

STENGEL HALL – ACADEMIC CENTER FOR EXCELLENCE

Linden Hall School for Girls
Lititz, Pennsylvania

THESIS PROPOSAL

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Mechanical Option
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Stengel Hall – Academic Center for Excellence is an essential building for the Linden Hall School for Girls in Lititz, PA. The current renovation and addition has overcome many unforeseen obstacles. The new mechanical system is comprised of outdoor split system units, high efficiency boilers, and several fan coil units throughout the building. This system is replacing the existing steam heating and window air conditioning units. The renovated mechanical system will greatly increase the comfort and controllability of Stengel Hall, however, there is potential for this building to become more sustainable.

Since Stengel Hall is only one of several campus buildings and all of the buildings operate on their own mechanical system, further investigation will be done to determine the loads of the other campus buildings and incorporate them into a new design. The proposed redesign will focus on increasing the sustainability of Stengel Hall alone as well as the rest of the Linden Hall campus. Both ground-source heat pumps and biomass energy will be extensively researched to determine the feasibility and benefits for the Linden Hall School for Girls. This will include sizing of the system, analyzing life cycle costs, and determining payback periods for each option.

Additionally, the impacts that both of the proposed systems will have on construction will be investigated as part of a breadth. The other required breadth will draw conclusions on how the redesign will affect the electric usage for Linden Hall. Lastly, seeing as Linden Hall currently has five electrical service entrances, the electrical breadth will determine it is in the interest of the school to reduce the number of electrical service entrances to obtain a better rate.

EXISTING SYSTEMS

The current mechanical design for Stengel Hall is comprised of five outdoor split system units and four high efficiency boilers. These systems will replace the existing steam heating system and provide air conditioning to the entire building. The terminal air distribution consists of several energy recovery ventilators and fan coil units providing conditioned air to the occupied building. Due to the severe space limitations ducts needed to be run as directly as possible to the space. The final design resulted in a constant volume system with twenty-eight fan coil units ranging from 1.5 tons to 5 tons located in the basement, attic, and within several mechanical closets on the second and third levels. These units provide ventilation air at minimum of 15 cfm/student at the school's request and adhere to the standards set by ASHRAE 62.1 and ASHRAE 90.1.

However, Stengel Hall is just one of several buildings that make up the Linden Hall School for Girls. The entire 47-acre campus is comprised of two classroom buildings, gymnasium, equestrian facility, admissions office, student lounge, library, dining facility, and three residential buildings. Most of the buildings are somehow connected or are in close proximity to one another with the exception of the gymnasium and equestrian facility (seen in Figure-1 to the right). Each building currently has a separate mechanical system and each system varies in the type of equipment.

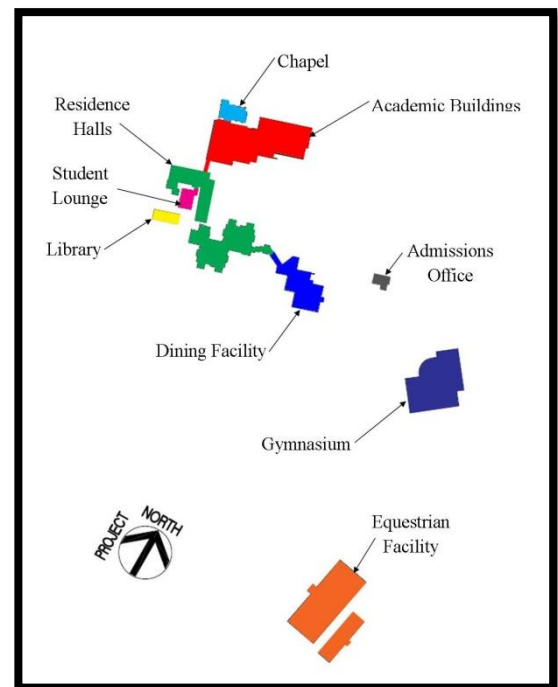


Figure-1 | Linden Hall Campus Buildings
Drawings provided by Chambers & Associates

Alternatives Considered

The current mechanical system meets the needs of Stengel Hall and will provide a much more comfortable atmosphere for learning. However, the system selection was driven by cost and the system with the lowest first-cost was selected. There is great potential to increase sustainability in the renovation and addition to Stengel Hall and the entire campus.

Due to the space limitations of Stengel Hall there are very few alternatives for air distribution within the building and the current terminal unit design is probably the best solution for the school. Therefore, the area that has the most potential for improving the efficiency is at the source of the heating and cooling. Both geothermal and biomass systems have been successful in other Pennsylvania schools and the Linden Hall campus could potentially benefit from these new developments.

Geothermal systems have become increasingly popular for schools because schools typically have land available for geothermal piping. Linden Hall does have space available for such piping within proximity to Stengel Hall and surrounding buildings. The system would drastically change the energy needs of the school and provide a much more sustainable source of both heating and cooling.

The Lititz Borough Historical Area Advisory Committee has strict regulations on many of the buildings on the Linden Hall campus including Stengel Hall. The façade must resemble that of the existing building and new construction must conform to the same size, shape, orientation, color, etc. Therefore, any exterior units must be carefully placed and also approved. There are parts of the Linden Hall campus that are not under quite as strict historical review and these areas are mostly used as athletic and equestrian facilities for the school. These areas provide an opportunity not only to place geothermal piping but also place a small structure to house additional equipment that would be necessary in a biomass system.

