



Sustainability Plan 2009

Table of Contents

- I. Introduction
 - a. Statement of Work
 - b. Previous Initiatives
 - c. Areas of Interest

- II. Specific Project Descriptions & Recommendations
 - a. Daylight Harvesting
 - b. Cleaning Practice Restructuring
 - c. Recycling Practice Restructuring
 - d. Combined Heat and Power
 - e. Solar Domestic Hot Water Heating
 - f. Wind Power
 - g. LEED Certification

- III. Fostering Sustainable Behavior and Managing Change

- IV. Performance Measures

Statement of Work – Sustainability Planning

Client: Franklin W. Olin College of Engineering

Executive Sponsor: Joanne Kossuth, Vice President of Operations

Email: Joanne.Kossuth@olin.edu

Date: December 12th, 2009

Student Name (s): Corey Cavicchi, Joshua Greenwood, John Meagher

<p>Background</p>	<p>Built in 2002 in Needham Massachusetts, Olin College seeks to redefine engineering as a profession of innovation encompassing the consideration of human and societal needs, the creative design of engineering systems, and the creation of value through entrepreneurial effort and philanthropy. The College is dedicated to the discovery and development of the most effective educational approaches and aspires to serve as a model for others. In order to become a leader, Olin College needs to make Sustainability a key focus of their operations. By coupling the outlined Sustainability plan with the past work that has already been accomplished, Olin College will become a leader in Sustainability.</p>
<p>Client Requirements</p>	<p>Olin College requires a Sustainability Plan that will actively involve the campus community in implementation of up to date technologies, foster respect for the surrounding environment, reduce their carbon footprint, and ultimately reduce costs. They do not want to negatively affect the aesthetics of the campus, the focus of the institution, or be inconvenienced by Sustainability.</p>
<p>Description of Project</p>	<p>The Sustainability Plan will focus on improvement in five main areas:</p> <ul style="list-style-type: none"> - Energy Use - Water Use - Recycling - Community Involvement / Student Competition - Alternative Energy Sources <p>The Sustainability Plan will investigate opportunities for:</p> <ul style="list-style-type: none"> - Daylight Harvesting - Cleaning Practice Restructuring - Recycling Practice Restructuring - Installing a Combined Heat and Power system, Solar Domestic Hot Water System, and Wind Technology - Obtaining LEED certification for existing buildings - Sustainability Training <p>The Sustainability Plan will include recommendations which can be used to change current and future operations. Where applicable, preliminary cost analysis will be shown to prove opportunity feasibility. The focus will be on reducing the environmental footprint of the campus and cost reduction.</p>

Previous Initiatives:

Olin College of Engineering has already taken several steps toward improving their environmental footprint. The most significant of which being the staffing of a full time Energy Manager on site. Through HVAC controls optimization, lighting upgrades, involved project management, and a strong focus on system operations, Olin College has reduced their energy consumption by 45% since 2006. Operational measures have included eliminating reheat systems by turning off the boilers in the summer, lowering and raising respective heating and cooling set-points in all spaces, and switching all buildings into setback mode during school breaks and unoccupied hours.

Olin College has also taken some more publicly noticeable steps. In 2008, the dining facility went tray-less to reduce food waste, dish washing water and energy consumption. Olin College competed in Recyclemania earning second place. Other awards include achieving the Green Needham Collaborative 10% Challenge and being awarded the Newton/Needham Chamber of Commerce Green Business Award in 2009.

Areas of Interest:

To build upon their previous initiatives and outline a continuing direction for the future, this Sustainability Plan will investigate all areas of interest that will positively promote Sustainability. Olin College has had some negative experiences with Sustainability initiatives in the past and is taking a much more reserved look for the

second time. Olin College has expressed interest in Daylight Harvesting, Cleaning Practice Restructuring, Recycling Practice Restructuring, Combined Heat and Power Systems, Solar Domestic Hot Water Heating, Wind Power, LEED Certification, Sustainability Training, Community Involvement, and Student Competition. Each of these areas have been discussed and studied and are described in the following sections. The measures investigated were carefully reviewed to ensure they would not affect the aesthetics, functionality, or operations of Olin College.

