# FAMU-FSU College of Engineering

# Department of Electrical and Computer Engineering

# Project Proposal and Statement of Work

# EEL4911C – ECE Senior Design Project 12

Project Title: Energy Management

Team #12

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Submitted in partial fulfillment of the requirements for

EEL4911C – ECE Senior Design Project 12

# Project Executive Summary

FSU is one of the largest universities in the country. With any institution, there are many costs associated with running and maintaining it. One fee that might get pushed to the back of the mind deals energy costs. FSU spends close to $30 million a year on energy costs. The design team was asked to help reduce this cost by implementing a Demand Side Management (DSM) system in two buildings on campus: Dirac and Shores. The design team will employ various methods found in DSM implementations throughout the world. The end goal is to have a final project that can be installed and used which mitigates the cost of the installation and parts in a reasonable period of time and then saves the university money all costs have been accounted for.

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# 1 Introduction

## Acknowledgements

The design team would like to thank Dr. Omar Faruque and Mr. Jim Stephens for their contributions so far to the project. These individuals have given the team much needed guidance and instruction on various aspects of the project. Mr. Stephens is supplying the team with the funds. The team would also like to thank the University for allowing the use of two buildings for our project implementation.

## Problem Statement

This project is to design, implement, and evaluate a demand side management program for two large buildings on the Florida State main campus. This project will collaborate directly with the FSU Utility department in order to implement a solution that will be able mitigate the demand of power for the buildings mostly during the peak energy usage times. The main goal of this project will be to create a design specifically tailored to each building that will be able to substantially lower energy use not only during peak demand, but possibly have an energy use average that is lower than the current average.

The number one priority of this project is to reduce the energy costs associated with running the University. The University as a multi-million dollar annual budget for the utility bill associated with electricity. The University is looking into ways to shave this bill down. The utility tariff that FSU is currently on must be taken into account when designing the Demand Side Management system. The design team has been tasked to implement a DSM scheme in two buildings on campus: Dirac and Shores. There are a few items that must be considered: critical loads in each building, the current systems implemented in the buildings along with the systems’ capabilities, and a way to capture and store relevant data.

There are a few different techniques that can be employed to decrease the overall energy use throughout the two buildings. Using the existing Siemens system in place, there are many different ways to approach a solution. The system can be used to control various loads that are in the building such as water pumps and large ventilation fans. Other loads that can be included in the system could be classroom components, computers, and vending machines. Other non-central solutions can also be employed such as motion activated lighting. Solar panels could also be a possible option for mitigating peak demand during the day. The Siemens system uses Power Process Control Language (PPCL) for programming the different functions of the DSM design.

## 1.3 Operating Environment

Some of the existing components of the Siemens system are housed in the same rooms as the water pumps and the air handlers. This is a dry room that is weather protected and stays a steady temperature throughout the year. Any equipment placed throughout the building will be in a climate controlled environment. If solar panels turn out to be a viable option, the equipment needed to convert, store, and invert will need to be in a weather protected housing. The team will ensure that all products implemented are stored in their recommended operating environment.

## Intended Uses and Users

The DSM design will contribute to cost savings in the utility cost aspect of running the university. It is intended to reduce the costs attributed to energy usage. It will ensure that the total peak demand charge is lower each month by implementing a DSM design in the two buildings chosen. The system will have the capability of monitoring and recording data such as energy usage throughout the day, temperature in the different rooms and spaces, and possibly CO2 levels throughout the building.

This system will be maintained by people with the proper experience and the end user/implementer will be a knowledgeable engineer with experience with the FSU Siemens system. There will be no one working on the system without the proper authority or know-how.

## Assumptions and Limitations

Assumptions: The first assumption the design team has had to make is that the tariff rate FSU is currently on will not change its basic structure. The rates may go up; however, this should not affect the design at all. When writing a program, the writer usually assumes that the data received is correct. This is not always the case. For example, a temperature sensor could constantly read 75 deg F or could read 100 deg F. The program will make assumptions based off of the readings at the given time even if they are incorrect. Any issues similar to this must be fixed as quickly as possible.

Limitations: There are quite a few limitations that must be considered. For starters, the buildings environment must be maintained. The users of the building want a nice, comfortable environment to work and learn in. There are limitations in the sector of solar viability for this project. The university gets a 7.5% discount on the energy bill for using Tallahassee Utilities exclusively. The cost of buying and implementing solar must be negated by the cost saving attributed to reduced energy consumption. Another limitation is the supercomputer in the Dirac building. This computer is often making computations for various scholars at the university and is considered a critical load. Not only does the supercomputer have to remain properly powered, but the room it is housed in must have the proper temperature and ventilation.

## Expected End Product and Other Deliverables

The end product will be a system that adapts to a given set of inputs and mitigates the peak demand on a daily bases to reduce the costs attributed to energy use by the university. This design will ensure that no critical loads are affected and that the Quality of Life in the buildings will be maintained.

# 2 Concept Generation

## 2.1 Variable Frequency Drives

Variable frequency drives can be used in a wide array of applications when it comes to demand side management. A synchronous motor’s speed is determined by the frequency of the alternating current supplied to it, given by:

Where is the speed in revolutions per minute of the motor, f is the supply frequency (60 Hz for most American applications), and n is the number of poles on the motor. Additionally, there are Affinity laws for pumps that relate the variables for pump performance such as shaft speed, head, and flow rate to the power consumption and capacity for the pump. These laws state that running a motor at 50% of its full speed can reduce the power consumption by 12.5% of the full power. Since the motors used in the air handlers, water pumps, and supply fans are some of the main consumers of energy for the two buildings, installing variable frequency drives and regulating the speeds of these motors based on the demand is one of the most effective ways to respond to the peaks in consumption. Virtually all of the motors in the Dirac library have variable control, so this building would only require the system to control the speeds for these mottos throughout the course of the day. However, the Shores building contains mostly fixed speed motors, so there would need to be an upgrade to the existing system in order for this option to be implemented. However, for a 40 horsepower motor, of which there are two in the Shores building, the power consumption running at full load would be approximately 30 kW. This means that a 30% reduction for one of these motors would result in a 9 kW usage reduction. Assuming that the reduction would occur for two hours during the peak times each day, this would result in a reduction of over 6,500 kWh per year.

### 2.1.2 Taco-HVAC Advantage 61

Features:

Under load and overload detection and alarm.

Low flow detection.

1 to 900 HP 3-phase 380-480V.

Graphic screen with customizable display.

Optional application card for multiple pump system control.

Continuous, real-time display of operating parameters of the motor.

Using a variable speed AC drive such as the Taco-HVAC Advantage 61 would allow for the motors in either building to be controlled both in the mechanical rooms and from the central utilities plant. The graphic display simplifies the user interface and can be programmed for different modes of operation. This device could also be interfaced with the existing Siemens system to allow for remote control of motor speeds from the central utilities plant. Using a variable speed drive also provides a one size fits all approach to regulating pump speeds in that it can be used with motors ranging from 1-900 HP, which covers all of the pumps that would need to be modified.

