**Alternative and Efficient Energy on Embry-Riddle’s Daytona Beach campus**

**A Feasibility Report with Comparative Analysis**

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**Abstract**

This report investigates the feasibility of alternative energy on Embry-Riddle Aeronautical University’s Daytona Beach campus and is beneficial to the budget committee, and the environmental section of student government. Embry-Riddle has a prestigious reputation for the flight program and the different engineering majors, and is growing is prestige for other majors. At this time, society is very focused on “going green”, sustainability, and alternative energy. It is for this reason, Embry-Riddle should focus on the same aspects to keep up prestige.

Research involved Investigation of numerous scholarly articles, statistics from the Environmental Protection Agency’s program EnergyStar, and success stories from universities such as NorthWestern. This research combined with a personal email interview with from Blake Klockenga. a Building Automation/ Energy Specialist on Embry-Riddle’s Daytona Beach campus, what is found is that Solar Panels have the potential to be established on the student village as well as the M building. These buildings have the most potential based on what has already been implemented on campus, and the amount of energy being utilized in these buildings.

**Introduction**

**Background**

Embry-Riddle Aeronautical University is a well-known university and a leading example to many other schools. With consideration to this reputation, it’s surprising to see sustainability in energy is not more focused on by the school. Sustainable energy would be efficient usage of energy, as well as using alternative energy sources. Per the Florida Power and Light bill (2016) for the university, 37,428,595 kWh were used in the 2015-16 cycle, up over 1,000,000 kWh from the year before, and costing the university $2,895,491. A transition to efficient and sustainable energy would include implementing a monitor power management system (MPMS), solar panels, and more efficient lighting sources such as LED lighting rather than fluorescent.

**Statement of the Problem**

As a leading school in aviation and engineering, energy should be a focus, especially in a society focused on going green. The only solar panels on campus are four that sit on top of the student center and power the hot water for that building. That implementation was so successful the building ended up not needing all the heating systems, because the ones connected to the panels ended up working better. This heating system was so effective, and yet wasn’t implemented in any other aspect of the campus, such as the dorms where, hot water is used.

**Purpose**

My report will be on the feasibility of implementing alternative and sustainable energy measures on Embry-Riddle’s Daytona Beach campus and determining what buildings, if any, would be the most compatible with solar energy, and where on campus energy could be saved. or not the construction of a nuclear facility is even possible, and ultimately deciding if the massive investment will prove to be beneficial to the count. This report will be primarily beneficial to the Environmental committee section of the Student Government Association on campus.

**Scope**

This report focuses on the economic aspects of solar energy on campus, the academic benefits, and other areas to improve efficiency. To do this, I will be considering the following specifics:

1. Energy consumed on campus
2. Energy efficiency measures within buildings such as what type of light bulbs being used
3. How other universities fundraised for the solar panels.

This report will not consider such things as hazards and effects of weather on solar panels, or politics that may be involved.

**Research Methodology**

For the purposes of this technical report, I will be considering sources specifically regarding energy at Embry-Riddle’s Daytona Beach campus and energy consumption at colleges and universities in general. Utilizing sources such as the FPL bill, and energy audits done by students and faculty. I will be able determine what alternative energy method would best benefit the university. I will be looking at comparative studies and experiments of types of solar panels to determine the most efficient type for the campus. Ultimately, much of the university-specific information was retrieved from emails from Blake Klockenga. Mr. Klockenga is a Building Automation/ Energy Specialist on Embry-Riddles Daytona Beach campus. He also provided copies of the most recent Florida Power and Light (FPL) bill. The Environmental Protection Agency’s (E.P.A) program Energy Stars websites and resources were utilized, as well as an energy audit performed by a team of students led by Akash Raigangar for an upper level humanities course taught by Dr. Aunaud, but analyzed by Captain Randall Lynch who found it credible and released to anybody who requested it.

**Analysis**

**Main Energy Uses**

Embry-Riddle’s Daytona Beach campus is continually growing and developing, and the energy usage is reflecting that. According to Florida Power and Light (FPL) (2016), the Embry-Riddle Daytona Beach campus uses 37,428,595 kilo-Watt Hours (kWh) annually, at a cost of $3,084,184, meaning energy costs $.0824/kWh. This number will be used in any calculations determining cost using kWh when cost is not provided.