II. Specific Project Descriptions & Recommendations

Daylight Harvesting

Lighting is one of the larger components of Olin College's electricity use, ranging from 25 to 30% of total electrical consumption, which contributes many tons of green house gas (GHG) emissions into our atmosphere every year. In order to reduce electricity consumption, operating costs and GHG emissions, Olin college will investigate all aspects of energy management, and especially daylight harvesting. Daylight harvesting is defined as reducing the amount of artificial lighting when natural daylight is available for use, accurately controlled (photocell) and distributed throughout a space evenly. Daylight harvesting can be implemented in all of Olin's existing buildings and should be heavily considered in any type of new construction on campus.

Olin's architecture holds several places in all five building that Daylight Harvesting could be utilized, for instance, hallways, offices, stairwells, lounges and mechanical spaces. Olin has two existing electronic lighting control systems that can help reduce installation cost and provide exceptional control for Daylight Harvesting. Daylight

Harvesting, when designed and installed correctly, will reduce operational costs, increase visual comfort, increase equipment life, and reduce GHG emission. Olin's energy management staff will evaluate every selected space to ensure the lighting will be acceptable to occupants. When evaluating a space there are several issues that must be investigated before a system is installed, which are: reflections, daylight distribution, specific light levels, and glare. As for Daylight Harvesting in new construction, the article Daylighting by Gregg D. Ander, FAIA (<http://www.wbdg.org/resources/daylighting.php>) states that increasing lighting construction cost from 0.5 to 0.75 dollars per square foot to design and install daylight harvesting systems will show an annual improved life-cycle cost from .05 to .20 dollars per square foot. This will be attractive on a return on investment (ROI) analysis and will lower the college's new building operating and maintenance costs.

An example of a Daylight Harvesting opportunity at Olin would be at the Academic Center in the two emergency stairwells. These stairwells contain hundreds of feet of fluorescent lighting that continually operate 24 hours a day. The two stairwells both have a 50 to 60 foot glass curtain wall which, at night, directs light onto the exterior walkway below. This design is a great at night but during day time hours these walls of glass allow high levels of daylight through, eliminating the need for the several hundred feet of fluorescent light. This is a perfect application for Daylight Harvesting and it is safe to say this project would pay back in less than two years. The Utility (NSTAR http://www.nstar.com/docs3/application_forms/bs-commercial-lighting.pdf) offers many incentive programs to customers that are looking to make energy efficiency upgrades.

This program pays for a percentage of the parts need for a project and will be part of Olin's ROI analysis.

Implementation of Daylight Harvesting at Olin College is a forward step toward environmental stewardship. The college will continually pursue Daylight Harvesting within their existing buildings and incorporate Daylight Harvesting design into any future building construction. This will help reduce operating cost, maintenance costs and lower the GHG emissions.

Recommendations for daylight harvesting would include having Olin's energy manager evaluated the campus for harvesting opportunities. A light meter, which measures lumens, would be used to prove light levels in selected spaces. Once light levels are approved an electrician would referrer the building drawings to find the most cost effective controls scheme for the job. A return on investment (ROI) analysis would be conducted to determine if the project is feasible. ROIs should not exceed two year as the project would not be financially attractive. Olin College has skilled and licensed in-house personnel who could handle most daylight harvesting projects. In-house projects would cost the college a fraction of normal contractor costs and could make almost any project financially attractive. The sooner the daylight harvesting is implemented the faster Olin realize reductions in energy cost and GHG emissions.

Cleaning Practice Restructuring

To move Olin College toward environmental stewardship all aspects of a facility must be reviewed to reveal any unfriendly environmental practices and correct them. Like

many other U.S. facilities, Olin College has recently tried to take steps in the green cleaning direction but has not yet reviewed its entire cleaning program to transform it into a sustainable cleaning program. The custodial department has been experimenting with new green cleaners and has tried to employ a manageable inventory for cleaning supplies. These two objectives are a start but are only pieces to the whole sustainability program. A sustainable cleaning program focuses on using environmentally friendly products in the correct fashion to create a safe indoor environment for all occupants.