## 2.2 Load Scheduling

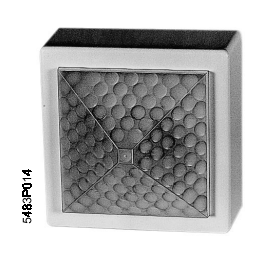
Currently, the buildings proposed for the project have some levels of load scheduling that can be improved upon in order to reduce the overall energy usage. For instance, the schedule currently employed for the Dirac library has the air handling units running 24/7, even though the building is generally closed between the hours of 1-8 AM. During these times there is a reduction in the demand placed on the building due to its lack of occupancy. Therefore, rather than running equipment such as the air handlers and outlets providing power to the computer labs during this time period, it would be beneficial to develop a schedule that could create a standby mode when the building is unoccupied. Since there is an existing scheduling system that deals primarily with the HVAC equipment, it would be relatively simple to modify the program to implement a new schedule. The existing system also means that the cost to implement this option would be negligible due to the fact that most of the required monitoring systems and equipment are already in place. This option for scheduling would be most beneficial for the Dirac library due its current setting of running at occupancy levels on a 24/7 basis. Reducing this to more accurately reflect the actual usage of the building would allow for a reduction of power consumption and could open up possibilities for peak shifting through diverting the energy that would have otherwise been used into storage. The Shores building on the other hand already has a schedule controlling the equipment usage, so implementing this option would have a lesser effect. The current schedule has the air handlers operating between the hours of 6:30 AM - 6:00 PM so that the load will be reduced during the nighttime when the building is vacant. However, there could still be a way to refine the current schedule to control additional loads or create a more accurate representation of the occupancy levels throughout the day.



Current Shores AHU Schedule

In order to refine the schedule for each of the buildings, it would be beneficial to install occupancy sensors to collect accurate and detailed data on the usage of the buildings. This can be done through the traditional motion sensor that is commonly used for lighting applications, or can be implemented by using carbon dioxide sensors mounted in either the individual rooms or in the return air ducts. These are commonly used in ventilation systems to determine the amount of fresh air required when regulating supply fans to reduce demand. These sensors provide the necessary data to monitor the effects of reducing fan speeds on the indoor air quality, and also give a good representation of the amount of people inside of the building.

### 2.2.1 Motion Sensors - Siemens Presence Detector QPA82.2

Installing a motion detector such as the one depicted can be beneficial for monitoring the activity in a certain room or corridor, and can be used to control either the lighting or HVAC systems serving those areas. This motion detector uses microprocessor based passive infrared to detect very subtle changes in movement. This high level of sensitivity can be used even in classroom or study area environments where students would be seated for extended periods of time. The time delay for turning off lighting or equipment can also be varied from 5 minutes in areas where there is a heavy flow of traffic like hallways, up to 15 minutes for more idle areas such as lecture halls to prevent the lights from turning off while the space is still occupied. Implementing these sensors allows for a demand-dependent control of lighting and HVAC as opposed to the fixed time schedules already in place. Due to the detection area however, it would be necessary to have multiple sensors installed in the various hallways and lecture halls for these buildings in order to fully cover the spaces that were being monitored. Most readily available motion sensors will have the option to be either ceiling or wall mounted so installation space does not pose much of a concern.

### 2.2.2 Wall Mounted CO2 Sensors - Siemens QPA2000

Another option for detecting whether certain rooms are occupied is to use wall mounted CO2 sensors. These sensors can provide a room by room analysis of the carbon dioxide concentration. One of the main advantages to this implementation is that measuring the demand for the rooms using CO2 also provides an air quality analysis along with determining if the room is occupied or not. This lets the user know whether or not the air quality standards are being maintained when supply fans are running at reduced capacities and can measure levels ranging from 0 to over 2000 parts per million. These sensors can also measure environmental variables such as the temperature and humidity in the building, and come with the option for a display on the sensor for real-time analysis from within the area it is serving. These sensors tend to be slightly cheaper than using a duct mounted sensor, but it would be necessary to install a larger quantity throughout the building in order to cover all of the necessary spaces. While this option would most likely be the more expensive route when considering using CO2 sensors, it would give a more accurate representation of the individual rooms or areas of detection than using a duct mounted sensor due to having multiple detectors covering smaller areas.

### 2.2.3 Duct Mounted CO2 Sensors - Siemens QPM2100

The alternative option for using CO2 sensors would be to install duct mounted sensors. While these would not provide the level of detail obtained from having a wall mounted sensor in each individual room, the cost to purchase and install them would be quite a bit lower. The cost per sensor is higher than using the wall mounted style, but implementing this option would require fewer overall sensors. Rather than having multiple sensors for each area of detection, one sensor could be placed in the return air duct for each floor to provide an overall picture of the air quality for the building. In cases such as the library study areas where it is likely that the occupants will be dispersed among the area fairly evenly, these sensors would still provide an accurate reading of the CO2 levels, duct air temperature, and duct air humidity. This allows for a reduction in the cost for implementation in areas where there are not extreme highs and lows in terms of level of occupancy.

## 2.3 Thermal Storage

The idea of using thermal storage is another option to be considered when looking into DSM strategies. Using some form of thermal storage would help with peak shifting by using slightly more load during the off-peak hours in order to curb the usage when demand and prices are high. One example of this that has already been implemented at the AME building near the College of Engineering is the use of chilled water storage tanks. Installing these tanks provides the ability to store chilled water during off-peak hours when the energy cost is low. Once this water is stored, it can then be used to supplement the air handlers during peak hours to reduce the amount of supply cold water being used. In a scenario where one of these tanks would be installed, it would be necessary to calculate the flow rate during the peak hours for the building in order to determine the capacity needed depending on how long it is desired to supplement the water usage. For example, the Dirac building averages a water usage of approximately 200 gallons per minute under normal conditions. Assuming that during peak times this increases by roughly 15%, this creates a 30 gpm peak in usage. Since the peak occurs for roughly two hours on a daily basis, the required capacity to offset this peak would be 3600 gallons. This value could be altered to increase or decrease the amount of water supplemented, or to alter the length of time the tank would be used. The main limiting factor for this option would be the space concern. If the buildings were separated from main campus this would not be an issue, but since space is limited the available areas would need to be analyzed to determine if a tank could fit without a major disruption to the flow of foot or vehicle traffic in the area.

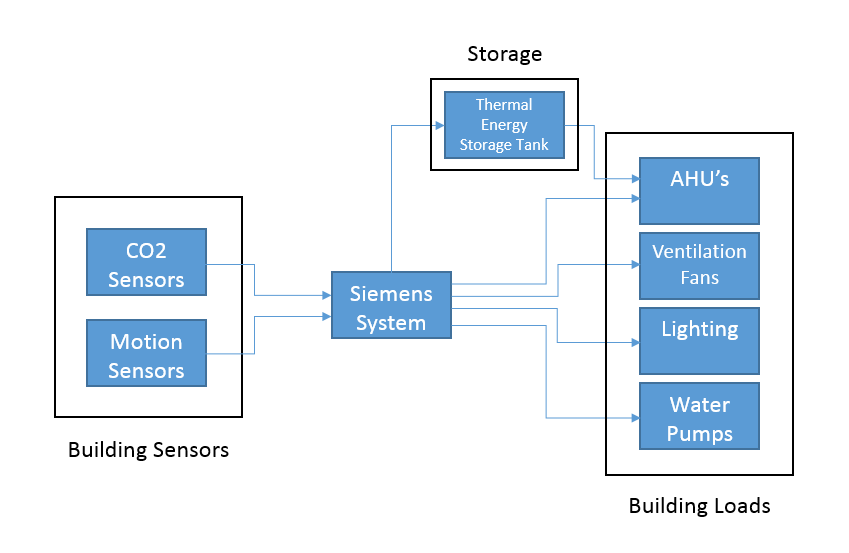
## 2.4 Lighting Renovation

Another option available for overall power reduction in the two proposed buildings would be updating the lighting throughout the inside and outside of the buildings. This is a way to reduce not only the peak, but also the energy usage during off-peak hours. Most of the current fixtures are using fluorescent bulbs, which use approximately 25 W per bulb. In a three bulb lamp this translates to a 75 W usage if the lamp is fully on. There are currently available LED replacement tubes that can produce a comparable light output while using approximately 18 W per bulb. This means that for every three bulb lamp there would 21 W reduction per lamp. Assuming roughly 1000 lamps per building, this would result in a 21 kW reduction assuming mainly three bulb lamps or 14 kW reduction assuming mainly two bulb lamps. This reduction would affect both the peak and off-peak hours and generally lower the load on the building. It is safe to assume that not all of the fixtures in the buildings will have three bulbs, so the actual reduction would fall in the mid-teens kW range. However, due to the current costs of LED bulbs, this option may not be suited to immediately take effect. Rather than going through the buildings and demolishing the existing lights to replace with newer ones, it may be a better strategy to implement this as the current fixtures reach the end of their life cycle. Delaying the implementation of this option also allows for technological advancements to either lower the price of the LED bulbs and fixtures or to increase their efficiency. Historically, the price for LED bulbs has been decreasing steadily, so when it comes time to replace the currently installed fixtures with their LED counterparts, the overall length of time required for the savings to recoup the installation cost will be even shorter.

