Rainier Electric

Lewis Hall Energy Retrofit

2012 Green Energy Challenge

Ben Leventer | Marc Kinsman | Eddie Baker | Greg Goebel | Kevin Marck | Christian McCuen

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Rainier Electric

April 15, 2012

Ken Kubota, Project Manager
University of Washington
320 E. Stevens Way NE
Seattle, WA 98195-5611

Dear Mr. Ken Kubota,

Rainier Electric appreciates the opportunity to present our proposal for an energy efficient upgrade of Lewis Hall. We intend to complete the proposed scope of work in 33 calendar days beginning June 10, 2013, and achieve substantial completion by July 12, 2013. The initial project cost is **$455,193**. We have identified **$86,461** in incentives and rebates that will reduce your upfront cost to **$368,732**. Implementation of this project will generate sufficient savings to return your investment in **7.43 years**.

Rainier Electric's proposed project team consists of 6 design and construction professionals, all having the common goal of providing the owner with the most energy efficient systems available. Our aim as an electrical contractor and energy solutions provider is to develop a strategy that considers all energy savings possibilities. Our scope of electrical work includes a complete lighting retrofit, installation of VFDs, and a photovoltaic systems. We have also designed window upgrades and optional skylights in our proposal. Although these upgrades fall outside the scope of our work, this implementation will vastly increase energy efficiency of Lewis Hall. Retrofits falling outside our electrical scope will be managed by Rainier Electrical and subcontracted to specialty contractors. Additionally, Rainier Electric will work closely with you to increase UW's campus energy awareness by involving and improving upon current sustainability efforts.

We have also performed a LEED analysis for Lewis Hall based on LEED Existing Building 3.0 guidelines. We have identified **52 immediate points**. Included is a narrative describing the projected points along with a LEED scorecard and a breakdown of the points acquired.

Rainier Electric understands that the UW is dedicated to being on the forefront of environmental sustainability without sacrificing the historical integrity of the campus created by buildings like Lewis Hall. We are proud to be given the opportunity to assist UW in this commitment. Our team confident that our proposal will not only meet your requirement, but surpass any previous standards.

Rainier Electrical would like to apply a technical analysis score adjustment as follows:

Lighting Retrofit x ***1.4***
Energy Use Retrofit x ***0.6***
Alternative Energy x ***1.0***

Again, we thank you for the opportunity to submit our proposal. We look forward to providing the electrical work and solution management for this project.

Sincerely,

Ben Leventer
Project Manager
Rainier Electrical Inc.

Client Summary

The University of Washington provided Rainier Electric with an excellent opportunity by promoting Lewis Hall as a building for NECA's Student Chapter to evaluate in "The Green Energy Challenge." Although Lewis Hall is seen as an iconic building on campus, it has the potential to meet the high sustainable standards of the university.

Originally constructed in 1896, Lewis Hall is a 23,200 sq. ft. building located in the northern section of the University of Washington's campus. Initially built to serve as the men's dormitory, the building currently serves as a home for office and administration space for the Foster School of Business and other programs. Lewis Hall's outdated electrical systems have provided Rainier Electric the opportunity for drastic savings in energy consumption.

Striving to be a leader in sustainability the University of Washington is committed to environmental responsibility, recently requiring all new student housing to meet or exceed the LEED Gold rating. A multi faceted approach is currently being undertaken to turn the UW into a "green" campus. Recycling, composting, and sustainable dinning programs have all been recently implemented on campus. Additionally the UW is focused on elevating awareness of the sustainable actions being made to its campus. As students become more aware and interested in sustainability the University of Washington will continue to raise the bar for green campuses nationwide.

Rainier Electric has two main points of contact for the retrofit of Lewis Hall: Ken Kubota, a project manager at the Capitol Projects Office (CPO) and Keith Salmon, Facilities Manager of Lewis Hall. The Capital Projects Office is responsible for developing and overseeing most projects on the UW campus.They both emphasized the importance of taking a comprehensive approach to the renovation of Lewis Hall.

Lewis Hall has long been recognized as a building in need of renovation. Upgrading Lewis Hall presents a unique opportunity to combine the University of Washington's green aspirations with its historical roots. This renovation will inspire the UW community by a restoring life to a building in need.

Mission Statement

"Promoting Green Energy by providing our clients with service that is both Energy Efficient and Economically Effective."

Rainier Electric strives to make the world a greener, more sustainable place by providing the highest caliber of energy efficient electrical construction. Our involvement and dedication to the green energy industry has created our excellent reputation. Our experience allows us to provide service and significant value to our clients.

Project Team

Ben Leventer, Project Manager: Ben will coordinate all team activities and serve as the primary source of communication between the project team and client. Ben managed the development of this proposal and holds authority over his team's decision making process.

Eddie Baker, Lighting Design Engineer: Eddie conducted a thorough analysis of the current lighting system at Lewis Hall. He developed a new energy efficient lighting system that includes daylighting and occupancy controls.

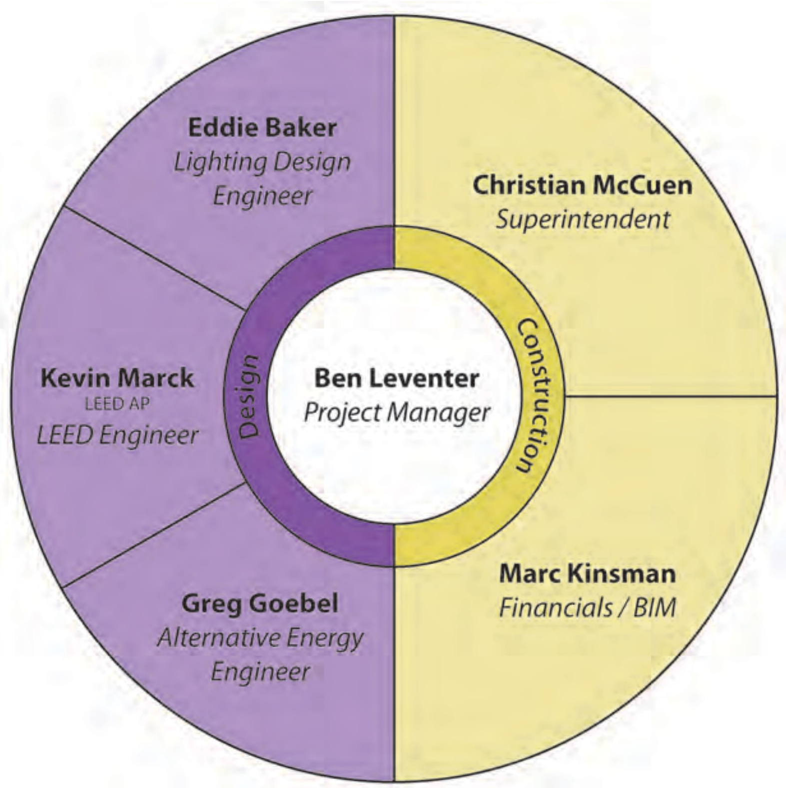
Greg Goebel, Alternative Energy Engineer: Greg performed an extensive analysis of the most effective alternative energy solutions available. Based on those findings, Greg's developed the most suitable alternate energy production system.

Marc Kinsman, Financial Coordinator/BIM: Marc was responsible for handling the team's budget. Also, Marc performed preliminary virtual coordination and assisted the superintendent.

Kevin Marck, LEED AP, LEED Engineer: Kevin's main responsibility is to ensure the retrofit achieves necessary LEED standards.. Also, Kevin identified all applicable rebates and incentives.

Christian McCuen, Superintendent: Christian surveyed the area surrounding Lewis Hall and created a site logistics plan. He was also responsible for developing the project schedule.

Organizational Chart



Team Resumes

Benjamin L. Leventer
(360) 393-1348 • benlev@comcast.net
4628 22nd Ave. NE. • Seattle, WA 98105

Objective

Obtain an internship in order to gain experience and prepare myself for my future in the Construction Management field.

Education

University of Washington

2008-Present Undergraduate: Construction Management Seattle, WA

GPA: 3.31

Skills/Achievements

- NECA Student Chapter President
- Selected Member of MCAA National Student Competition
- Multiple Dean's List Awards

Experience

Intern

Summer 2012 Walsh Construction Co. Seattle, WA

- Duties yet to be determined.

Team Captain

January 2012 – Present NECA Green Energy Challenge Seattle, WA

- Lead team of 6 students, create plans to retrofit a building for optimal energy efficiency.
- Respond to RFP, suggest systems, provide plans, budget, and a schedule for project.

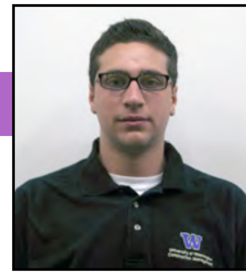
Barback, Busser

June 2010 - Present Wild Ginger Seattle, WA

- Bus and reset tables, serve water.
- Stock bar and help bartenders.

Rainier Electric

Team Resumes



Eddie Baker

(206) 334-2869 • ebaker22@washington.edu
2731 44th Ave. SW • Seattle, WA 98116

Objective

To find the right company that promotes growth within its organization,that presents challenges to encourage self-development that compliments my personal strengths, and allows me to see other parts of the country and/or world, all while working with people I enjoy being around.

Education

University of Washington

2009-Present Undergraduate: Construction Management Seattle, WA

GPA: 3.46

Skills/Achievements

- Attained Eagle Scout rank, Boy Scouts of America Troop 284
- MCA Student Chapter President
- Varsity Lettered in four high school sports.

Experience

Intern

Summer 2012 Hermanson Company Seattle, WA

- Duties yet to be determined.

Standards Board Senior Brother Marshall

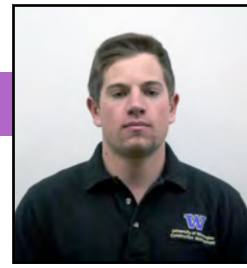
August 2009 – Present Sigma Phi Epsilon Seattle, WA

- Perform media related jobs at numerous sporting events.
- Write stories, conduct interviews/research.
- Assist Sports Information Directors.

Athletic Communications Department

April 2010 - Present University of Washington Seattle, WA

- Perform media related jobs at numerous sporting events.
- Write stories, conduct interviews/research.
- Assist Sports Information Directors.



Gregory M. Goebel
(360) 929-0982 • doubleg@u.washington.edu
4532 19th Ave. NE. • Seattle, WA 98105

Objective

To find a strong, competitive internship over the summer where I can expand my knowledge of the construction field and work towards a full time position with said company.

Education

University of Washington

2009-Present Undergraduate: Construction Management Seattle, WA

GPA: 3.1

Skills/Achievements

- Revivification Award for Theta Delta Chi Fraternity
- Naval ROTC Scholarship
- Team Captain for HS Football and HS Track Team

Experience

Pre-Construction Intern

Summer 2012 McCarthy Building Co. San Fran., CA

- Duties yet to be determined.

House Manager

Fall 2010 – Fall 2011 Theta Delta Chi Seattle, WA

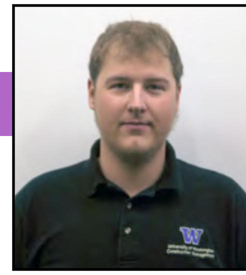
- Managed all repairs and remodels within the fraternity including: renovation of foyer, dry wall repair, bathroom tile, painting, plumbing, and window repairs.
- Managed fraternities work week. Managed over 60 brothers as well as planning the projects that took place throughout the week.

General Construction

Summer 2008 & 2009 K & D Enterprise Oak Harbor, WA

- General construction including: roofing, siding, painting, deck and fence building, and landscaping.
- Shadow manager during booking of jobs, performing tasks on site, and final steps of construction.

Team Resumes



Mark R. Kinsman

(425) 785-5671 • mark@kinsman.net
1818 N 46 St. • Seattle, WA 98103

Objective

To find a construction internship with an emphasis in BIM technology.

Education

University of Washington

2008-Present | Undergraduate: Construction Management | Seattle, WA

GPA: 3.37

Skills/Achievements

- SolidWorks
- Autodesk Inventor, Revit Architecture, Navisworks
- Programming C#, C++, Java, Python
- AutoDesk Student Expert (Campus Manager)

Experience

BIM Intern

Summer 2012 | Hathaway Dinwiddie | San Fran., CA

- Meet with customers, determine need and specification.
- Design features and structures, estimate project.
- Construct all items agreed upon, ensure customer satisfaction.

Owner/Operator

May 2010 – Present | Design/Build Landscaping | Seattle, WA

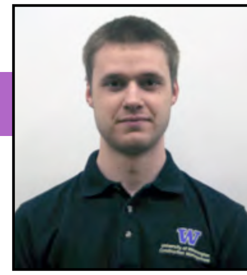
- Meet with customers, determine need and specification.
- Design features and structures, estimate project.
- Construct all items agreed upon, ensure customer satisfaction.

Supervisor

June 2006 - Present | Snoqualmie Learning Center | Seattle, WA

- Manage and schedule ski and snowboard instructors, plan and lead safety meetings.
- Hire and fire employees, interact with customers, book keeping and payroll.
- Open, close, and operate facilities.

Team Resumes



Kevin Marck

(206) 405-0451 • kmarck@u.washington.edu
4530 17th Ave. NE • Seattle, WA 98105

Objective

Obtain a summer internship in the Seattle area to help develop my understanding of the construction industry.

Education

University of Washington

2009-Present   Undergraduate: Construction Management   Seattle, WA

GPA: 3.5

Honors/Achievements

- Journey of Hope: rode bike across country, team raised over $600,000 for people with disabilities.
- Guide dog raiser.
- Member of MCAA student chapter competition.
- University of Washington Mascot Student Handler.

Experience

Intern

Summer 2012   Howard S. Wright   Seattle, WA

- Duties yet to be determined.

Housing Manager

2010-2011   Pi Kappa Phi   Seattle, WA

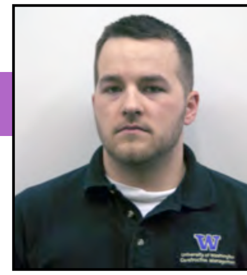
- House property manager, 3 total properties.
- Organized, planned, and managed 80 fraternity members to clean and fix house properties, executed in 2 different weeks.
- Performing all general handyman jobs around the properties.
- Coordinating plumbers and contractors for upkeep of properties.

Apartment Maintenance

2009-2010   Lorig Apartments   Seattle, WA

- Responsible for all general maintenance.
- Managed 5 man painting crew, recording their progress..

Team Resumes



Christian McCuen

(206) 661-8499 • christian.mccuen@gmail.com
9226 NE 126th PL • Kirkland, WA 98034

Objective

Serve in a part-time position or a summer internship position with the goal of becoming a full-time employee with a construction management firm.

Education

University of Washington

2010-Present — Undergraduate: Construction Management — Seattle, WA

GPA: 3.3

Skills/Achievements

- Crew Member on multiple Allied Restoration Company projects.
- MCAA Student Competition Vice President.
- Head intern at the Master's Commission.

Experience

Intern

2012 – Present — Granite Construction Inc. — Seattle, WA

- Working on Eastside Corridor Constructor (JV) SR 520 expansion project in Bellevue, WA.
- Attend to both on-site and office duties.

Maintenance Manager

2008 - Present — Christ Church Kirkland — Seattle, WA

- Building maintenance and janitorial service.
- Maintain security, alarm, HVAC, and A/V systems.

Tutor

Fall 2011 — University of Washington — Seattle, WA

- Tutored students in COM 220: Public Speaking.
- Helped students and gave advice on homework assignments and speeches.

Lighting Retrofit

The current lighting design of Lewis Hall allows for significant improvement in energy efficiency. As part of the retrofit of Lewis Hall, Rainier Electric is proposing a new lighting design that minimizes energy usage and improves performance.

We have identified five major tasks within the lighting retrofit:

1. **Replace existing T12 fluorescent fixtures with T5 fixtures**
2. **Decrease mercury content (pg/lm-h value) within the building's lamps**
3. **Add occupancy sensors to all offices, rooms, and hallways/corridors**
4. **Add photo sensors to rooms and areas with large windows and high exposure to natural light**
5. **Install high efficiency fixtures in areas of egress**

Lighting Breakdown

Proposed Lighting Financial Breakdown		
Annual Savings ($)	**Net Customer Cost ($)**	**Payback Period (yrs)**
27,357	52,495	1.92

When designing the lighting, Rainier Electric compared the benefits of implementing T8 and T5 fixtures. Rainier Electric determined that energy savings with the T5 fixtures significantly outweigh the lower initial cost of T8 fixtures. Additionally, T5 fixtures reduce the mercury content and provide a better distribution of light.

Proposed Lighting Retrofit - T5		
Existing	**T5 Retrofit**	**Annual Savings**
157,122 kWh/yr	51,624 kWh/yr	105,498 kWh/yr
Alternative Lighting Retrofit - T8		
Existing	**T8 Retrofit**	**Annual Savings**
157,122 kWh/yr	91,652 kWh/yr	65,470 kWh/yr

Fixture Per Floor Breakdown

Existing Fixtures					
Fixture	**1st Floor**	**2nd Floor**	**3rd Floor**	**4th Floor**	**Total**
4’ T12	88	82	91	22	283
Proposed					
Fixture	**1st Floor**	**2nd Floor**	**3rd Floor**	**4th Floor**	**Total**
4’ T5	56	50	55	16	177

Rainier Electric’s proposed lighting system design will reduce the overall number of total lighting fixtures, consuming less energy while providing more light in needed areas.

Figure 1: Floor 2 (Typical floors 1-3).

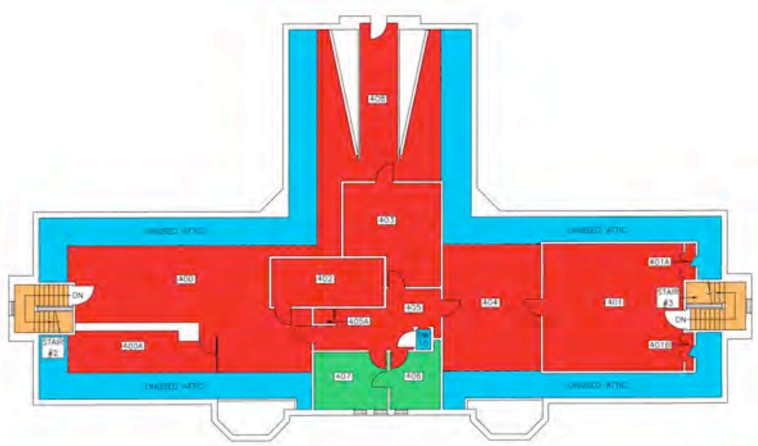


Figure 2: Floor 4.

Typical Office Upgrade

There are 65 offices in Lewis Hall. Typical offices house one employee; larger offices host multiple employees. T12 lighting in all offices are controlled by individual switches. With the higher lumen output of the T5 fixtures, we will be able to reduce the number of fixtures from four to two in a typical office. The reduced number of fixtures and the implementation of occupancy sensors will greatly increase office lighting efficiency.

Existing

- (4) 4' T12 fixtures (dual lamp)
- 96 Watts/unit
- Magnetic Ballasts
- Individual switch controlled
- No Occupancy Sensors

Proposed

- (2) 4' Canlyte T5 fixtures
- 56 Watt/unit
- Program start ballasts
- Wall mounted Wattstopper occupancy sensor
- Ceiling mounted Wattstopper photosensors/ occupancy sensors (larger offices)

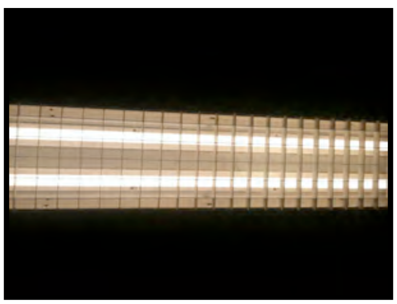


Figure 3: Existing T12 fixture.