To implement this type of program, Olin College will need to restructure its current conventional cleaning program. Restructuring will start by standardizing cleaning procedures which will create quality and infection control. Employees will be required to complete comprehensive safety and procedural training annually to adhere to cleaning and safety policies. Cleaning and safety policies and protocols will be posted in the break room for employees to freely view. Sustainable cleaning equipment upgrades that include replacing paper towels with reusable micro fiber cloths or purchasing HEPA vacuum cleaners which remove 99.99% of allergens and dust particles from the air will reduce Olin's waste and improve indoor environment quality. Replacing conventional cleaning products with effective green cleaners that are non toxic, plant based, contain no volatile organic compounds, and will deliver improved occupant health and productivity because of the absence of conventional cleaner irritants in the air. These objectives are not easily implemented and it is recommended that a sustainability committee of motivate individuals be formed to drive the sustainable cleaning program changes.

Recycling Practice Restructuring

Olin College currently has a recycling program with bins in every room for paper and bottles adjacent to the trash receptacles. This program has been only moderately successful due to the fact that trash and recyclables inevitably become mixed together. A single stream recycling program could be a successful alternative to the current system. This would require single trash receptacles in all rooms for all waste items, and a single recycling bin for all recyclables. The recycling would then be sorted at a remote location out of sight from the main area of campus. This would ensure that ALL recyclables would be recycled, whether the students intended to separate their wastes or not. Students could then be given the opportunity to work in the sorting facility as a part time job during school or it can be outsourced to the waste management provider. An alternative to manual sorting could depend on the outcome of the recycling competition outlined in Section III of this report.

Although this type of recycling is different than most are used to, other colleges such as Colorado State University, Colorado College, and Drake University have had positive feedback from single stream recycling, and so have municipal counties in Maryland and Colorado. It is recommended that Olin begin this initiative in the next 1 to 2 years or whenever the next waste management contract is ready for renewal. If the current provider cannot provide this service then alternatives should be investigated. This will allow Olin College ample time to prepare an implementation plan, organize a new protocol for waste pick up, and advertise to the campus about the new way to manage waste. The extra bins removed from the campus from the traditional recycling method should be kept in storage in case the single stream method does not work out. For more information on the success of the above mentioned locations visit the following websites:

Colorado State University:

<http://media.www.collegian.com/media/storage/paper864/news/2009/04/20/News/SingleStream.Recycling.Process.New.To.Campus.Sorted.By.WellOiled.Machine.video-3717059.shtml>

Colorado College:

<http://sustainability.coloradocollege.edu/single+stream>

Drake University:

http://www.greenstudentu.com/uncategorized/drake_university_campus_single_stream_recycling.aspx

Combined Heat and Power

Combined heat and power (CHP) is a renewable energy option for Olin which could hold several sustainable benefits for the future of the college. These benefits include:

- Student education
- Reduction in electricity and natural gas costs and consumption
- Reduced green house gas emissions (GHG)
- CHP Boiler and Chiller replacement options

Olin has two options for CHP units. The first option is cogeneration which produces electricity for consumption and hot water for use in space heating loop and/or domestic hot water. The second option is Tri-generation (combined cooling, heating and power

units or CCHP) which adds an absorption chiller to the CHP unit. This chiller option gives Olin more opportunities to use the heat produced by the engine thus allowing for more run time and attractive return on investment numbers. These units are relatively expensive to install, roughly \$604 per kilowatt (kW) of output power. CHP and CCHP units offer a low life-cycle cost for around 20 years and should pay for itself in 7 years or less.