## 2.5 Photovoltaics

The option to implement a photovoltaic system to aid in the peak clipping process was one of the original ideas that came to mind for the DSM project. Using solar generation seems like a good idea due to the fact that the peak production times for a solar system would coincide with the peak usage times for the buildings. In the middle of the day when the buildings are heating up the most would also be the time when the solar array would be getting the most sunlight and generating its peak power. The main drawback for the solar option is the current cost for the technology. Attempting to produce enough energy to offset the peak for these buildings would require at least a 50 kW array, which can cost over $100,000. The expected time required for these arrays assuming they are mainly being used to generate during the peak would be approximately 20 years. In general it is desirable for new technology to be able to pay for itself within less than half of that time period, and the hardware that would be used for the arrays could not be expected to last for two decades without needing repair and maintenance. Therefore, it seems that the current technological capabilities do not allow for the implementation of this option due to the high cost of installation and maintenance. However, as with most technologies solar is constantly becoming more efficient and less costly. While this may not currently be available, it is an option that would be worth evaluating in future assessments to determine if the benefits with newer technology can outweigh the costs.

# Proposed Design



## 3.1 Variable Frequency Drives

### 3.1.1 Overall Design and Methodology

The idea of the variable speed drives is to reduce the speed and therefore energy consumption of the various motors while still meeting all ventilation and cooling requirements for the building. The motors used in various applications throughout the building do not need to be run at full speed at all times. These variable speed drives will be implemented with the Siemens system in order to be controlled properly.

### 3.1.2 Outcomes

The Variable Frequency drives will:

* Allow precise control of the motors in the buildings
* Reduce energy consumption throughout the day
* Enable peak clipping in response to rising demand

### 3.1.3 Contingency Plan

It has been proven to work in other buildings on campus. The energy cost reduction attributed to installing the variable speed drives prove beneficial. If the variable speed drives fail, they will need to be worked on and fixed by a trained technician.

## 3.2 Load Scheduling

### 3.2.1 Overall Design and Methodology

Load scheduling will be implemented through the use of occupancy sensors to determine the usage levels for each building. For this project, the main technology used will be duct mounted CO2 sensors to determine the air quality and occupancy levels for each floor of the buildings. These sensors will provide the necessary data to determine both the current air quality and occupancy levels at any given time. This data will allow for a demand response based schedule as opposed to the current fixed schedules.

### 3.2.2 Outcomes

The load scheduling design will accomplish:

* Reduced energy usage during peak demand
* More accurately measured air quality metric data to better monitor room climate and adjust the ventilation accordingly
* Provide approximation of building occupancy

### 3.2.3 Contingency Plan

In the event that the option to use duct mounted CO2 sensors becomes unavailable, there are a few options that could take its place with comparable performance and cost. Installing wall mounted CO2 sensors would cause an increase in installation cost, but would give a more accurate representation of the buildings occupancy. This technology could also be combined with the use of traditional infrared motion sensors in order to reduce cost while providing occupancy data on an individual room basis.

## 3.3 Thermal Storage

### 3.3.1 Overall Design and Methodology

The thermal storage unit will aid in the reduction of the peak demand by supplying stored cold water to one or possibly both buildings. By storing water during non-peak times and using the cold water during peak times, the energy costs associated with supplying the building with cold water during peak times will be negated for a period of time. The cold water will remain stored until the daily peak is approaching. Once the system detects an oncoming peak, the cold water in the storage tank will be used until the peak is over or until there is no more cold water in storage. The cold water storage will be connected to the existing pipeline infrastructure at FSU main campus. The valve and pumps for the thermal storage system will ultimately be controlled by the campus wide Siemens system.

### 3.3.2 Outcomes

The thermal storage system will be able to do the following by the end of the project:

* Consistently reduce the peak demand daily by reducing the areas of energy consumption that deals with producing and pumping cold water.
* Provide enough storage to supply the building(s) with cold water during the peak
* Use the current water cooling system at main campus to supply the thermal storage system

### 3.3.3 Contingency Plan

With some research, it was determined that the thermal storage solution is cost effective to implement; however, there are other factors that must be accounted for such as location for the tank. A similar system is actually being used by a building owned and operated by FSU. If the system is implemented and has a failure, trained technicians will need to service it.

## Lighting Renovation

### Overall Design and Methodology

The idea will be to replace the fluorescent lighting in the two buildings with more energy efficient LED lighting. Philips, along with other companies, make LED tubes that directly replace the lighting fixtures used in almost all of the buildings at FSU. There are a few considerations when looking to replace fluorescent lighting with LED lighting. One way to implement this change is to replace the fluorescent bulbs directly with LED bulbs as the fluorescent bulbs start to go out. There are LED T8 replacement tubes that directly work with the current fluorescent fixtures installed in the buildings at FSU. Another option is to replace the ballasts with new ballasts designed to supply power to LED tubes. These ballasts are also dimmable which allows for further energy savings.

### Outcomes

The lighting renovations will be able to do the following:

* Reduce the total energy usage by the university
* Reduce the peak demand
* Possibly dim an appropriate amount to reduce energy consumption while maintaining proper lighting requirements

### Contingency Plan

With a bit of cost analysis, it was determined that LED lighting is a definite possibility. The difference in price of the LEDs compared with fluorescent bulbs will be offset by the energy savings well within the life expectancy of the LED tubes. This idea can also be implemented in almost all other buildings on FSU campus.

# Statement of Work (SOW)

## 4.1 Task: Project Management

### 4.1.1 Project Manager:

Will be responsible for the overall completion of the design. Patrick’s roles will be to maintain the Statement of Work laid out in this report and hold others responsible for their tasks assigned. This includes keeping the deadlines outline in this report and communicating results with the necessary advisors.

### 4.1.2 Design Distribution

The total design will be split evenly between all team members, with specific members focusing on the specific areas in which their expertise lies.

#### 4.1.2.1

Matthew Streich will concentrate on the implementation of different coding and implementation of design blocks that can be used to optimize the system. He will need to research the proprietary Siemens coding language that is currently used on the system. He will also need to find ways to relay the data that will be output from the different tools being implemented on the system.

#### 4.1.2.2

Dallas Perkins will be focusing the construction standards and the actual implementation of the design. Dallas has a background in construction and his knowledge of how to read schematics and determine different criteria from blueprints will be vital in the implementation and planning of additions to the system. The construction plans that have been provided by Jim Stephens will be reviewed by Dallas to get a basic layout of the constraints that we are going to have with our design.

#### 4.1.2.3

David Gonsoulin will be the main researcher and also be the one responsible for simulating the system that will be designed. David will be reviewing different DSM techniques as well as different technologies that can be implemented to meet the goals laid out. He will also need to use a program, such as Matlab, to simulate the system additions that will implemented. This will allow the group to analyze possible problems and needed additions for the implementation.

#### 4.1.2.3

Patrick Dawson will be responsible for analyzing the economic impacts of the system. He will need to interpret the different rate tariffs that are imposed by Tallahassee Utilities and accurately forecast the economic benefits of the system. This will allow for an accurate budget based upon the savings that the system will bring the University.

