# The Ed Roberts Campus

## Proposal

Anderson Clemenceau
Mechanical Option

Advisor: Donghyun Rim

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# Executive Summary

This report will outline the alternative designs being proposed for the Ed Roberts Campus in order to improve energy performance and reduce the annual cost of operation. To be clear, the ERC does meet or exceed all codes and requirements and is equipped with an effective mechanical system that operates effectively. This academic exercise will be to compare and contrast two different systems.

When assessing design alternatives for the building, it was important to consider what other systems the proposed change would affect. In addition, what benefit could result from the change? The costs associated with implementing the change and operating the new system must also be considered. With these questions in mind, the decision was made to investigate the implementation of an airside economizer in the ERC's mechanical system. Currently, the building does not utilize any return air and there could be great potential for savings with the use of this system. Checks will be performed to ensure that other systems will remain operational with this change. Additionally, special checks will be performed for indoor air quality with the introduction of recirculated air.

The breadth topics that will be investigated include an architectural and electrical analysis, and go beyond basic checks performed in the depth assessment. The purpose of the architectural breadth is to investigate the effects on the building resulting from the rerouting of duct work in order to supply return air to the AHUs. The purpose of the electrical breadth will be to investigate the installation of an occupancy sensor system for the lighting and mechanical systems in each zone of the building for potential energy savings.

The tools required for these assessments include energy modeling software, such as eQuest and Trane Trace, and the computation software, Engineering Equation Solver (EES). Finally, a spring work schedule is attached to plan workflow throughout the semester. It includes milestones to monitor progress toward the completion of the project.

# Building Overview

The Ed Roberts Campus is a 2-story, 80,000 sq. ft., transit-oriented community center located in downtown Berkeley, California. The campus is connected to a BART Station (Bay Area Rapid Transit) and is designed with a focus on accessibility for people with disabilities. Completed in 2011, the ERC is home to exhibition spaces, meeting spaces, a child development center, a fitness center, vocational training facilities, and offices.

Every square foot of the building is designed far and above the requirements of the Americans with Disabilities Act through a design concept called "Universal Design". Universal Design aims to create environments that are useful for people of all ages and abilities without additional cost. Extra-wide corridors, automatic doors, two-sided elevators are examples of this design ideal. In addition, the ERC's fully accessible connection to the BART station works to connect people directly to airports and bus stations around the city.


**Leddy Maytum Stacy Architects**

# Existing Mechanical System

## Airside Equipment

The airside equipment for the building includes five Air Handling Units, 59 zone-level water source heat pumps, and nine exhaust fans. AHU-1, AHU-3, and AHU-4 are constant volume units. AHU-1 serves the south end of the east wing and supplies 7,800 cfm. AHU-3 and AHU-4 serve the South and North, respectively, ends of the western wing, and supply 3,500 and 6,000 cfm of airflow. The final two air handling units utilize fans with Variable Frequency Drives, and thus supply varying volumes of air to the space. AHU-2 supplies the BORP office area with 5,500 cfm of air, and AHU-5 serves the courtyard area with 5,000 cfm.

| AHU | Area Served | % Outside Air | CFM |
|---|---|---|---|
| AHU-1 | East Wing - South | 100 | 7,800 |
| AHU-2 | BORP | 100 | 5,500 |
| AHU-3 | West Wing - South | 100 | 3,500 |
| AHU-4 | West Wing - North | 100 | 6,000 |
| AHU-5 | Covered Court | 100 | 5,000 |

Water Source Heat Pump units manufactured by McQuay meet most of the cooling and heating loads of the building. The zones of the building are served by one of the following types of heat pump, based on the load requirements of the space, and there were a total of 59 units at design. Each unit contains one water coil for both heating and cooling needs. Each unit also contains one supply fan.

Since the ERC utilizes a 100% Outdoor Air system, all air is exhausted by nine fans that serve different areas of the building. Exhaust Fans 1, 3,4,5, and 7 serve the BORP Office and other general office spaces. EF-2 serves restroom exhaust requirements. The largest fan, EF-6, serves the entire basement level parking garage with 72,000 cfm of airflow. The remaining fans serve smaller electrical, elevator and garbage rooms.