***M Building Car Charging Station***

The M building on campus has many labs in it for the mechanical engineering students and is also a charging location for smart cars. This feature gets utilized, meaning that the ‘green cars” are still not entirely clean, due to the fact that the M building is not powered by any green energy. Implementing enough solar panels onto this building to counteract those cars charging would decrease the amount of kWh used in that building. Per the FPL bill, in 2016, 65,127kWh were used by the M building (2017b). According to a journal article by Henry A. Bonges III and Anne C. Lusk, most current electric cars have a 20-kWh battery, last 70-100 miles, and has an average charge time of about 3.1 h (2016). Using this information and the fact energy costs Embry-Riddle $.0824/kWh, one car’s full charge costs about $1.64. However, two cars can charge at once at the M building. So even if these charging locations only get used twice per day for two cars, every day that is $2,406 and 14,600 kWh spent on charging cars. This number makes the M building car charging station an adequate energy consumer to have powered by solar energy.

***Student Village***

The Student Village is home to four different residence halls: O’Connor, Wood Hall, Adams Hall, and Stimpson. Each of these come with many amenities, such as mini fridges, and microwaves, the upperclassman dorms have a full-size fridge, stove, and space to plug in permitted additional cooking items (Housing, n.d.). Along with these services, there are also two restaurants, two laundry facilities, the computer repair shop, and the housing and residence life office. It is for this reason that so much energy is getting used, from the hot water heaters (for showers, food, and laundry), to the light bulbs. The Student Village uses 4,144,080kWh annually, making up more than 10% of total energy consumed on campus, costing the university $305,216.90 in 2016 (FPL, 2017a), and holds the title as the campus’s highest energy consumer. This information is important because in order to know where to cut down on energy, it is important to understand where most of the energy is being used.

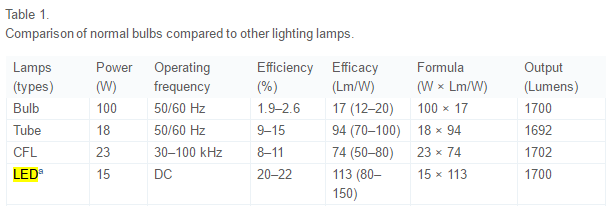
**Areas to Improve Energy Efficiency**

As Embry-Riddle grows, it would be beneficial to grow in energy efficiency as well. Per a 2014 energy audit, written and conducted by a team of students led by Akash Raigangar, if Embry-Riddle cut back on energy wasted by turning off lights, computers, and projectors at night, the Daytona Beach campus could cut back on about 10% of the energy consumed on campus. That is the same amount of energy consumed in the Student Village, meaning that the same amount of energy wasted by the university equates to the amount of energy used in the largest energy consuming building on campus.

***Lighting***

Little thing such as lighting can have a larger impact when calculated on a large scale, such as a campus like Embry-Riddle. In a personal interview, Blake Klockenga, the Building Auto/Energy Specialist for Embry-Riddle Aeronautical University, provided a description of the types of light bulbs used on campus: “We mostly have T8 compact fluorescent lamps, and some T5 bulbs” (March 7, 2017). The T8 compact fluorescent lamps (CFLs) are what are used inside the dorms. There are about 18 individual rooms per floor of Wood Hall, and there are four floors of rooms in that residence hall, making about 72 individual rooms in Wood Hall. Per dorm room, there are two T8 bulbs, resulting in 144 T8 bulbs in only Wood Hall.

On a larger scale, if you take into consideration all floors of dorms in the Student Village, there are approximately 414 dorm rooms. If there are 818 T8 fluorescent lamps in the dorms in the Student Village, replacing every single one of those could have many positive effects. Chen and Chung researched the possibility retrofitting light emitting diodes (LEDs) with T8 fluorescent tubes and they found that “replacing 36 W T8 fluorescent lamp with 20 W LED, would have around $288 saving in 5-year operation” (as cited in Ganandran, Mahlia, Ong, Rismanchi, & Chong, 2014). What this means is that by replacing all the fluorescent lamps, in an operational span of five years could save the University upwards of $8,000. Another benefit that could transpire from this transition, can be found in the study, where the authors state that “LEDs cost higher than T8 to T5 converters but LED tubes have a significantly extensive lifespan of almost five times more dependent on the quality” (as cited in Ganandran, Mahlia, Ong, Rismanchi, & Chong, 2014). This means, that as well as saving money just through the less amount of energy used it will save money due to the decrease in repairing and replacing the bulbs.