## Task: Research

### 4.2.1 Objectives

#### 4.1.2.1

The purpose of this task is to look into different DSM techniques. This is a crucial step, as one must research many different DSM implementations to make sure that all possible avenues of energy savings are found. This will also include economic analysis of the rate tariffs in Tallahassee

### 4.2.2 Approach

#### 4.2.2.1

One will be using published articles that can be found through the IEEE explorer website to begin getting ideas on what are relevant technologies for the system.

### 4.2.3 Subtask: Research specific technologies

#### 4.2.3.1 Objective:

##### 4.2.3.1.1

The research of specific technologies through the IEEE website will give the team multiple different avenues to choose from when thinking about actual design.

#### 4.2.3.2 Approach:

##### 4.2.3.2.1

Once the basic technologies that are going to be implemented have been identified then one must look at an array of different manufacturers. This will allow for cost analysis and product review before purchase in the implementation phase of the project

### 4.2.4 Subtask: Research Rate Tariffs

#### 4.2.4.1 Objective:

##### 4.2.4.1.1

The rate tariffs must be analyzed through the basic information given by Tallahassee Utilities. These rate plans will allow for accurately determining different ways to save both energy and money.

#### 4.2.4.2 Approach:

##### 4.2.4.2.1

Rate tariffs are published online and the team will ask for assistance from Jim Stephens to make sure that the all the fine details are comprehended.

## 4.3 Task: Design

### 4.3.1 Objectives

#### 4.3.1.1

This task will take the basic ideas that have been gathered through research and turn them into a design of a system that can be implemented with positive economic impact to the university. The key task is being able to design a system that can be put into place that will make financial sense to the University. This means that the system must save more money that it costs to implement.

### 4.3.2 Approach

#### 4.3.2.1

The team will use multiple different avenues that were explored during the research phase to create a comprehensive design. This design should use multiple different techniques of energy and cost savings.

### 4.3.3 Subtask: Variable Frequency Drives

#### 4.3.3.1 Objectives

##### 4.3.3.1.1

The purpose of adding variable frequency drives is to reduce power being consumed by the drives. This is accomplished by reducing the speed of the motor when higher frequency of motor speeds is not needed. This can reduce energy costs up to 6,500 kWh per year in the shores building alone.

#### 4.3.3.2 Approach

##### 4.3.3.2.1

One will implement these variable frequency drives where fixed speed drives are already in use. There may be limits on installation based upon location of hardware, access, and ability of installation. The location of communication lines must also be considered to capture data from the hardware.

#### 4.3.3.3 Subtask: Interface with Siemens System

##### 4.3.3.3.1 Objective:

###### 4.3.3.3.1.1

The system must be able to interface with the current Siemens system in order to control the variable speed drive and to write software to correspond with demand on the system

##### 4.3.3.3.2 Approach

###### 4.3.3.3.2.1

One will need to review different pieces of hardware in order to make sure that the equipment being purchased can be easily added to the Siemens system. Considerations also include, the flexibility of control of the motor, data that can be collected, and simplicity of installation.

#### 4.3.3.4 Subtask: Monitoring Software

##### 4.3.3.4.1 Objective

###### 4.3.3.4.1.1

Monitoring software will be used to output the data collected on speed of the drive throughout the day in order to accurately analyze the cost savings from implementation.

##### 4.3.3.4.2 Approach

###### 4.3.3.4.2.1

One will need to interface the hardware with the existing Siemens system to be able to capture data from the equipment. The data must be exported into a specified central repository in order to be collected and analyzed for economic impacts on the DSM system.

### 4.3.4 Subtask: Load Scheduling

#### 4.3.4.1 Objectives

#### 4.3.4.1.1

Load scheduling can be used to mitigate peak demand costs as well as serve as a tool to create a more even load. One will need to observe which non- essential tasks that are performed throughout peak demand can be scheduled for times when the load is less.

#### 4.3.4.2 Approach

##### 4.3.4.2.1

One will monitor the use of non-essential loads in both the Shores building and Dirac Library to see where load can be shifted to different parts of the day or canceled out completely. The Siemen’s system that is currently being used can be helpful in that it can show which non-essential loads are being used at different parts of the day and when the loads can be shifted or shut off.

#### 4.3.4.3 Subtask: Identifying Loads to be shifted

##### 4.3.4.3.1 Objective

###### 4.3.3.4.1.1

The purpose of this task is to identify which specific loads can be shifted. These loads must be non-essential and must not impact the inhabitants of the building or the work being done in the building

##### 4.3.4.3.2 Approach

###### 4.3.3.4.2.1

One will need to survey the users of the buildings, speak with leadership of the buildings, and work with FSU utilities to identify which loads are eligible for shifting. The loads must not only be non-essential, but when shifted, have a positive impact on the load throughout the day. (I.e. even the total load or decrease over all load, etc.)

#### 4.3.4.4 Subtask: Schedule loads

##### 4.3.4.4.1 Objective:

###### 4.3.4.4.1.1

The loads that have been identified to be shifted must be shifted to have a positive impact on the total load. This could include shifting usage to even the total load of the building, reducing consumption at certain times, or turning off the load when not necessary.

##### 4.3.4.4.2 Approach:

###### 4.3.4.4.2.1

The Siemen’s system will be used to identify the appropriate times to shift loads to. It will also be used to identify when usage should be decreased or increased based upon load of the entire building. One will also use the system to identify peak times to shut off usage of the non-essential loads in the building

#### 4.3.4.5 Subtask: Monitoring Software

##### 4.3.4.5.1 Objective:

###### 4.3.4.5.1.1

Software must be implemented to track and monitor the data that will be produced from the load scheduling. This will allow for economic analysis and efficiency improvements by monitoring the pertinent data produced by the Siemens system.

##### 4.3.4.5.2 Approach:

###### 4.3.4.5.2.1

One must apply coding additions to the current Siemens to be able to relay pertinent data to a central repository for economic analysis. Once into the central repository, the data must be interpreted through specific formulas that will prove as economic analysis of the system. Also, this collection of data will allow for review of efficiency of the system and possible improvements in the future.

### 4.3.5 Subtask: Thermal Storage

#### 4.3.5.1 Objectives

##### 4.3.5.1.1

Implement a financially responsible and efficient storage of energy through thermal tanks. This will allow for storage of energy during off peak times and use of the stored energy during peak times. This could dramatically improve energy costs because energy use during peak times can be up to 2.5 times more than during off peak times.

#### 4.3.5.2 Approach

##### 4.3.5.2.1

Storage through thermal tanks is an efficient way to store energy during off peak times. The addition of water tanks that can be cooled during off peak hours and then be used to chill air handlers could potentially save the university an extensive amount of money on their energy costs. This implementation has been seen on other parts of the FSU campus and with results

#### 4.3.5.3 Subtask: Analysis of possible locations for tanks

##### 4.3.5.3.1 Objective:

###### 4.3.5.3.1.1

One must thoroughly research the buildings to understand if there is an efficient way to install and maintain these large water tanks

##### 4.3.5.3.2 Approach:

###### 4.3.5.3.2.1

The building schematics and building representative must be contacted and informed of the possible addition of these tanks. Through cost analysis and cooperative research, one must be able to deduce if this approach is feasible or if it is not the right fit for these certain buildings.

#### 4.3.5.4 Subtask: Scheduling of Storage

##### 4.3.5.4.1 Objective

###### 4.3.5.4.1.1

The times at which these tanks can be stored and then release to most efficiently impact the loads of the air handlers must be analyzed.