Olin College will complete an extensive feasibility study to ensure the most cost effective decisions are made. Sizing is the most critical part of a CHP installation because this type of equipment needs to operate 95% of the year in order to achieve an acceptable return on investment (ROI). The study will look at Olin's historical electricity and natural gas base loads to determine what size CHP unit can operate most effectively. In Olin's case, the electrical base load is far larger and more consistent than the heating and cooling base loads. This heating and cooling load inconsistency is a direct cause of Olin's innovative energy management program and will make the study more complicated. Currently the boiler plant is shutdown for 3 summer months and the chiller plant runs intermittently throughout the cooling season. Unfortunately, this means there is no constant heating and cooling base load at Olin College which poses a problem for CHP/CCHP installations. Although, NSTAR is now required to maintain a certain number of customers with CHP units under its domain which has caused the company to create very attractive incentive programs for new CHP/CCHP unit installations. Adding NSTAR's incentive program (http://www.nstar.com/docs3/tech_show/nstar-chp.pdf) to the benefits of lowered demand and utility costs, and the educational benefit to the student body may push the ROI to become attractive even with Olin's current operating schedule.

Tri-generation is the recommended system to conduct a feasibility study on as cogeneration will definitely not work for Olin College because of the lack of a heating load.

Solar Domestic Hot Water Heating

Given the hilltop location of Olin College with most of its buildings rooflines being above the tree line, it has been thought that Solar Hot Water heating may be a viable source of renewable energy. Three of Olin's academic buildings offer a total of 20,000 Square Feet available for Solar Hot Water Panels. A study at Babson College, directly next door to Olin, showed that solar collectors could produce up to 235.6 kBTU per square foot per hour. This energy would be used to preheat Domestic Hot Water for bathrooms and lab stations within the academic buildings as well as for the dining facilities, and will save approximately 3 Therms of Natural Gas per square foot of collector. Costs for this type of project are generally high because of its unique characteristic but a publicly recognized facility like Olin College would be an excellent display for this relatively new technology. The simple payback for the project at Babson next door was 28 years.

We recommend that Olin College invest in this new technology to honor their mission: "Olin College prepares students to become exemplary engineering innovators who recognize needs, design solutions, and engage in creative enterprises for the good of the world." This is an emerging technology that we feel will eventually be common on all structures, and needs to be implemented in order to be studied. Given the current age of the buildings and the current prosperity of the college, we recommend implementing this in the next 1 to 5 years.

Wind Power

Since Olin College is committed to sustainability, the application of wind power on the campus is being explored. Obviously the campus is under certain constraints and limitations due to its environment. The college cannot install an entire wind farm. It is not practical or feasible. However, it is potentially feasible to install one reasonably sized wind turbine that would produce some, if not all, of the college's power. To do this the college would need to undertake a wind study. This study would be used to determine where, if anywhere, would be the optimal location to install a wind turbine. This study would be focused on observing and recording the wind trends on campus. For a wind turbine site to be viable on a utility level, the site would need to meet a minimum average speed of six meters per second, or thirteen miles per hour. This data would be collected and evaluated to determine if there is a viable site on campus for a wind turbine. If it is found that there is a viable point of interest on campus there are two possible avenues that the school could take for wind power. They could either do one large turbine that would produce a significant amount of power or they could do numerous small turbines. The small turbines would provide significantly less power than the large one, but they would be more aesthetically pleasing.

One of the most influential factors with any new initiative is the financial support that it would receive. The college would need to investigate what possible state incentives it would qualify for. One possible incentive would be the exemption from the excise tax for Wind Powered Systems. This exemption would last for the length of the system's depreciation period. Another possible incentive would be the Renewable Energy Property

Tax Exemption. If the site qualified, it would be exempt from property taxes for a period of 20 years. Another incentive would be the Renewable Energy Equipment Sales Tax Exemption. The state would exempt the sales tax for any equipment purchased in direct relation to the system. These incentives are just a few of many that could be used to provide the proper backing for the project. The installation project could be completely financially covered by government programs.

