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14. ABSTRACT
Energy is a National Security Issue and therefore the nation must embark upon new ideas and methods of meeting its energy requirements. To meet this challenge, the nation must employ both energy conservation measures and alternative energy sources. The Cooperative Developmental Energy Program (CDEP) at Fort Valley State University (FVSU), in partnership with the Museum of Aviation located at Robins Air Force Base, proposes the development and implementation of energy investment strategies as a viable demonstration of the use of new workable energy technologies.

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Report Title

An Analysis of the Use of Energy Audits, Solar Panels, and Wind Turbines to Reduce Energy Consumption from Non Renewable Energy Sources

ABSTRACT

Energy is a National Security Issue and therefore the nation must embark upon new ideas and methods of meeting its energy requirements. To meet this challenge, the nation must employ both energy conservation measures and alternative energy sources. The Cooperative Developmental Energy Program (CDEP) at Fort Valley State University (FVSU), in partnership with the Museum of Aviation located at Robins Air Force Base, proposes the development and implementation of energy investment strategies as a viable demonstration of the use of new workable energy technologies.

First, this project will expand the opportunities for CDEP students to learn about energy conservation measures by being taught how to conduct energy audits on buildings located on the campus of FVSU and at the Museum of Aviation. Systems included are lighting, heating, ventilation, air conditioning, water usage, roof, and building envelope.

Secondly, CDEP students will assist in the collection and analysis of data gathered from the operations of solar panels and wind turbines as well as calculate the "green" impact of using solar and wind energy to reduce the amount of energy consumed from non renewable energy sources.

Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in peer-reviewed journals:

(b) Papers published in non-peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in non peer-reviewed journals:

(c) Presentations

Number of Presentations: 0.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received	Paper

TOTAL:

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received	Paper

TOTAL:

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

(d) Manuscripts

Received	Paper

TOTAL:

Number of Manuscripts:

Books

Received Book

TOTAL:

Received Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

Graduate Students

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Post Doctorates

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

NAME	PERCENT_SUPPORTED	National Academy Member
Isaac J. Crumbly	0.00	
Haixin Wang	0.33	
FTE Equivalent:	**0.33**	
Total Number:	**2**	

Names of Under Graduate students supported

NAME	PERCENT_SUPPORTED	Discipline
Brittany Brown	0.22	
DeVaughn Brown	0.22	
Brittney Crockett	0.22	
Patrick Cummings	0.22	
Brianna Daniels	0.22	
Joshuah Davis	0.22	
Marci Early	0.22	
Altony Hall	0.22	
Rickell Hardaway	0.22	
Allante Harrison	0.22	
Justin Hicks	0.22	
Jovon James	0.22	
Timothy Snow	0.22	
Brian Tucker	0.22	
Reggie Wootson	0.22	
Christain Falzone	0.22	
Carey Green	0.22	
Nicholas Jones	0.22	
Latisha Pryor	0.22	
Keith Roberson	0.22	
Asher Sampong	0.22	
Grant Tollett	0.22	
Shanice White	0.22	
Sheriece White	0.22	
Jaylan Dawson	0.22	
Ashley Davis	0.22	
Jazmin Bennett	0.22	
Christan Hill	0.22	
FTE Equivalent:	**6.16**	
Total Number:	**28**	

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period:	13.00
The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:......	13.00
The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:......	0.00
Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):......	7.00
Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:......	0.00
The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense	0.00
The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields:......	0.00

Names of Personnel receiving masters degrees

NAME

Total Number:

Names of personnel receiving PHDs

NAME

Total Number:

Names of other research staff

NAME	PERCENT_SUPPORTED
Lisa D. Rashidi	0.00
FTE Equivalent:	**0.00**
Total Number:	**1**

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

Technology Transfer

EXECUTIVE SUMMARY

Energy is a national security issue and, therefore, the nation must pursue new ideas and methods of meeting its energy requirements. To meet this challenge, the nation must employ both energy conservation measures and alternative energy sources. The Cooperative Developmental Energy Program (CDEP) at Fort Valley State University (FVSU) in collaboration with the Museum of Aviation (MOA) at Robins Air Force Base investigated the impact that energy audits could have on energy usage. Water audits were also conducted on seventeen buildings on the campus of FVSU.