##### 4.3.5.4.2 Approach

###### 4.3.5.4.2.1

One will use the current Siemens system to analyze and interpret the load usage of the air handlers and when the peak use could be mitigated. The rate tariffs of Tallahassee must also be analyzed to ensure that the tanks are being cooled at the cheapest energy cost to the University.

#### 4.3.5.5 Subtask: Monitoring Software

##### 4.3.5.5.1 Objective:

###### 4.3.5.5.1.1

Software must be implemented to track and monitor the data that will be produced from the thermal storage tanks. This will allow for economic analysis and efficiency improvements by monitoring the pertinent data produced by the Siemens system.

##### 4.3.5.5.2 Approach:

###### 4.3.5.5.2.1

One must apply coding additions to the current Siemens to be able to relay pertinent data to a central repository for economic analysis. Once into the central repository, the data must be interpreted through specific formulas that will prove as economic analysis of the system. Also, this collection of data will allow for review of efficiency of the system and possible improvements in the future.

### 4.3.6 Subtask: Lighting Renovation

#### 4.3.6.1 Objectives

##### 4.3.6.1.1

Lighting renovation could make a significant impact to both off peak and peak loading of the building. The researched performed in the following sections will allow for implementation of multiple different lighting renovation techniques in order to reduce load, shift load, and create positive financial impacts for the University.

#### 4.3.6.2 Approach

##### 4.3.6.2.1

Through the research performed in the previous section, one has devised that the feasible lightning renovations would be: updating lighting, adding lighting/motion sensors to rooms, actively controlling lighting.

#### 4.3.6.3 Subtask: Updating Lighting

##### 4.3.6.3.1 Objectives

###### 4.3.6.3.1.1

The goal would be to change out all of the lighting currently being used in the buildings for more efficient and longer lasting LED bulbs.

##### 4.3.6.3.2 Approach

###### 4.3.6.3.2.1

There are two avenues with which to change the lighting. One would be to go ahead and change all the lighting at once. This would create waste and lost time. Another option would be to install a new LED bulb whenever the old bulb goes out. This is the most efficient and cost productive method.

#### 4.3.6.4 Subtask: Adding Lighting/Motion Sensors

##### 4.3.6.4.1 Objectives

###### 4.3.6.4.1.1

Add motion sensors or optimize the current motion sensors to decrease lighting needs throughout the building.

##### 4.3.6.4.2 Approach

###### 4.3.6.4.2.1

By installing or optimizing the current motion sensors in rooms, one would be able to decrease load when rooms are not in use. One must consider the practicality of having these sensors in busy rooms as well as the cost to savings ratio of the hardware.

#### 4.3.6.5 Subtask: Control of Lighting

##### 4.3.6.5.1 Objectives

###### 4.3.6.5.1.1

Control the lighting in a room through dimming switches or through turning off lighting when building not in use.

##### 4.3.6.5.2 Approach

###### 4.3.6.5.2.1

Install dimming switches in order to decrease the amount of light produced in a room without the consumers being aware. Another option is to ensure that lightning is off or at low levels when buildings are not in use.

#### 4.3.6.6 Subtask: Monitoring Software

##### 4.3.6.6.1 Objective:

###### 4.3.6.6.1.1

Software must be implemented to track and monitor the data that will be produced from the lighting renovations. This will allow for economic analysis and efficiency improvements by monitoring the pertinent data produced by the Siemens system.

##### 4.3.6.6.2 Approach:

###### 4.3.6.6.2.1

One must apply coding additions to the current Siemens to be able to relay pertinent data to a central repository for economic analysis. Once into the central repository, the data must be interpreted through specific formulas that will prove as economic analysis of the system. Also, this collection of data will allow for review of efficiency of the system and possible improvements in the future

### 4.3.7 Subtask: Photovoltaics

#### 4.3.7.1 Objectives

##### 4.3.7.1.1

Investigate whether or not installing PV on rooftops on the Shores or Dirac building is possible and economically feasible. PV could be a great option to flatten the peak of the load in both buildings but the difficulties come with installation on tile roofs.

#### 4.3.7.2 Approach

##### 4.3.7.2.1

Contact local solar installation firms as well as consult Jim Stephens on the possibility of using this technology. The University promotes Green Energy, so this might be an avenue to promote conservation.

#### 4.3.7.3 Subtask: Scouting of Possible PV Locations

##### 4.3.7.3.1 Objective

###### 4.3.7.3.1.1

Walk through buildings and roofs to find possible settings for PV.

##### 4.3.7.3.2 Approach

###### 4.3.7.3.2.1

Contact local installation firms to get a cost estimate on the nearby roofs. The tile roofs, on many buildings across campus, cost more to install PV, so if a non-tile roof could be ascertained, the economics might become realizable.

#### 4.3.7.4 Subtask: Analysis of Economic Impacts

##### 4.3.7.4.1 Objective

###### 4.3.7.4.1.1

Review the cost estimates provided by local installation firms against the economic benefits of installation.

##### 4.3.7.4.2 Approach

###### 4.3.7.4.2.1

Forecast the economic benefits by reviewing cost analysis with faculty advisors and sponsor. Ensure that the profitability of installation will be realized within a manageable time frame.

#### 4.3.7.5 Subtask: Monitoring Software

##### 4.3.7.5.1 Objective:

###### 4.3.7.5.1.1

Software must be implemented to track and monitor the data that will be produced from the PV. This will allow for economic analysis and efficiency improvements by monitoring the pertinent data produced by the Siemens system.

##### 4.3.5.5.2 Approach:

###### 4.3.5.5.2.1

One must apply coding additions to the current Siemens to be able to relay pertinent data to a central repository for economic analysis. Once into the central repository, the data must be interpreted through specific formulas that will prove as economic analysis of the system. Also, this collection of data will allow for review of efficiency of the system and possible improvements in the future

### 4.3.6 Subtask: Ventilation Control

#### 4.3.6.1 Objective

##### 4.3.6.1.1

Ventilation control can create a large impact on the load for the buildings. One must consider many different components for comfort level in the building, but if the approach is sound, then it can provide a large economic impact.

#### 4.3.6.2 Approach

##### 4.3.6.2.1

One will need to investigate multiple different avenues of ventilation control such as CO2 sensors and cooling of building during off peak hours.

#### 4.3.6.3 Subtask: CO2 Sensors

##### 4.3.6.3.1 Objective

###### 4.3.6.3.1.1

Installation of CO2 sensors can be an addition to the Variable Frequency motors installed in the previous sections. These CO2 sensors will provide data on how much more airflow is needed in rooms.

##### 4.3.6.3.2 Approach

###### 4.3.6.3.2.1

These sensors can be installed either in air ducts or in specific rooms. They can be installed in air ducts if the ducts are output from similar sized rooms. If the room’s size varies largely, than sensors must be installed in individual rooms.

#### 4.3.6.4 Subtask: Cooling of Buildings during Off Peak

##### 4.3.6.4.1 Objective

###### 4.3.6.4.1.1

Cooling the building off during off peak times so that the building needs less air during the day could provide large economic impacts for the system. This technique will take careful scheduling and consideration of local weather.

##### 4.3.6.4.2 Approach

###### 4.3.6.4.2.1

One will need to consider the type of insulation installed in the building, where most cool air is needed in the building throughout the day, and how much temperature rise occurs in a building throughout the day.

#### 4.3.6.5 Subtask: Monitoring Software

##### 4.3.6.5.1 Objective:

###### 4.3.6.5.1.1

Software must be implemented to track and monitor the data that will be produced from ventilation control. This will allow for economic analysis and efficiency improvements by monitoring the pertinent data produced by the Siemens system.