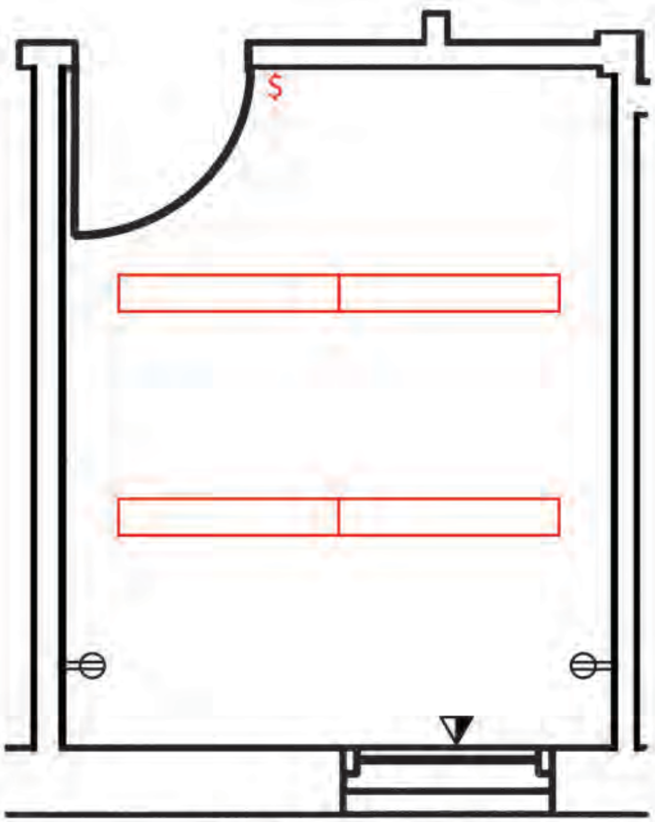
Figure 4. Proposed Canlyte T5.

Figure 5: Rendering of new office lighting.

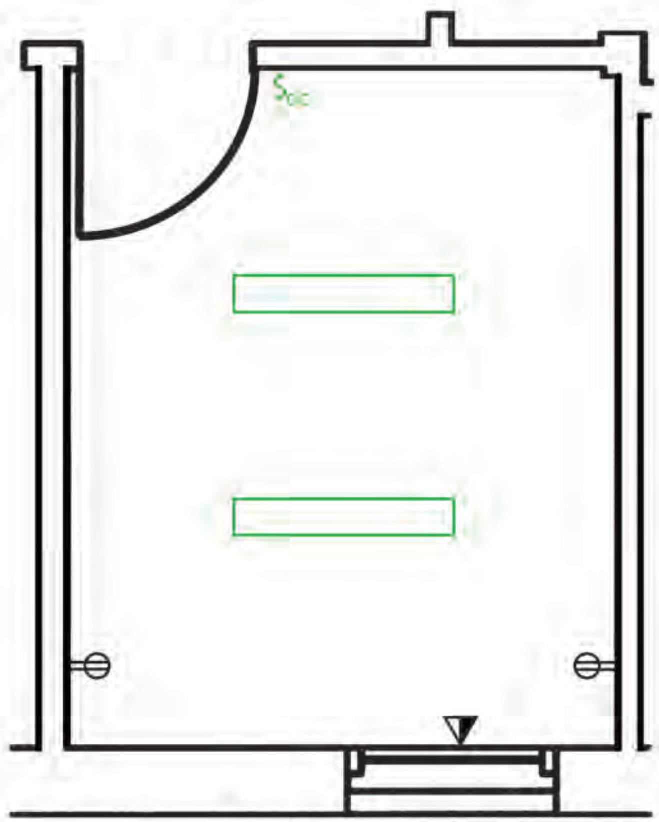
*See following page for reflected ceiling plan of existing office vs. proposed office.

Fixture Legend

	Old T12 Fixture		Canlyte AGC-2 T5
$	Switch	$OC	Occupancy Sensor Switch
	Wall Mounted 4-Port Data		Duplex



Typ. Office Existing



Typ. Office Proposed

Rainier Electric

120 Architecture Hall | University of Washington | Seattle, WA 98195

Typical Office Reflected Ceiling Plan

Lewis Hall Energy Retrofit

April 15, 2012

LH - E 4.2

Hallway / Corridor Upgrade

Hallway lighting consists primarily of T12 fluorescent lighting on 8' centers with some historical pendant fixtures in the front entry way. Lighting is controlled by a central control panel. Large windows are present in the stairwells. T5 fixtures, occupancy sensors, and photo sensors will be installed to ensure the usage of day lighting is maximized and energy wastage is minimized.

Existing

- 4' T12 fixtures(dual lamp), 8' on-center
- 96 Watts/unit
- Magnetic ballasts
- Central Control Panel
- No occupancy/photo sensors

Figure 6: Existing Hallway.

Proposed

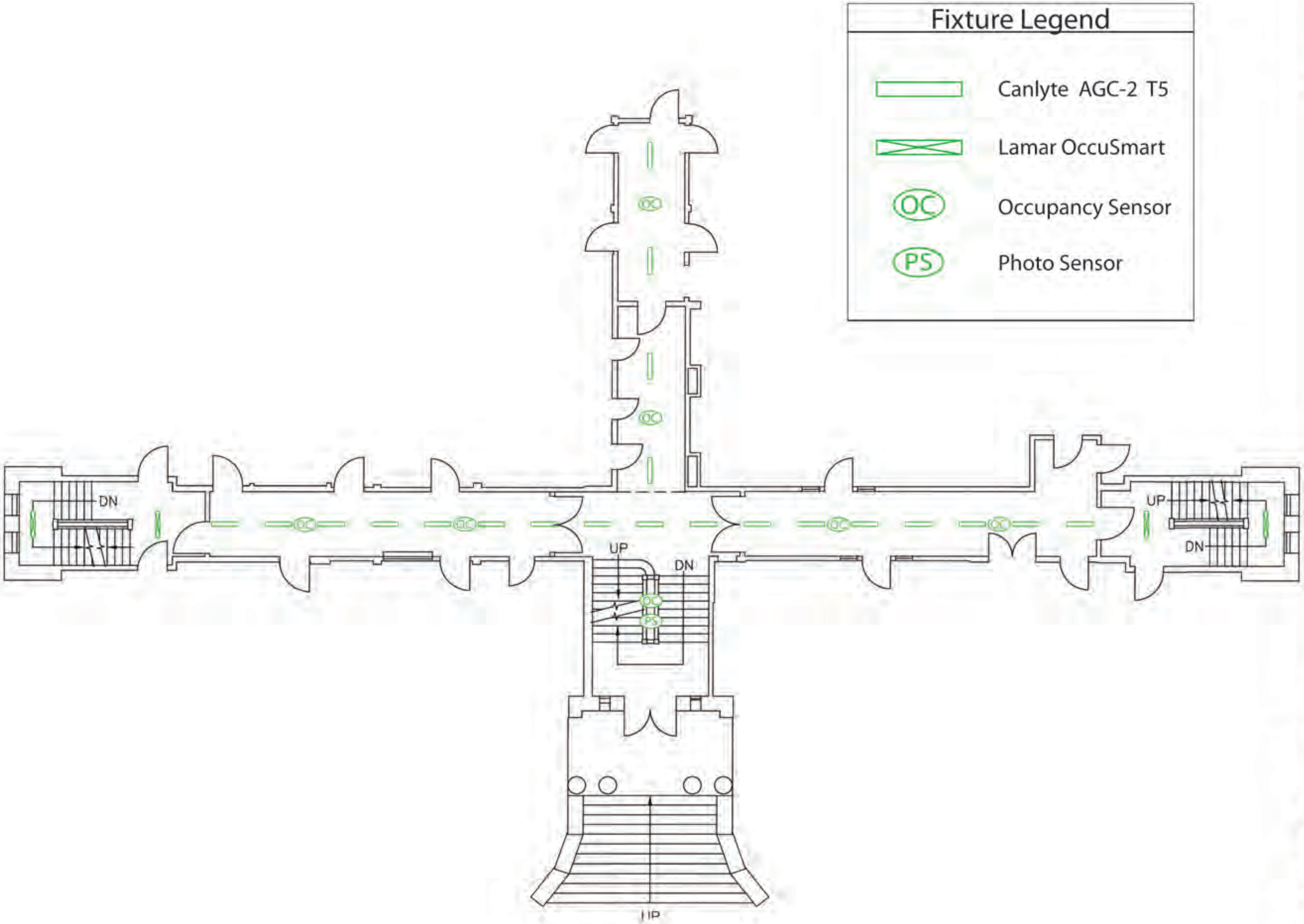
- 4' Canlyte T5 fixtures, 8' on-center
- 56 Watts/unit
- Program start ballasts (many with dimming coordinated with PV)
- Lamar Occu-Smart Fixtures (Stairwells)
- Ceiling mounted Wattstopper, Dual Tech DT-300, occupancy sensor
- Ceiling mounted Wattstopper photo sensors (areas near windows)

Figure 7: Lamar Occu-Smart Fixture.

Stairwell Upgrade: Lamar Occu-Smart Fixtures

Per city of Seattle code, egress areas (specifically stairwells) must maintain a minimum lighting level of 10 foot-candles when an occupant is located within the stairwell. In order to abide by these codes, we propose installing Lamar Lighting Occu-Smart fixtures. These fixtures have an internal high-frequency, supersonic sensor and require no added occupancy or photo sensors. These sensors ensure energy is not wasted when stairwells are not occupied. Selectable standby options can be set at 5,10, 20, & 30% of nominal light output. Occu-Smart fixtures are battery backed, which will be critical for emergency lighting.

*See following page for reflected ceiling plan of proposed hallway.



Rainier Electric
120 Architecture Hall | University of Washington | Seattle, WA 98195

Hallway Reflected Ceiling Plan

Lewis Hall Energy Retrofit

April 15, 2012

LH - E 4.3

Common Area / Conference Room Upgrade

There are multiple common areas on different floors of Lewis Hall. The existing T12 Fluorescent linear lights are controlled by individual switches. Proposed T5 fixtures, occupancy, and photo sensors will be installed to reduce energy waste.

Existing

- 4' T12 fixtures(dual lamp)
- 96 Watts/unit
- Magnetic ballasts
- Individual switches
- No occupancy/photo sensors

Proposed

- 4' Canlyte T5 fixtures
- 56 Watts/unit
- Program start ballasts (many with dimming coordinated with PV)
- Ceiling mounted Wattstopper, Dual Tech DT-300, occupancy sensors
- Ceiling mounted Wattstopper photo sensors (areas near large windows)

Figure 8: Common area, 2nd floor.

Figure 9: DT-300 occupancy sensor.

Wattstopper Dual Tech DT-300 Occupancy Sensors

Wattstopper Dual Tech DT-300 Ceiling Sensors combine the benefits of passive infrared (PIR) and ultrasonic technologies. Lights will only activate when both technologies detect the presence of occupants. These highly sensitive, and low-profile sensors provide 360 degrees of coverage, eliminating false-on/off issues. Installation of DT-300 sensors will minimize wasted energy due to unoccupied lighting.

Site Lighting Upgrade

The existing exterior lights consist of two pole lights, four above-door lights, and the two spot lights. Currently, these fixtures are on a poor schedule. By installing LED fixtures and photosensors, Rainier Electric will minimize wasted energy.

Existing

- (2) 150 Watt HPS Pole Lights
- (4) 150 Watt HPS Door Lights
- (2) MH 1000 Watt Spotlights
- Controlled by central panel
- No occupancy/photo sensors

Figure 10: Existing outdoor light.

Proposed

- (2) 10 Watt LED Pole Lights
- (4) 80 Watt LED Door Lights
- (2) 630 Watt LED Spotlights
- Outdoor Wattstopper photo sensors on each light

Figure 11: Proposed daylight sensor.

Current Footcandles

Using a BEHA UNITEST 93514 foot-candle meter, we recorded readings at multiple locations. The current foot-candles are very low, and do not meet recommendations. From survey results given to employees of Lewis Hall, we found that many people complained about the low levels of lighting within the building. By implementing T5 fixtures our lighting retrofit will provide for better distribution and higher levels of lighting, increasing user satisfaction and overall efficiency.

Location	Lights On		Lights Off	
	Day	Night	Day	Night
Center of Office	102	44	52	2.1
Under Office Desk	32	7.5	18	1.2
Common Area	105	51	69	2
Stairwell	96	67	78	5
Hallway	42	38	4.9	1
Front Entry	29	29	25	5.2

Proposed Foot-candles

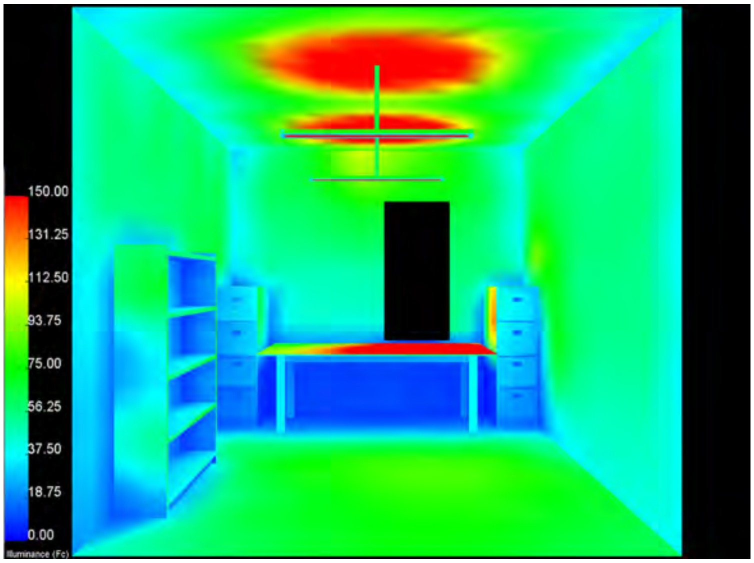


Figure 12: Photometric reading, lights on.

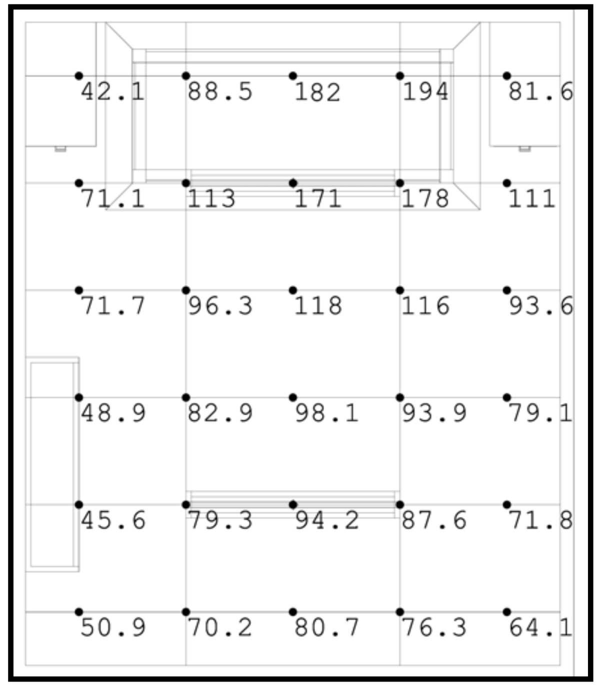


Figure 13: Proposed foot-candle distribution.

Fluorescent Lamp Disposal

The Resource Conservation and Recovery Act (RCRA) regulate the management and disposal of fluorescent light bulbs and other mercury-containing bulbs. Rainier Electric will ensure that the existing mercury-containing light fixtures will be disposed of properly and safely. We have negotiated and developed a plan with EcoLights Northwest to pick-up, haul, and properly recycle all necessary light bulbs from Lewis Hall. Cost breakdown for disposal can be found in financial tables.

Lighting Summary

Rainier Electric's suggested design will improve the interior and exterior conditions while also becoming more energy-efficient. Annual savings of **105,498 kWh/Yr** will convert to **$27,357**. The total lighting system will be installed with a cost of **$52,495** to you, paying for itself in **1.92 years**. The T5 fixtures allow Rainier Electric to provide a fixture that disperses light effectively, balancing luminance levels. Additionally, introducing occupancy and photo sensors will eliminate unnecessary energy consumption. Through the use of natural lighting, artificial lighting demand will decreases, creating a more efficient building.

Skylighting Option

Rainier Electric acknowledges the desire to improve the energy efficiency of the existing systems at Lewis Hall while decreasing demand for artificial lighting by bringing in more natural daylight. We conducted an analysis of Lewis Hall using a UNITEST Luxmeter and identified the 4th floor as a major source of energy inefficiency. Few windows are present and the current design does not utilize natural daylight, thus creating a large need for artificial lighting.

<u>4th Floor Existing Conditions</u>
- 5800 sq. ft
- 35 sq. ft of windows
- 5 foot-candles produced by daylighting
- Artificial lighting required: 70 fc

The 4th floor is mostly common space and because computers are regularly used, at least 75 fc are needed to provide sufficient lighting. Rainier Electric recognizes that installing skylights would be an option to meet our clients requests and increase daylighting in the 4th floor.

Skylights are included in the proposal as an owner mandated upgrade. Rainier Electric concluded that installation of skylights would not be beneficial. We received a bid of **$228,520** for furnishing and installing 6 skylights. The benefits provided by skylights do not justify this high cost. Furthermore, skylights would significantly reduce the amount of usable space for the PV system and would lower energy produced on-site. However, we understand that cost may not be the deciding factor and have included skylights as a ‘below the line’ option.

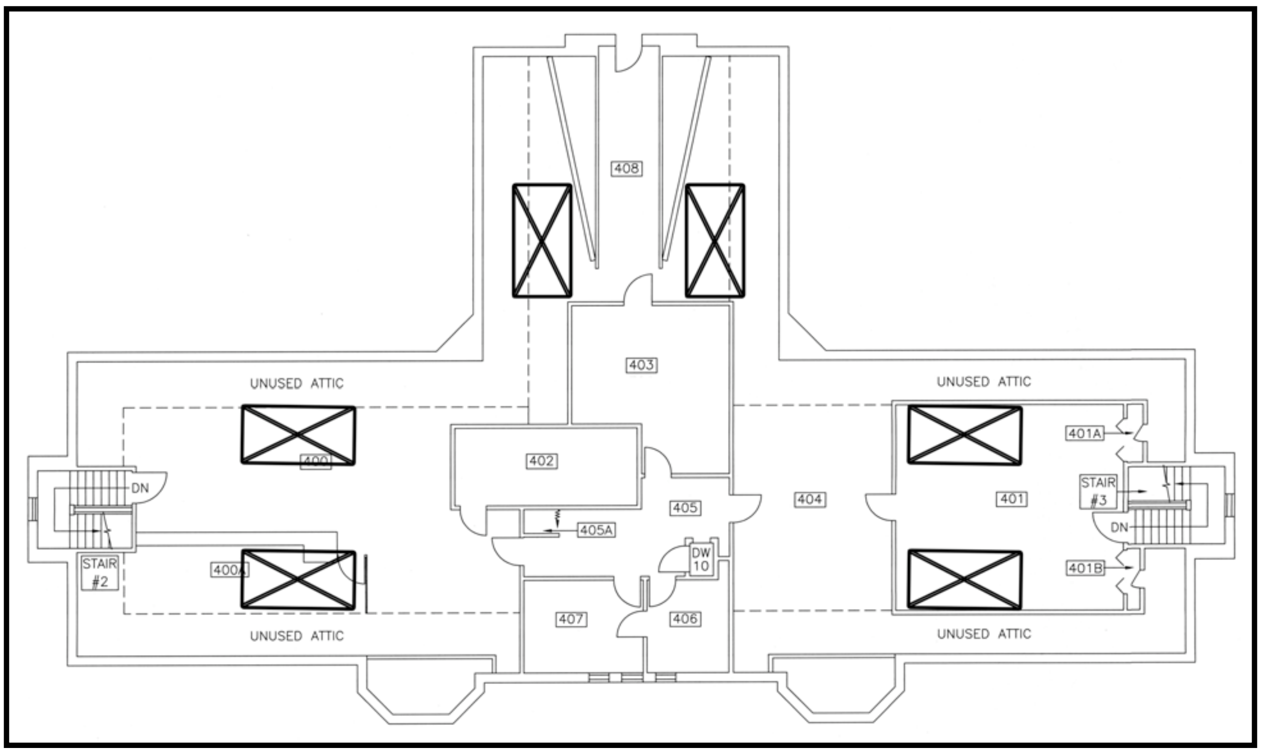


Figure 14: Potential placement of skylights.