It is recommended that Olin College implement a means of recording the wind trends for the area for a period of no less than one year. Once the study is concluded the data should be analyzed to determine if the location is viable for a wind turbine. If the site is deemed viable, the application process to qualify for any and all government incentive programs should begin within the next fiscal year. If proper approval is granted the school should begin construction of the wind turbine system. The entire project should be completed, from beginning to end, within three calendar years. This endeavor is extensive and time consuming but it is worth every ounce of effort when it is completed.

LEED Certification

Another possible avenue that the college could look into is getting one, if not all, of the buildings on the campus some degree of LEED Certification. LEED stands for Leadership in Engineering and Energy Design. LEED Certification is a program founded and administered by the United States Green Building Council. The purpose of this program is to ensure that builders are being as environmentally responsible as possible while providing a safe and healthy place to live and work while maintaining a profitable operation.

There are many different levels of LEED Certification that are awarded by specific LEED Accredited Professionals. These professionals are independent third parties that inspect and verify that a building has met certain requirements and criteria. These criteria are separated into different categories. Each of these categories has their own scoring system with a certain number of points. After a site has been assessed the points are tallied and if the site has earned enough points, it receives certification. The more points the site receives, the higher the certification. The certifications range from certified to silver to gold to platinum. Under the current rating system, Olin College would focus on the category of LEED for existing buildings, Operations and Maintenance.

The college has already taken the first steps towards making LEED part of their culture by beginning the certification of one of the buildings on the campus. The next logical step is to continue with the certification process in the current building. Once that building is finished and certified it is recommended that the school focus its efforts on at least one of the other buildings on campus. The process is long and can be an added expense without immediately noticeable rewards but it is the environmentally conscious and socially responsible course of action. With the proper steps taken, Olin College can be on the forefront of sustainability and lead the way for others to follow in the future.

III. Fostering Sustainable Behavior and Managing Change

In order to promote Sustainability, Olin College should separate their focus into two categories; the students and the public. To engage the students, promotion of Olin's initiatives can begin in the buildings via fliers and posters and move into the electronic realm on billboards, student websites, and student e-mails. For example, a footnote could be created on

each of the students e-mail accounts that say “Olin College asks you to please think twice before printing this e-mail.” Students should be encouraged to share rides, reduce waste, conserve water, and conserve energy, both thermal and electrical. The students should be notified of heating and cooling setpoints programmed in all of the buildings, the amount of energy consumed by each dormitory, and how much waste is recycled and disposed of each year. The facilities maintenance department function and contact information should be advertised to the students and posted in every room so they know who and where to contact if they encounter a problem. This will maintain student trust and comfort in the new Sustainability Policies. All these suggestions can be implemented in the next year or less.

Because Sustainability often benefits from motivation, we suggest competitions be created for the students to actively become involved. Competitions could include least water, electricity, and natural gas consumed per dormitory, most environmentally responsible atmosphere, and for the technically motivated, a competition to create a trash sorting recycling robot. Because the latter is of such high level action, it could be included in the student’s curriculum so academic credit will be received for participating. Professors would become involved in the competition and judging, and the final contest would be advertised to the outside community. It is recommended that this type of action be implemented in the next 2 to 5 years to maintain focus on more attainable measures in the first 1 to 2 years.

It is recommended that the outside community be incorporated into Olin College’s Sustainability initiatives by ways of transparency and disclosure. It should be clearly advertised what steps the campus is taking to increase Sustainability and the public should be encouraged to follow their footsteps. Milestones of the Sustainability plan should be documented and

advertised locally so the public community has an idea of how the campus is doing. A letter could be sent out to all neighbors within a certain radius that displays Olin College's Sustainability mission, goals, reasons for implementation, and quarterly progress.