## Cooling and Heating Equipment

The cooling plant of the ERC's mechanical system is comprised of two rooftop cooling towers. Chilled water is used to supply the water coils in AHUs 1-4, all 59 of the zone level water sourced heat pumps, and the three zones of radiant flooring. The heating plant is made up of two boilers within the rooftop mechanical room. Hot water is supplied to water coils in all five AHUs, zone level water sourced heat pumps, and radiant flooring.

More detailed descriptions of this equipment and other related components can be found in Technical Report 3.

# Proposed Alternatives

The following is a list of options that were considered as possible areas of investigation for the Ed Roberts Campus. It is important to note that while alternatives are being suggested, they are not suggesting that the current design is inadequate in any way. This is an academic exercise in energy use of different mechanical systems.

1. Implementation of on-site renewable energy sources
    a. Solar Panels for electricity or hot water demand
    b. Potential for utility cost savings and life cycle payback
2. Use of all Packaged Rooftop DX units
    a. Potential savings in water use
    b. Investigate potential energy savings
3. Use of an economizer for the airside system.
    a. Investigate free cooling potential
    b. Utility bill savings from reduced operation
    c. Potential to downsize system for energy savings

Each of these alternatives would offer different challenges and insights. For the purposes of time and scope of the thesis project, one must be selected. Renewable on-site energy would be a viable option, but might not provide enough areas of investigation for the project duration. Geothermal hot water was considered an option, but lack of space would limit its effectiveness. Option 2, packaged rooftop DX AHUs, would be viable but it might not be enough of a change to provide significant comparison. For these reasons, Option 3 appears to be the best choice for this thesis proposal.

## Depth

### Airside Economizer

For this portion of the thesis project, the implementation of an economizer for the airside system will be investigated for possible energy savings in the Ed Roberts Campus. At current state, the mechanical system of the ERC does not utilize any kind of return air. It would be worthwhile to compare the current building to one that does use an economizer, and it may give some insight on the reasoning behind the original design.

### Potential Impact

If this system is implemented, I think there is potential for energy savings. Initial research suggests that free cooling could be used during large portions of the year in this climate zone. At very least, it will be a useful educational exercise to compare the energy use of this kind of system to the actual energy use of the current building. I would like to investigate the possibility that taking advantage of free heating and cooling could lead to potential downsizing of equipment, including the zone level Water Source Heat Pumps.

Any effects on indoor air quality, resulting from recirculating air, will need to be investigated due to the sensitivity of the building occupants. Effects of humidity will be explored to determine if recirculating air will require extra humidity control measures.  This change should have minimal impact on other building systems. However, checks will be performed to ensure that those systems remain in tact.

# Breadth

## Architectural Breadth

Since much of the exhaust ducts were never intended to be routed back to the air handling units,  there could be some significant impacts on the architecture of the building if return air ductwork was installed. Therefore I will investigate the impacts of this return air ductwork as it relates to ceiling space and shaft space.  It is possible that

## Electrical Breadth

This portion of the breadth investigation will be to design and implement an occupancy sensor system for the lighting, as well as occupancy control for the mechanical systems which is commonly called Demand Control Ventilation.  This would replace the current control systems the building has in place, which were time-of-day control for lighting and zone thermostat control for mechanical systems.  I think it is would be possible to save additional energy with this system in place, and reexamining the electrical systems with the new mechanical systems would be a valuable academic exercise.

# Tools

There are a variety of tools that will be required to fully analyze the proposal I have set out to complete.  An energy modeling program, eQuest, will be used to calculate the energy use of the current and proposed mechanical systems of the ERC.  Trane Trace has been used in the past but proved to be problematic with the current building mechanical system setup.  If more detailed calculations are deemed necessary, Trane Trace will be used because of the added detail it provides over eQuest. In addition, these programs will be used to calculate the economic effects of the proposal.  Calculations may also be performed using Engineering Equation Solver (EES).