A professional contractor, Valu-Tech Design Solutions (VTDS), was employed to conduct energy audits and instruct and train 28 students (15 students for summer of 2012 and 13 students for summer of 2013) on energy auditing and how to calculate potential energy savings. The students received hands-on training on how to conduct energy audits on four FVSU buildings and three MOA buildings and how to conduct water audits on seventeen FVSU buildings. Overall, the audits included electricity, natural gas, and water consumption. Systems evaluated included lighting, heating, ventilation, air conditioning, roof and building envelop, and water plumbing equipment.

Overall, the project results revealed that the four FVSU buildings could reduce the usage of energy ranging from 17 to 27.8 percent by installing direct digital control programming for room occupancy. Also, the study revealed that one MOA building could reduce energy usage by 27.8 percent by installing a more energy efficient geothermal ground source heat pump system. Water conservation studies showed that by installing faucets and shower heads with a reduced gallon per minute flow rate and a reduced gallon per flush for toilets and urinals, FVSU could reduce water usage by twenty percent.

Each student completed approximately 330 hours of classroom education and on-the-job training in the subjects of energy auditing/energy management. At the end of each 9 week internship experience, the students were presented with Certificates of Completion and Competency from VTDS which qualifies them to conduct field investigations of buildings, perform energy audit/savings calculations, and make sound energy conservation recommendations.

The student interns also received 30 hours each of instruction on solar and wind technology as renewable energy sources via lecture, research assignments, and simulation. However, the students and project team did not collect and analyze data from the actual operations of solar panels and wind turbines during the project period due to delays in receiving approval from the Georgia Board of Regents to install solar panels and wind turbines on the Fort Valley State University campus. The project's renewable energy objective will be accomplished during the post-project period, which will be ongoing for years to come. Additionally, the students took several fieldtrips to conferences, power plants, and other energy-related facilities.

In an effort to centralize data collection from solar panels and wind turbines, FVSU permitted the project to convert a 24' X 24' room in the Computer Technology and Mathematics building into a control room. The control room is used to collect and process the real time data from solar panels and wind turbine(s) including wattage, voltage, and amperage. Also, the control room will

measure in real time the impact that ambient environmental conditions such as temperature, cloud cover, and wind speed have on the generation of energy by solar panels and wind turbines. Additionally, the control room will also serve as an Energy Education and Research Center (EERC) for the University. The EERC will provide the FVSU and the external community with access to energy education and provide FVSU students and faculty with access to conducting energy research.

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I. INTRODUCTION

The project entitled, "An Analysis of the Use of Energy Audits, Solar Panels and Wind Turbines to Reduce Energy Consumption from Non Renewable Energy Sources,' was conducted on the campus of Fort Valley State University (FVSU). The Cooperative Developmental Energy Program (CDEP) at FVSU managed the project. The objective of the project was to engage STEM students and FVSU faculty in research related to energy conservation measures and two renewable energy sources, solar panels and wind turbines. The project expanded opportunities for CDEP students to learn about energy conservation measures; twenty-eight (28) students were taught how to conduct energy audits and the benefits of using renewable energy sources (such as solar panels and wind turbines) to generate energy.

The Museum of Aviation located at Robins Air Force Base was a partner in the project and served as one of the training sites for the students to conduct energy audits. The students also conducted audits on buildings located on the FVSU campus. The energy audits addressed electricity, natural gas, and water consumption. Systems included in the audits were lighting, heating, ventilation, air conditioning (HVAC), water usage, and roof and building envelope. Upon completing the audits for both the MOA and the FVSU campuses, the students along with Valu-Tech Design Solutions (VTDS) –a professional contractor hired to conduct energy audits and instruct and train the students on energy auditing-prepared a detailed assessment report of recommendations for potential energy savings.

Each student completed approximately 330 hours of education and on-the-job training in the subjects of energy auditing/energy management. At the end of the 9 week internship experience, the students were presented with Certificates of Completion and Competency from VTDS which qualifies them to conduct field investigations of buildings, perform energy audit/savings calculations, and make sound energy conservation recommendations. Additionally, the students involved in the project were all STEM majors and received funding for scholarships (included tuition, room and board, and mandatory fees); all students engaged in the project maintained a grade point average of 3.0 or above.

The student interns also received 30 hours each of instruction on solar and wind technology as renewable energy sources via lecture, research assignments, and simulation. However, the students did not collect and analyze data from the actual operations of solar panels and wind turbines during the project period due to delays in receiving approval from the Georgia Board of Regents to install solar panels and wind turbines on the Fort Valley State University campus. This project objective will be accomplished during the post-project period, which will be ongoing. Additionally, the students took several fieldtrips to conferences, power plants, and other energy related facilities.

