strengths:
Knowledge in the construction, owner representative, & architectural field. My work experience is as follows:

- 2005 Turner Construction ACE Mentor Program intern. Learned most of what I know today from that experience. From the documentation process, to walking the site for safety on site.

- 2006 Gibbions, Fortman, & Associates, Architectural intern. Learned the architects' side of the fence (documentation, etc.)
  2007 Farrodyne, Manufacturing Techinician. Utilized a Water jet machine to cut programmed AutoCAD files on stone, glass, carpet, & steel. Let's just say it was my first 'real' job.

- 2007-Present 6 North Michigan Properties, Owner's Rep. assistant. I do essentially everything to anything. From contacting buyers for coordination of moving walls, etc. to clarifying contract documents for the subcontractors. I work with many subs and Turner as the G.C.. MG Electric works on the jobsite and is part of the ECA.

As you can see, I have much experience in everything. My strengths for this particular IPRO would be images for the website, graphic design in general, & possible communication with electrical contractors for misc. items.

Needs & Expectations:

Hopefully we have a group of like-minded people who are confident and not afraid to dive into the class and get the job done. I will call people on their laziness if there is a possible issue down the road, but hopefully the free dinners thing helps motivate everyone if it is approved.

Other Skills:
Just anything, from networking to electrical contractors or aiding in leading the team to a successful, working web site. I'll be happy to know that I aided in helping out the many electrical contractors in the Chicago land area personally, by building the website.

Soren Haurberg

Strengths:

Years of experience in the IT field doing everything from technical support to web and software design. Specifically knowledge of: databases, web languages such as HTML, PHP, and JavaScript, web design concepts, and application programming and design skills.

Weaknesses:

I am not well versed in the electrical contracting field. I've had basic electronics classes for circuitry and such but nothing on the scale we are dealing with. I also don't know the codes to be followed for green building and such

Goals for the IPRO Team:

I want to help make a website that will be satisfy our informational goals, be suitable for our target audience, maximized for good functionality, have high search engine optimization, and clean eye-catching design. I would like to be able to use our project as a portfolio piece when job seeking in the future.

Jae Lee

I served in the Korea Army for 2 years, where I learned a lot of things. I have strong sense of responsibility and I am always eager to learn. Since my major is applied mathematics, I am good at calculation.
I want to be more familiar with green technology by doing this IPRO.

Kunal Patel

T, Electrical and Computer Engineering

(a) Programming knowledge, Worked in Zero Energy Lab - IPRO,
Strong interest in Green Technology and development of Green Electrical and Computer hardware.

(b) Putting together a website to provide useful information.

(c) Meet the goal of providing information and setting up the website.

Wing Hong Wong

Role: Secretary, Power Distribution

I am a fourth year student studying in Electrical Engineering and planning on specializing in the power field. I had a previous internship at Hawaii Electric Co., in which I worked with transmission lines and the Outage Management System. As a side project, I also worked on a wind farm project by gathering preliminary power system data for the contractors. I can contribute to this IPRO in regards to knowledge in areas of renewable energy and power distribution.

Joshua Horwath

(a) 4th year EE student. Developed 2 Web apps during an internship with a consulting firm.

(b) Learn more about ECA and Web development.

(c) Would like to contribute to the development of the Web app for the ECA, learning more about LEED, the ECA, and Web development.

Gbenro Odunaiya

2a) Strengths:
- 4th year ECE (Elec n Comp Engin) major
- Programming skills in web languages and languages
- IT experience in database management
- Build websites

b) New skills:
- Knowledge about LEED and how it affects me as an Electrical Engineering major

c) Expectation:
- Meet overall goal of the IPRO which is mainly creating an interactive website

Yongdoo Lee

Strength:
My major is Civil Engineering, so I've seen and experienced about construction field a bit. Especially, I'm familiar with
design, materials, and foundation. I can handle some graphic
programs like Photoshop and painter a bit, so if some graphic works are needed, I can support other people.