Energy Usage Retrofit

Energy use Analysis

Rainier Electrical conducted a comprehensive study concerning the energy usage Lewis Hall's HVAC system and current building envelope and identified sources of energy inefficiency. Results were discussed with a partner mechanical contractor, who provided insight to the most effective and feasible solutions. We have created a two step energy usage retrofit plan to help our client achieve their goal of increased energy efficiency.

1) **Install Variable Frequency Drives on water pumps**
2) **Replace existing glazing**

HVAC Existing Conditions

<u>Heating Process of Lewis Hall</u>

Lewis Hall generates heat from steam. Steam is received via underground pipes from the UW's Central Power Plant, which provides heat to a majority of the buildings on campus. A hot-water boiler in the Mechanical Room of Lewis converts the steam. Hot water is then pumped throughout the building. Heating is done locally through radiators. Radiators are extremely efficient and have a very low maintenance cost, so no upgrade is needed.

<u>Heating Equipment</u>

- **Aerco KC-1000 Water Hot Boiler:** Converts incoming steam into usable energy, uses gas and electrical energy to heat return water.
- **(3) 1 hp, Circulating Hot Water Pumps:** Pump hot water to heat building, returns water to hot water boiler.

<u>Ventilation/AC</u>

There is no mechanical cooling systems in place and a very limited ventilation system serves only a few rooms. Because mechanical ventilation is so minimal, retrofitting this system would not prove beneficial.

Pump VFD Installation

Existing Conditions

- (3) 1 hp, Grundfos UP40-160 pumps

- Required to pump heat 2730 hours annually

- No VFDs = Energy loss when pumps run and switch on/off

Currently, there are three pumps circulating heat through Lewis Hall. Seattle's climate makes heating necessary throughout most of the year. As the pumps switch on and off, energy surges to 600% of normal and large amounts of energy are wasted(see APPENDIX B). When on, pumps run at full capacity, decreasing energy efficiency. When running, the pump consume 750 watts per hour each(see APPENDIX B). On average, pumps run for 10 hours a day to maintain comfort levels in Lewis Hall, excluding the summer months July-September.

Annual Energy Consumption of Pumps				
Number of Pumps	**Run Time (hrs)**	**Energy Required to Run Pumps (kWh)**	**Start/Stop Energy Consumption (kWh)**	**Total Energy Consumption (kWh)**
3	2,730	6,143	3,686	9,829

Proposed Retrofit

- Install Variable Frequency Drives, improve energy efficiency

- Reduce average pumping speed, introduce "soft" start

Rainier Electric will install Altivar 61 VFDs, by Scheider Electric, on each pump. Installation of these VFDs provides a cost effective solution to increase energy efficiency at Lewis Hall. VFDs produce a "soft" start and stop for the pumps, virtually eliminating the initial power surge associated with start/stop losses. Furthermore, VFDs allow the output from pumps to match heating needs, eliminating excess pumping and improving energy efficiency. Estimates show that on average, pumps will run at 80%, using only 50% of the energy required to run at 100% (see APPENDIX B). VFDs will be installed by Rainier Electric.

Annual VFD Savings				
New Energy Consumption	**Energy Savings (kWh)**	**Energy Savings ($)**	**Cost of Pumps ($)**	**Payback Period (yrs)**
3,686	6,143	1,536	2,734	0.66

Glazing Existing Conditions

Rainier Electric conducted a survey of Lewis Hall's building envelope and concluded that the current glazing results in a major source of heat loss. 21% of Lewis Hall's building envelope is glazing. Windows are single pane, double hung, wood framed, and allow for a significant amount of heat to transfer through the windows.

Figure 15: Existing window in stair well

<u>Current Windows</u>

- Amount of Glazing: 2833 sq. ft.

- U-value: 0.90 BTU/hr-ft2 -°F

- Annual Heat Loss: 76534.03 kWh

- Annual Heat Loss: $20,673

Existing Heat Loss Due to Glazing					
Sq. Ft. Glazing	**U-Value (BTU-hr-sq.ft.-°F)**	**°F-Hours**	**Heat Loss (kBTU)**	**Heat Loss (kWh)**	**Annual Cost of Lost Energy ($)**
2,833	0.90	110,664	282,160	82,692.93	20,673

Glazing Retrofit

<u>Client's Input for Glazing Retrofit:</u>

- Improve energy efficiency of Lewis Hall

- Maintain "historic" looks of Lewis Hall from exterior

Rainier Electric has concluded that the best option for the glazing retrofit will be to replace all existing windows with T7 Talon window assemblies by Eagle Window and Doors. With these windows, Rainier Electric can satisfy the needs of our client at a very reasonable price. Rainier Electric selected the T7 Talon windows because of their superior ability to reduce heat loss while retaining a sufficient amount of solar gain and providing the desired look.

<u>Proposed Retrofit: T7 Talon Windows</u>

- Double hung, insulated glass, Low-E

- U-value = 0.31 BTU/hr-ft2 -°F

- "Wooden" frame and colonial glass stops provide historic look

- Annual Cost Savings = $13,553

Heat transfer occurs through three actions: **conduction, convection, and radiation**. The selected assemblies reduce heat transfer in all three ways. A bronze frame provides a thermal barrier, drastically decreasing conduction of heat through the frame. Two panes of insulated glass reduce convection. The special low-emitting coat on the surface prevents heat transfer through radiation. Furthermore, the frame has wooden veneers and colonial glass stops, which add to the historic look. Overall, the proposed assemblies will significantly lower heating costs while maintaining the aesthetic appeal of Lewis Hall's current windows.

Glazing Retrofit				
Existing Heat Loss (kWh)	**Retrofit Heat Loss (kWh)**	**Annual Savings (kWh)**	**Annual Savings ($)**	**Payback Period (yrs)**
82,692.93	28,483.12	54,209.81	13,553	11.51

Rainier Electric will subcontract the furnishing and installation of windows to Washington Window and Doors, a certified dealer of Eagle products. John Rhea, General Manager of the Redmond Team, provided Rainier Electrical with a quote and an estimated bid price of **$171,712** (*APPENDIX B).

Alternative Energy Retrofit

Existing Conditions

- **Lewis Hall has 2 large roof surfaces facing southwest**
- **Each surface is at a 45° angle**
- **Approximately 113.73 m^2 of available surface**

Utilizing a Solar Pathfinder, Rainier Electric concluded the optimal placement for a PV system is the southwest facing roof surface. No significant shading will pose a threat, allowing 100% solar access during the peak hours. One square meter of solar panel facing due south at a tilt angle of 34° will produce, on average, 3.83 kWh/day. With a roof pitch of 45° (12 in 12) a reduction of 1.3% must be noted. On top of this, a 5.4% reduction must be taken as a result of the southwest orientation of the roof. This results in a realistic average of **3.58 kWh/day/m^2**.

Photovoltaic Design

- **Each side of roof houses 7 vertically aligned, single strings**
- **5 panels per string maximizes usable space**
    - **(*APPENDIX C, String Sizing)**

Appropriate string sizings ensures necessary voltage is maintained to operate the system without exceeding the inverters specified range. Optimal placement avoids shadings, allowing the PV system to operate at full capacity.

Figure 16: Render of Lewis Hall with proposed PV design.

Solutions Overview

- **(70) SunPower E19 320 Panels on the Southwest Facing Roof**
- **Annual Production of 28,685 kWh**
- **Annual savings of $7,171**
- **Payback Period of 10.36 Years**

With an area of 112 m^2 of solar panels the maximum potential from the sun is 400.96 kWh/day. One of the leading factors in the selection of the SunPower panels was that they're of the monocrystalline silicon variety and offer one of the highest conversion efficiencies yet to date on the market. With a conversion efficiency of 19.6%, a reasonable output from the system will be an annual production of 28,685 kWh.

Estimated Payback Period								
Upgrade	**Initial Cost**	**-**	**Instant Incentives**	**=**	**Total Cost**	**÷**	**Annual Energy Reduction**	**ROI (yrs)**
PV System	$117,290	-	$43,008	=	$74,282	÷	$7,171	10.36

- See page 34 for cost break down
- See page 39 for incentive breakdown

During our analysis, Rainier Electric also considered locally made, Sillicon Energy SiE200 panels. Due to the low conversion efficiency of these panels (15%), the SunPower panels generate more energy and provide greater cost savings.
(*APPENDIX C, SiE200 Cost Breakdown)

<u>Photovoltaic System</u>

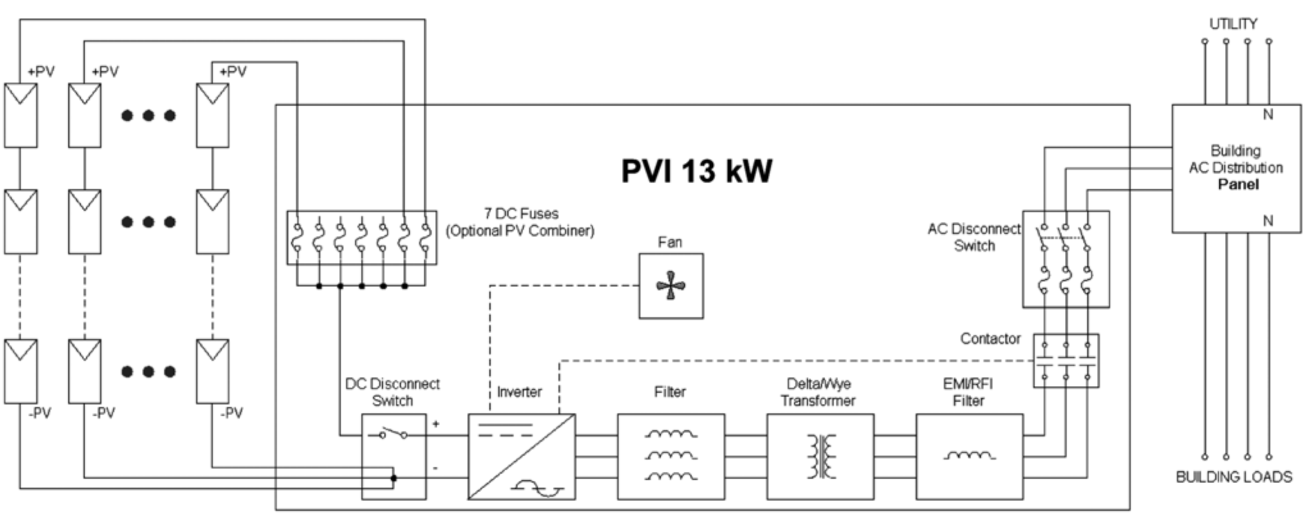


Figure 17: PV Schematic Layout.

Inverter

- **(2) Solectria PVI 13 kW Inverters**
- **Selection was driven by ability to handle absolute max power of 21,760 kW**
- **Invertors will be placed inside attic directly under the front eve**

Solectria is the leading US based inverter company with an established track record of quality products. The inverter selected for this installation provides 95.5% efficiency, reducing energy lost through the DC to AC conversion process. The warranty period is 5 years. Inverters will be mounted directly under the front eve of the roof, inside the attic. This provides a clean, dry, and cool location for the inverter to achieve the longest life and highest efficiency possible. Wiring for the inverter will feed into the main electrical room through the dumb weightier shaft, running 50' vertical and 35' horizontal.

Mounting System

Proposed: Unirac Sun Frame System

Working with the client, we discovered early on their emphasis towards maintaining the aesthetic appeal of Lewis Hall. To meet the client's needs we have selected the Unirac Sun Frame system for the mounting of our photovoltaic panels. The Sun Frame system allows panels to sit in low, gap-free rows with matching colors of module frames while providing enough distance from the roof to provide proper cooling airflow to optimize module performance. In addition the system will minimize penetrations and increase span distances to decrease installation time. Backed by a ten-year warranty, this system will provide the necessary framing, in addition to its sleek design.

A major concern with the mounting system is the possibility of leaking. Seattle's annual rainfall is over 50 inches and the average annual snowfall is 8 inches. Inherently, this weather poses a risk to the PV System. Rainier Electric will minimize this risk by properly protecting penetrations with manufacturer approved sealant.

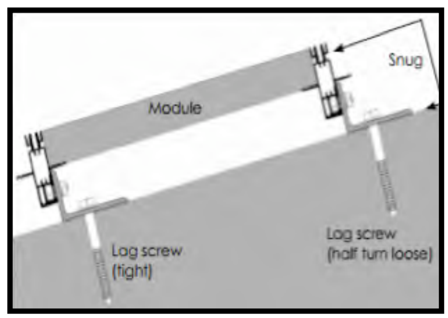


Figure 18: Proposed mounting system.

Corporate Image

The City of Seattle, along with the entire state of Washington, strives towards excellence in sustainability. With the University of Washington recently being named America's "Coolest School," the retrofit of Lewis Hall will continue to prove UW's excellence in sustainability. Rainier Electric holds true to creating an on-campus example for future renewable energy usage and promoting an environmentally conscious image.

Lewis Hall remains as one of the oldest buildings on campus after original construction took place in 1896. Located directly off the main road through campus, Lewis Hall is easily visible to students and visitors on campus. Installing the solar panels on the frontal roof surface of the building allows our panels to be easily visible to all. These panels will serve as an example of University of Washington's commitment towards sustainability; while justifying the ability to maintain a historic appeal, whereas benefiting from today's technology.

Schematic Estimate & Schedule

Schedule Summary

The schedule for this project is separated into 3 main scopes of work: Lighting Retrofit, Energy Usage Upgrades, and Alternative Energy Installation. Rainier Electric has scheduled 6 weeks for the work (June 10 - July 12). This timeframe was selected in accordance with the clients requests, specifically to permit the coordination of work during a period when the majority of school is not in session and use of Lewis Hall is low. Work activities have been organized in an effective manner to maximize productivity and to the university. Weather will be ideal for construction and the potential to disrupt campus operations will be minimal.

Schedule Sequencing

Overview
This project will take place in a top-down sequence. Construction will begin on upper sections and subsequent work activities will occur in a descending order. Our simple yet efficient schedule breaks the work into 7 stages.

1. Mobilization
2. Scaffolding Installation
3. Glazing Retrofit
3a. Skylights(Optional)
4. PV Installation
5. Lighting Retrofit
6. HVAC Retrofit
7. Demobilization

The retrofit of Lewis Hall will be systematically completed throughout June 2013 and July 2013. Work begins a week after spring quarter ends, so personal on campus will be minimal. We expect Notice to Proceed on June 11, 2013. Substantial completion will be reached on July 10, 2013, with project completion scheduled for July 17, 2013. Lewis Hall will be off-limits to students and faculty during the construction process so as to expedite the project schedule and enhance student/staff safety throughout the project.

Faculty of Lewis Hall will be relocated to Condon Hall during construction. Condon Hall is nearby on campus and is meant to accommodate those displaced during construction.

Stage 1: Mobilization
To effectively manage the schedule and ensure a smooth project, Rainier Electric makes crew mobilization and site preparation a top priority. We have proposed the use of unoccupied space in Lewis Hall for the site office and crew lunchroom. All fencing, materials, and equipment will be delivered during this stage. A safety plan will also be put in place and workers will be briefed on any site-specific conditions. In the following stages, additional safety plans and measures will be enforced accordingly. We recognize that a successful project begins with excellent and efficient safety and mobilization plans.

Stage 2: Scaffolding Installation
Scaffolding is required for the Glazing upgrade and does not fall under our scope of work. Costs associated with scaffolding are included in the bid provided by Washington Window and Door. We have accounted for time required in our schedule to accurately display the sequence of construction.

Stage 3: Glazing Retrofit

The windows of Lewis Hall will be systematically replaced over 13 days in multiple phases to eliminate crew overlap and delays. Once Level 4 is complete, the installation of the PV system can occur. If the skylight option is chosen, PV installation will not start until the Southwest frontal section of the roof is completed. This schedule allows us to efficiently coordinate the individual upgrades.

Stage 3a. Skylights (OPTIONAL)

If the decision is made to include skylights on the project, Rainier Electric will subcontract the supply and installation. Work will take place over 8 days, starting June 17 and ending June 26. The southwest face will be first section completed, allowing for timely PV Installation.

Stage 4: PV Installation

The six-day PV installation is scheduled to begin June 24. Prior to PV Installation, 4 safety line anchors will be installed by a subcontractor at a cost of **$2488**. This will provide proper anchorage for all fall arrest safety lines, worn by all workers on the roof. A mobile truck crane will be in place to hoist necessary materials. Once these conditions have been established, three tasks remain within Stage 4.

A) Installation of the racking system: The entire PV system is dependent on the racking system and it must be installed first. Effective placement of panels and connections can not occur until the racks are in place.
B) Installation of panels and inverters: After the racks are secured, panels and inverters can be installed. These are both relatively simple activities that can be completed simultaneously. Also, simultaneous installation makes the next step more effective.
C) Wiring and connections: When installation of both panels and inverters is finished, wiring and connections between the two components can be completed quickly and effectively. The final connection will be made to Panel 1A, completing the PV system.

Stage 5: Lighting Retrofit

The interior lighting upgrade consists of four major steps:

- Old Fixture Demolition
- New Fixture Installation
- Controls Installation
- Trim/Finish/Start-up

This stage begins on level 4 and continues down floor by floor. Once the interior lighting retrofit is complete, exterior lighting installation begins.

Stage 6: HVAC Retrofit

This stage will consist of the installation of Variable Frequency Drives (VFDs) on Lewis Hall's mechanical equipment. Although this is a short part of the schedule, this stage is of utmost importance as it will dramatically decrease the energy usage of the building's HVAC equipment.

Stage 7: Demobilization

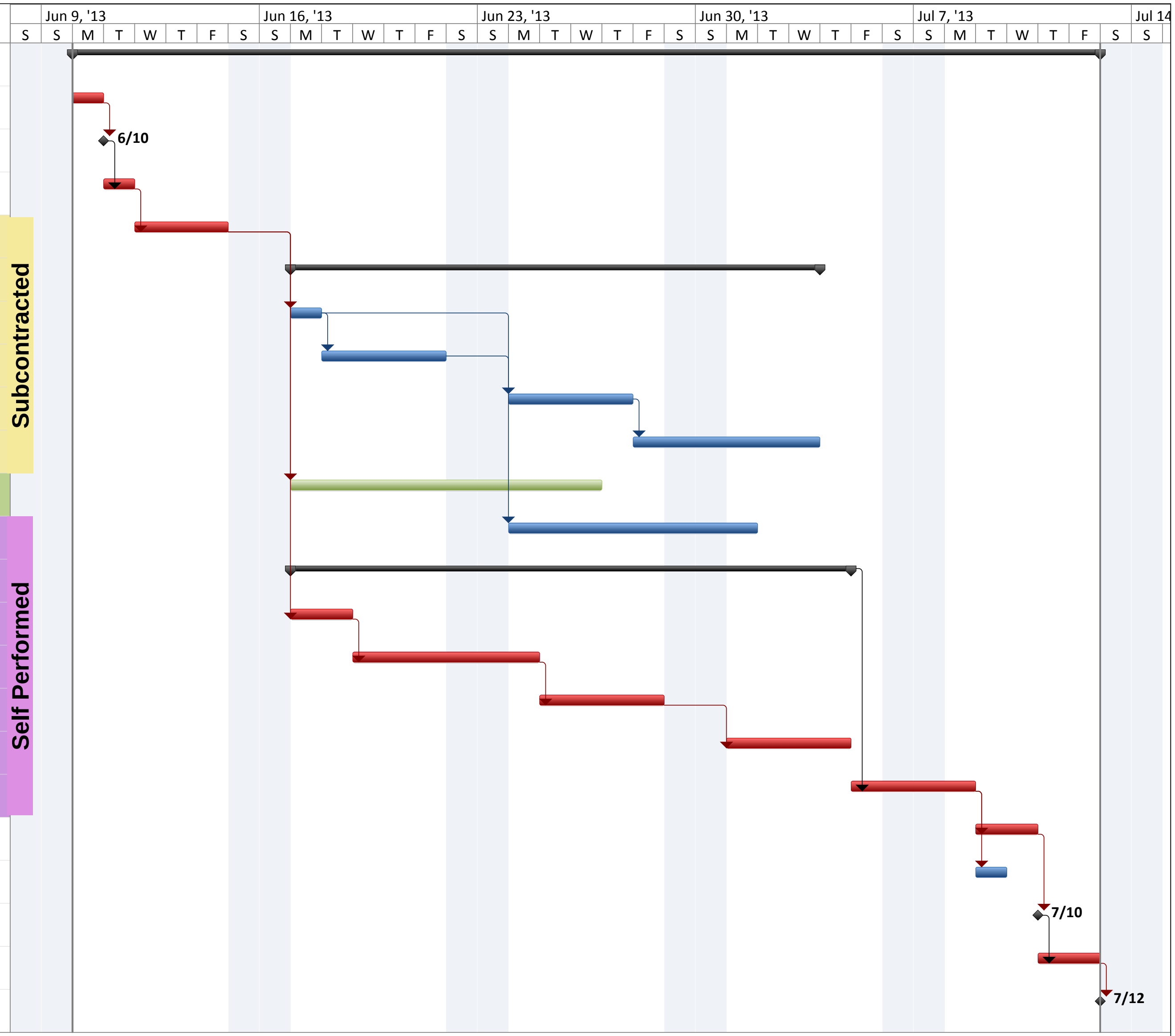
Once each stage has been completed, the subcontractors have moved out, and each system has been tested and commissioned, site demobilization will begin. Commissioning and Start-Up procedures will begin during this phase. The scaffolding will be disassembled and removed from the site. All equipment and tools will be accounted for and either returned or delivered to the company warehouse. Chain-link fencing will be removed along with the site storage container.