During the academic-year, the students met five weekends (once a month) for three hours each week with VTDS audit instructor and audit engineers. The purpose of these sessions was to familiarize students with an introductory level of exposure to energy auditing and to prepare them for their summer internships in energy auditing. Topics covered consisted of energy unit conversion, analysis of utility bills, incorporating benchmarking studies, analyzing lighting systems, and HVAC systems.

Three mobile SolaRover solar power units (Mohave 3, 3.06 kW solar array; Alvord 2.0 kW solar array with an AirDolphin Pro wind turbine attached; and an Alvord Drone 2.0 kW solar Array) were purchased for the project. Also, to assist with transporting the student interns to the Museum of Aviation for training on energy auditing and various fieldtrips, a twelve passenger Ford Econoline van was purchased. The van will also be used to transport the mobile solar panel units to various sites to promote education on renewable energy.

FVSU permitted the project PI to convert a 24' X 24' room in the Computer Technology and Mathematics building into a control room. The control room is used to collect and process the real time data from solar panels and wind turbine(s) including power (wattage) voltage (potential), and current (amperage). Also, the control room will measure in real time the impact that ambient environmental conditions such as temperature, cloud cover, and wind speed have on the generation of energy by solar panels and wind turbines. Additionally, the control room will also serve as an Energy Education and Research Center (EERC). The EERC will provide the FVSU and the external community with access to energy education and provide FVSU students and faculty with access to conducting energy research.

II. RESEARCH FINDINGS

A. Energy Auditing and Recommended Energy Conservation Measures

Valu-Tech Design Solutions (audit engineers accompanied by student interns) performed professional energy audits on four buildings at the Fort Valley State University Campus and three buildings at the Museum of Aviation (MOA). The audits focused on heating, ventilation and air conditioning (HVAC), water, and lighting systems. The audits typically began with existing data collection (drawings, equipment specifications, usages, etc.) and continued through discussions with site staff, on-site system verification, analysis, and recommendations.

1. Fort Valley State University (FVSU) Buildings and Descriptions

Academic Classroom & Lab Building (ACL Building), Computer Technology & Mathematics Building (CTM Building), Patton Hall, and Wildcat Commons 2

Academic Classroom & Laboratory Building (ACL)

Constructed in 2009, the ACL building primarily consists of classrooms, computer labs and faculty offices. Between the two wings of the building, there is a large open atrium with skylights. It is a brick structure, consisting of approximately 22,100 sq. ft. on the 1^{st} floor, 19,900 sq. ft. on the 2^{nd} floor, and 18,700 sq. ft. on the 3^{rd} floor (60,700 sq. ft. total). There is no basement.

The roof is sloped over the entire 3rd floor. It is insulated with 6" of fiberglass (R-24) directly under the roof sheeting. There is an attic. The net (less window area) wall area of ACL building is about 23,200 sq. ft. The walls are brick and metal stud construction with 10" of rigid insulation. The insulation value is probably R-24. The building has about 14,400 sq. ft. of tinted, double-pane windows including doors. The window area consists as a percent of gross wall area per the direction that the wall faces is as follows.

North – 30.1%South – 44.3%East – 33.6% West – 45.1%

The high fenestration percentage in all walls especially the south and west increases the building's solar heat gain tremendously. The dark tinting helps reduce this effect.

All of the classrooms, lecture hall, and hallways are lighted with T-8 fluorescents which provide an efficient lumen per watt ratio. The center atrium has a combination of fluorescent down lights and a few halogen lamps. The connected load of all the building lighting is 96.4 kilowatts. All lighting is manually controlled. Many lights were observed to be left on during evenings, weekends and holidays when they are not needed.