Weakness:
I don't have enough idea about EE. I just know very simple things that I've learned.

Goals for this IPRO:
I want to know and experience more about LEED, and I want to apply the idea to real construction field.

Hyeon Im

Strengths:
Since I worked in architecture firm in Korea, I am good at graphic design with Photoshop, Illustrator and 3d max.
I could make diagrams. I also have an experience with a professional presentation in competition.

Weakness:
As an international student, I am still difficult to having a conversation professionally.

Expectation:
I hope to know more about LEED as an architectural major.

Lexie Manke

I am an architecture student in my last year. Some strengths are the I have taken IPRO before so I know from the past what to expect from the I-pro office regarding deliverables. I am stellar in researching material, but have a weakness in web design. I have worked in construction as an intern for over two years, so have a good understanding what happens on a job site.

Jason Mitchell

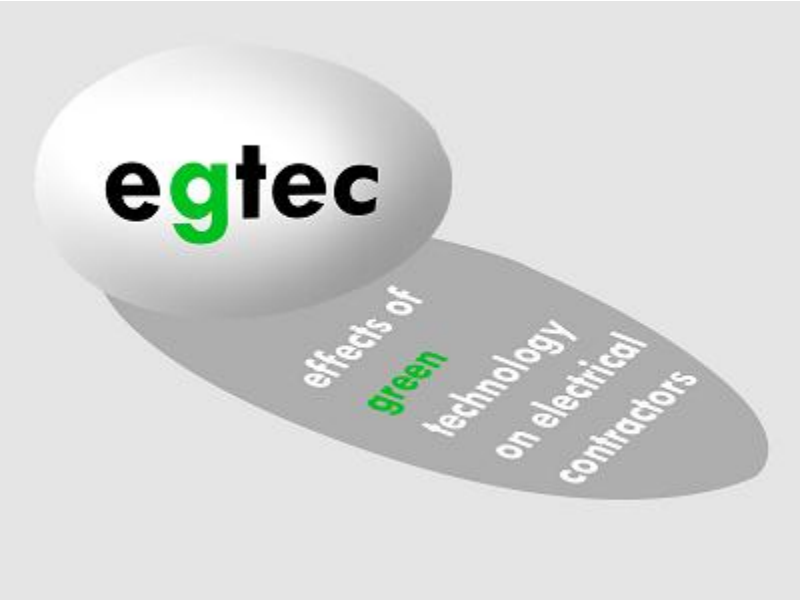
I am a fifth year architect.

Skills: Graphics, MEP (as it relates to architecture)

Experience: I have previous experience with the current IPRO project

Team Identity

The name of our team is EGTEC. It stands for Effects of Green Technology on Electrical Contractors.



Team Purpose

The purpose of this IPRO is to develop a template for a website to host a user-friendly online database of green technologies information for the Electrical Contractors' Association of the City of Chicago. This website will involve providing data on green electrical products with cut sheets, pricing and distributor information, return on investment projections, and LEED certification facts. The use of this website should help create a well informed transition from industry standard electrical products, to green alternative products, as well as cut down on miscommunication between architects and electrical contractors.

Team Values

In order to provide a resource in helping Chicagoland electrical contractors meet Leadership in Energy and Environmental Design (LEED) and United States Green Building Council (USGBC) standards, our team abides by the current values:

- Meet rules and regulations set forth by LEED and USGBC standards in green technology.
- Meet existing Chicago building codes while remaining environmentally friendly.
- Ignore Chicago building requirement that will cost the project extra time and money to make green.
- Follow LEED and Chicago building guidelines, while remaining conscientious of return on investment.
- Provide relevant and accessible incentives for contractors to uphold LEED and USGBC standards.
- Subscribe to the guidelines of Federal and State laws for green technology.
- Provide everything the customer demands, while keeping within a required budget.
- Sacrifice required green building technologies and procedures in order to save the customer money.
- Forgo the customer's budget in order to satisfy their every need.
- Focusing on the demands of ECA while carrying each required component through LEED certification.
- Responsible in learning the requirements of ECA and find successful way to help electrical constructors meet LEED and USGBC requirements on their site.
- Follow the code of ethics set forth by a LEED and USGBC.