After these stages are complete, substantial completion will be declared and a Temporary Certificate of Occupancy will be issued, allowing school staff and students access to the building. A punch list will then be created in order to make sure the owner is completely satisfied with every aspect of the electrical retrofit and every concern/problem is taken care of. Once the items on the punch list are completed, the Lewis Hall Electrical Retrofit project will be complete.

Warranty / Continuing Operations

All services provided by Rainier Electric are covered by a full one-year warranty. Insurance coverage for defective workmanship within the first year following completion will be covered 100 percent. Optional continued services can be provided for a negotiated fee following the warranty period.

ID	Task Name	Duration	Start	Finish
1	**Lewis Hall Electrical Retrofit**	**25 days**	**6/10/13**	**7/12/13**
2	RFP / Contract	1 day	6/10/13	6/10/13
3	Notice to Proceed	0 days	6/10/13	6/10/13
4	**Stage 1 - Mobilization**	1 day	6/11/13	6/11/13
5	**Stage 2 - Scaffolding**	3 days	6/12/13	6/14/13
6	**Stage 3 - Glazing Retrofit**	**13 days**	**6/17/13**	**7/3/13**
7	Level 4	1 day	6/17/13	6/17/13
8	Level 3	4 days	6/18/13	6/21/13
9	Level 2	4 days	6/24/13	6/27/13
10	Level 1	4 days	6/28/13	7/3/13
11	*Stage 3a - Skylights (Optional)*	8 days	6/17/13	6/26/13
12	**Stage 4 - PV System**	6 days	6/24/13	7/1/13
13	**Stage 5 - Lighting Retrofit**	**14 days**	**6/17/13**	**7/4/13**
14	Level 4	2 days	6/17/13	6/18/13
15	Level 3	4 days	6/19/13	6/24/13
16	Level 2	4 days	6/25/13	6/28/13
17	Level 1	4 days	7/1/13	7/4/13
18	**Stage 6: HVAC Retrofit**	2 days	7/5/13	7/8/13
19	**Stage 7: Demobilization**	2 days	7/9/13	7/10/13
20	Commissioning / Start-up	1 day	7/9/13	7/9/13
21	Temporary Certificate of Occupancy	0 days	7/10/13	7/10/13
22	Punch List/Inspection	2 days	7/11/13	7/12/13
23	Project Completion	0 days	7/12/13	7/12/13



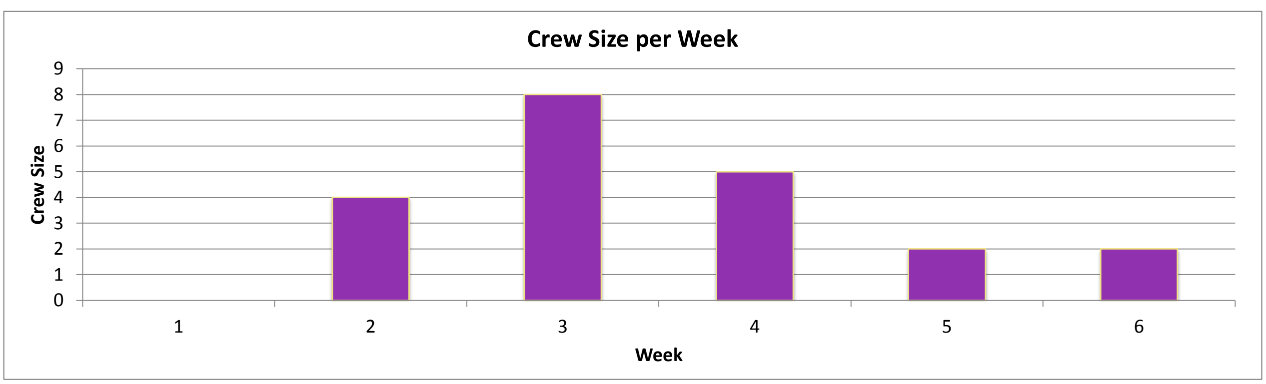
Project: Lewis Hall
Date: 4/14/12

Critical Split | Task | Milestone | Summary | Optional Task | Critical

Page 1

Work Breakdown

Activity Based Crew Forecast		# Days	Start	Finish	Budget Hours	6/10 Week 1	6/17 Week 2	6/24 Week 3	7/1 Week 4	7/8 Week 5	7/15 Week 6
Task #	Activity										
12	Stage 4 - PV System	6 days	Mon 6/24/13	Fri 7/1/13	159			4	3		
13	Stage 5 - Lighting Retrofit	14 days	Mon 6/17/13	Mon 7/8/13	245						
14	Level 4	2 days	Mon 6/17/13	Thu 6/18/13	29		2				
15	Level 3	4 days	Wed 6/19/13	Mon 6/24/13	72		2	2			
16	Level 2	4 days	Tue 6/25/13	Fri 6/28/13	72			2			
17	Level 1	4 days	Mon 7/1/13	Thu 7/4/13	72				2		
18	Stage 6: HVAC Retrofit	2 days	Fri 7/5/13	Mon 7/8/13	15					2	2
	Available Work Days			**Total Hrs**	**419**						
	27			**Total Crew Size**		0	4	8	5	2	2



Schematic Estimate

Rainier Electric performed an in depth energy analysis and considered all possible energy efficient retrofit options to reduce costs to UW without sacrificing the iconic look of Lewis Hall. The schematic estimate includes a lighting retrofit, energy usage retrofit, and an alternative energy retrofit. Costs included in the schematic estimate contain all materials, labor, and small tools. The schematic estimate is intended to provide a clear and concise breakdown of of the major costs associated with our scope of work.

Rainier Electric obtained labor units from the 2011-2012 NECA labor units manual in addition to subcontractor bids. Material prices were compiled through a combination of local supplier quotes adjusted accordingly by local NECA sponsors.

Base Package

Lighting Retrofit	$78,515
- Interior Fixture Upgrade	
- Exterior Fixture Upgrade	
- Lighting Control Upgrade	
Energy Usage Retrofit	$174,446
- VFDS	
- Glazing Retrofit	
Alternative Energy Retrofit	$117,290
- Roof Mounted PV System	
General Conditions	$27,666
Margin, B&O Tax, Contingency	$54,789
Total	**$455,193**
(Less Grants, Rebates, Incentives)	($86,461)
Total Installed Cost	**$368,732**

Budget Options

Skylights	$262,110

Budget Summary									
Lewis Hall									
System Description	**Budget**	**Materials**	**Labor Hours**	**Quotes**	**Straight Time Labor ($60)**	**Labor Subtotal**	**Supervision ($80/hr) 15% of**	**Total Craft Labor**	**Small Tools (2%)**
Lighting Upgrade	$ 58,319	$ 46,304	163.60		$ 9,816	$ 9,816	$ 1,963	$ 11,779	$ 236
Lighting Controls	$ 20,196	$ 14,225	81.30		$ 4,878	$ 4,878	$ 976	$ 5,854	$ 117
Mechanical System Upgrade	$ 2,734	$ 1,632	15.00		$ 900	$ 900	$ 180	$ 1,080	$ 22
Photovoltaic System	$ 117,290	$ 105,592	159.28		$ 9,557	$ 9,557	$ 1,911	$ 11,468	$ 229
Window Upgrade *(Subcontracted)*	$ 171,712	$ -	-	$ 171,712	$ -	$ -	$ -	$ -	$ -
Safety Line Anchors *(Subcontracted)*	$ 2,488	$ -	-	$ 2,488	$ -	$ -	$ -	$ -	$ -
Subtotal	**$ 372,738**								
General Conditions	$ 27,666								
Margin (12%)	$ 44,729								
B&O Tax (0.699%)	$ 2,605								
Contingency (2%)	$ 7,455								
Project Total	$ 455,193								
Rebates & Incentives	*$ 86,461*								
Proposed Project Total	**$ 368,732**								
Annual Electric Savings	**$ 49,617**								
Return on Investment (Years)	**7.43**								
Options:									
Skylight	*$ 262,110*								

* 12% Margin consists of 6% company overhead and 6% fee and risk.

General Conditions				
Lewis Hall				
Indirect Labor				
	Hours		**Cost Rate ($)**	**Cost Extension ($)**
Project Manager	60		80	$4,800
Alternative Energy Specialist	40		100	$4,000
Estimator	8		60	$480
LEED Coordinator	32		55	$1,760
Lighting Designer	16		55	$880
Financial Coordinator	8		45	$360
Administration - Accounting Backup	16		40	$640
Electrical Engineer	8		125	$1,000
Safety Officer	8		55	$440
Indirect Labor Subtotal:				**$14,360**
General Expenses				
	Weeks	**Qty**	**Cost Rate ($)**	**Cost Extension ($)**
Fencing	6		300	$1,800
Service Van: Foreman	6		250	$1,500
Mobile Truck Crane	1		4,800	$4,800
Storage Container	6		50	$300
Telephone	6		33	$198
Electrical Permit: City of Seattle		1	4,480	$4,480
Recycling	6		38	$228
General Expense Subtotal:				**$13,306**
General Conditions Total:				**$27,666**

Lighting Upgrade

Lewis Hall

	Lighting Upgrade							
	Material Description	**Qty**	**$ Cost/Unit**	**Unit**	**Material**	**Labor Hours**	**Unit**	**Labor**
1	T5 Fixture	128	210	E	$26,880	0.75	Hr	96
2	T5 Fixture (Dimming)	49	280	E	$13,720	1	Hr	49
3	Lamar Occu-Smart Fixture	18	210.64	E	$3,792	0.7	Hr	12.6
4	Outdoor LED Pole Light	2	120	E	$240	0.75	Hr	1.5
5	Outdoor LED Door Light	4	95	E	$380	0.75	Hr	3
6	Outdoor LED Spotlight	2	185	E	$370	0.75	Hr	1.5
7	T8 Disposal Cost	283	3.26	E	$923		Hr	0
					$46,304			**163.60**

	Lighting Controls Upgrade							
	Material Description	**Qty**	**$ Cost/Unit**	**Unit**	**Material**	**Labor Hours**	**Unit**	**Labor**
1	Wall Mounted Occ Sensor	80	85	E	$6,800	0.4	Hr	32
2	Ceiling Mounted Occ Sensor	28	150	E	$4,200	0.85	Hr	23.8
3	Ceiling Mounted Photo Sensor	13	165	E	$2,145	1.5	Hr	19.5
4	Outdoor Photo Sensor	8	135	E	$1,080	0.75	Hr	6
					$14,225			**81.30**

Energy Usage Upgrade

Lewis Hall

	Material Description	Qty	$ Cost/Unit	Unit	Material	Labor Hours	Unit	Labor
Mechanical System								
1	Altivar 61	3	544	E	1,632	5	Hr	15
					$ 1,632			**15**
Window Retrofit								
	Material Description	**Qty**	**$ Cost/Unit**	**Unit**	**Material**	**Labor Hours**	**Unit**	**Labor**
1	39x69	36	(See Quote)	E			Hr	0
2	39x81	32	(See Quote)	E			Hr	0
3	41x77	28	(See Quote)	E			Hr	0
4	Other	50	(See Quote)	E			Hr	0
					$ -			-

Alternative Energy Upgrade

Lewis Hall

	Material Description	Qty	$ Cost/Unit	Unit	Material	Labor Hours	Unit	Labor
Rooftop PV System								
1	SunPower SPR-320-WHT	70	$986	E	$69,049	1.06	Hr	74.2
2	Solectria PVI 13kW 13kW Inverter	2	$9,849	E	$19,698	15	Hr	30
3	Unirac SunFrame PV Mounting System (100' lengths)	6.05	$9	E		9	Hr	55.08
3a	SF RAIL 192', THREADED, DRK	36	$198	E	$7,115		Hr	
3b	SM SPLICE BAR SERRATED DRK	24	$6	E	$149		Hr	
3c	SF CAPSTRIP, 192", F, DRK	36	$70	E	$2,525		Hr	
3d	SF CAP SCREW, 1/4 X 1", DRK	660	$1	E	$667		Hr	
3e	SM L-FOOT SERRATED W/HDW, DRK	72	$5	E	$327		Hr	
4	Electrical Supplies (disconnects, combiner/fuse box, meter base, conduit, wire, etc)	1	$6,063	E	$6,063			
					$105,592			**159.28**

Financing Plan

Grants, Rebates, Incentives

Overview

We have found all applicable rebates for the work that will be performed on Lewis Hall and included a brief explanation of each rebate or incentive. The financial analysis shows a payback period of 7.32 years. From federal, state, and county incentives this project qualifies for a total of $86,461 money that will be directly returned to the owner.

Lighting Incentives

Seattle City Light:

For lighting retrofit Seattle City Light offers multiple cash incentives to offset the cost of the new system. These incentives have the potential to cover up to 70% of the total direct cost. For this project we will be taking advantage of the incentives for occupancy sensors, $30 for wall mounted/$90 for ceiling mounted, and the energy saved from new lighting, $0.20 per kWh saved.

Lighting Incentives		
Seattle City Light - Energy Smart Services Program		
Incentive	**kWh Saved**	**Total Savings**
$0.20/kWh	105,498	$21,099
Seattle City Light - Occupancy Sensory		
Incentive	**Quantity**	**Total Savings**
$30 per Wall Mounted	80	$2,400
$90 per Ceiling Mounted	28	$2,520

Photovoltaic Incentives

Bonneville Environmental Foundation:

This grant program was established in 2002 to promote the use of renewable energy. The grant will cover 50%-100% of a 1.1 kW system. The planned system on this project is greater than these specifications, which would qualify the project for the Bonneville incentive program for larger renewable energy project. From this grant we will save 33% of the photovoltaic costs.

Washington State's Renewable Energy:

In the state of Washington a cash incentive is offered for the production of energy through a photovoltaic system. On this project we will be using equipment produced outside of Washington for which the state will pay $0.15 per kWh produced, up to $5000 until 2020.

Photovoltaic Incentives		
Bonneville Environmental Foundation		
Incentive	**Project Cost**	**Total Savings**
33% of project cost	$117,290	$38,705
Washington State Renewable Energy Production Incentive		
Incentive	**kWh Produced**	**Total Savings ($5,000 max per year)**
$0.15/kWh produced	28,685	$4,303

Window Incentives

Seattle City Light:

Seattle City Light also offers an incentive for the installation of energy efficient windows. By replacing the single pane windows with double pane windows this project qualifies for the incentive. Seattle City Light will pay $0.29/kWh saved by installing the new windows.

Window Incentives		
Seattle City Light - Efficient Windows		
Incentive	**kWh Saved**	**Total Savings**
$0.29/kWh	54,209.8	$15,721

Mechanical Incentives

Puget Sound Energy:

The installation of Variable Frequency Drives (VFD) onto the HVAC pumps will qualify the project for $100/hp incentive. The VFD's that will be installed are 1 hp each.

Seattle City Light

Seattle City Light offers an incentive based on kWh saved by installing VFD's. The incentive will pay $0.23/kWh saved through the installation of the new VFD's.

Mechanical Incentives			
Puget Sound Energy- Energy Efficient Equipment (VFD's)			
Incentive	**Quantity**	**HP**	**Total Savings**
$100/HP	3	1	$300
Seattle City Light- Energy Efficient Equipment (VFD's)			
Incentive	**kWh Produced**		**Total Savings**
$0.23/kWh	6,143		$1,413

Total Savings: <u>$86,461</u>

LEED Incentives

<u>King County Department of Natural Resources and Parks:</u>

Through our LEED analysis we have achieved 52 points and a LEED Silver rating. King County offers grants to major renovations of projects that achieve a LEED Gold Rating. Through other retrofits Lewis Hall would be able to earn the additional 8 points needed in order to become eligible for this grant in the future. As a LEED Gold building, Lewis Hall would qualify for a King County grant of up to $35,000. Achieving LEED Gold would increase total savings to **$121,461.**

Financing Strategies

Rainier Electric has designed a very productive PV system and we have decided that it would not be beneficial for Lewis Hall to engage in a solar power purchasing agreement. Recently Solar Power-Purchasing agreements have grown more popular. In the state of Washington, they are still relatively new, and there is not much precedent set. Seattle City Light has a system to buy back excess power generated by PV systems. However, our estimates show that Lewis Hall will not generate more power than is required for the building. Additionally, the following challenges have confirmed that we will not be negotiating a power-purchase agreement:

- More complex negotiations and potentially higher transaction costs than buying PV system outright
- Administrative cost of paying two separate electricity bills if system does not meet 100 percent of site's electric load
- Potential increase in property taxes if property value is reassessed
- Fairly limited federal sector experience .

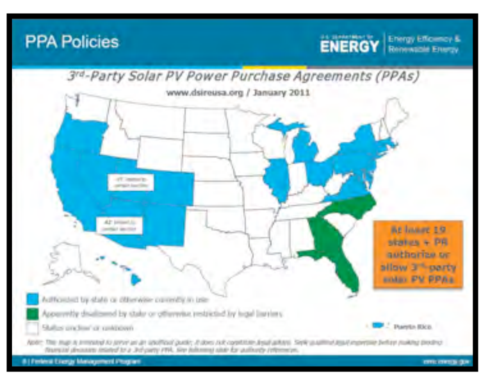


Figure 19: Power Purchase Agreements

Energy Savings		
Lewis Hall		
Annual Energy Reduction		
Upgrade	Annual Reduction (kWh/Yr)	Annual Reduction ($)
Lighting Upgrade	105,498	$27,357
Mechanical System Upgrade	6,143	$1,536
Window Upgrade	54,210	$13,553
Photovoltaic System	28,685	$7,171
Lewis Hall	**194,536**	**$49,617**

Payback Analysis								
Lewis Hall								
Return on Investment & Cumulative Savings (Incentives and Energy Reduction)								
Upgrade	**Initial Cost**	**-**	**Instant Incentives**	**=**	**Total Cost**	**/**	**Annual Energy Reduction**	**Return on Investments (Years)**
Lighting Upgrade	$78,515	-	$26,020	=	$52,495	/	$27,357	1.92
Mechanical System Upgrade	$2,734	-	$1,713	=	$1,021	/	$1,536	0.66
Window Upgrade	$171,712	-	$15,721	=	$155,992	/	$13,553	11.51
Photovoltaic System	$117,290	-	$43,008	=	$74,282	/	$7,171	10.36
Lewis Hall (Inc. GC's)	**$455,193**	**-**	**$86,461**	**=**	**$368,732**	**/**	**$49,617**	**7.43**

*Assumptions: Renewable Energy Production Incentives ($5,000/year) for photovoltaic system assumes no increase in energy rates

LEED Existing Building Review

Analysis

The University of Washington has requested LEED Certification for the retrofit of Lewis Hall. Through unique energy solutions Rainier Electric has developed a plan to obtain, at a minimum, **LEED SIlve**r. The proposed retrofit will meet all local and national standards for energy efficiency, along with all minimum requirements for LEED Existing Buildings. In accordance with U.S. Green Building Council Standards, our proposed retrofit will earn Lewis Hall **52 LEED Points.** Additionally, we have included potential future LEED credits which would certify the building for LEED Gold.