Dr. Nasrullah Kahn from the Department of Electrical Engineering of Comsats Institute of Information technology published a study comparing different lighting sources. In his article, he stated “LEDs and electrode less induction lamps have 9–10 times longer lives compared to CFL. They have higher PF (power factors) and lower THD (measure of distortion) compared to CFL” (Kahn, 2011). He provided Table 1, pictured below.

(Khan., 2011).

LED is shown highlighted since that is the source of lighting of interest. Under the ‘operating frequency’ it has DC, which means direct current. Having a DC lighting system is more efficient because it doesn’t need as much energy flowing to it, consequently, it can be more easily powered by sources such as solar panels. The Efficacy column measures Lm/W (Lumens per Watt) which is the measure of how well the light source produces visible light. This information is significant because by using less power (W), the light source has a higher efficiency and efficacy. According to Lowe’s website, a 2 pack of “Utilitech 2-Pack 32 W Equivalent Bright White T8 LED Tube Light Bulbs” is about $14, so two dollars per tube light bulb (Lowes, n.d.). At this price, it would cost about $5726 for the bulbs. Utilizing the ERAU specific crowd funding website, on campus fundraisers, and sponsorships, this number would be an easy feat.

***Monitor Power Management***

One way to create efficiency on campus would be to implement a monitor power management system (MPMS). The E.P.A. Energy Star program was created to "conduct a basic engineering research and technology program to develop, evaluate, and demonstrate non–regulatory strategies and technologies for reducing air pollution" (Energy Star, n.d.-a). Energy Star released a monitor power management campaign. Universities that have joined this campaign include The Harvard University Kennedy School of Government, Penn State campus,

University, and Tulane University (Energy Star, n.d.-b). A monitor power management system would automatically put a computer into low power sleep mode when not in use.

According to the Environmental Research Report team 97% of computers in the College of Business were left on after hours of operation, the team also determined that there are 73,660

computers on campus (2014). In an Energy Star report, they stated that “The Harvard University Kennedy School of Government (KSG), in partnership with ENERGY STAR, is saving more

than $14,000 a year on its energy bills by enabling 800 computer monitors to power down to sleep mode when not in use” (n.d.-b). If Embry-Riddle replicated this on the Daytona Beach Campus, then the university would see an equal number of savings to begin with, and if the system worked well, the university can increase the amount of computer monitors utilizing the program.

**Successful Implementations of Alternative Energy**

Embry-Riddle has already made strides in utilizing alternative energy sources. These strides show that the university is making attempts, and should be analyzed further to see how they can be implemented in other locations on campus.

*****Solar panels on top of the Student Center***

Figure 1 Google Earth Satellite Image of Solar Panels on top of Student Center, Embry-Riddle (2017)

There are four solar panels on top of the Student Center, as shown in Image 1. These solar panels were considered an incredible success in terms of energy production. Four were installed to take care of all the water heating needs inside of the Student Center, due to how much was needed to cook all the meals, and clean all the dishes. These panels generated far more power than originally expected, and there was too much energy produced for the hot water heaters, so one of the panels got shut off.

Given the high success rate of this project, this same system should be implemented, if not in all of the residence halls, then the Student Village. This implementation could help create the energy used in producing the hot water for the cooking done in the restaurants, the laundry rooms, and the bathroom facilities, for showers or sinks.