ACL's HVAC system consists primarily of a 380 ton water-cooled centrifugal chiller and a 2,610 MBH hot water boiler fired by natural gas which serve six (6) air handlers, 29 single duct variable air volume (VAV) boxes with hot water reheat coils, and 44 fan powered VAV boxes with hot water reheat coils. The chiller, boiler, and associated pumps are located in the 1st floor Mechanical Pump Room #119. The air handling unit or AHU-1 (14,000 CFM) is located in 1st floor Mechanical Room #130; AHU-2 (16,500 CFM) is located in 2nd floor Mechanical Room #234; AHU-3 (28,300 CFM) is located in the 3rd floor Mechanical Room #335; AHU-4 (13,700CFM) in located in 1st floor Mechanical AHU Room #112A; AHU-5 (13,600 CFM) is located in 2nd floor Mechanical AHU Room #213A; AHU-6 (10,200CFM) is located in the 3rd floor Mechanical AHU Room #315A. All six air handlers have a hot water pre-heat coil, a chilled water cooling coil. Only AHU's 2 and 3 have a 100% outside air economizer. AHU's 1, 2, and 3 have a 20% glycol energy recovery coil to pre-condition outside air. Temperature in the various rooms is regulated by the VAV and PIU boxes. The lab classrooms in the west wing contain 31 fume hoods and 24 vented cabinets which are served by six (6) exhaust fans @ 12,000 CFM each. The HVAC control system is a Honeywell Excel 5000 direct digital control (DDC) system. The supply fans on all six AHUs have variable frequency drives (VFDs) to adjust for duct static pressure. There are no VFDs on any other mechanical equipment. The control system is not programmed with an evening, weekend, or holiday temperature setback schedule, or for "occupied" / "unoccupied" modes. All AHUs and some fans run constantly 24/7/365. This was confirmed by on-site discussions with a Honeywell Controls service person on June 20, 2012.

The ACL building energy audit revealed that signification saving could be achieved by: (1) Programming automatic reset control on HVAC chiller; (2) Using thermostat set-points; (3) Install photo sensors in large lobby and; (4) Install occupancy sensors in classrooms. Table 1 shows the annual saving for each recommendation in terms of kilowatt (kW) usage, annual savings in dollar amount base on $0.076 per kW, dollar costs for improvement, and the payback time to cover the costs for improvement in months and years. Thus, Table 1 reveals that automating reset control on the chiller requires two months payback time; installing thermostat set points four months; installing photo sensors and tine control in lobby eight months; and installing occupancy sensors in classrooms 2.3 years.

Table 1. Energy Conservation Measures and Payback Period - ACL Building

Academic Classroom and Laboratory Building (ACL)

Recommendations, Savings, and Projected Payback

Assessment Recommendations	Annual Electric Savings (kWh)	Annual Financial Savings	Total Cost	Payback (years)
Programming automatic reset control of chiller	147,549	$11,213.72	$2,000.00	2 months
Thermostat Setpoints	435,964	$30,133	$10,000	4 months
Install Photo sensors and time controls in lobby	5,798	$440.65	$330.00	8 months
Install Occupancy Sensors in classrooms	139,224.6	$10,581.07	$24,360.00	2.3 yrs
Total Potential Savings	728,535.6	$52,368.44	$36,690.00	

Benchmarking is the process of measuring, comparing, and tracking a building's energy consumption and is a critical step to understanding and reducing a facility's energy consumption and carbon footprint. Benchmarking compares a building's key performance energy metrics to similar buildings in a similar environment to determine a building's energy efficiency and cost reduction. The three classroom buildings on FVSU's campus were also subjected to benchmarking analysis. Table 2 shows the ACL building's annual energy consumption was 2,382,320 kW for 60,700 sq. ft. which resulted in exceeding the regional benchmark by 2.4 times.

Table 2. Facility Benchmark – ACL Building

Facility Benchmark ACL Utility Usage Benchmark				
Energy Usage	**Square Footage**	**Actual Benchmark (kWh/SF/yr)**	**Regional Benchmark**	**Compared to Benchmark**
2,382,320	60,700	39.2474	16.0	2.4x times

Assessment Recommendations

By programming the ACL building's DDC system and the fume hood control system to use "occupied/unoccupied" schedules and settings, the minimum annual savings is predicted to be about 673,600 kWh, Table 3. . Installing a programming DDC system can reduce energy usage by 28 percent.

Table 3. Assessment and Recommendation – ACL Building

Building	Recommendation	Current annual energy cost ($/yr)	Projected Cost Energy savings ($/yr)	%	Improvement cost($)	Payback (yrs)
ACL Building	Programming DDC systems & Occupancy sensor	$184,151	$51,700	28%	$ 51,663	1

Computer Technology & Mathematics Building

Constructed in 1994, the CTM Building is primarily classrooms and faculty offices. Between the two classroom wings, there is a large open atrium with clearstory windows. It is a brick structure, consisting of approximately 18,900 sq. ft. on the 1^{st} floor, 15,300 sq. ft. on the 2^{nd} floor, and 15,300 sq. ft. on the 3^{rd} floor (49,500 sq. ft. total). There is no basement or attic. There is a 3,600 sq. ft. auditorium on the 1^{st} floor.