Project Related LEED Credits

Energy and Atmosphere

EA Credit 1: Optimize Energy Efficiency Performance **17 Points**

Case 1: Eligible for Energy Star

Receive a minimum EPA Energy Star energy performance rating of 93.
(*APPENDIX D, EPA Energy Star Point Breakdown)

Annual Energy Consumption					
Pre-Retrofit (kWh)	**Post-Retrofit (kWh)**	**% of Energy Used Post-Retrofit**	**Annual PV Energy Produced (kWh)**	**On-site Energy Production (%)**	**EPA Performance Rating**
234,147	96,981	41.4	28,685	29.6	93

EA Credit 2.1: Existing Building Commissioning- Investigation **2 Points**

Option 1: Commissioning Process

Develop an ongoing commissioning plan for all of the building's major energy-using systems.

- Document the breakdown of energy use in the building.
- Identify any improvements that would provide cost-effective energy savings and document the cost-benefit analysis associated.
- Correct any operating problems identified by the occupants regarding comfort and energy use.

EA Credit: 2.2: Existing Building Commissioning- Implementation **2 Points**

Implement minor improvements in order to make sure all major energy systems are operating correctly and maintained effectively to optimize energy performance.

- Implement low or no-cost operational solutions and improvements.
- Provide training for management in order to develop a stronger skill set relating to sustainable building operations topics.
- Continually update all building operating plans to reflect all updates.

EA Credit 2.3: Existing Building Commissioning- Ongoing **2 Points**

Utilize commissioning to address any changes in facility occupancy, use, maintenance and repair.

- Implement a commissioning program that includes system testing, performance verification, corrective action response, and other documentation to address any other possible operating problems.
- Develop a written plan to summarize the commissioning cycle (not to exceed 24 months) of the building.
- At least of the scope of work included in the first commissioning cycle will occur prior to the date of application for LEED 2009.

EA Credit 3.2: Performance Measurement- System Level **2 Points**

Develop a breakdown of energy use in the building using metering to determine consumption of major mechanical systems. Use the meter to record at least 80% in two of the three largest energy use categories.

Metered Systems		
Largest Energy Use Categories	**Annual Energy Use (kWh)**	**Portion Metered**
Heating System	35,497	100%
Lighting System	51,624	100%
PV Production	-28,685	100%

EA Credit 4: On-Site and Off-Site Renewable Energy **6 Points**

Use onsite energy to offset the buildings energy needs. We will have 29.6% of onsite renewable energy. This is 28,685 kWh of the 96,981 kWh needed for the building. (*APPENDIX D for point breakdown)

Indoor Environmental Quality

<u>IEQ Credit 2.2: Controllability of Systems- Lighting</u> **<u>1 Point</u>**

At least 50% of occupants that use lighting controls will be able to adjust the lighting to meet the needs and tasks for each individual.

<u>IEQ Credit 2.4: Daylight and Views</u> **<u>1 Point</u>**

Through computer animation show that 50% or more of all regularly occupied spaces areas achieve daylight luminance levels of a minimum of 10 foot-candles (fc) and a maximum of 500 fc in a clear sky condition on September 21 at 9am.

Figure 20: Render of office, lights off.

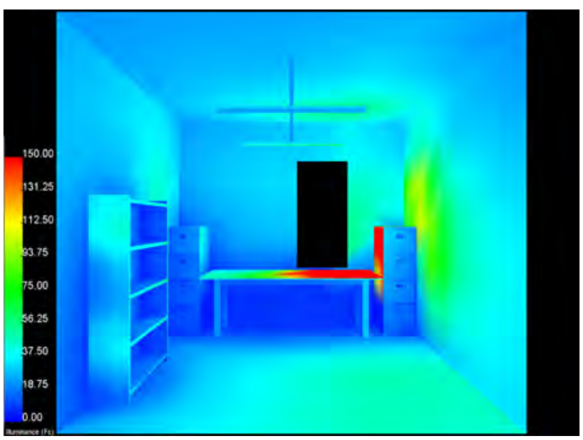


Figure 21: Photometric distribution, lights off.

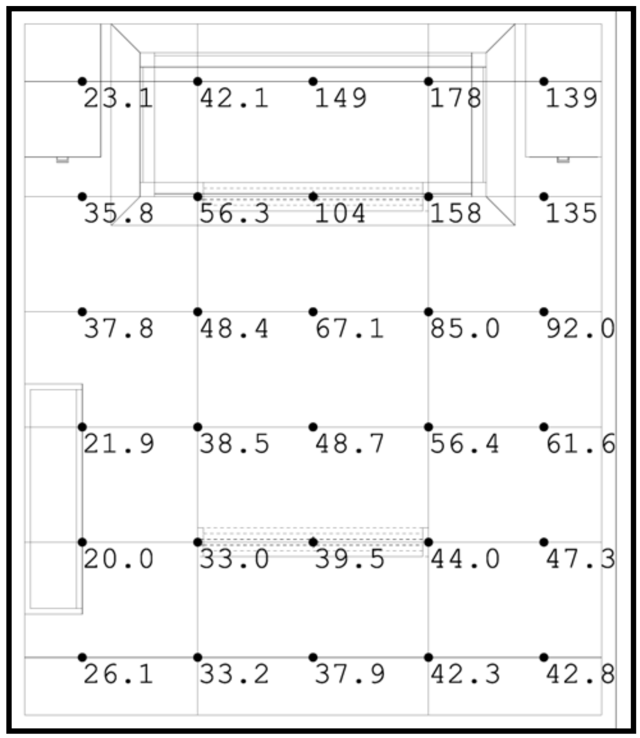


Figure 22: Distribution of foot-candles, lights off.

Material and Resources

<u>MR Credit 4: Sustainable Purchasing- Reduced Mercury in Lamps</u> **<u>1 Point</u>**

Develop a lighting purchasing plan for all light fixtures that specifies maximum level of mercury permitted in lamps. The plan must have at least 90% of all mercury-containing lamps meet the overall target of mercury content of 90 picograms per lumen-hour.

Mercury Content per Lamp					
Brand	**Lamp Type**	**Lamp**	**Lamp per Fixture**	**# of Fixtures**	**pg/lu-hr Rating**
Canlyte	Fluorescent	F28 T5	2	177	25.4

Innovations in Operations

IO Credit 2: LEED Accredited Professional **1 point**

At least one principal participant on the project team will be LEED Accredited Professional (AP).

Owner Facilitated LEED Credits

The following are credits that Rainier Electric feel are very reasonable for Lewis Hall to obtain. In order to qualify for these credits our team will work to develop plans to be implemented. The cooperation of all employees of Lewis Hall is instrumental in order to ensure qualification for these credits.

Sustainable Sites

SS Credit 4: Alternative Commuting Transportation **9 Points**

Reduce the number of commuting round trips made by regular building occupants. Performance Calculations are made to a baseline case that assumes all regular occupants commute alone in conventional automobiles. An occupant commute survey will be distributed to collect anonymous results and document the percent fewer trips than the conventional LEED baseline.(Survey and results can be found in APPENDIX D)

Material and Resource

MR Credit 1: Sustainable Purchasing- Ongoing Consumables **1 Point**

Maintain a sustainable purchasing program, which will cover materials with a low cost per unit that are regularly used and replaced throughout the building. This includes paper, toner cartridges, binders, batteries and desk accessories. A point will be awarded to the project when the sustainable purchases total at least 60% of all purchases (by cost). Sustainable purchases are defined by meeting at least one of the following requirements:

- Purchases contain at least 10% postconsumer and/or 20% postindustrial material.
- Purchases contain at least 50% rapidly renewable materials.
- Purchases contain at least 50% materials harvested and processed or extracted and processed within 500 miles of the project.
- Purchases consist of at least 50% Forest Stewardship Council (FSC)-certified paper products.
- Batteries are rechargeable.

MR Credit 2: Sustainable Purchasing- Durable Goods **2 Points**

Achieve sustainable purchases of at least 40% of total purchases of electric-powered equipment during the performance period. Sustainable purchases shall meet one of the following criteria:

- The equipment in ENERGY STAR qualified
- The equipment replaces conventional gas-powered equipment

MR Credit 6: Solid Waste Management- Waste Stream Audit **1 Point**

Conduct a waste stream audit of building's entire ongoing consumables waste stream, in order to establish a baseline that identifies the types of waste making up the waste stream of the building. Identify any possible opportunities to increase recycling and waste diversion.

MR Credit 7: Solid Waste Management- Ongoing Consumables **1 Point**

Maintain a waste reduction and recycling program that addresses materials with a low cost per unit and regularly used. (List of items found in MR Credit 1)

- Reuse, recycle or compost 50% of the ongoing consumables waste stream.
- Have a battery recycling program in place to diver at least 80% of discarded batteries from the trash. Diversion performance must be verified annually.

MR Credit 8: Solid Waste Management- Durable Goods **1 Point**

Maintain a waste reduction and recycling program that addresses durable goods, such as office equipment, appliances, external power adapters, televisions, and other audiovisual equipment. Reuse or recycle 75% of the durable goods waste stream during the performance period.

MR Credit 9: Solid Waste Management- Facility Alterations and Additions **1 Point**

Divert at least 70% of waste generated by facility alterations and additions from disposal to landfills. Items include:

- Structures (wall studs, insulation, doors, windows)
- Panels
- Attached finishings (drywall, trim, ceiling panels)
- Carpet
- Other flooring materials
- Paints, adhesives, sealants, and coatings

Indoor Environmental Quality

IEQ Credit 2.1: Occupant Comfort- Occupant Survey **1 Point**

Implement an occupant comfort survey anonymously collecting results on occupant comfort issues.

- Survey at a minimum 30% of occupants
- Documenting results
- Developing a course of action to correct the issues found in the survey.
- At least one occupant will be surveyed during the performance period.

(Survey and results can be found in the APPENDIX D)

Total Immediate LEED Points: 52

Possible Future LEED Credits

With necessary funding the following LEED credits can be easily obtained. By doing so the building would be a LEED Gold certified building, which would qualify for the King County Department of Natural Resources and Parks grant for $35,000.

Water Efficiency

WE Credit 2: Additional Indoor Plumbing Fixture and Fitting Efficiency **1-5 Points**

During the performance period have in place strategies and systems that in aggregate produce a reduction in indoor plumbing fixtures and fitting potable water use. A reduction of 30% from the baseline will qualify for 5 LEED points.

Indoor Environmental Quality

IEQ Credit 3.1-3.6: Green Cleaning **1 Point Each, 6 Total**

Implement a cleaning program, using sustainable cleaning material, products and equipment in order to have a high performance green cleaning policy. Employ permanent entryway systems at least 10 feet long in the primary direction of travel to capture dirt and particles entering the building. Develop a plan to manage indoor pests in a way that protects human health and the surrounding environment.

Total Potential LEED Points: 63

Rainier Electric

LEED 2009 for Existing Buildings: Operations & Maintenance

Project Checklist

Project Name

Date

Y	?	N				Points
9		17	**Sustainable Sites**		Possible Points:	26
		4	Credit 1	LEED Certified Design and Construction		4
		1	Credit 2	Building Exterior and Hardscape Management Plan		1
		1	Credit 3	Integrated Pest Mgmt, Erosion Control, and Landscape Mgmt Plan		1
9		6	Credit 4	Alternative Commuting Transportation		3 to 15
		1	Credit 5	Site Development—Protect or Restore Open Habitat		1
		1	Credit 6	Stormwater Quantity Control		1
		1	Credit 7.1	Heat Island Reduction—Non-Roof		1
		1	Credit 7.2	Heat Island Reduction—Roof		1
		1	Credit 8	Light Pollution Reduction		1
	5	9	**Water Efficiency**		Possible Points:	14
Y			Prereq 1	Minimum Indoor Plumbing Fixture and Fitting Efficiency		
		2	Credit 1	Water Performance Measurement		1 to 2
	5		Credit 2	Additional Indoor Plumbing Fixture and Fitting Efficiency		1 to 5
		5	Credit 3	Water Efficient Landscaping		1 to 5
		2	Credit 4	Cooling Tower Water Management		1 to 2
31		4	**Energy and Atmosphere**		Possible Points:	35
Y			Prereq 1	Energy Efficiency Best Management Practices		
Y			Prereq 2	Minimum Energy Efficiency Performance		
Y			Prereq 3	Fundamental Refrigerant Management		
17		1	Credit 1	Optimize Energy Efficiency Performance		1 to 18
2			Credit 2.1	Existing Building Commissioning—Investigation and Analysis		2
2			Credit 2.2	Existing Building Commissioning—Implementation		2
2			Credit 2.3	Existing Building Commissioning—Ongoing Commissioning		2
		1	Credit 3.1	Performance Measurement—Building Automation System		1
2			Credit 3.2	Performance Measurement—System-Level Metering		1 to 2
6			Credit 4	On-site and Off-site Renewable Energy		1 to 6
		1	Credit 5	Enhanced Refrigerant Management		1
		1	Credit 6	Emissions Reduction Reporting		1
8		2	**Materials and Resources**		Possible Points:	10
Y			Prereq 1	Sustainable Purchasing Policy		
Y			Prereq 2	Solid Waste Management Policy		
1			Credit 1	Sustainable Purchasing—Ongoing Consumables		1
1			Credit 2.1	Sustainable Purchasing—Electric-Powered Equipment		1
1			Credit 2.2	Sustainable Purchasing—Furniture		1
		1	Credit 3	Sustainable Purchasing—Facility Alterations and Additions		1
1			Credit 4	Sustainable Purchasing—Reduced Mercury in Lamps		1
		1	Credit 5	Sustainable Purchasing—Food		1

Y	?	N				Points
			Materials and Resources, Continued			
1			Credit 6	Solid Waste Management—Waste Stream Audit		1
1			Credit 7	Solid Waste Management—Ongoing Consumables		1
1			Credit 8	Solid Waste Management—Durable Goods		1
1			Credit 9	Solid Waste Management—Facility Alterations and Additions		1
3	6	6	**Indoor Environmental Quality**		Possible Points:	15
Y			Prereq 1	Minimum IAQ Performance		
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control		
Y			Prereq 3	Green Cleaning Policy		
		1	Credit 1.1	IAQ Best Mgmt Practices—IAQ Management Program		1
		1	Credit 1.2	IAQ Best Mgmt Practices—Outdoor Air Delivery Monitoring		1
		1	Credit 1.3	IAQ Best Mgmt Practices—Increased Ventilation		1
		1	Credit 1.4	IAQ Best Mgmt Practices—Reduce Particulates in Air Distribution		1
		1	Credit 1.5	IAQ Mgmt Plan—IAQ Mgmt for Facility Alterations and Additions		1
1			Credit 2.1	Occupant Comfort—Occupant Survey		1
1			Credit 2.2	Controllability of Systems—Lighting		1
		1	Credit 2.3	Occupant Comfort—Thermal Comfort Monitoring		1
1			Credit 2.4	Daylight and Views		1
	1		Credit 3.1	Green Cleaning—High Performance Cleaning Program		1
	1		Credit 3.2	Green Cleaning—Custodial Effectiveness Assessment		1
	1		Credit 3.3	Green Cleaning—Sustainable Cleaning Products, Materials Purchases		1
	1		Credit 3.4	Green Cleaning—Sustainable Cleaning Equipment		1
	1		Credit 3.5	Green Cleaning—Indoor Chemical and Pollutant Source Control		1
	1		Credit 3.6	Green Cleaning—Indoor Integrated Pest Management		1
1		5	**Innovation in Operations**		Possible Points:	6
		1	Credit 1.1	Innovation in Operations: Specific Title		1
		1	Credit 1.2	Innovation in Operations: Specific Title		1
		1	Credit 1.3	Innovation in Operations: Specific Title		1
		1	Credit 1.4	Innovation in Operations: Specific Title		1
1			Credit 2	LEED Accredited Professional		1
		1	Credit 3	Documenting Sustainable Building Cost Impacts		1
		4	**Regional Priority Credits**		Possible Points:	4
		1	Credit 1.1	Regional Priority: Specific Credit		1
		1	Credit 1.2	Regional Priority: Specific Credit		1
		1	Credit 1.3	Regional Priority: Specific Credit		1
		1	Credit 1.4	Regional Priority: Specific Credit		1
52	11	47	**Total**		Possible Points:	110

Certified 40 to 49 points   Silver 50 to 59 points   Gold 60 to 79 points   Platinum 80 to 110

Project Management Plan

Site Layout

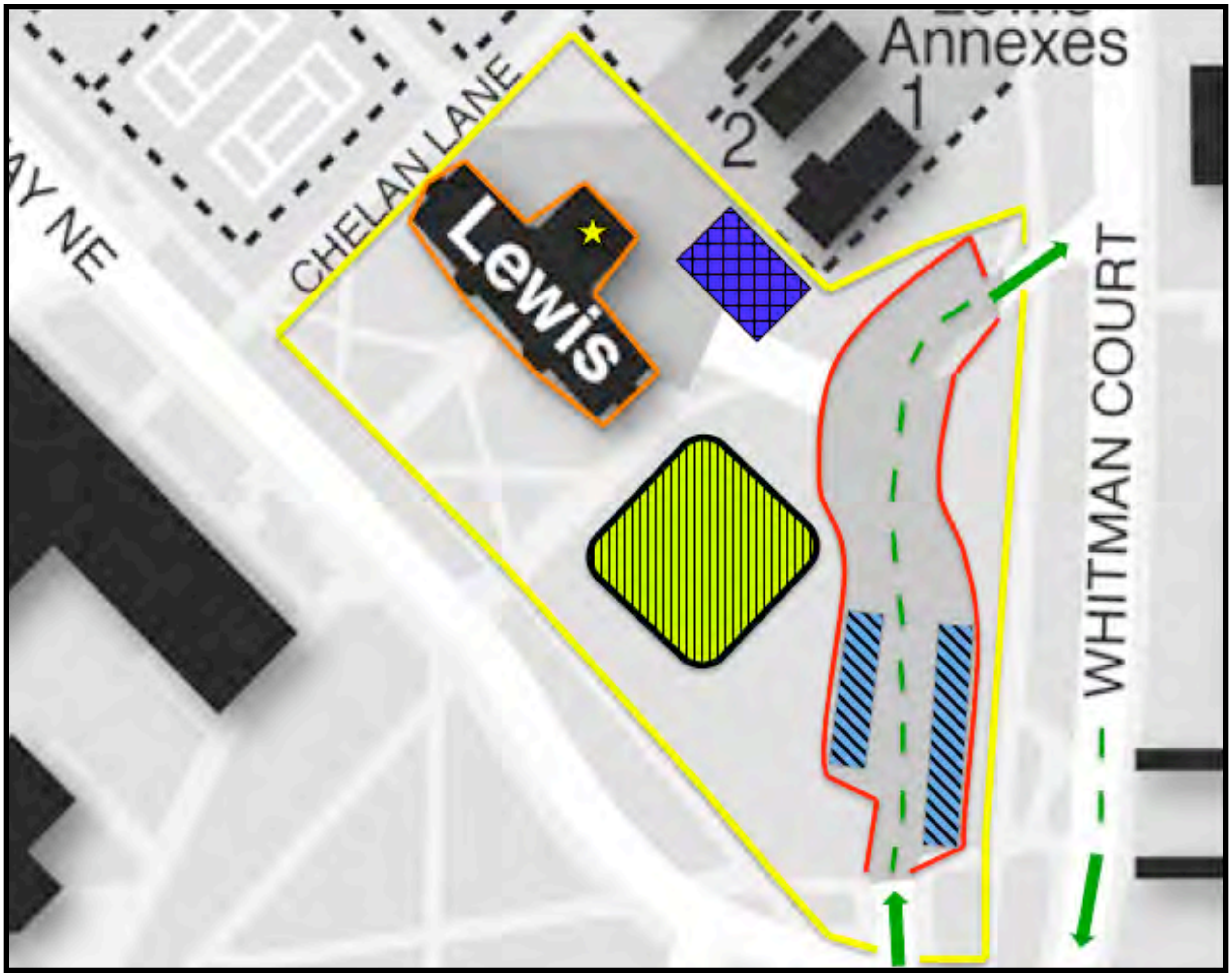
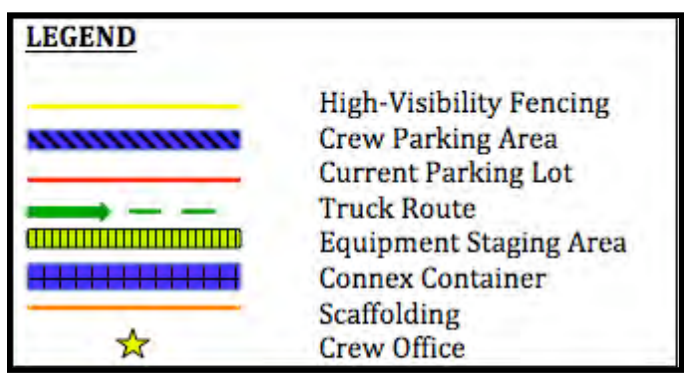


Figure 23: Site Layout Plan.