**Thermal Energy Storage system (TES)**

A successful way that Embry-Riddle\* has embraced sustainable energy is through the Thermal Energy Storage system (TES). In an email, Mr. Klockenga described the system, stating that “The air conditioning system is a T.E.S. (Thermal Energy Storage) system. We build ice on off peak times and burn the ice at on peak. We have two TES plants that are combined together” (Personal Communication, March 3, 2017). These systems are located next to the Lehman building. In a state such as Florida, having this efficient cooling system helps keep the kWh down rather than wasting it on how much air conditioning campus would need. This air conditioning system is one example that the university does want to increase energy efficiency.

**Opportunities for Solar** **on Campus**

Embry-Riddle’s Daytona Beach campus has the potential for solar panels to help provide energy, especially given that is located in sunny Florida. With mechanical engineering students having an alternative energy track, and civil engineering students having an environmental track, implementing solar on campus could be accomplished by these students.

**M Building**

The M building has the potential to utilize solar energy. In Megan Fellman’s article for NorthWestern University, she discusses the Ford Motor Company Engineering Design Center. According to the article, two student groups worked for two years to fundraise “more than $117,000 from on- and off-campus sponsors and worked with many University groups” (Fellman, 2011) for a solar set up that generates an estimated 20,000 kWh. This number is more than estimated for the M Building charging station use, and because of this, putting solar panels on the M building would both counteract the impact of the charging station, and help power some of the machinery in the CNC and Lathe Machine lab. If Embry-Riddle could utilize on- and off-campus sponsors for this, as well as the online ERAU specific crowdfunding site to fundraise about 100,000 over the course of two years, then initializing the solar panels would have a net zero cost, and would begin to benefit the campus immediately.

**Incentives**

With these statistics in mind, with tuition at about $42,000 per undergraduate student per year, there are more than 70 students on campus whose tuition makes up only the energy on campus. Students come to Embry-Riddle for a better education, and for the prestige of the university.

The Mechanical Engineering Students already have some experience working with solar panels, as written about by James Roddey in his article “Embry-Riddle, Daytona State College Partner to Compete in U.S. Dept of Energy’s Solar Decathlon 2017” published in the Embry-Riddle Newsroom. In his piece, Roddey states that the Solar Decathlon “puts students’ classroom skills to the test in a real-life project that exemplifies teamwork across the disciplines of science, engineering, green technology and mathematics” (2016). Putting classroom skills to test is something the University prides themselves on.

The students in this College of Engineering and College of Business on the Daytona Beach campus could benefit from a solar implementation project, in the same way students at NorthWestern University did. Joshua Kaplan was the project manager for the Engineers for a Sustainable World Club, and a chemical engineering major participating in the development for his university (Fellman, 2011). After the project, he stated “I learned so much from this experience, from grant writing to project management” (as cited in Fellman, 2011). Embry-Riddle prides itself on preparing students for corporate work and actively encouraging students to do hands on work. Skills such as grant writing and project management are skills that are best obtained through actually applying them and it is for this reason, implementing a plan to begin a similar project, led by students would be beneficial to the students.

Accordingly, the University should be investing the student’s money into more grants, more research opportunities, or constant improvements on campus and not solely the energy consumed on campus.

**Conclusion**

Based on this research, it is feasible for Embry-Riddle to convert to more sustainable energy and solar energy. This transition would be beneficial to Embry-Riddle Aeronautical University due to the fact campus uses so much energy which takes up the budget, and the fact that the sustainable revolution is falling over the country, and as a leading school, Embry-Riddle should participate in this. This transition would be able to be accomplished for some aspects almost immediately, and other aspects, such as solar panels, it could take up to two years, but would have long term savings.

**Recommendations**

**For Environmental Committee**

**Collaborate with IT to install MPM Program**

The program provided by Energy star is free, and should be installed into computers in 24-hour computer labs. Tony Sharp is an IT Support Manager at the Daytona Beach campus, and his contact information can be found on the ERNIE people search. Reaching out to him should be the first step, from there, starting the installation would be most effective in the college of business labs.

**Work with the building Specialists**

Going through Randy Howard’s office assistants may be the best way to establish contact with the building specialists. Once contact is established, work together with them to switch the lightbulbs in the student village residence halls. Bulbs should be switched to 20 W LED bulbs. The best deal on bulbs at the time of implementation can be ordered from Utilitech online.