The roof is flat and consists of 15,300 sq. ft. over the 3^{rd} floor and 3600 sq. ft. over the 1^{st} floor auditorium. It is estimated that the roof has an average of 3" rigid insulation which is approximately R-12.

The net (less window area) wall area of the CTM Bldg. is about 18,700 sq. ft. The walls are brick and block construction with 2" of rigid insulation. The insulation value is probably R-8. The building has about 6,280 sq. ft. of insulated, double-pane windows including door glass. The window area as a percent of gross wall area per the direction that the wall faces is as follows.

North – 4.7% South – 45.8% East – 45.8% West – 4.1%

The high fenestration percentage in the south and east walls increases the building's solar heat gain tremendously. All windows are tinted. All of the classrooms, lecture hall, and hallways are lighted with T-8 fluorescents which provide an efficient lumen per watt ratio. The center atrium has a combination of fluorescent and metal halide lamps. The connected load of all the building lighting is 78 kilowatts. The non-HVAC equipment consists of a few office copiers and PCs which are insignificant. All lighting is manually controlled. Many lights were observed to be left on during evenings, weekends and holidays when they are not needed.

CTM's HVAC system consists primarily of a 170 ton water-cooled centrifugal chiller and a 1,600 MBH hot water boiler fired by natural gas which serve four (4) air handlers, 22 single duct variable air volume (VAV) boxes with hot water reheat coils, and 15 fan powered VAV boxes with hot water reheat coils. AH-1 (11,200 CFM), AH-2 (11,200 CFM), the chiller and the boiler are located in the main mechanical room on the 1st floor. AHU-3 (21,815 CFM) is located in the 3rd floor mechanical room, and AH-4 (5,500) is located on the 2nd floor. All four air handlers have a hot water pre-heat coil, a chilled water cooling coil, and a 100% economizer. Temperature in the various rooms is regulated by the VAV boxes.

The CTM building energy audit revealed that signification saving could be achieved by: (1) Installing photo sensor in large lobby area; (2) Using thermostat set-points; (3) Replacing current EXIT lights with LEDs and; (4) Installing occupancy sensors in classrooms. Table 4 shows the annual saving for each recommendation in terms of kilowatt (kW) usage, annual savings in dollar amount base on $0.076 per kW, dollar costs for improvement, and the payback time to cover the costs for improvement in months and years. Table 4 reveals payback for installing photo sensors and time control in the lobby was three months; for thermostat set points 6 months; installing occupancy sensors in classrooms 1.03 years; and replacing EXIT lights with LEDs 1.5 years.

Table 4. Energy Conservation Measures and Payback Period - CTM Building

W.W.E. Blanchet Computer, Technology, and Mathematics Building (CTM)

Recommendations, Savings, and Projected Payback

Assessment Recommendations	Annual Electric Savings (kWh)	Annual Financial Savings	Total Cost	Payback (years)
Install MH,Photo sensors & time controls in lobby	20,176	$1,533.37	$370.00	3 months
Thermostat Setpoints	227,128	$17,261	$10,000	6months
Install Occupancy Sensors in classrooms	146,931.2	$11,166.77	$11,600.00	1.03yr
Reaplace current EXIT lights with LEDs	4467.60	$362.17	$525.00	1.5yrs
Total Potential Savings	398,702.8	$30,323.31	$22,495.00	

Table 5 benchmark analysis revealed that the CTM building energy consumption was 1.7 times higher than buildings in the region with similar metrics. By implementing the recommendations from the energy audit, the CTM building's energy consumption will be more aligned with benchmark achievement.

Table 5. Facility Benchmark – CTM Building

Facility Benchmark CTM Electric Energy Usage Benchmark				
Energy Usage	**Square Footage**	**Actual Benchmark (kWh/SF/yr)**	**Regional Benchmark**	**Compared to Benchmark**
1,353,300	49,500	27.3393	16.0	1.7x times

Assessment Recommendations

Table 6 revealed by programming the Blanchet CTM Building's direct digital control (DDC) system to use "occupied/unoccupied" schedules and settings, the minimum annual savings is predicted to be approximately 255,500 kWh. Installing a programming DDC system can reduce energy usage by 17 percent.