##### 4.3.6.5.2 Approach:

###### 4.3.6.5.2.1

One must apply coding additions to the current Siemens to be able to relay pertinent data to a central repository for economic analysis. Once into the central repository, the data must be interpreted through specific formulas that will prove as economic analysis of the system. Also, this collection of data will allow for review of efficiency of the system and possible improvements in the future

## 4.4 Task: Implementation

### 4.4.1 Objective

#### 4.4.1.1

The implementation will be done in such a fashion that the total cost of the system will be paid back by savings in a timeframe of seven years. One would like to see economic analysis that proves the system to not only pay for itself, but provide large savings in the long run to the university. This savings will hopefully provide energy savings as well which will help mitigate the universities environmental footprint.

### 4.4.2 Approach

#### 4.4.2.1

Implementation of the design will be done first using simulation tools, such as Matlab. Secondly, the data collected from simulation must be compiled and review by the team, sponsor and advisors to prove economic impact to the University. Finally, physical implementation will be scheduled by the FSU Utilities department and conducted by paid laborers.

### 4.4.3 Subtask: Simulation using Matlab

#### 4.4.3.1 Objective:

##### 4.4.3.1.1

The goal of this simulation would be to accurately portray the system designed in the previous phase. This simulation will allow for review of possible inefficiencies, ensure financial benefits and predict energy savings.  

#### 4.4.3.2 Approach

##### 4.4.3.2.1

Using Matlab, the group will place the specifications designed along with previous year’s data from the Siemen’s system, to simulate how the system will react and ensure that the specific settings added will be the most efficient process.

#### 4.4.3.3 Subtask: Review of Simulation

##### 4.4.3.3.1 Objective

###### 4.4.3.3.1.1

This review will allow for optimization of the DSM system. The results from this review can be placed back in the simulation and then additional reviews may take place to ensure that the most optimized system will be in place.

##### 4.4.3.3.2 Approach

###### 4.4.3.3.2.1

The group will first review the results amongst themselves to ensure that the DSM system is optimized. Then they will consult with the sponsor as well as the advising team to ensure that the correct changes have been made and that the system is as efficient as possible.

### 4.4.4 Subtask: Physical Implementation

#### 4.4.4.1 Objective

##### 4.4.4.1.1

Once the review stage has been complete, the physical implementation can begin. Although students will not be allowed to physically install hardware on high voltage systems, they must ensure that their design is correctly being put into place.

#### 4.4.4.2 Approach

##### 4.4.4.2.1

FSU Utilities will hire a team of qualified workers to install necessary hardware for the DSM system. The team must actively participate in necessary reviews of the implementation to ensure correct installation of their design.

### 4.4.5 Subtask : Integration into Siemens System

#### 4.4.5.1 Objective

##### 4.4.5.1.1

The purpose of integrating the DSM system into the current Siemen’s system is to be able to use the over eight hundred thousand data points that are currently connected to the Siemen’s system to provide analysis and feedback on the DMS system.

#### 4.4.5.2 Approach

##### 4.4.5.2.1

The integration with the Siemen’s system will consist of ensuring that all hardware connections are accurate, writing programs to ensure data collection from Siemen’s system will be sent to a central repository, and that the current Siemen’s system can control different implemented hardware.

#### 4.4.5.2 Subtask: Hardware Connections

##### 4.4.5.2.1 Objective

###### 4.4.5.2.1.1

All hardware that has been installed for the DSM system must integrate and provide data back to the Siemen’s system. The current Siemen’s system already has over eight hundred thousand data points, and the group will hope to install a handful more.

##### 4.4.5.2.2 Approach

###### 4.4.5.2.2.1

To ensure accuracy, the group may need to review the data being added to the Siemen’s system and compare it with what the physical hardware is actually outputting. This will ensure accurate data collection for analysis in the future.

#### 4.4.5.3 Subtask: Coding for Siemen’s

##### 4.4.5.3.1 Objective

###### 4.4.5.3.1.1

The purpose of this task is to be able to send all the necessary data from the Siemen’s system, to a central repository for collection and analysis. This coding will allow for easy access and manipulation of the data that the Siemen’s system already stores from its data points across the FSU grid.

##### 4.4.5.3.2 Approach

###### 4.4.5.3.2.1

The team will need to write high level design of code so that a Control’s engineer, working for FSU Utilities, may write programs in the Siemen’s proprietary code language. The high level design code must accurately portray the necessary steps and processes for the entry of data to the central repository.

#### 4.4.5.4 Subtask: Control of Hardware

##### 4.4.5.4.1 Objective

###### 4.4.5.4.1.1

The current Siemens system allows for manipulation of hardware from a central program. One must ensure that the hardware installed on the system can interact and be manipulated by the Siemens software.

##### 4.4.5.4.2 Approach

###### 4.4.5.4.2.1

The group will need to test and physically ensure that the hardware responds to the necessary actions taken from the central Siemen’s program. There are currently many pieces of hardware on the Siemen’s system that cannot be accurately controlled by the central program. This is would not be beneficial for our DSM system, and the necessary tests to ensure accuracy, must be taken.

## 4.5 Task : Analysis

### 4.5.1 Objective

#### 4.5.1.1

The analysis that will be done will ensure that once the system is implemented, the economic and energy savings forecasted were met. This will help with the future changes to the system, implementation of additional hardware, and using DSM on different buildings across campus.

### 4.5.2 Approach

#### 4.5.2.1

All the data collected should be placed in a central repository where one may implement an array of formulas to forecast and analyze the data. It will be necessary to create formulas to analyze economic impact to the University, future savings of the system, environmental impact, and efficiency of the system.

### 4.5.3 Subtask: Economic impact to the University

#### 4.5.3.1 Objective

##### 4.5.3.1.1

The purpose of the analysis of the economic impact to the University is to be able to portray the amount saved from system implementation. This will allow for future DSM systems to be installed and show the importance of the steps taken in this project.

#### 4.5.3.2 Approach

##### 4.5.3.2.1

One will need to create accurate formulas to depict economic savings during different time frames and provide monetary values from the data being collected. This analysis must be easily accessible and most importantly, accurate.

### 4.5.4 Subtask: Future Savings

#### 4.5.4.1 Objective

##### 4.5.4.1.1

The future savings analysis is crucial to this team because the team members will not be around to see all the benefits that the DSM system will reap. The forecast must be accurate and it must show how the savings will be created in the future. This information will also show that the system implemented will hopefully pay for itself within the timeframe of 7 years.

#### 4.5.4.2 Approach

##### 4.5.4.2.1

The team will need to create forecasting formulas that will use the data collected in the central repository, past data that has been collected by the Siemen’s system, as well as weather data that can be found on the internet. The sponsor, advising faculty, and potentially a business faculty member, must be consulted to ensure that the forecasting is accurate for the system.

### 4.5.5 Subtask: Environmental Impact

#### 4.5.5.1 Objective

##### 4.5.5.1.1

The goal of this study is to analyze how the DSM management system impacts the environment. A DSM system is created to save money, but most likely it will also have a positive effect on the environment by shedding load. This effect must be analyzed and reviewed for future systems.

#### 4.5.5.2 Approach

##### 4.5.5.2.1

The team must create formulas to accurately portray how the DSM system is impacting the environment. This does not linearly map to economic savings, and most only consider energy conserved, not load shifted.

### 4.5.5 Subtask: Efficiency of the System

#### 4.5.5.1 Objective

##### 4.5.5.1.1

The efficiency of the system must be analyzed to ensure that future changes can be easily made. This DSM system will help create savings for the current load used by the building, but if load shifts or changes, then steps must be taken to increase efficiency for the new load.

#### 4.5.5.2 Approach

##### 4.5.5.2.1

One will need to create formulas to portray the efficiencies of the system and provide information on where it can be improved. This may mean showing scheduling of load and how the current load affects the system.