- Lack of knowledge of the codes of ethics amongst the workers.
- Difficulty to ensure uniform compliance to set code of ethics.
- Providing LEED certified supervisors and common contractors with the knowledge and tools to ensure uniform compliance and knowledge of code of ethics.
- Understanding and consistently applying the code of ethics set forth by a LEED and USGBC.
- Following Chicago electrical code and underwriters laboratory (ULC) standards.
- Making an effort towards new "greener" standards that replace existing "tried, true, and cheaper" standards..
- New standards are not proven, and may increase the risk of danger to the customer.
- Following the electrical industry standards of ECA and developing their own methodology of ensuring new standards are as "tried and true" as the old ones.
- New methods and standards as appealing as or more desirable than the old standards.
- Assuming the responsibility as "Stewards of the Planet," for the benefit for future generations.
- Community may disagree with guidelines set forth by LEED and USGBC.
- High price of environmentally friendly, "trendy" products may make contractors not use them due to their inflated costs.
- Consider the community's view points on LEED and determine the true value of green products.
- Offering the community substantial knowledge of the advantages to using "green" technologies and procedures, for example long-term return cost as well as benefits for the future environment.
- Making changes to satisfy the community needs, provide valuable information as reference and motivation to choose a more sustainable products and practices

Appendix B. Sub-Team Research

HVAC

HVAC stands for "heating, ventilation, and air conditioning" which are based on the principles of thermodynamics, fluid mechanics, and heat transfer. The main criteria for HVAC were to find products that meet and contribute to LEED standards. These products are able to operate more efficiently than their equivalent counterparts and thus reduce the overall power consumption for a customer who is utilizing the products. In addition, the products which use a non CFC based refrigerant (R410A) or Water sources as a fuel are environmentally friendly. I categorized into basic component in HVAC system, which are Air Conditioners, Furnaces, Heat Pumps, and Packaged Systems. Buildings pursuing LEED certification need to evaluate many things relating to energy efficiency and indoor environmental quality. Two categories within the LEED-EB rating System, Energy & Atmosphere and Indoor Environmental Quality, offer a number of points that are connected with HVAC systems and operations.

Related to this category, LEED credits can be specifically gained for:

1. Required conditions for LEED credits in HVAC are Minimum level of energy efficiency, Solid waste management, and Outdoor air introduction and exhaust systems. These are prerequisite values for LEED credits.

   Rating Categories: EAC1.1, EAP1, EAP2, MRP1.1, and EQC1.

2. Technology added to Performance Measurement is necessary to provide accurate energy-use information to support energy management and identify opportunities for additional energy savings improvements. The product which has monitoring system could get 3 point.

   Rating Categories: EAC 3.2 - 3.3

3. Emission Reduction Report, all of the significant types of pollutants reduced by energy efficiency. Performance Solutions on the HVAC system can be used to reduce many different pollutants including PM10 and PM2.5 particulate. Available point is 1.
   Rating Categories: EAC 6

4. Technology to Thermal Comfort Monitoring supports the appropriate operations and maintenance of buildings and building systems. A comfortable thermal environment that supports the productivity and well-being of building occupants.
   Rating Categories: EQC 2.3

Water Efficiency

The main goal of this research is finding information of products and manufacturers about water efficiency that are meeting LEED standard. Especially, it is focused on the water efficiency products that are related to energy efficiency and renewable energy.
Among the LEED categories, Water Efficiency credit 1(WE1), 2, 3 and 5 could impact on electrical contractors, so researched products are belong to this categories.

Water Efficiency (WE)

Credit 1. Optimize Energy Performance
Credit 2. On-site renewable Energy
Credit 3. Enhanced Commissioning
Credit 5. Measurement & Verification

1. Solar power product for restroom

a. Using solar power for sensor of product.
b. From using solar power, there is no need to change battery or using electricity.
c. Products which are using solar power is not that expensive than regular products.