Table 6. Assessment and Recommendation – CTM Building

Building	Recommendation	Simulated annual energy cost ($/yr)	Projected Cost Energy savings ($/yr)	%	Improvement cost($)	Payback (yrs)
CTM Bldg	Programming DDC system	115,379.94	19,600	17%	11,500	0.6

Patton Hall Building

Constructed in 1937, the Patton Hall is currently home for music education. It is a brick structure, consisting of approximately 8700 sq. ft. on the 1st floor and 7500 sq. ft. on the 2nd floor (16,200 sq. ft. total). It has a partial basement consisting of storage and mechanical rooms. There is an attic above part of the second floor consisting of about 3,200 sq. ft. The building consists of classrooms, instructor offices, individual practice rooms, and large group practice rooms for the orchestra, and choirs.

The roof is steeply peaked above the 3,200 sq. ft. attic. The rest of the roof is flat with an approximate area of 5,500 sq ft. The flat roof areas have insulation. The original sloped roof does not. The net (less window area) wall area of Patton is about 12,500 sq. ft. It could not be verified as to how much insulation the wall contained. It is doubtful the original walls have any. The building has about 1,350 sq. ft. of insulated, double-pane windows including door glass. The window area as a percent of gross wall area per the direction that the wall faces is as follows.

North – 13.7% South – 2.1% East – 12.5% West – 9.4%

Lower fenestration percentage in the south and west walls is very good for reducing solar heat gain.

All of the rooms and hallways are lighted with T-8 fluorescents which provide an efficient lumen per watt ratio. The connected load of all the building lighting is 28.5 kilowatts. The non-HVAC equipment consists of a few office copiers and PCs which are insignificant. All lighting is manually controlled. Many lights were observed to be left on during evenings, weekends and holidays when they are not needed.

Patton Hall's entire HVAC system was replaced in 2001. The system consists primarily of a 50 ton air cooled package chiller and a 520 MBH (Thousands of British Thermal Unit per Hour) hot water boiler fired by natural gas which serves three air handlers and 26 single duct variable air volume (VAV) boxes. AHU-1 (7,300 CFM) and the boiler are located in the basement. AHU-2 (4300 CFM) is located in the attic, and RAH-1 sits on the flat roof above the west half of the building. All three air handlers have a hot water pre-heat coil and a chilled water cooling coil. Temperature in the various rooms is regulated by the VAV boxes. All the VAVs have hot water reheat coils.

The Patton building energy audit revealed that significant savings could be achieved by: (1) Installing thermostat set points and; (2) Implementing recommended changes in Table 7 which reveals that a significant reduction in kilowatt (kW) usage can be achieved annually. Savings in dollar amounts are based on $0.076 per kW. Payback time is calculated on estimated costs of installing recommended remedies times month or years it takes for savings to equal estimated cost of installing remedies. The audit predicted that the recommended remedies would result in an annual reduction of 51,409 kWh times $0.076 per kW will result in $3,907 in savings. The cost of the recommended remedies was estimated to be $10,000 resulting in 2.56 payback years.

Table 7. Energy Conservation Measures and Payback Period – Patton Hall

Robert W. Patton Hall Facility

Recommendations, Savings, and Projected Payback

Assessment Recommendations	Annual Electric Savings (kWh)	Annual Financial Savings	Total Cost	Payback (years)
Thermostat Setpoints	51409	$3907	$10,000	2.56 years

Table 8 benchmark analysis revealed that Patton Hall's energy consumption was 1.2 times higher than buildings in the region with similar metrics. By implementing the recommendations from the energy audit, the Patton Hall building's energy consumption will be more aligned with benchmark achievement.

Table 8. Facility Benchmark – Patton Hall

Facility Benchmark Robert W. Patton Hall Usage Benchmark				
Energy Usage	**Square Footage**	**Actual Benchmark (kWh/SF/yr)**	**Regional Benchmark**	**Compared to Benchmark**
314,970	16,000	19.68	16.0	1.2x times higher

Assessment Recommendations

By programming the Patton Hall DDC system to use "occupied/unoccupied" schedules and settings, the minimum annual savings is predicted to be about 48,600 kWh. Table 9 reveals a projected 12 percent savings with installing the recommended remedies with a payback time of 2.8 years.

Table 9. Assessment and Recommendation – Patton Hall

Building	Recommendation	Simulated annual energy cost ($/yr)	Projected Cost Energy savings ($/yr)	%	Improvement cost($)	Payback (yrs)
Patton Hall	Programming DDC system & Occupancy sensor	30,104.35	3,700	12%	10,500	2.8

Wildcat Commons #2 Building

Constructed in 2006, the Wildcat Commons 2 (WC#2) is a brick structure with pitched roof, consisting of 64 rooms with approximately 14,214 sq. ft. on the 1st floor, 14,214 sq. ft. on the 2nd floor, and 14,213 sq. ft. on the 3rd floor and 14,213 sq. ft. on the 4th floor (56,864 sq. ft. total). There is no basement.