## 4.6 Task: Documentation

### 4.6.1 Objective

#### 4.6.1.1

The purpose of documentation of our design is to make this project easily accessible and reproducible. This DSM project should be a leader for a change in many buildings across campus and in Universities throughout the country. The example provided here will provide benefits that can hopefully be replicated and used as a baseline for other projects in the future.

### 4.6.2 Approach

#### 4.6.2.1

The documentation of the data will be made in reports that are assigned by the course as well as the necessary documentation to compete in a Senior Design Competition for the FEEDER program.

### 4.6.3 Subtask: Course Reports

#### 4.6.3.1 Objective

##### 4.6.3.1.1

There are design milestones, reports, and presentations that must be completed and thoroughly reviewed by the advising faculty. These will help provide feedback to the team on where they can improve their own management and skill set to create a better DSM system.

#### 4.6.3.2 Approach

##### 4.6.3.2.1

One will submit the necessary reports and presentations. These tasks will be managed by Patrick Dawson and must be split to the appropriate parties when necessary. Team work will be crucial.

### 4.6.4 Subtask: FEEDER Competition

#### 4.6.4.1 Objective

##### 4.6.4.1.1

There may be a possibility to compete in a Senior Design competition held by FEEDER (Foundation for Engineering Education for Distributed Energy Resources). This will be a great opportunity to spread knowledge on DSM systems and share the team’s experience with other students

#### 4.6.4.2 Approach

##### 4.6.4.2.1

The specifics of the competition have not yet been released. The team must ensure that all proper documentation is being done for the design milestones, so that when the information on the competition is released, the team can submit in a timely fashion.

# 5 Risk Assessment

If implemented by the FSU utilities department, our demand-side management system will involve the modification of existing power systems in buildings, as well as the installation of new sensors/equipment in buildings. This creates the potential for risk to both the people installing the equipment, and the actual equipment itself. This section will examine some possible risks, and mitigation strategies the team is taking to limit/eliminate this risk. Potential risks include:

## 5.1 Physical Risks:

### 5.1.1 Installation Risk

Risk: Modifying/replacing the existing electrical system will involve handling building main lines, as well as disconnecting/connecting new wires for equipment. These lines are deadly, so only someone who has been trained and licensed as an electrician should handle the building power system. Installation of new sensors could involve the use of power tools, which if improperly trained can prove dangerous to the user or bystanders. Modifying systems can involve the use of a ladder, which could lead to falling injuries if improperly used. Equipment that has not been properly installed could also pose a fire hazard.

Solution: Contract out an electrician to perform building installation with the FSU utilities department. Familiarize ourselves with the National Electric Code (NEC) when planning our design. Get design signed off by the FSU utility department in-house professional engineer. Read safety manuals before using ladders/power tools.

### 5.1.2 Equipment damage

Risk: Modifying/replacing existing power system components in buildings could cause power outages/surges in power that could damage critical loads. Many of these loads are expensive to replace, additionally there is a supercomputer in the Dirac building, which if damaged would disrupt experiments and destroy potentially useful data.

Solution: Model solutions extensively before implementation, including surges/high loads being introduced in order to test how the system will react. Get the professional engineer at FSU to review and sign off on our system design. Study which loads can absolutely not be affected by demand side management, and which we can modify.

### Software Failure

Risk: Although not technically “physical”, software malfunctions could cause equipment damage, as well as increase utility cost.

Solution: Create a number of test cases for software in simulation stage. Prove that all algorithms/programs written are invariant.

### 5.1.4 Quality of Life (QOL) risks

Risk: Modifying the HVAC system could pose the risk of lowering the quality of life in the buildings. Modifying the system to do more cooling in the morning could lead building users to be uncomfortably cool or hot. Modifying the speed of the fan could lead to the build-up of excess CO2, which could lead to building users getting headaches or feeling tired, in extreme situations even leading to unconsciousness and death. Even in minor cases this is unacceptable, as university buildings need to be conducive to learning and studying.

Solution: Monitor building temps, provide safeguards in software to keep temperatures from going out of an acceptable range, provide manual override in the case of faulty sensors. Use CO2 sensors to monitor levels of the gas, adjusting fan speeds accordingly to provide proper building ventilation.

## Administrative Risks

### 5.2.1 Completion Risks

Risk: Not allowing enough time for testing/implementation of design. There is a significant amount of time that must be allotted to complete this project, if not properly planned than the project could fail. There is also the risk of a team member being unwilling or unable to complete all tasks that are assigned to them.

Solution: Schedule extensively for upcoming deadlines. Communicate plan with customer, advisor, and Dr. Frank, in order to stay on top of what needs to get done. Schedule regular meetings with team, discuss who is doing what and timeframe for each item, assist struggling team members in order to achieve goal. Make sure skill-set is diversified, there shouldn’t only be one person who knows how to do a critical task.

### 5.2.2 Cost Risks

Risk: Improperly gauge cost savings of equipment we install. This could lead to the project costing money rather than saving money, and will discourage future collaboration between the FSU utility department and the COE senior design program.

Solution: Study rate plan, always anticipate real-world savings to be less than simulation, research items to make sure they perform as well as they are specified to, and price-shop to get the best deals possible.

# 6 Qualifications and Responsibilities of Project Team

This team has an extensive background in power electronics and software, the key components of demand-side management, including workplace and classroom experience in both fields.

## 6.1 Team Members

### 6.1.1 Patrick Dawson (Team Leader)

Patrick has experience through both classes and through internships that relate well with this project. He has excelled in courses that will help design this project, such as electronics. Also, he has leadership experience through clubs such as Engineers without Borders and attending the World Energy Engineering Congress. He has three internships and his last was with a large utility. He will be able to bring this knowledge into the group and help realize concepts such as rate tariffs and the economics behind a public utility. His role as group leader will be managing the team with a sense of responsibility and respect. He must be able to see long-term goals and set up a plan in order to develop ideas. He needs to promote cooperation through the group and hold team members accountable for meetings.

### 6.1.2 Dallas Perkins (Chief Research Officer)

Responsibilities shall include analyzing the current building conditions and possible implementations available for demand side management. This will include examining the blueprints and specifications for each building to determine which areas the energy reduction techniques can be applied in. He is expected to contribute an understanding of the design of commercial buildings and the interpretation of plans due to his background working for a construction design engineering firm.

Technical Area: his study in the field of power and energy will provide a knowledge base for the power distribution and three-phase analysis needs of the project. He is expected to contribute to the analysis of the power supply network for each of the buildings and in the process of designing a new, more efficient system.

### 6.1.3 Matthew Streich (Communication Liaison and Verification Officer)

The communication liaison will be responsible for arranging meetings, and will serve as the buffer between the group and the advisor/sponsor. The liaison also keeps records of all group meetings, posting results to bb. The verification officer takes theory calculated and simulates this data in MATLAB, verifying the correctness of the design calculations performed. Matt has programming experience in both hardware and software in a variety of languages, from high-level OOP to assembly in two internships at a fortune 500 company as well as work at CAPS

### 6.1.4 David Gonsoulin (Financial Advisor)

The responsibilities of the Financial Advisor includes, but is not limited to, the following: managing the project budget, keeping records of purchases and other expenses, and coordinating the purchasing of any needed equipment or items. The areas of contribution for David include: microcontroller programming, network programming, three-phase analysis, and power electronic design. The programming background could be useful for implementing a complete system in the building of choice. The system may include a central processing unit that takes in data from the rest of the building. Based on the input data, the central processing unit must instruct different microcontrollers as to what to do. Three-phase analysis will prove useful when looking at the building plans; this will facilitate a better understanding of the entire building electrical system.