For both the public and the students, a "suggestions box" should be created electronically so if anyone notices any opportunities for improvement, identifies a source of waste, or has an idea that could help, they can have a place to contribute. People are not simply important to the success of this program - they are critical. It is imperative that the program deeply involve all levels of the staff and the student body to develop a conservation ethic, share in its rewards, and truly foster Sustainability in the Olin College Community. Training can be offered to anyone associated with Olin College that wishes to learn more about Sustainability. Every person involved with Olin College can help by being aware of their own environmental footprint. Sustainability will not succeed if only one person participates in Sustainability Plan 2009 but if everyone works together, Olin College can become a leader in environmental responsibility beginning today.



Current Behavior	Desired Behavior	Potential Barriers	Benefits of Success	Strategy
Control Campus Lighting with Timers and Occupancy Sensors	Also Control Lighting via Photocells to Utilize Natural Daylight	Executive Level Staff and their Desired Aesthetic of the Campus	Reduced Energy Consumption and Reduced Greenhouse Gas Emissions	Implement Daylight Harvesting Control in Spaces Where Complaints are Least Likely and Ensure Proper Design
Cleaning supplies used are non biodegradable, and toxic to produce	Clean entire campus with biodegradable, plant based products which emit no VOC's	Increased product cost and resistance to change cleaning methods	Improved Indoor Air Quality and Environmental Footprint	Replenish Supplies with Sustainable Alternatives. In the Interim, Test new Products to See Which are Appropriate for Olin
Waste is Separated in Individual Bins by Bottles and Cans, Paper, and Trash.	All Recyclables will be placed in One Container Separate from the Trash and Sorted Off Site	Existing Waste Management Contract, Managing what Students Throw in the Recycling Bin	Increased Amount of Material Actually Recycled, Minimized Waste Pick Up by Custodial Staff	Renew Waste Management Contract with Single Stream Recycling
Waste Heat from Hot Water Generation is Wasted Out the Smokestack.	Cogeneration Units that Produce Electricity and Hot Water at the Same Time	Installation Costs, Life Cycle of Existing Equipment	More Efficient Use of Purchased Utilities, Less Greenhouse Gas Emissions	Plan for Replacement of Existing Equipment with Combined Heat and Power Systems at the End of Their Useful Life
Hot Water is Produced by Burning Natural Gas	Energy From the Sun to be Collected to Pre-Heat Water.	Installation Costs, Life Cycle of Existing Roofing	Reduced Fossil Fuel Consumption, Improved Environmental Footprint	Fund Project Through Some Sort of Emerging Technology Grant Coupled with Educational Grants
No Power is Currently Generated On Site	Generate Electricity via a Wind Turbine	Location, Wind Speed, Local Zoning Laws, Installation Costs	Decreased Energy Costs, Positive Environmental Image	Investigate Wind Patterns on Campus, Locate Site, Investigate Federal Grants.
Buildings Are Operated Efficiently but are not Documented by Any Official Means	Certify Buildings as Efficient Using LEED Standards	Upgrade Costs, Certification Costs, Project Management ManPower Requirements	Recognized Buildings, Reduced Operational Costs, Positive Environmental Image	Obtain LEED Certification for the Most Eligible Building and then Expand. Construct Any New Buildings in the Future to LEED Standards.

IV. Performance Metrics

It is recommended, and truly necessary, that Olin College monitor the performance of each implemented Sustainability Project. Continuous utility monitoring should be the ultimate metric for assessing attained savings and reduced greenhouse gas emissions. For measures like Daylight Harvesting, Combined Heat and Power, and Solar Domestic Hot Water Heating, direct On-The-Meter savings should be instantly visible (taking into account proper adjustments for weather and occupancy changes). For measures such as Cleaning Practice and Recycling Restructuring, Operational costs may not actually be reduced; however occupant health and productivity can be assessed. It is recommended that a before and after survey be created to determine the effectiveness of changing operations toward Sustainability. LEED Certification and Wind Power will show an eventual cost savings but will have substantial payback periods before they show up on utility bills. LEED is often expensive to attain depending on what level of certification is desired. Wind Turbines are quite capital intensive but immediately start paying for themselves. It is recommended that building by building metering be used to assess the savings associated with LEED buildings and that a separate meter be installed on the wind turbine to monitor its output.