Site Logistics

- Chain link fencing surrounding the construction zone.
- Locking gates at all entrances.
- Trucks enter the site from the South and exit to the North.
- Crew parking provided on-site.
- Storage container located behind Lewis Hall.
- Equipment staging South of building.
- Superintendent manages site coordination, materials, and equipment.



Safety

Rainier Electric holds all employees to strict safety standards. Our Experience Modification Rate is a low 0.56, far below the industry standard of 1.0. We maintain an effective safety program that eliminates risks before they occur. Bi-weekly safety meetings will brief employees on site-specific conditions and potentials hazards.

Required Personal Protective Equipment

- Hard Hat
- Safety Glasses
- Reflective Vests
- Ankle-high Work Boots
- Work Gloves
- Ear Plugs (when applicable)
- Fall Protection (when applicable)
- Durable Work Attire

Figure 24: Safety sign.

Sustainable Innovation

At Rainier Electric we are always working to reduce our carbon footprint in any way possible. Recently as a company we have adopted the use of technology to reduce the amount of paper and other materials used. On this project each member of the team will be using iPad’s in replacement of a majority of the paper documents including specs, drawings, and RFI’s . Paper copies of plans are not only expensive and use a great deal of resources but they are also cumbersome to update. WIth iPad’s on the project, one member of the team will be able to make necessary changes to the drawings, specifications, or any other work, and instantly the rest of the team will be notified of the change. This allows us to be more competitive and provide better value.

The University of Washington and Rainier Electric can together help progress the standards of environmentally conscious construction on the campus through the use of new technology. The simple implementation of the Apple iPad will reduce the carbon footprint of our construction and also set a new standard for any future construction on the campus.

Figure 25: On-site iPad use

Outreach Appendix

Campus Energy Awareness Program

Overview:
Our client has expressed the importance of promoting energy awareness not only through our electrical retrofit of Lewis Hall but through a strategic action plan that will focus on converting students and faculty from careless users to active savers of energy. With the University of Washington already being named America's "Coolest School" by *Sierra Magazine,* it is safe to say that the building blocks have been laid for Rainier Electric to implement programs that will continue to communicate energy consciousness. Behavioral change is a slow process and Rainier Electric is looking to obtain small wins over an extended period of time, influencing those on campus.

Awareness:
SEED 'Students Expressing Environmental Dedication' has established itself as the leading organization for promotion of sustainability at the University of Washington. Working with SEED, Rainier Electric has been able to draw attention towards energy awareness on campus. Current committees under the SEED organization include the Compost Committee in support of expanding the composting program on campus. The largest of the three subcommittees being the Reduce, Reuse, & Recycle Committee ("3R") who have projects ranging from discouraging the use of disposable water bottles, reducing the hand-towel consumption on campus, and an initiative to reduce the use of harmful fragrance chemicals. Finally the Outdoors Committee allows for students to break away from their desks and perform campus cleanups.

Rainier Electric will work with the "3R" Committee in the reduction of energy consumption across campus. Hanging inspirational posters around campus will raise awareness and engage the UW community in energy saving practices. This is an effective and low-cost way to promote energy awareness.

Additionally, Rainier Electric will host two site tours of Lewis Hall: June 26 and July 6. These tours are intended to educate students and staff on the strides that the University of Washington is taking towards energy efficiency. This will excite the UW community, in turn spreading awareness throughout the campus. Personal Protective Equipment will be provided for visitors by Rainier Electric.

Competition:
The University of Washington Environmental Stewardship & Sustainability has put in place a sustainability pledge program that Rainier Electric can transform into a competition between the dormitories on campus. This is a great opportunity for students and faculty to get involved and will continue to prove the University of Washington's commitment to setting the bar in environmental stewardship.

Rules for Competition:

- 1 pt will be awarded for each percent of the student body that gives a successful pledge toward saving energy in their dormitory
    - Examples:
        - Take the stairs whenever possible
        - When possible, use natural daylight rather than electric lights
        - Turn off all lights when you leave a room

- 10 pts will additionally be awarded for each percent of energy reduction in their dormitory
    - A 12% reduction in energy use would yield 120 pts for said dormitory

- Individuals who gave a pledge and are apart of the dormitory with the most points will receive the prize of discount Seattle Mariners baseball tickets for an all dormitory game

- Competition will take place over the course of a quarter, allowing students ample time to reduce their energy usage

Social Media:
In today's day and age students are more than ever connected via the Internet, and in particular through such social networks as Facebook and Twitter. What better way to keep students updated on their energy consumption and continue to influence behavioral change for energy awareness than through technology. Rainier Electrical has selected Lucid Dashboard System as the best possible solution to keep students aware of their energy consumption. Lucid is a display system that allows residents to view, compare, and share building energy use information in real time on the web. Students will be encouraged to make it a habit to check the Lucid Energy Dashboard, which is why each building will have a Lucid kiosk.

The Lucid Dashboard System will empower students to conserve resources and become better energy managers, with the help of a Campus Conservation Nationals (LCCN) energy use reduction competition. LCCN allows participating universities to compete against other schools in the challenge of achieving the greatest possible energy and water reductions in residence halls over the course of a quarter. In particular the UW student body will compete against students at Washington State University. Such competition shall help involve students who would have been otherwise reluctant without bragging rights over the rival Cougars at stake. After an extended period of time where the student body achieves measurable reductions in electricity and water use a new culture would rise amongst the campus with a focus towards energy conservation.

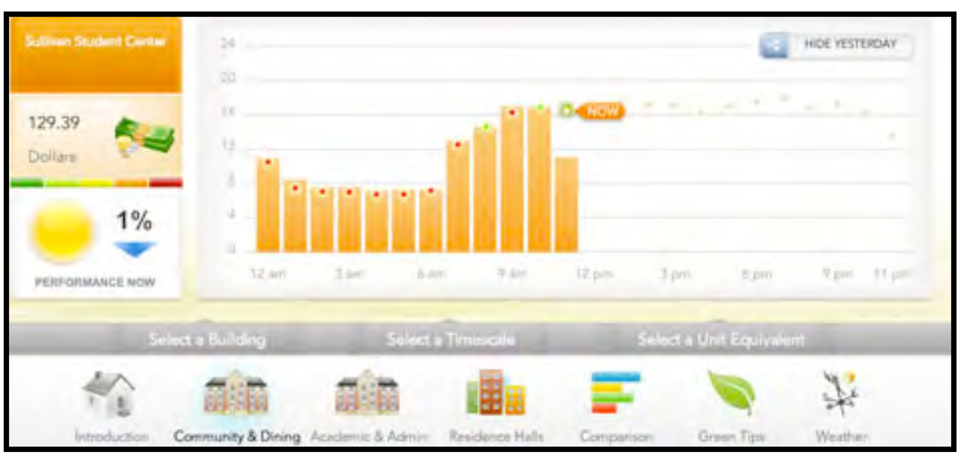


Figure 26: Lucid Dashboard System showing energy consumption.

Campus Energy Awareness Implementation

Five-Step Student Awareness implementation Plan

Step One: Establishing Credibility
The University of Washington already supports multiple student organizations committed to expressing environmental dedication. In order to properly integrate with these existing programs we must form another student organization with a focus on energy awareness. Becoming involved with student organizations like SEED and the University of Washington Environmental Stewardship & Sustainability will establish our dedication to this cause.

Step Two: Connecting With Leaders Within Dormitories
Prior to our involvement with the residential halls on the campus our student organization must reach out to the perspective RAs in each dormitory to help develop an action plan to achieve the most out of our plan. High traffic areas should be identified and potential leaders amongst each floor should be labeled in an extra effort to spread the word of energy conservation.

Step Three: Develop SMART Goals
In order to maximize results in energy awareness SMART goals must be established for the residence halls:

Specific: Lowering energy usage in dormitories through successful pledges
Measurable: Energy shall be lowered by X percentage
Attainable: A decrease in 10 - 15% of energy usage in each dormitory
Relevant: Goals will directly support creating an energy conscious culture
Timely: Competition for reducing energy usage will exist over the course of a quarter

Step Four: Motivate Students
Prior to the competition hallways, bulletin boards, and high traffic areas will be signed with posters (See Poster Example, pg. 55). These posters should catch the students' eye and help begin the thought process of a more energy aware attitude. Motivating students prior to the competition will be crucial to obtaining full participation

Step Five: Executing the Competition
At the beginning of the quarter students will return to dormitories equipped with the Lucid Dashboard System and will be informed of the competition between the dormitories to receive pledges on how to lower energy usage. Results will be tracked through the Lucid kiosk and students will compete with the Washington State University on lowering energy and water usage.

Campus Energy Awareness Feedback

To: Greg Goebel

RE: Campus Energy Awareness Plan

Students Expressing Environmental Dedication (SEED) has reviewed the proposal for an energy retrofit in Lewis Hall. Many of your techniques in particular posters, competition, and social networking are the same techniques we at SEED use for raising awareness. While you have some strong ideas we do have a few suggestions for strengthening your plan.

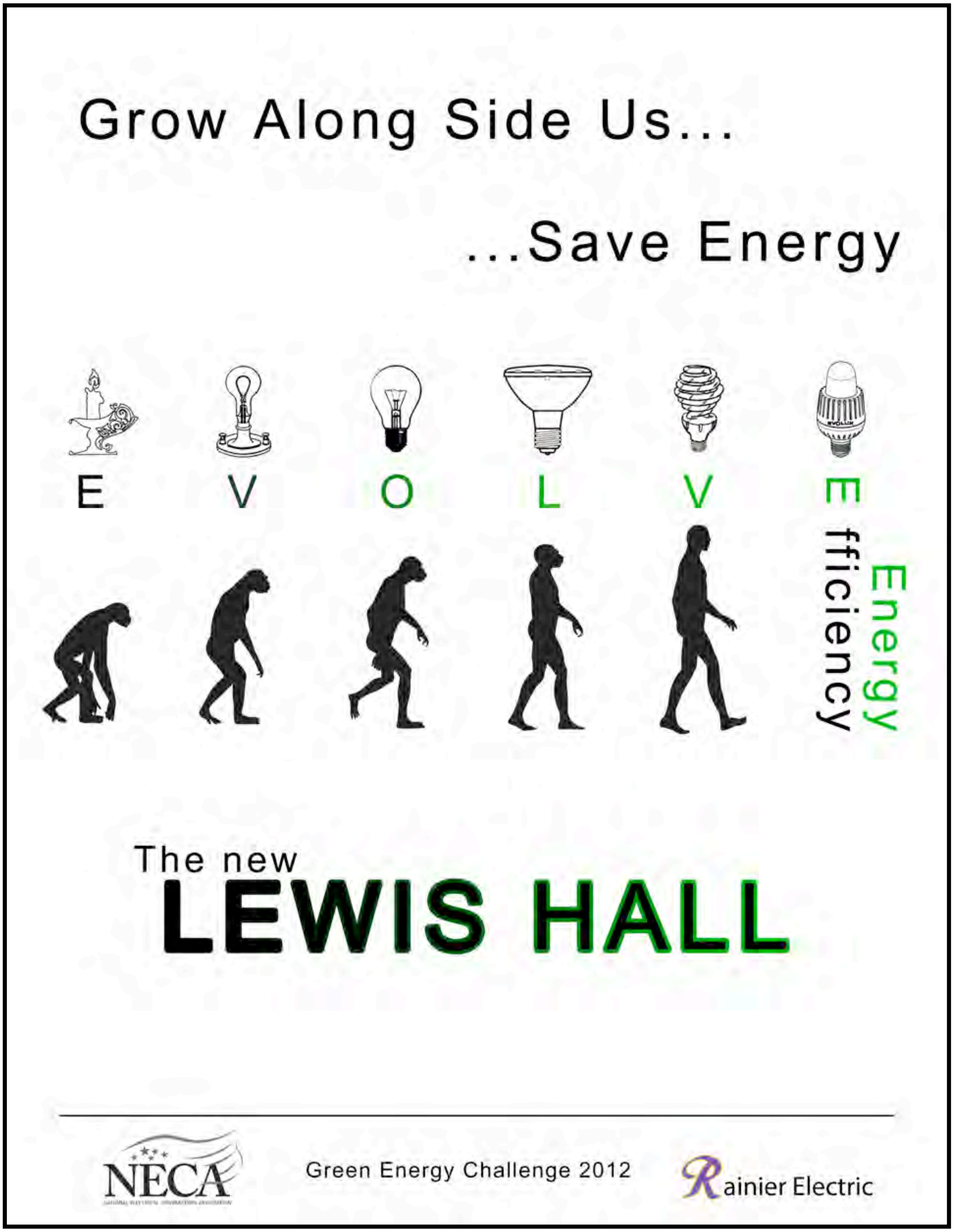
- While Posters can be effective, you must realize that residence halls are at all times littered with posters. How will your poster prove to be more than just 1 in 100 messages bombarded upon student on what they should do. Also, what steps will you take to ensure your posters are noticed (e.g. size & color)? Once noticed what steps will be taken in design to convey the correct message. Posters can be a great way to spread word, however they are at the same time the easiest to go unnoticed.
- In addition to collaboration with existing environmental groups such as SEED and University of Washington Environmental Stewardship & Sustainability, consider collaboration with other on campus groups. In particular Residence Hall Student Association (RHSA), National Residence Hall Honorary (NRHH), and Hall Councils which plan programming in their respective residence halls.
- Beyond posters how else do you plan to inform students on the upcoming competition involving sustainability pledges? Through involvement with the organizations mentioned above you should have better luck at spreading word on upcoming events.
- With this competition you must be able to ensure fairness. When prizes are involved students will take advantage of the system and in this case students could give multiple pledges that they do not withhold to. We propose placing a greater amount on the energy reduction portion, as this part of the competition cannot be faked.

Here at SEED we approve of your ideas proposed to create a more energy aware campus. We offer the above suggestions as ways to elaborate on and refine those ideas. I appreciate your commitment to our cause and look forward to hearing back from you soon.

Thanks,

SEED

Poster Example



Feedback Letter From Client

UNIVERSITY *of* WASHINGTON
Capital Projects Office

April 9, 2012

RE: Rainier Electric's Lewis Hall Energy Retrofit

Dear NECA Review Team,

The Capital Projects Office has been working with the University of Washington (UW) student team, Rainier Electric for over 3 months in providing information regarding energy use and other building documentation for Lewis Hall, an office building located on University of Washington's Seattle campus. Rainier Electric has provided a full comprehensive document proposing how Lewis Hall could become more energy efficient. The team highlights many different systems, and has done a thorough amount of research and analysis when doing this design. They have also developed a student awareness plan describing how students on campus can become more involved in helping the UW campus go green. We hope to implement many of the strategies they have provided in several different ways. Lewis Hall has been on our "buildings in need of renovation" list for quite some time, so their proposal could provide very useful information and ideas for future plans.

Rainier Electric has continued to impress myself, the Capital Projects Office, and other on campus organizations. They have made countless trips to Lewis Hall and my office to ensure that a complete and accurate analysis takes place. They have acted with a very professional manner and have developed ideas and designs that seem extremely professional. When faced with difficult tasks or any challenges they have worked very well with each other and whoever necessary to conquer any obstacle and create an outstanding final product. It has been my pleasure to work with Rainier Electric.

Sincerely,

Ken Kubato

Ken Kubato
Project Manager
Capital Projects Office
University of Washington
206-616-0360

Article in University Newsletter

April 12, 2011

University of Washington - Press Release

UW Students Compete in Green Energy Challenge

A team of UW students are competing in a national student competition known as the Green Energy Challenge, sponsored by the National Electrical Contractors Association (NECA). The competition involves the analysis of an academic building and the identification of retrofits to the building that can reduce its energy consumption. Working with the University's Capital Projects Office and Facilities Service Office, the students selected Lewis Hall for their analysis. This building was built in 1896 to serve as the University's first men's dormitory. After completing their assessment of the existing conditions, the students have developed a proposal to:

- Replace interior lighting fixtures
- Installation of new lighting controls
- Replacement of exterior lighting fixtures
- Installation of variable frequency drives on pumps that circulate hot water through the building
- Installation of solar panels on the building roof
- Replacement of exterior window glazing

Lewis Hall was originally constructed in 1899 as a male dormitory

Team members working on this proposal are Ben Leventer, Greg Goebel, Eddie Baker, Marc Kinsman, Christian McCuen, and Kevin Marck from the Department of Construction Management. They have been working on this competition since January and will be submitting their proposal by April 15, 2012. They are competing with teams from 16 other universities. The proposals will be evaluated, and the three finalists invited to attend the NECA Convention in Las Vegas at the end of September

Local NECA Chapter Interaction

NECA Interaction			
Person	**Company**	**Means**	**Interaction**
Tommy Key	NECA	NECA Board Meeting	Acted as our initial connection in finding assistance from local contractors
Barry Sherman	NECA	NECA Board Meeting	Acted as our initial connection in finding assistance from local contractors
Joe Berger	VECA Electric	Face to Face VIsit	Assisted with overall proposal development and LEED advice
Casey Stulc	VECA Electric	Face to Face Visit	Provided feedback on scheduling and labor hours
Nick Lopez	Cochran Inc.	Face to Face Visit	Provided material and labor costs
Lezlie Lang	VECA Electric	Phone Conversation	Provided contacts for vendors
Brian Jones	Valley Electric	Face to Face Visit	Provided team with LUXMeter
Ed Adams	MacDonald Miller Facility Solutions	Email / Phone Coversation	Assisted in developing a lighting plan for Lewis Hall

Appendix A - Lighting

Rainier Electric

Conservation Project Summary

Lewis Hall @ UW
Facility Name

320 Lewis Hall, Box 353200	Seattle	WA	98195
Street Address	**City**	**State**	**Zip Code**

I. Baseline Lighting System	(description shown on attached worksheets)			157,122	**kWh/Yr**
II. Proposed Lighting System	(description shown on attached worksheets)			51,624	**kWh/Yr**
III. Annual Savings	(baseline kWh/Yr - proposed kWh/Yr)			105,498	**kWh/Yr**
	at energy rate of	$0.250	**/kWh**	$26,374	**/Yr**
	(baseline kW - proposed kW)			18.036	**kW**
	at energy rate of	$4.540	**/kW**	$983	**/Yr**
		Total Annual Savings		**$27,357**	**/Yr**
		Annual Greenhouse Gas Avoidance:		**63.299**	**/Metric tons**

IV. Project Costs:	
1. Material Costs	$60,529
2. Total Costs (Including Labor & Indirect Costs)	$78,515
VII. Estimated Power Company funding/rebates	
$.20/kWh	$21,099.57
$30/$90 Per Occ Sensor	$4,920.00
VIII. Net Customer Cost	$52,495
1. Simple payback	**1.92 years**
2. Return on Investment	**52%**
X. The project description and costs shown in this proposal are valid until	15-May-12

Company Name:	Ranier Electric				
Street Address:	120 Architecture Hall, University of Washington				
City:	Seattle	**State:**	WA	**Zip Code:**	98105
Phone Number:	206-334-2869			**Date:**	15-Apr-12
Authorized Signature:	*Eddie Baker*				

(Sign and date below to give notice to proceed. Final contract documents will reflect any changes to the estimated power company grant amount.)