The net (less window area) wall area of WC#2 is about 50,176 square feet. The walls contain R-13 batt insulation. The building has about 7,560 square feet of operable windows including door glass. The window area as a percent of gross wall area per the direction that the wall faces is as follows.

North –27 %   South – 27%   East –24%   West – 20%

Lower fenestration percentage in the south and west walls is very good for reducing solar heat gain. All of the rooms and hallways are lighted with T-8 fluorescents which provide efficient lumens per watt ratio. All lighting is manually controlled, except the hall ways lighting, which has no controls. Wildcat Commons 2 (WC2) entire HVAC system was installed in 2007.

Assessment Recommendations

As shown in Table 10, retrofitting the non-programmable thermostats with standalone VT7300C5000 thermostats with wireless communication card option will enable remote control. Also, the lighting level on the hallways is higher than the IESNA (Illuminating Engineering Society of North America) recommended lighting levels for a hallway (15-30fc); de-lamping the hallways will reduce the lighting energy use and also installing occupancy sensor or timer controls in laundry room and computer room. By implementing the recommendations of the energy audit, WC2 building can reduce energy usage by 20 percent.

Table 10. Assessment and Recommendation – WC2

Building	Recommendations	Current annual energy cost ($/yr)	Projected Cost Energy savings ($/yr)	%	Improvement cost($)	Payback (yrs)
WC2	De-lamping hallway fixtures	69,570.60	3,723	5%	0	immediate
WC2	Retrofit room thermostats		10,436	15%	40,000	3.8

a. Water Efficiency

As the nation and world's population increase, water resources are becoming increasingly scarce. Therefore, there is a need to reduce water consumption whenever possible. Congress issued the initial guidelines for flow control in various plumbing products via the Energy Policy Act of 1992. This Act regulated the volume of water that could flow through residential, commercial, and industrial plumbing equipment. The legislation also set maximum flow rates in gallons per minute (gpm) and gallon per flush (gpf) for the following classes of products[1]:

- Faucets and shower heads-2.5 gpm
- Faucet replacement aerators-2.5 gpm
- Pre-rinse spray valves-1.6 gpm
- Toilets-1.6 gpf
- Urinals- 1.0 gpf

[1] Thumann, Al, Willam J. Younger, and Terry Niehus. "Water Conservation." *Handbook of Energy Audits*. Eighth ed. Fairmont, 2010. 455-458. Print.

CDEP interns performed independent studies on water efficiency with the intent to assess the flow rates of existing plumbing equipment on the FVSU campus; make recommendations to install plumbing equipment that is more water efficient; and determine payback time for installation costs. The plumbing equipment (fixtures) that the students assessed consisted of comparing shower heads, urinals, and water closets with water efficient ones. Eighteen buildings were included in the study: twelve dormitories or student housing, three classroom buildings, one administration building, a student center, and a conference center. The buildings are listed below:

- Boyd Hall Dormitory
- Davison Hall Dormitory
- Jeanes Hall Dormitory
- Josephine Hall Dormitory
- Moore Hall Dormitory
- Wildcat Commons Building 1
- Wildcat Commons Building 2
- Wildcat Commons Building 3
- Wildcat Commons Building 4
- Wildcat Commons Building 5
- Wildcat Commons Building 6
- Wildcat Commons Building 7
- Troup Administration Building
- Horace Mann Bond Academic Building
- Lottie B. Lyons Student Center
- Blanchet Computer Technology and Mathematics Building
- Academic Classroom & Laboratory Building
- C.W. Pettigrew Center

Statistics have shown that approximately 50% of water used indoors is utilized for sanitary purposes such as bathroom sinks, showers, urinals and toilets [2]. Most of the water fixtures within the buildings that were included in the auditing process varied from one building to another. From the information gathered during the auditing process, there were a total of 956 toilets, 870 shower heads, 1,582 bathroom faucets, and 154 laboratory faucets, each with a variety of brands and a variety of flow rates. Also, there were a total of 389 kitchen faucets, each with a variety of brands and flow rates.

The water supplied to the campus is purchased from the Fort Valley, GA Utilities Commission through a meter that is common to many of the buildings on campus. According to the available data, 39,711,632 gallons of water were consumed during the eight month period for the year 2011 at a total cost of $125,885.87 with an average cost of $3.17 per 1,000 gallons.