# Research

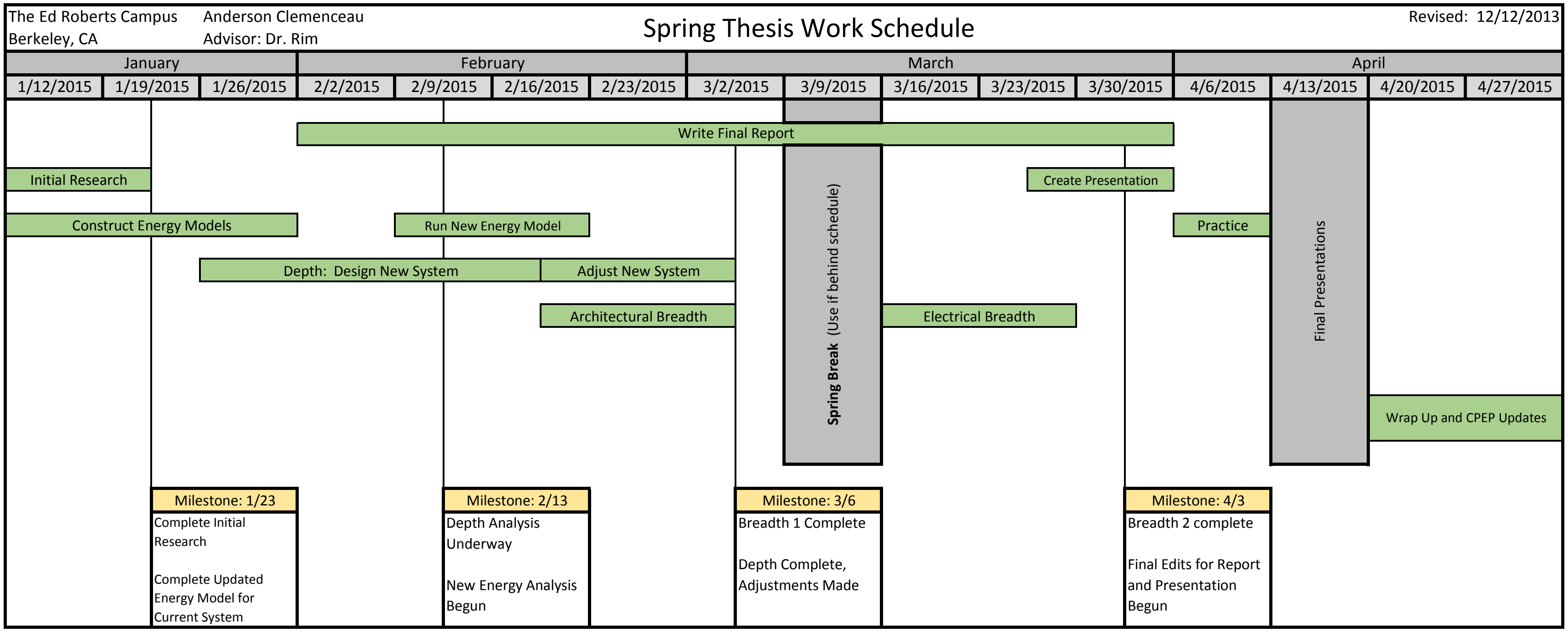
## Depth – Airside Economizers

Taylor, Steven. "Select & Control Economizer Dampers in VAV Systems." *ASHRAE Journal*(2014). Print.

ASHRAE 2009 Fundamentals Handbook

## Breadth

"Lighting Controls." *Energy.gov*. 29 July 2012. Web. 11 Dec. 2014. <http://energy.gov/energysaver/articles/lighting-controls>.



The Ed Roberts Campus
Berkeley, CA
Anderson Clemenceau
Advisor: Dr. Rim
Spring Thesis Work Schedule
Revised: 12/12/2013
January
February
March
April
1/12/2015
1/19/2015
1/26/2015
2/2/2015
2/9/2015
2/16/2015
2/23/2015
3/2/2015
3/9/2015
3/16/2015
3/23/2015
3/30/2015
4/6/2015
4/13/2015
4/20/2015
4/27/2015
Write Final Report
Initial Research
Create Presentation
Construct Energy Models
Run New Energy Model
Practice
Depth: Design New System
Adjust New System
Architectural Breadth
Electrical Breadth
Spring Break (Use if behind schedule)
Final Presentations
Wrap Up and CPEP Updates
Milestone: 1/23
Complete Initial Research
Complete Updated Energy Model for Current System
Milestone: 2/13
Depth Analysis Underway
New Energy Analysis Begun
Milestone: 3/6
Breadth 1 Complete
Depth Complete, Adjustments Made
Milestone: 4/3
Breadth 2 complete
Final Edits for Report and Presentation Begun