By implementing a biomass system the school will be able to use renewable energy such as wood or local farm waste to generate heat and electricity. This type of system is also becoming popular for schools because of the scalability of the system. Each system is designed to meet the needs and goals of the client.

An additional benefit of implementing new technologies into a school such as Linden Hall is the educational value it adds for the students. The addition and renovation of Stengel Hall include a green roof that will be as a learning tool for students. A biomass system or geothermal system will definitely provide the same kind of opportunities.

Proposed Redesign

The overall goal of the proposed redesign is to provide a more sustainable and maintainable mechanical system for Stengel Hall and the Linden Hall School for Girls. As per a facility study of the Linden Hall campus, one of the considerations of the school is to have a campus-wide heating and cooling system. A campus-wide system could potentially reduce maintenance costs and provide a more efficient system. Both the geothermal system and biomass system will be researched to evaluate the feasibility and efficiency for the Linden Hall School for Girls. This main evaluation will not only include a redesign based on the demand of Stengel Hall but address the school's goal of creating a campus-wide heating and cooling system.

This redesign will require load calculations to be conducted for the other buildings on the Linden Hall campus. These loads will be used in addition to the loads already calculated for Stengel Hall to size the potential systems.

Both of the proposed systems are more advanced than the existing systems at Linden Hall and therefore particular attention will be given to the maintainability of the systems during analysis. A complete life cycle study of both systems will be conducted to compare the maintenance costs, operating costs, energy savings, and overall benefit for Linden Hall. This study will serve as the main tool for determining if either a geothermal system or biomass system would serve as a feasible solution for the needs of the campus and Stengel Hall.

Lastly, the added electrical loads and construction for either of the proposed systems will be evaluated as breadth topics.

Construction Breadth

The construction process would drastically be affected by either of the proposed mechanical systems. A further investigation of the impacts on the construction schedule and added costs will be conducted to fully evaluate the feasibility of either a geothermal system or biomass system.

The biomass system will require an entirely separate building to house additional equipment; an added expenditure that will play a heavy role in the viability of this system. Additionally, the Linden Hall School's schedule will play a heavy role on the flexibility to the construction schedule.

Electrical Breadth

The proposed mechanical systems will introduce additional equipment to Stengel Hall as well as eliminating the need for some of the existing equipment. A study will be conducted researching how the proposed changes will affect the electrical needs of Stengel Hall. Calculations will be done to determine if the existing electrical distribution equipment is able to handle the additional equipment load, if it is insufficient new distribution equipment will be selected.

Additionally, the existing electrical service for the campus is comprised of five service entrances. Analysis will be performed to determine if the campus could efficiently operate with fewer service entrances. This could potentially lower the electric rates charged by the power company and save the school money. To do this, the electric bills for the Linden Hall campus will be utilized to determine the demand and the PPL rates for varying demand levels and electric uses will determine if there is any potential savings.

Energy Simulation Programs

To evaluate the demand and loads on the other Linden Hall Campus buildings simple DesignBuilder models will be created for evaluation in EnergyPlus. DesignBuilder is a program already installed and provided to students on most of the AE Computers used as an interface between design and energy simulation. EnergyPlus is a free program provided by the US Department of Energy used to run energy simulations.

Linden Hall School for Girls – Facility Study Report

This document provides a detailed description of the needs of the school and the existing conditions. All of the mechanical systems for the campus buildings are included and will provide the needed information to evaluate the feasibility of replacing the existing systems on buildings other than Stengel Hall.

Local Businesses

Contacts with local business that specialize in biomass systems have been provided by Chambers & Associates; the architect for the Stengel Hall project. AFS Energy Systems, located in Leymoine, PA, will be contacted for information and assistance with biomass systems design.

PPL Electric – Rates and Tariffs

The rates and tariffs of PPL Electric will provide valuable information on the feasibility of reducing the service entrances on the Linden Hall Campus.

Geothermal Research

To gain a foundation understanding of ground source heat pumps the information provided by the U.S. Energy Information Administration has been utilized. This online source explains the uses of geothermal energy, the environmental impacts, geothermal power plants, and geothermal heat pumps.

"Geothermal - Energy Explained, Your Guide To Understanding Energy." *U.S. Energy Information Administration (EIA)*. 20 May 2011. Web.
<http://www.eia.gov/energyexplained/index.cfm?page=geothermal_home>.

Biomass Energy Research

The following publications aid in the understanding of the feasibility of using biomasses to produce energy. The first source explains the available biomass sources, how energy is produced, biomass energy potential, and the associated risks of using biomass energy. The second source is a presentation that outlines the availability of biomass products, and incentives available for using a biomass system.

"How Biomass Energy Works." *Clean Energy*. Union of Concerned Scientists, 29 Oct. 2010. Web.
<http://www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-biomass-energy-works.html>.

Patton-Mallory, Marcia. "Energy: Why Biomass?" Biomass and Bioenergy Coordinator, US Forest Service, Dec. 2007. Web. <<http://www.afsenergy.com/images/PDFs/US%20Forest%20-%20Why%20Biomass.pdf>>.

PROPOSED SCHEDULE