Owner/Owner's Agent Signature: **Date:**

Rainier Electric

Rainier Electric

Lewis Hall @ UW
Facility name

Eddie Baker — **15-Apr-12**
Form completed by — Date

	Location				Existing Lighting										Proposed Lighting						
Ln. #	Location Name (floor, room #, etc.)	Qty.	Lamp Type	Lamp Watts	Ballast Type	Watts/ Unit**	Total kW	Hours/ Yr	kWh/Yr	Ln #	Description/Model	Qty.	Lamp Type	Lamp Watts	Ballast Type	Watts/ Unit	Total kW	Hours/ Yr	kWh/ Yr	Unit Cost	Material Cost
1	1st Floor Office	72	2/T12	46	M	96	6.91	4,380	30,275	1	T5 Fixture	40	2/T5	28	E	56	2.24	3,650	8,176	$210.00	$ 8,400.00
2	2nd Floor Office	68	2/T12	46	M	96	6.53	4,380	28,593	2	T5 Fixture	36	2/T5	28	E	56	2.02	3,650	7,358	$210.00	$ 7,560.00
3	3rd Floor Office	78	2/T12	46	M	96	7.49	4,380	32,797	3	T5 Fixture	42	2/T5	28	E	56	2.35	3,650	8,585	$210.00	$ 8,820.00
4	4th Floor Office	16	2/T12	46	M	96	1.54	4,380	6,728	4	T5 Fixture	10	2/T5	28	E	56	0.56	3,650	2,044	$210.00	$ 2,100.00
											Office WM OCC	80								$85.00	$ 6,800.00
											Large Office/Conf Room PV	10								$165.00	$ 1,650.00
5	1st Floor Hall/Common	16	2/T12	46	M	96	1.54	8,760	13,455	5	T5 Dimming Fixture	16	2/T5	28	E	56	0.90	6,570	5,887	$280.00	$ 4,480.00
6	2nd Floor Hall/Common	14	2/T12	46	M	96	1.34	8,760	11,773	6	T5 Dimming Fixture	14	2/T5	28	E	56	0.78	6,570	5,151	$280.00	$ 3,920.00
7A	3rd Floor Hall/Common	13	2/T12	46	M	96	1.25	8,760	10,932	7A	T5 Dimming Fixture	13	2/T5	28	E	56	0.73	6,570	4,783	$280.00	$ 3,640.00
8	4th Floor Hall/Common	6	2/T12	46	M	96	0.58	8,760	5,046	8	T5 Dimming Fixture	6	2/T5	28	E	56	0.34	6,570	2,208	$280.00	$ 1,680.00
											Hallway CM OCC	28								$150.00	$ 4,200.00
9	Stairwells 1st Floor	8	1/CFL	36		36	0.29	8,760	2,523	9	Lamar Occu-Smart Fixtures	6	2/T8	32		64	0.38	876	336	$210.64	$ 1,263.84
10	Stairwells 2nd Floor	5	1/CFL	36		36	0.18	8,760	1,577	10	Lamar Occu-Smart Fixtures	4	2/T8	32		64	0.26	876	224	$210.64	$ 842.56
11	Stairwells 3rd Floor	5	1/CFL	36		36	0.18	8,760	1,577	11	Lamar Occu-Smart Fixtures	4	2/T8	32		64	0.26	876	224	$210.64	$ 842.56
12	Stairwells 4th Floor	4	1/CFL	36		36	0.14	8,760	1,261	12	Lamar Occu-Smart Fixtures	4	2/T8	32		64	0.26	876	224	$210.64	$ 842.56
											Historical Fixture PV	3								$165.00	$ 495.00
13	Outdoor Pole Lighitng	2	1/HPS	120		150	0.30	3,650	1,095	13	LED & PV	2	LED	100		100	0.20	3,650	730	$255.00	$ 510.00
14	Outdoor Door Lighting	4	1/HPS	120		150	0.60	3,650	2,190	14	LED & PV	4	LED	80		80	0.32	3,650	1,168	$230.00	$ 920.00
15	Outdoor Spotlight	2	MH	1000		1,000	2.00	3,650	7,300	15	LED & PV	2	LED	620		620	1.24	3,650	4,526	$320.00	$ 640.00
16										16A											
										16B	T12 Disposal	283								$3.26	$ 922.58

Existing Totals 313 **kW** 30.860 kWh 157,122

Proposed Totals 607 **kW** 12.824 **kWh** 51,624

Total $ 60,529.10

VO SERIES
CUSTOM LUMINAIRES
VOYAGER

Job Name	
Catalog Number	
Notes	Type

****2' model shown with optional Green Light Savers phosphorescent strip - see back for details****

Scan QR code to be directed to this product on the web!

features

- A unique bi-level luminaire controlled by an integral ultra-sonic motion sensor, designed to provide safe, dependable illumination while conserving energy. Suitable for ceiling or wall mounting
- Bi-level fixtures operate at a low standby light level, offering safety and security with full light output instantly upon occupancy with areas fully lit only as needed
- Ideal for stairwells, restrooms, laundry rooms and other areas where maximum light levels are not required on a constant basis
- The ultra-sonic sensor features enhanced sensitivity and a lamp conditioning circuit (patented) that keeps new lamps on for 100 hours to assure long lamp life and proper operation
- For safety and compliance purposes in areas designated as emergency egress, we recommend choosing a standby light level that will provide minimum code compliant light levels while in the standby mode. In most municipalities, this is 1 FC average See back for options

construction

- Housings are die-formed of code gauge steel, with riveted socket supports
- Quality construction throughout for long-term dependable service
- New York City Department of Buildings calendar number #43525
- Ends are die formed for a clean, smooth look
- Ample knockouts are provided for convenient mounting with recessed or surface power feeds
- Premium lamp holders with rotary lock standard
- Meets ADA requirements for wall mounting
- All fixtures are U.L. listed and IBEW union made

diffuser

- One-piece extruded linear ribbed clear, light stabilized acrylic is standard, 100% DR acrylic available
- Features a linear refractive pattern for even illumination
- Grooved formation on the edges allow for a tight, no light leak attachment to the body
- Optional white powder coated perforated steel diffuser

electrical

- All electrical components are U.L. listed
- Electronic Class P ballasts standard
- Optional battery backup available for one or two light emergency operation at various output levels. Please consult factory for your specific emergency pack requirements

finish

- Prior to painting, all metal parts are treated with a multi-stage phosphate bonding process to ensure adhesion and inhibit rusting
- Painted with a lighting grade baked white enamel, having a reflectance factor exceeding 87% for premium quality and durability

sensor

- High frequency, extremely sensitive ultra-sonic, internally mounted
- LED status indicator light
- Exclusive lamp conditioning circuit (patented)
- Fail-safe feature switches light level to high (100%) if sensor is physically damaged
- 5 minute walk-test feature, easy-set time and sensitivity controls, compact design

LaMar Lighting Company, Inc.

Protected by one or more US Patents Nos. 7,271,543 & 7,081,715

occu-smart® technology

All units are U.L. listed as emergency power and lighting equipment (U.L.-924) when equipped with optional battery back-up and meet requirements of the life safety code/NFPA101, NEC/OSHA and most state and local codes.

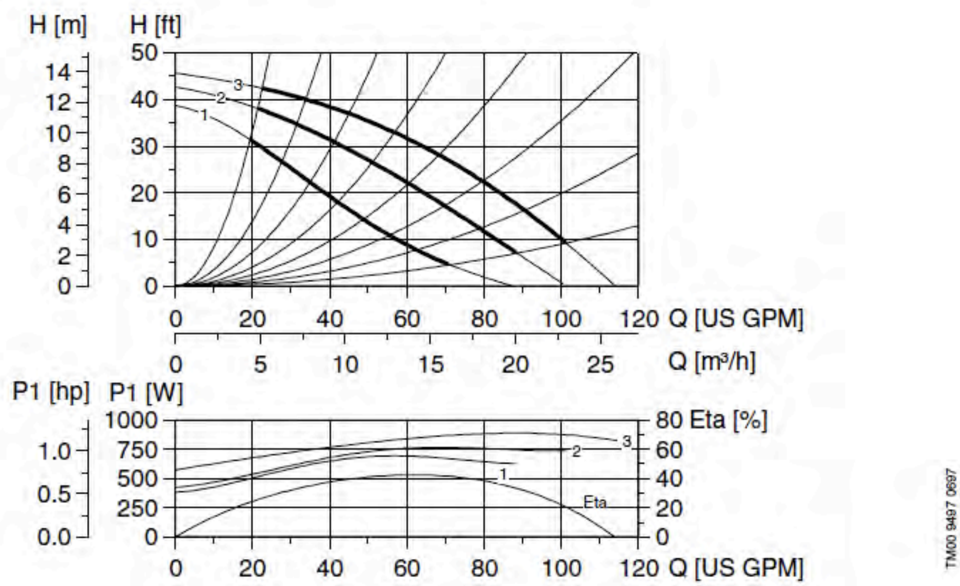
Appendix B - Energy Usage

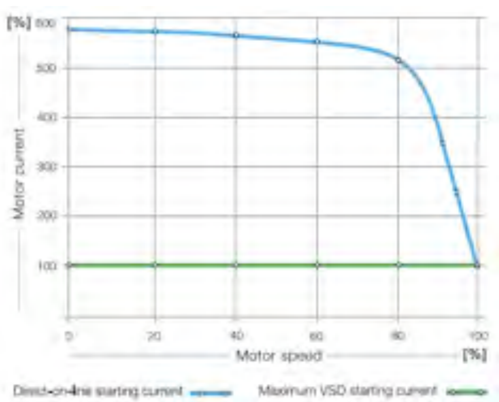
Pump VFDS

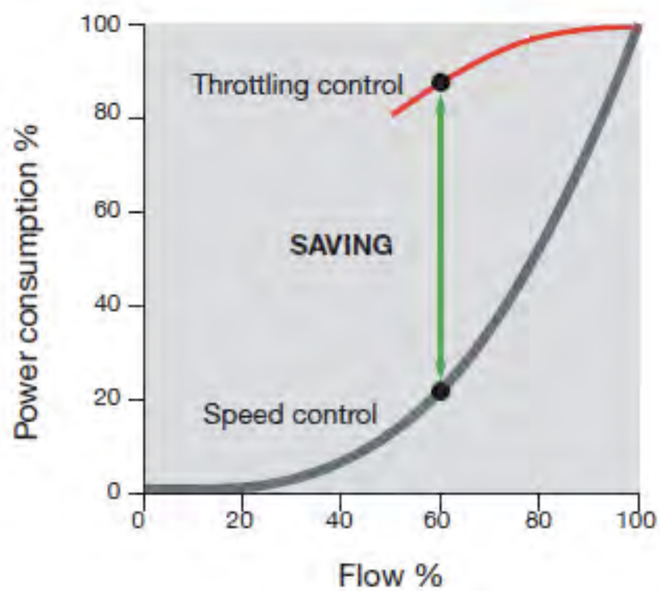
Performance curves

UPS 40-160/2
1 phase 115 V, 230 V, 60 Hz

Performance curves







Glazing

REDMOND WA 98052

Job Name: **Quote:** TBD

Rated Units:

Qty	Line	Position	Unit Type	Unit Width	Unit Height	Unit Sqft	Total Sqft	U-Value	SHGC	VLT	Weighted Contribution to Entire Job	Performance Class
28	100	1	Special CLAD DH CUSTOM PRODUCT	41.	77.	22.4334	628.1352	0.31	0.3	0.51	194.	
32	400	1	Special CLAD DH CUSTOM PRODUCT	39.	81.	22.6009	723.2288	0.31	0.3	0.51	224.	
2	500	1	Special CLAD DH CUSTOM PRODUCT	39.	81.	22.6009	45.2018	0.31	0.3	0.51	14.013	
36	600	1	Special CLAD DH CUSTOM PRODUCT	39.	69.	19.2884	694.3824	0.31	0.3	0.51	215.	
2	700	1	Special CLAD DH CUSTOM PRODUCT	39.	69.	19.2884	38.5768	0.31	0.3	0.51	11.959	
8	800	1	Special CLAD DH CUSTOM PRODUCT	27.	73.	14.14	113.12	0.31	0.3	0.51	35.067	
2	900	1	Special CLAD DH CUSTOM PRODUCT	31.	57.	12.7606	25.5212	0.32	0.27	0.46	8.167	
1	1000	1	Special CLAD WINDOW CUSTOM PRODUCT	41.	52.	15.3301	15.3301	0.3	0.31	0.53	4.599	
2	1100	1	Special CLAD DH CUSTOM PRODUCT	33.	81.	19.1895	38.379	0.31	0.3	0.51	11.897	
3	1200	1	Special CLAD DH CUSTOM PRODUCT	33.	77.	18.1348	54.4044	0.31	0.3	0.51	16.865	
6	1300	1	Special CLAD DH CUSTOM PRODUCT	29.	77.	15.9855	95.913	0.31	0.3	0.51	29.733	
7	1400	1	Special CLAD DH CUSTOM PRODUCT	27.	81.	15.778	110.446	0.31	0.3	0.51	34.238	
7	1500	1	Special CLAD DH CUSTOM PRODUCT	27.	69.	13.4655	94.2585	0.31	0.3	0.51	29.22	
2	1600	1	Special CLAD DH CUSTOM PRODUCT	27.	69.	13.4655	26.931	0.31	0.3	0.51	8.349	
2	1600	2	Special CLAD DH CUSTOM PRODUCT	27.	31	5.974	11.948	0.28	0.36	0.62	3.345	
2	1700	1	Special CLAD DH CUSTOM PRODUCT	31.	105.	23.344	46.688	0.31	0.24	0.4	14.473	
1	1800	1	Special CLAD DH CUSTOM PRODUCT	39.	105.	29.2259	29.2259	0.31	0.24	0.4	9.06	
2	1900	1	Special CLAD DH CUSTOM PRODUCT	31.	57.	12.7606	25.5212	0.32	0.27	0.46	8.167	
1	2000	1	Special CLAD DH CUSTOM PRODUCT	39.	57.	15.9759	15.9759	0.32	0.27	0.46	5.112	
					Totals:		2833.1872				878.4465	
								Weighted Average			0.3101	

Sq. Ft.	X	Labor and Material	+	Delivery	+	9.5% Tax	=	Total
2,833		$55/sq.ft.		$1000.00		$1489.43		$171,712.43

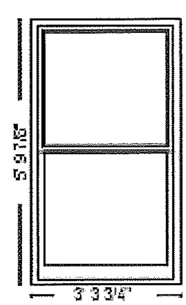
Quote # TBD

Line	Item Number	UM	Qty	Quote #
600	CDHGCSTM	EA	36	TBD

Special CLAD DH CUSTOM PRODUCT

1 WIDE UNIT, 4 9/16" Wall, NO STEP JAMB, Pine, PineJamb, w/Nailfin, A753 Brickmold No Sill Nosing, Sierra Bronze 2604, Frame Sierra Bronze 2604, Sash Sierra Bronze 2604, Colonial Glass Stop,

T7 TALON DOUBLE HUNG, 3', 3", 3/4", 5', 9", 7/8", BEIGE JAMBLINER, 2 LOCKS, NO LIFTS - NO LIFT PREP, AUX SILL STOP, SATIN CHROME, ANNEALED, Insulated Glass, T=Low-E (272), ANNEALED, Insulated Glass, B=Low-E (272), DP POS 50, DP NEG 50, WOOD VENEER INSERT, B & T, STANDARD, BRONZE FIBER MESH,



Rough Opening: 3' 4 1/4" X 5' 10 3/8"

Appendix C - Alternative Energy

PV System if Skylights Installed

- **Total Area of Skylights: 24.06 m^2**
- **Available Area for PV System: 89.67 m^2**
- **54 SunPower E19 320 Modules at a cost of $69,396.45**
- **Unirac SunFrame System**
- **2 Solectria PVI 10 kW Inverters**

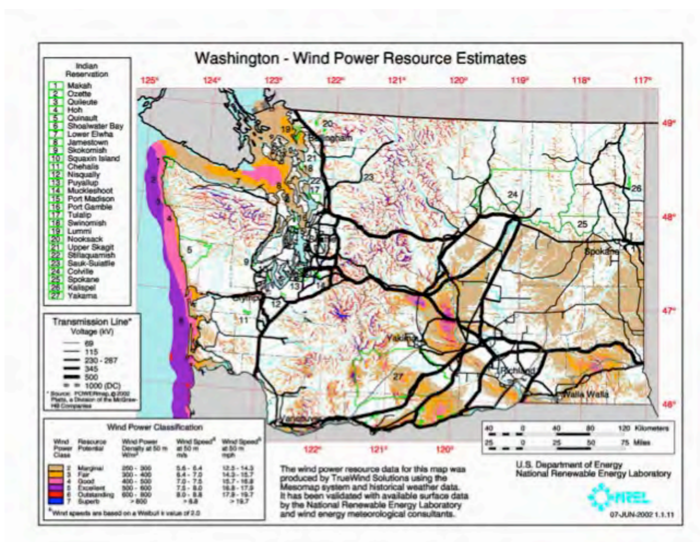
While Rainier Electric does not propose the installation of the 9' x 14.5' skylights it is ultimately up to our client and we recognize their decision. If this is the case we have proposed to install 54 SunPower E19 320 modules on the same southwest-facing roof. This system will provide annually 22,142 kWh at a cost savings of $5,535.50.

Payback Period									
Upgrade	**Initial Cost**	**-**	**Instant Incentives**	**=**	**Total Cost**	**÷**	**Annual Energy Reduction**	**Payback Period**
Photovoltaic System	$108,533.96	-	$39,137.51	=	$69,396.45	÷	$5,535.50	12.5 Years

Wind Analysis

When Rainier Electric was looking to incorporate a wind energy system into the alternative energy production option for Lewis Hall, both available wind energy and turbine electricity production were determining factors. After researching the wind speeds in Seattle, WA an average speed of only 8.5 miles per hour was found over the most recent decade. We have determined that wind energy is not a feasible alternative energy production.

However, if looking for a system to incorporate with the retrofit of Lewis Hall the biggest concern lies in finding a turbine with minimal cut-in speeds. Cut-In speed is the wind speed at which the wind turbines begin to produce electricity. For typical turbines the cut-in speed is between 7 – 10 mph. Since winds speeds at this location only average 8.5 mph, this system was deemed not economically viable and we have chosen not to implement it into our system because of the low amount of energy that is produced from wind turbines if any.



Most Feasible Wind Energy System

- **Eagle Model E12 Turbine at $638 per turbine**
- **Cut-In Speed: 4.7 mph**
- **$26.28 Savings / Year**
- **Payback Period: 24.28**

Alternative - Locally Manufactured Panels

- **Silicon Energy SiE 200 Panels**
- **Each Panel covers less of an area requiring 86 panels to cover 112 m^2**
- **Produces 22,048 kWh annually at an energy savings of $5,512**

Washington Renewable Energy Production Incentives		
Customer-Generation Using:	**Economic Development Factor**	**Incentive Payment (Rate per kWh*)**
Solar Modules & Inverters Manufactured in WA	2.4 + 1.2	$0.54
Solar Modules Manufactured in WA	2.4	$0.36
Inverter Manufactured in WA	1.2	$0.18
Blades of Wind Generator Manufactured in WA	1.0	$0.15
Anaerobic Digester or Other Solar Equip.	1.0	$0.15
All other Electricity Produced By Wind	0.8	$0.12
Maximum Annual Incentive: **$5,000** Maximum Incentive: **$5,000 per year Until June 30th, 2020** *Incentive Payment Rate = ($0.15/kWh)(Economic Development Factor)		

Silicon Energy is the leading producer of PV systems in Washington State located 30 miles north of Seattle in Arlington, WA. Rainier Electric would be able to take advantage of the $0.54 per kWh incentive offered by the state of Washington for PV panels and inverters manufactured within the state. However, this is capped at $5,000 a year leaving only $40,000 over the next 8 years.

