Thesis Proposal

FDA Building One – White Oak, MD

R. Andy Pahwa

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Thesis proposal serves as an opportunity to explore possible areas of redesign and their impact. For FDA Building One, an extensive solar study will be performed. The proposal has been revised to include a direct current application analysis as part of the electrical breadth. The constructability of embedding wall insulation with thin film battery will be evaluated as part of the CM breadth. A holistic DC approach to increase efficiency, include renewable energy storage and reduce equipment sizing will be the focus of the thesis project.

Executive Summary:

The objective of this proposal is to summarize the information gathered from previous Technical Reports, explore possible areas of depth and breadth study and formulate a look-ahead schedule for the spring semester. Currently FDA Building One uses three air handling units to serve perimeter offices, security pavilion and the core ventilation needs, providing minimum outside air requirements to all zones. The building is hooked up to a central utility plant that provides electricity, chilled/hot water to coils of the air handling units and fan coil units in perimeter offices as well as steam to the domestic hot water exchangers. An energy model was created to evaluate the energy usage of the building. Some potential areas of redevelopment have arisen over the course of studies this semester.

First potential area of redesign will focus on a solar study for the building. The roughly 25,000 SF of roof could provide ample space to install photovoltaic collectors. Energy could be used within the building or redistributed to surrounding buildings. This equates to saving of tax dollars; or at least tax dollars put to better use. A thorough financial feasibility study will be key in implementation.

To build upon a system of photovoltaic collection, a study into direct current uses will be conducted. Being able to use DC with photovoltaic collectors will alleviate inefficiencies that are generally associated with DC to AC converters used in common systems. This would be a good option to tie into photovoltaic collectors to elevate the systems of the building to level higher than it has achieved. The advantages of running a DC system would be widespread throughout the building, especially where current systems run on energy from the central utility plant.

Another common issue with utilizing alternative power generated on site is the ability to store it. Thin film battery has been developed by various outlets – university research as well as commercial R&D. Its application in this case will be evaluated. The constructability of embedding thin film battery into the wall insulation will be studied. The large surface area will allow for large storage capacity while reducing area required by conventional batteries. The advantage of keeping with a DC application throughout the building will allow equipment sizing within the building to be reduced. This is being studied in an effort of making a good design better.

Building Overview:

FDA Building One is the seventh White Oak structure completed as part of the FDA's consolidation project on the White Oak, MD campus. GSA oversaw the renovation of the 102,000 square foot, four-story historic Building One - originally the headquarters of the Naval Surface Warfare Center for 52 years - to accommodate portions of the FDA's Office of the Commissioner and related executive functions.

Flanked by two office buildings, Building One creates a formal entry forecourt. The building integrates 148 offices, nine conference rooms and several workstations and shared business areas and connects to the campus' first Central Shared Use space with access through the first floor lobby.
The building was the first on the FDA Campus to receive LEED Gold certification.

The design of the building is entirely historic preservation with a few modern touches to the façade. Special considerations were taken into account in order to compliment the design of the existing buildings as well as match the architectural materials that were selected for the original campus facade. The historical considerations of this building played a large role in the building material selection as well as the façade and glazing design

Mechanical System Overview:

FDA Building One receives conditioned supply air from three air handling units (AHU's). The first of the AHU's (OAHU-1) is strictly providing 100% outside air to the peripheral office spaces, the AHU supplying the security pavilion and VAV boxes serviced in part by the third AHU; sized at 5,300 CFM with an energy recovery wheel. The AHU servicing the security pavilion (AHU-2) is provided at constant volume, sized at approximately 7,300 CFM with reheat. The AHU servicing conference rooms and interior areas (AHU-1) through VAV and CAV boxes as well as Dual Duct Air Terminal Units, sized at 19,000 CFM with pre-heat. Two-pipe fan coil units (FCU's) are used in both the electrical closets and telecommunications closets, as well as around the perimeter in private offices.

The building is a part of the larger campus which is serviced by a Central Utility Plant containing a co-generation plant, chillers, boilers, cooling towers, etc. This is in part of an energy saving strategy, in conjunction with reliability concerns, to provide the entire campus with electricity, heating and air conditioning. The utility plant will be able to monitor loads amongst the various buildings and size up or down the supply of utilities based on the demand loads. In this manner, the utility plant itself can function with utmost efficiency, allow for redundancy and extreme load scenarios.

Redesign Considerations:

Solar studies of the building will be performed to evaluate the benefits of implementing a photovoltaic collection system on the roof of the building. The roof has an area of 25,000 SF to work with, which is a substantial area that is not being constructively utilized. The energy generated from the photovoltaic panels can be used toward the building's immediate load. Distribution to surrounding buildings will also be considered in cases of excessive generation. The methods learned in AE 456, Solar Thermal Collection systems and design course will be implemented. The use of Engineering Equation Solver and a step by step guide developed in the course will assist in designing a system to fit the capacity of the building given the climate and location.