W.E.1. Optimize Energy Performance
W.E.2 On-site renewable Energy

2. Solar power water heater

a. Using solar power for heating water
b. Saving electricity for heating : Supplemental water heat from the sun can provide 40-70% of hot water needs
c. Many states are offering rebates and tax incentives for installing solar power products.

W.E.1. Optimize Energy Performance
W.E.2 On-site renewable Energy

3. Solar power water pump

a. No electricity is needed for pumping
b. Effective on the areas that water piping is expensive

W.E.1. Optimize Energy Performance
W.E.2 On-site renewable Energy

Lighting

The main goal for the lighting research was to find product and manufacturers information for lighting systems that contribute to meeting LEED standards. There are 4 LEED criteria which are related to the lighting. Every criteria indicates that the most important factor of applying LEED credit in lighting section is energy saving.

1. Light Pollution Reduction

a. Intention : Minimize light trespass from the building and site.

b. Strategy : To minimize light trespass, focus on lighting fixture, which has full cutoff luminaries, low- reflectance surfaces, and low-angle spotlights.

2. Optimize Energy Performance

a. Intention : Using energy efficient lighting.

b. Strategy : Compare energy performance and identify the most cost saving product by computer simulation. Every different kinds of lamp can apply for this credit.

3. Controllability of systems : Lighting

a. Intention : Provide a high level of lighting system control to individual occupants.

b. Strategy : Integrate lighting systems controllability into the overall lighting design, providing ambient and task lighting while managing the overall energy use of the building. Ballast and sensor which manages control of lighting can apply for this credit.

4. Daylight and Views: Daylight.

a. Intention: Provide a connection between indoor and the outdoors through the introduction of daylight. Maximize interior day lighting.

b. Strategy: Predicts daylight factors via computer simulation of manual calculation. Considering shallow floor plates, increased building perimeter, exterior and interior permanent shading devices, high performance glazing and automatic photocell-based controls, might be helpful to increase day lighting

Power Distribution

The main criterion for power distribution research was to find products that meet and contribute to LEED standards. These products are able to operate more efficiently than their equivalent counterparts and thus reduce the overall power consumption for a customer who is utilizing the said product. In addition, products such as variable frequency motor drives reduce power consumption by adjusting their power usage based on current work load and extra power demand caused by a motor speeding up or slowing down. Many products in this category pertain to distribution methods related to renewable sources of power generation such as solar and wind power. Products such as parallel switchgear and automatic transfer switches allow for a building's power source to be switched dynamically from grid power to renewable sources, to allow for the greatest efficiency in power use, determined either the occupants or the Building Automation System.

Related to this category, LEED credits can be specifically gained for:

1. Significant portions of the building's energy coming from renewable sources, such as biomass, solar, and wind.
2. Technology added to building to monitor its real energy consumption over time, such as meters capable of running backwards when the building is actually returning power to the grid rather than consuming power, due to on-site renewable energy creation.
3. Technology or operable windows added to allow users to control the thermal and/or lighting conditions of their specific workspace.
4. Use of enhanced commissioning, a process in which the installation of mechanical, renewable energy, and lighting systems is checked for accuracy by a separately contracted Commissioning Agent (CxA) and then support is given to ensure that the required documents and knowledge are imparted to the building owner to ensure that the system can be kept to the high level of operation for which it was design.

Appendix C. Useful Web links

Electrical Contractors' Association of the City of Chicago, Inc.	www.ecachicago.com
Huen Electric Inc.	www.huenelectric.com
Illinois Institute of Technology	www.iit.edu
International Brotherhood of Electrical Workers	www.ibew.org
Lutron Inc.	www.lutron.com
McGraw Hill Companies, Inc.	www.mcgraw-hill.com
McQuay International	www.mcquay.com
National Electrical Contractors' Association	www.necanet.org
Siemens Inc.	www.usa.siemens.com
United States Green Building Council	www.usgbc.org