Payback Period								
Upgrade	**Initial Cost**	**-**	**Instant Incentives**	**=**	**Total Cost**	**÷**	**Annual Energy Reduction**	**Payback Period**
Photovoltaic System	$137,600	-	$50,408	=	$87,192	÷	$5,512	15.8 Years

Sillicon Energy Panel SiE 200 Specs

Electrical Characteristics Measured at STC*	SiE160	SiE165	SiE170	SiE175	SiE180	SiE185	SiE190	SiE195	SiE200
Rated Power (Pmax) Watts	160	165	170	175	180	185	190	195	200
Maximum Power Voltage (Vmp)	24.7	24.8	24.8	24.9	25.0	25.1	25.3	25.5	25.6
Maximum Power Current (Imp)	6.5	6.7	6.9	7.0	7.2	7.4	7.5	7.7	7.8
Open Circuit Voltage (Voc)	29.9	30.0	30.0	30.1	30.2	30.3	30.5	30.5	30.6
Short Circuit Current (Isc)	7.6	7.7	7.8	7.8	7.8	7.9	7.9	8.2	8.4
Maximum System Voltage (VDC)	600								
Series Fuse Rating Amps (Amps-DC)	15								
Temperature Coefficients	Pmax: -0.566%/°C			Voc: -0.389%/°C			Isc: 0.109%/°C		

SUNERGY SYSTEMS™

21.8kW SOLAR SELF-GENERATION PROJECT #1 CONTRACT

A. Client Details		****
Customer:	Lewis Hall Retrofit	Direct Telephone:
Address:	320 Lewis Hall Seattle, WA 98195	Email:

Estimated Project Start Date:	**Projected Installation Completion Date:**

B. Itemized Project/System Equipment

Manufacturer Name	Item Quantity	Full System Product or Service Description	Unit Price	Total Amount
SunPower	70	SunPower SPR-320-WHT (22.4 kW) STC Rated Photovoltaic Modules	$986.42	$69,049.40
Solectria	2	Solectria PVI13kW 13kW Inverter	$9,849.00	$19,698
Unirac	1	PV Array Mounting System	$10,781.56	$10,781.56
Electrical	1	Electrical Supplies (disconnects, combiner/fuse box, meter base, conduit, wire, etc)	$6,063.19	$6,063.19
Sunergy Systems	1	Engineering and Installation	$15,681.95	$15,681.95
Sunergy Systems	1	Net-Metering registration, Grant Writing, Filing for al incentive programs, misc	$2,768.49	$2,768.49
			System Cost	**$124,042.59**
5 Year Warranty (Parts, Materials, and Labor)				Included
Utility District Net-Metering Fee				$150.00
Permits other Fees				$20,408.52
S&H				$8,228.74
State Sales Tax				Exempt
City Sales Tax				Exempt
			S&H,Tax,Fee	**$28,787.26**
			Total Cost	**$152,829.85**

C. Project Payment Deposit Schedule

Payment 1: ($1500) deposit due at contract signing	Payment 2: Due upon order of material ($105,930.90)
Payment 3: Due at inspector signoff ($45,398.95)	

SUNPOWER

E19 / 320 SOLAR PANEL

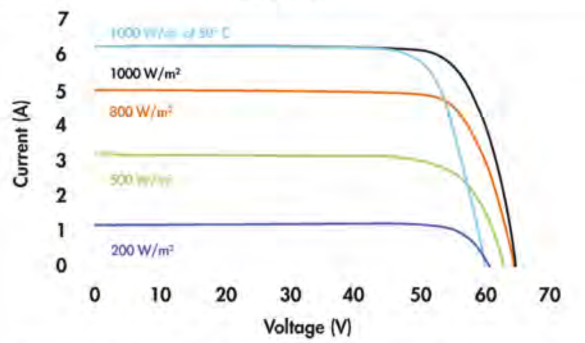
MAXIMUM EFFICIENCY AND PERFORMANCE

Electrical Data

Measured at Standard Test Conditions (STC): irradiance of 1000W/m², AM 1.5, and cell temperature 25° C

Peak Power (+5/-3%)	P_{max}	320 W
Efficiency	η	19.6 %
Rated Voltage	V_{mpp}	54.7 V
Rated Current	I_{mpp}	5.86 A
Open Circuit Voltage	V_{oc}	64.8 V
Short Circuit Current	I_{sc}	6.24 A
Maximum System Voltage	UL	600 V
Temperature Coefficients	Power (P)	-0.38% / K
	Voltage (V_{oc})	-176.6mV / K
	Current (I_{sc})	3.5mA / K
NOCT		45° C +/-2° C
Series Fuse Rating		20 A

I-V Curve



Current/voltage characteristics with dependence on irradiance and module temperature.

Mechanical Data

Solar Cells	96 SunPower all-back contact monocrystalline
Front Glass	High transmission tempered glass with anti-reflective (AR) coating
Junction Box	IP-65 rated with 3 bypass diodes Dimensions: 32 x 155 x 128 (mm)
Output Cables	1000mm length cables / MultiContact (MC4) connectors
Frame	Anodized aluminum alloy type 6063 (black)
Weight	41.0 lbs (18.6 kg)

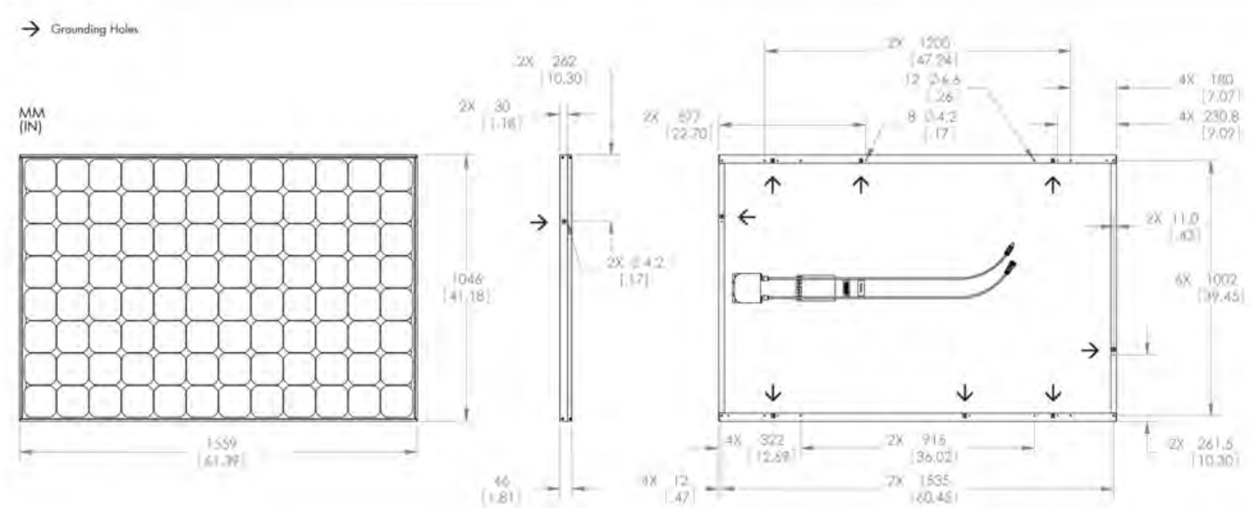
Tested Operating Conditions

Temperature	-40° F to +185° F (-40° C to + 85° C)
Max load	113psf 550 kg/m² (5400 Pa), front (e.g. snow) w / specified mounting configurations 50 psf 245 kg/m² (2400 Pa) front and back – e.g. wind
Impact Resistance	Hail 1 in (25 mm) at 51mph (23 m/s)

Warranties and Certifications

Warranties	25 year limited power warranty
	10 year limited product warranty
Certifications	Tested to UL 1703. Class C Fire Rating

Dimensions



CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

Visit sunpowercorp.com for details

sunpowercorp.com
Document #001-65474 Rev** / LTR_EN

String Sizing

PV System Sizing Calculations

Project: Lewis Hall Energy Efficiency Retrofit

Responsible: Rainier Electric

Sizing Calculations

Maximum Series Module Calculation

Vadj = Voc + [(Record Low Temp ºC – STC Cell Temp ºC) x Voltage (Voc)]
= 64.8V + [(-17.8 C - 25 C) x -.1766V/C]
Vadj = 72.36V
Max Modules in Series = UL / Vadj
= 600V / 72.36V
Max Modules in Series = 8.29 (round down), 8 Modules in Series (Maximum)

Minimum Series Module Calculation

Voltage (Voc) = Vmpp (x) Power (P)
= 54.7V (x) -.38%/k
Voltage (Voc) = -.208
Vadj = Vmpp + [(Avg High Temp + 30 C – STC Cell Temp ºC) x Voltage (Voc)]
= 54.7 V + [(59 C – 25 C) x -.208]
Vadj = 47.63 V
Min Modules in Series = Min Operating Power / Vadj
= 205 V / 47.73 V
Min Modules in Series = 4.3 (round up), 5 Modules in Series (Minimum)

My recommendation is to install on each roof surface 7 strings, (5- series modules per string). This will be a total of (35) modules per face, (70) modules total.

SUNPOWER SPR-320E

Open Circuit Voltage: V_{oc} = 64.8V
Rated Voltage: V_{mpp} = 54.7V
Temperature Coefficient for Voltage: Voltage (V_{oc}) = -.176 V/K
Temperature Coefficient for Power: Power (P) = -0.38% / K
Maximum System Voltage: UL = 600V

SOLECTRIA PVI 13 KW

Operating Range (MPPT) = 205V – 430V

SOLAR RADIATION DATA (SEATTLE, WA 47.5N, 122.3W)

Record Low Temp. = -17.8 degrees Celsius
Average High Temp. = 29 degrees Celsius (add 30 degrees for rack mounted modules

Appendix D - LEED

Green Energy Challenge 2012
Comfort Survey

The University of Washington NECA chapter would appreciate the participation in the following survey in order to discover shortcomings and develop energy efficient solutions to improve the work environment of Lewis Hall.

1. When working at Lewis Hall I turn off all lights when I leave my office.

YES NO

2. When at home I care more about conserving energy then when I am at Lewis Hall.

YES NO

3. When working at Lewis Hall I turn off all lights when I leave all rooms, including bathrooms and common areas.

YES NO

4. In my office I have ________(number) lights that I plug into an outlet.
Reasons for having extra lighting (ex. decoration, inadequate lighting, …)
____
____
____

The following questions are on a scale of 1-5, 1 being "very inadequate", and 5 being "very satisfied"

5. The energy efficiency of the building as a whole is _____________.

1 2 3 4 5

6. The overhead lighting in my office is _____________.

1 2 3 4 5

7. Natural lighting in my office is _____________.

1 2 3 4 5

8. The ability to control temperature within my office is _____________.

1 2 3 4 5

9. Air quality within the building is _____________.

1 2 3 4 5

Rainier Electric

Green Energy Challenge 2012
Occupant Commuting Transportation Assessment

The University of Washington NECA chapter would appreciate the participation in the following survey as a part of the LEED portion of the project.

Please check all answers that apply to your commuting habits.

1. My average one-way commute distance in miles is: ____________
2. Please indicate the method of transportation you used to get to work each day during the last week. If you used more than one mode of transportation, please indicate the mode used for the longest distance during your commute trip (i.e. if you took a train for 10 miles and walked 1 mile, indicate that you used Public Transit).

	Mon	Tue	Wed	Thu	Fri
Drove Alone					
Carpool					
Public Transit/Bus					
Vanpool					
Bicycle					
Walk					
Telecommute					
Sick / Vacation Day					
Other					

3. If you drive to work, please indicate the make, model, and year of your vehicle below:

   Make: ________________________ Model: __________________________ Year: ________

4. Please indicate whether your vehicle uses any of the following alternative fuels:

   ___Electricity (including gasoline-electric or diesel-electric hybrids)
   ___Hydrogen
   ___Propane or compressed natural gas
   ___Liquid Natural Gas
   ___Methanol
   ___Ethanol

5. If you carpool or vanpool, please indicate the total number of people typically commuting with you:

   1 2 3 4 5 6 7 8 9

6. Do you usually travel home using the same mode of transportation used to get to work? ________

   If “no”, please briefly explain your mode of transportation used to return home from work below:

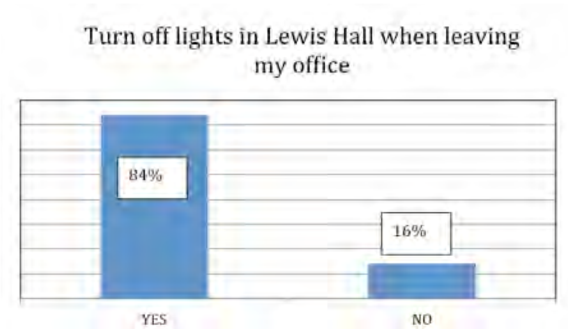
   ____
   ____
   ____

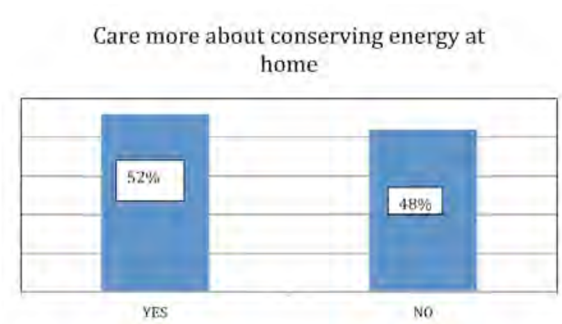
7. Does your typical commuting pattern change significantly depending on the time of year? If so, please explain below (i.e. bike in the summer instead of bus).

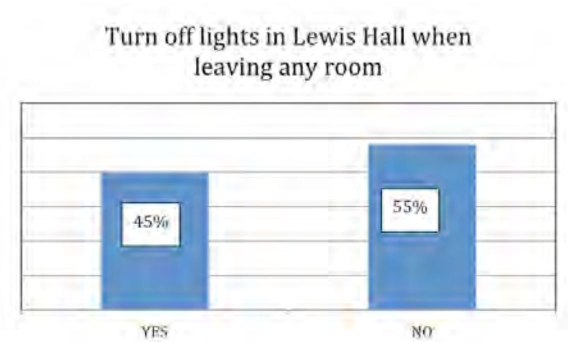
   ____
   ____
   ____

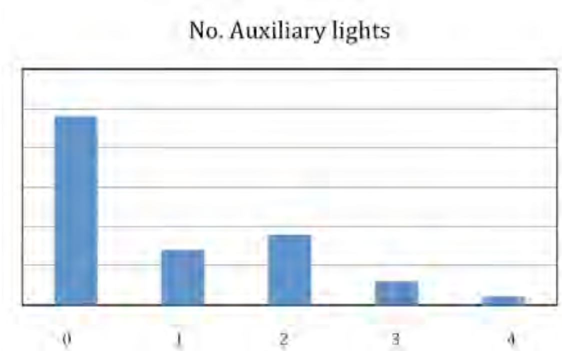
Survey Results

Comfort Survey

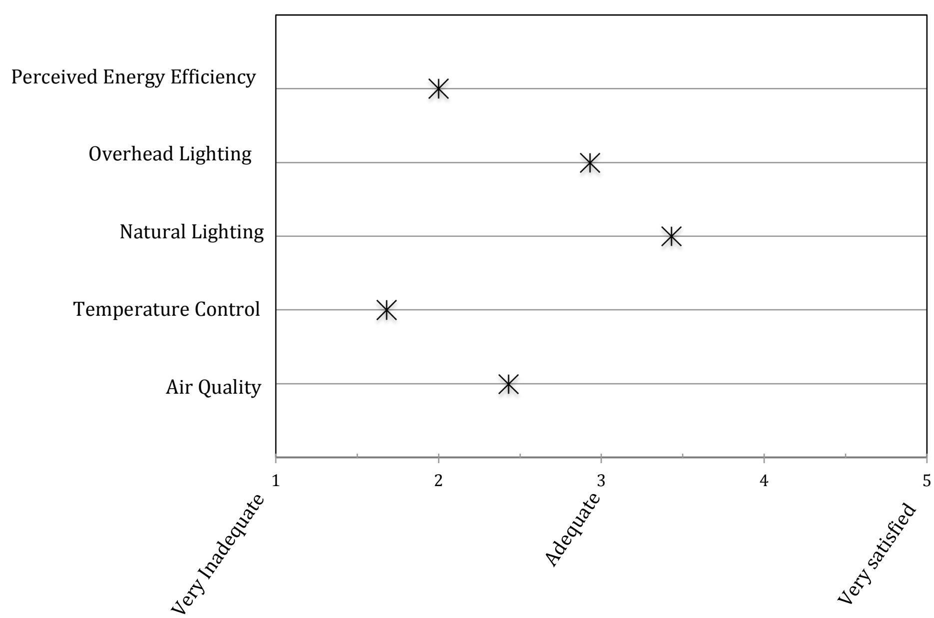




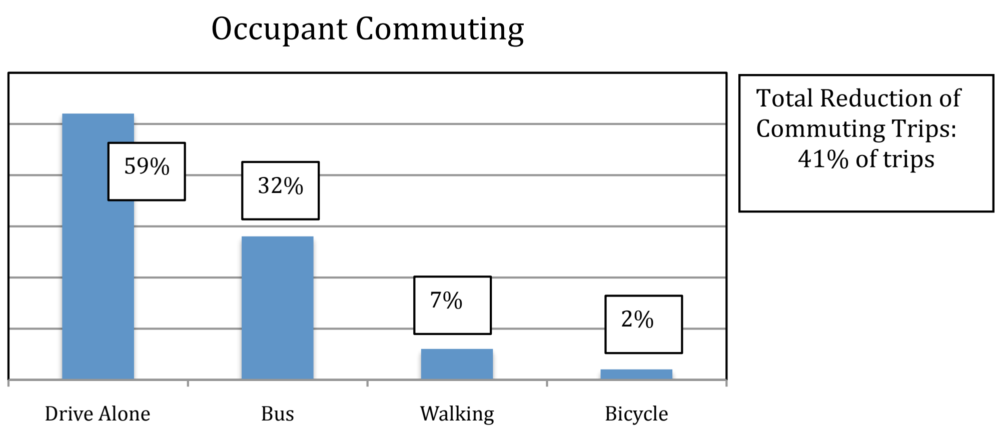




Lewis Hall Comfort Survey Results
(60% of Occupants Surveyed)



Commuting Survey



LEED Breakdown Tables

Energy & Atmosphere Credit 4	
Onsite Renewable Energy	Points
3.0%	1
4.5%	2
6.0%	3
7.5%	4
9.0%	5
12.0%	6

Water and Efficiency Credit 2	
Percent Reduction	Points
10%	1
15%	2
20%	3
25%	4
30%	5

Energy and Atmosphere Credit 1			
EPA Energy Star Energy Performance Rating	LEED Points	EPA Energy Star Energy Performance Rating	LEED Points
71	1	81	10
73	2	82	11
74	3	83	12
75	4	85	13
76	5	87	14
77	6	89	15
78	7	91	16
79	8	93	17
80	9	95	18

Energy Star Energy Efficiency

Facility Information Edit

Lewis Hall
E Stevens Way, Seattle, WA 98105
United States

Facility Characteristics Edit

Space Type	Gross Floor Area (Sq. Ft.)
Office	23,200
Total Gross Floor Area	23,200

* The Median Building is equivalent to an EPA Energy Performance Rating of 50.

Estimated Design Energy Edit

Energy Source	Units	Estimated Total Annual Energy Use	Energy Rate ($/Unit)
Electricity - Grid Purchase	kWh	68,296	$ 0.250/kWh
Natural Gas	cf	7	$ 0.011/cf
District Steam	MLbs.	261,106	$ 0.018/MLbs.

Source: Data adapted from DOE-EIA. See EPA Technical Description.

Results for Estimated Energy Use

Energy	Design	Target	Median Building
Energy Performance Rating (1-100)	1	93	50
Energy Reduction (%)	N/A	50	0
Source Energy Use Intensity (kBtu/Sq. Ft./yr)	16,259,960	101	202
Site Energy Use Intensity (kBtu/Sq. Ft./yr)	13,437,965	83	167
Total Annual Source Energy (kBtu)	377,231,060,754	2,342,870	4,685,740
Total Annual Site Energy (kBtu)	311,760,797,033	1,936,254	3,872,507
Total Annual Energy Cost ($)	$ 21,774	$ 0	$ 0
Pollution Emissions			
CO2-eq Emissions (metric tons/year)	24,613,523	153	306
CO2-eq Emissions Reduction (%)	-8050442%	50%	0%