**Collaborate with Students and Professors**

Students in the Alternative Energy track of Mechanical Energy are always striding to achieve more experience with solar panels. If the Environmental committee initiated contact with the students and professors, they could discuss how much impact the students could make. The Environmental committee should also schedule a discussion meeting inviting any students, faculty, and staff that would like to know more about the transition and take part in it. From there, the committee should post information flyers around the Student Center, as well as collaborating with the school run newspaper to write a piece on it.

**Fundraise**

Embry-Riddle has an online crowdfunding site specific to on campus activities. The site has an online application and guidelines, of which this project fits. This application and the guidelines can be found at http://givingto.erau.edu/how-to-give/crowdfunding.shtml. Prospective donors should be further inspected, but could be started with local and state government.

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**Appendix**

Transcript of Personal Communication with Blake Klockenga

Email Interview, February 23, 2017- April 17, 2017

Klockenga, Blake J.

Thu 2/23, 9:41 AM

Alexis,

I am contacting you in regards to the request for information on electric usage and cost for the Daytona Beach Campus. Please contact me if you need further information.

Regards,

Blake Klockenga

Embry Riddle Aeronautical University

Bldg Auto/Energy Specialist

386-226-6632

klockenb@erau.edu

Smith, Alexis R.

Thu 2/23, 9:58 AM

Blake,

Thank you so much for this information it is extremely helpful. Is there anything that shows how much energy is used in what buildings? Also, I just wanted to verify, nothing on campus is powered by any alternative energy source, correct? I'm thinking specifically the M building, Considering that is where you can charge your electric car. I am meeting with Captain Lynch this coming Tuesday to specifically discuss student and faculty projects regarding this. I am writing a feasibility report about alternative energy sources on campus, hence why I'm asking all of these specific questions. Can I reference these documents in my report?

thank you,

Alexis Smith

Klockenga, Blake J.

Thu 2/23, 2:36 PM

600 S CLYDE MORRIS BLVD # M BLDG.pdf

Alexis,

Some buildings are on the same meter and others are on their own. Nothing is powered by renewable energy. I’ve attached M building energy usage. Yes you can reference them. If you need anything else just ask.

Blake

Smith, Alexis R.

Fri 3/3, 9:37 AM

Good Morning Blake,

I had a couple more questions.

Do you have any record of the air conditioning system behind the Lehman building, or The solar panels on top of the Student center?

also, can you give me a rough percentage of how much of the budget the energy makes up? (for most universities on average it hovers around 3%)

Thank you,

Alexis Smith

Klockenga, Blake J.

Fri 3/3, 2:31 PM

Alexis,

The air conditioning system is a T.E.S.( Thermal Energy Storage) system. We build ice on off peak times and burn the ice at on peak. We have two TES plants that are combined together. What kind of data are you thinking you need from it. The solar panels on the roof of Student Center are for hot water. The total budget for all campuses is $324 million(http://ir.erau.edu/Factbook/Financial/). Daytona Beach campus energy is $3.7 million. I don’t know Prescott and Worldwide energy budget. I think you would be safe to say roughly it would be 3%.

Regards,

Blake Klockenga

Embry Riddle Aeronautical University

Bldg Auto/Energy Specialist

386-226-6632

klockenb@erau.edu

Smith, Alexis R.

Fri 3/31, 1:06 AM

Hello Blake,

the lighting in the dorms, specifically student village, would those lights be the T8? If they are, it is 2 T8 per room, and 8 per suite correct?

thank you,

Alexis Smith

Smith, Alexis R.

Wed 4/12, 8:30 PM

Blake,

I have a few more questions, If you could provide feedback I would appreciate it.

Are the light bulbs used in professors offices on campus, T8 light bulbs?

do you happen to know which building on campus uses the most kWh?

Thank You,

Alexis Smith

Klockenga, Blake J.

Thu 4/13, 8:17 AM

Alexis,

Student Village uses the most kwh. The offices are mostly t8 and I.T. would know about the computers.

Blake

Smith, Alexis R.

Mon 4/17, 10:05 AM

Hi Blake, Just want to ask for your permission,

Is it OK if I cite these emails?

Klockenga, Blake J

Mon 4/17, 11:00 AM

That’s fine.