Having personal rapport with several photovoltaic installation companies, investigation into innovative products will be critical. The financial feasibility and payback will be explored on a realistic basis, taking into consideration local contractor rates. The cost of electricity in the DC Metro area fully warrants such an investigation.

The electricity generated from the photovoltaic panels will be investigated for various uses in the building. Starting small, photovoltaic use for the domestic hot water will be explored. This would eliminate need for large flat plate heat exchangers on the first floor of the building. Individual instantaneous hot water heaters on the floors of the building can be used on a standalone basis. Further use and distribution of electricity will be explored.

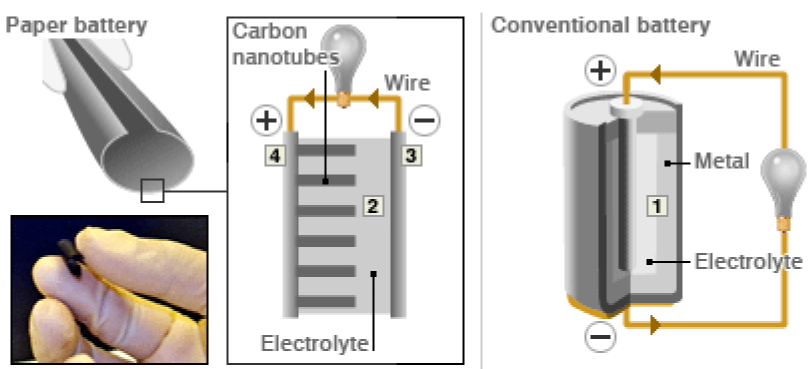
To further utilize the photovoltaic collection system, direct current uses will be evaluated. PV collectors harness solar energy and distribute it in the form of direct current. In typical PV applications, a DC to AC converter is installed to usefully utilize the power generated. The converter is typically a point of high inefficiency and can result in the pitfall of a PV installation. Aside from the inefficiency the converter itself is expensive. To overcome the limitation of a typical system, a direct current approach will be evaluated. Direct current uses can be evaluated for many systems within the building such as computer systems, lighting, fans and security controls.

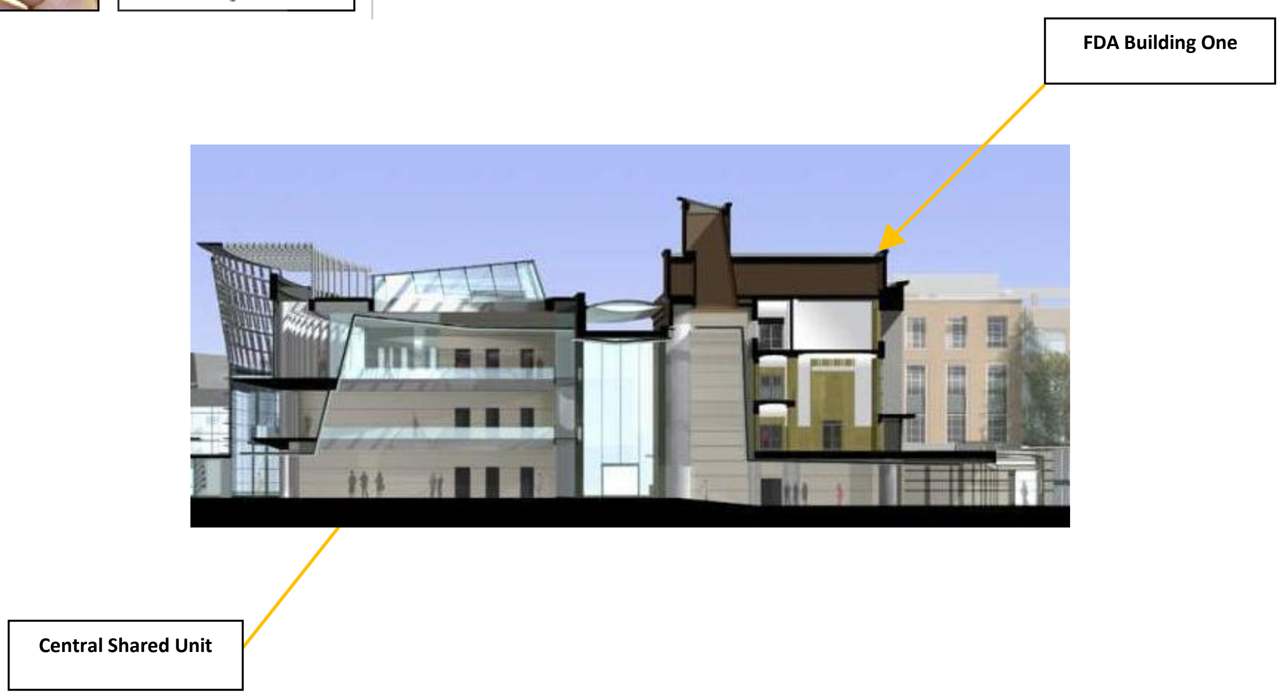
To provide redundancy, a centralized AC to DC converter would be required. The building is already configured for AC from the central utility plant and it would make sense to use it as backup. As seen in previous technical reports building occupancy loads have been a major use of electricity. For the building to utilize energy that it produces would alleviate loads on the central utility plant. To evaluate these applications, general direction from my consultant as well as department faculty will be relied upon. A research into the manufacturers of systems that use DC will be conducted.