## 6.2 Tasks

Team Member Key

|  |  |
| --- | --- |
| Member | Key |
| Patrick Dawson | A |
| Dallas Perkins | B |
| Matthew Streich | C |
| David Gonsoulin | D |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Task | Subtask | Title | Team Member(s) | Due Date | Skills and Knowledge |
| 1 |  | Project Management | A | 4/15/2015 | Leadership, Planning, Communication |
| 2 |  | Research | Mainly D  A,B,C to a lesser extent | 11/29/2014 | Reading Comprehension,  EE background, search engine use |
| 3 |  | Design | A,B,C,D | 1/19/2015 | Simulation Software, Critical Thinking, Power Systems, Programming |
|  | 1 | Variable Frequency Drives(VFD) | B,C | 11/27/2014 | Power Systems,  Software |
|  | 1.1 | Interface VFD with Siemens system | C | 11/5/2014 | Software |
|  | 1.2 | Monitoring Software | C | 11/9/2014 | Software |
|  | 2 | Load Scheduling | B | 11/15/2014 | Power Systems |
|  | 2.1 | Identifying Loads to be shifted | B | 10/31/2014 | Observation |
|  | 2.2 | Shift Loads | B | 11/15/2014 | Power Systems |
|  | 3 | Thermal Storage | D | 12/4/2014 | Power Systems, Thermodynamics,  Spatial Analysis |
|  | 3.1 | Analysis of possible locations of tanks | D | 11/11/2014 | Spatial Analysis |
|  | 3.2 | Scheduling of Storage | D | 12/4/2014 | Thermodynamics, Power Systems |
|  | 4 | Lighting Renovation | A,B,C | 1/1/2014 | Spatial Analysis, Budgeting, Wiring, Software |
|  | 4.1 | Updating Lighting | A | 12/20/2014 | Budgeting, Wiring |
|  | 4.2 | Adding Lighting Motion Sensors | B | 12/1/2014 | Spatial Analysis, Wiring |
|  | 4.3 | Lighting Control | C | 1/11/2014 | Software, Wiring |
|  | 5 | Photovoltaics | B,C,D | 1/19/2014 | Software, Power Systems, Energy Storage, Renewable Energy Planning, Budgeting |
|  | 5.1 | Scouting Possible PV locations | D | 10/31/2014 | Renewable Energy Planning |
|  | 5.2 | Analysis of Economic Impacts | D | 12/15/2014 | Budgeting |
|  | 5.3 | Monitoring Software | B,C | 1/19/2014 | Software, Power Systems |
|  | 6 | Ventilation Control | A,C | 12/31/2014 | Software, Power Systems, Wiring |
|  | 6.1 | Installing CO2 sensors | A | 12/2/2014 | Power Systems, Wiring |
|  | 6.2 | Cooling of Buildings during Off-Peak Hours | A,C | 12/25/2014 | Software |
|  | 6.2.1 | Monitoring Software | A,C | 12/31/2014 | Software |
| 4 |  | Implementation | A,B,C,D | 4/1/2015 | Programming, Wiring, Simulation Software(SIMULINK), Power Systems |
|  | 1 | Simulation | D | 1/31/2015 | SIMULINK |
|  | 2 | Review of Simulation | B,C,D | 2/5/2015 | Power Systems |
|  | 3 | Physical Implementation | A | 4/1/2015 | Wiring, Power Systems |
| 5 |  | Integration into Siemens System | B,C,D | 3/17/2015 | Electrician skills, Software Interfaces |
|  | 1 | Hardware Connections | School-contracted electrician | 3/1/2015 | Electrician skills |
|  | 2 | Interface Hardware into Siemens System | B,C | 3/5/2015 | Software Interfaces |
|  | 3 | Add extra controls software | C,D | 3/17/2015 | Software |
| 6 |  | Analysis | A,B,D | 4/1/2015 | Data mining, Budgeting,  Environmental Science |
|  | 1 | Economic Impact to University | A | 1/15/2015 | Budgeting |
|  | 2 | Future Savings | B | 1/17/2015 | Budgeting |
|  | 3 | Analyzing Environmental Impact | D | 1/1/2015 | Environmental Science |
|  | 4 | Measure Efficiency of Installed System | A,B,D | 4/1/2015 | Data Mining |
| 7 |  | Documentation | A,B,C,D | 4/5/2015 | EE background,  Programming(for psuedocode), Technical Writing |
|  | 1 | Course Reports |  | 4/5/2015 | Technical Writing, EE Background, Programming |

# 7 Schedule



# 8 Budget Estimate

|  |  |  |  |
| --- | --- | --- | --- |
| **Personnel** | Cost/unit | Total Units | Total Cost |
| Matthew Streich | $30/hr | 360 | $10,800 |
| Patrick Dawson | $30/hr | 360 | $10,800 |
| David Gonsoulin | $30/hr | 360 | $10,800 |
| Dallas Perkins | $30/hr | 360 | $10,800 |
| Electrician | $60/hr | 50 | $3,000 |
| **Subtotal A.** |  |  | $46,200 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Fringe Benefits** |  |  |  |
|  | $46,200 | .29 | $13,398 |
| **Subtotal B.** |  |  | $59,598 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Minor Expenses** |  |  |  |
| **Subtotal C.** |  |  | $59,598 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Overhead costs** |  |  |  |
|  | $59,598 | .45 | $26,819.10 |
| **Subtotal D.** |  |  | $86,417 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Equipment** |  |  |  |
| 40 Hp Variable Speed Drive | $5,500 | 2 | $11,000 |
| 120 Gallon Water Electricity Storage Tank | $1,600 | 1 | $1600 |
| LED Lights | $5.00 | 4,000 | $20,000 |
| Siemens Duct-Mounted Sensor | $600 | 10 | $6,000 |
| Motion Sensor | $50 | 200 | $4,000 |
| 1 kW Solar Panels | $1,000 | 400 | $400,000 |
| **Total Project Cost** |  |  | **$529,017** |

# 9 Deliverables

The deliverables for this project fall into one of several categories: the design plans which will be provided to FSU in order to purchase and install physical hardware if they decide to implement our design, the software which will accompany the physical hardware, and any reports that need to be made.

## 9.1 Reports

These include all of the design milestone reports, as well as our presentations that are made of the reports. These include of all of our findings during the project, including projected/actual scheduling, budget, as well as a full description of our design. It should extensively detail software and hardware design, including any necessary graphics/models, as well as include psuedocode and Unified Modeling Language (UML) descriptions for all software that is written. These reports can serve as a potential guideline if either the school or future senior design groups decide to implement demand-side management, and although design will likely not be portable can serve as a basic stepping stone.

## 9.2 Design

The actual full design of the project, will need to be provided to the FSU utility department for approval by their on-staff electrical engineers before anything can actually be implemented. The design should include simulation model files and results, so that test results can be verified. This will need to be done well in advance of the report deadline in order to actually be implemented, a March deadline is currently being planned for to allow 1 month plus for contractors to install the design, although more time would be desirable to possibly analyze the real-world impact of our design.

## 9.3 Software

This is the software built to interact with the Siemens controls interface currently in place. It will need to include psuedocode and prove loop invariance, as well as provide top-level UML diagrams. These design tools can aid in the porting of this software in future projects, and can allow engineers from outside our group to easily modify our code as needed.

# 10 References

[1] "Google Shopping." *Google Shopping*. N.p., n.d. Web. 17 Oct. 2014.

[2] "Download Center V3 Mobile // Version: 3.0.108. 76." *Siemens Download Center Mobile*. N.p., n.d. Web. 17 Oct. 2014.  
  
[3]"QPA2000." *- Building Technologies*. N.p., n.d. Web. 17 Oct. 2014.  
  
[4]"QPM2100." *- Building Technologies*. N.p., n.d. Web. 17 Oct. 2014.  
  
[5]"Taco-Hvac: Advantage 61 Variable Speed AC Drive." *Taco-Hvac: Advantage 61 Variable Speed AC Drive*. N.p., n.d. Web. 17 Oct. 2014.