Original Construction of FDA Building One

Lastly, an effort to efficiently store energy produced from the PV system will be explored. Thin film battery has been developed by various segments of the industry. University conducted research into manufacturing techniques as well as commercial R&D of streamlining processes has been introduced. One of the major applications of a producer of thin film batteries is embedding it into building insulation. Due to the thin nature of the battery, it can be easily concealed within the walls alongside thermal insulation without losing any efficiency. It would be optimal to store energy generated, rather than use what's needed when available and let the rest go to waste. Another advantage of such a practice would eliminate the need for large floor space to house batteries for storage of energy. The fact that a DC approach is being studied; the use of battery storage and usage would optimize the design.

The constructability of embedding the thin film battery with the insulation will be evaluated. The impact on schedule, cost and possible structural implications will be reported. Cost and performance information of the thin film battery will be solicited from manufacturers of the product. It's a new technology that could revolutionize how we approach renewable energy. It'd be worth exploring due to the fact that this building was renovated in an attempt to showcase a shift in approach for the FDA as well as GSA with emphasis on energy efficiency and alternative energy.





Predictions:

Right off the bat, I'm certainly optimistic of the redesign outcomes. With the building facing southwest, the photovoltaic panels will hopefully be successful. This could be a beneficial appropriation of tax payer funds that are used to operate the facility and campus as a whole. Other buildings on the campus have incorporated some solar harnessing methods or another, which is promising. Utilizing DC would greatly increase the efficiency of lighting, computer and security control systems. Further it would possibly reduce the size of the equipment such as pumps and fans as required by the MEP systems. The thin film battery application will be the most exciting and possibly the toughest aspect of the project. Not only is the providing of sufficient evidence of a successful application going to be difficult, a fundamental change in design approach will need to be accepted by the jury. After that, I'm sure that many positive outcomes will be demonstrated. The overall goal of this proposal is to take a building system that is already efficient and be able to elevate the building as whole to a level worth remarking.

Preliminary Research:

Topics included in this proposal have been a culmination of brainwaves from topics learned throughout Architectural Engineering coursework. My AE advisor contributed as an initial catalyst and I'm thankful for that. Many useful references have been made available for the in-depth study of the proposed topics. These include previous technical reports, graduate dissertations, engineering journal articles and ASHRAE handbooks. A continuous effort will be made to secure design documents from the engineers involved in the project. Short of that, conversations with design team will suffice. As already mentioned guidance from faculty will be critical and solicited every step of the way. In addition to the heavy reliance from manufacturing data required for the new systems proposed.

FDA Building One

Spring Thesis Schedule

R. Andy Pahwa

Mechanical Option

Advisor: Freihaut/Eplee

Milestone 1	Milestone 2	Milestone 3	Milestone 4
1/28/2011	2/18/2011	3/4/2011	3/25/2011

1/3/2011	1/10/2011	1/17/2011	1/24/2011	1/31/2011	2/7/2011	2/14/2011	2/21/2011	2/28/2011	3/7/2011	3/14/2011	3/21/2011	3/28/2011	4/4/2011	4/11/2011	4/18/2011
									Spring Break				Final Report Due April 7th	Faculty/Jury Presentations	ABET Analysis/ CPEP Update
Research Topics															
Obtain Design Documents															
	Solar Studies														
		Photovoltaic Array Design													
			Obtain Cost Info & Economic Feasbility												
					Energy Model Impact										
			Paper Battery Feasibility												
					PB Construtability										
							Schedule & Cost Impact								
					DC Implementation Studies										
	Revise Proposal						**Equipment Sizing**								
								Utility & Model Update							
										Cost Benefit					
										Finish Designed Systems					
										Finish Report					
												Finish Presentation			

Milestones		Deliverable
1	28-Jan	Completed Solar Studies and PV array Design
2	18-Feb	Updated Energy Model, Paper Battery Feasibility Studies
3	4-Mar	PB Constructability & DC Implementation Plan
4	25-Mar	DC Impact on Eqpt Sizing & Cost Benefit Analysis

Legend
Mech Depth
CM Breadth
Elec Breadth

References:

-KlingStubbins w/ RTKL. Architectural Construction Documents. Washington, DC

-ASHRAE Handbook of Fundamentals

-White Oak Laboratory Alumni Association: http://www.wolaa.org/historical_preservation.html

-Practicing Mechanical Engineer's LEED expertise

- Solar Engineering of the Thermal Processes by Duffie Beckman

- Heating, Ventilating, and Air Conditioning by McQuiston, Parker, Spitler

-Paper Battery Co: http://www.paperbatteryco.com