[2] *EPA*. Environmental Protection Agency. Web. 13 Apr. 2015.
<http://www.epa.gov/watersense/commercial/docs/watersense_at_work/#/58/zoomed>.

Table 11 describes the amount of savings in water usage that FVSU can achieve by: (1) changing urinals from 1.5 gpf to 1.0 gpf; (2) changing toilets from 3.5 gpf to 1.6 gpf; and (3) changing shower heads from 2.5 gpm to 1.5 gpm. Also Table 11 provides the analysis of annual savings in water usage (7,942,368g), money savings ($25,177.31), costs required to install water efficient plumbing equipment ($16,382.70), and payback time in years (0.65 year).

Table 11. Water Conservation Assessment, Recommendations and Payback Period

SAVINGS AND PAYBACK

Below is a breakdown of Fort Valley State University's savings opportunities:

Assessment Recommendations	Annual Water Usage Savings (gallons)	Annual Financial Savings	Total Cost	Payback (years)
Changing urinals from 1.5 gallons/flush to 1.0 gallons/flush	367,920	$1,166.31	$2,732.40	2.34
Changing toilets from 3.5 gallons/flush to 1.6 gallons/flush	1,800,288	$5,706.91	$9,408.00	1.65
Changing shower heads from 2.5 gallons/minute to 1.5 gallons/minute	5,774,160	$18,304.09	$4,242.30	0.23
Total Potential Savings	**7,942,368**	**$25,177.31**	**$16,382.70**	**0.65**

b. FVSU Implements Energy Conservation Measures

Following the results of energy auditing on the FVSU campus, the Office of Plant Operations (maintenance) began to implement one of the recommendations that resulted from the audits. The Office of Plant Operations began installing occupancy sensors to turn the lights off when classroom and offices are not occupied during the workweek and weekends. As of December 31, 2014, approximately 40 percent of the buildings on FVSU's campus have been equipped with occupancy sensors. The plan is to complete the installation occupancy sensors in all buildings by the end of 2016.

When funds become available, FVSU is planning to implement additional energy and water conservation measures recommended by the study associated with the HVAC systems, faucets and shower head flow rates, and gallons per flush for toilets and urinals. The PI and project team will continue to collect and evaluate data on an on-going basis. As a result of funding this project, the Office of Army Research and the overall public will benefit from future publications and conference meetings.

2. Robins Air Force Base Museum (RAFB) Buildings and Descriptions

1500 Eagle Building, 1506 Century of Flight, Building1507 WW II Scott Building

1500 Eagle Building

Constructed in 1991, the Eagle Building is the main building on the museum campus. In addition to housing many historical exhibits and aircraft, it contains theaters, conference rooms, a café, and the museum administration offices. When viewed from the sky, its basic shape is that of the US Air Force Roundel, with the insignia actually painted on the metal roof. It has a 120' diameter central rotunda that extends from the ground floor to the roof (approximately 54 feet). Three rectangular wings radiate from the rotunda. The north and south wings are three stories each. The west wing which contains the Scott Auditorium, gift shop and art gallery is only 2 stories. Construction drawings for the Eagle Building were fairly limited. Plan view dimensions and some wall sections were available, but there were no elevations or mechanical equipment drawings. No specifications were available. Original reflected ceiling drawings showing lighting were found.

The entire building is metal construction. The blue color metal roof has 8 inches of fiberglass blanket beneath the sheeting, and the white walls are double skinned metal panels with 6 inches of insulation inside. The flat metal roof has an area of about 29,000 square feet. The net (less window area) wall area of the 3 story portion is about 45,000 square feet. There is about 3000 square feet of double pane blue-tinted windows on the building. Two all glass entrances with vestibules on the 1st floor add another 300 square feet of fenestration. Total floor area of the Eagle Bldg. is approximately 62,000 square feet.

The Eagle Building's lighting and non-HVAC equipment load was estimated to be 0.7 watts per square foot using data from the original reflected ceiling plans and field observations. Most of the lighting load in the Eagle Building is incandescent in order to provide good color rendition for the exhibits. Offices, conference rooms, café, restrooms and some hallways are lighted with T-8 fluorescents which provide very efficient lumens per watt ratio. The non-HVAC equipment consists of a few office copiers and PCs. The café kitchen has several refrigerators, warmers, and a hot dog warmer. The building HVAC system consists entirely of nine (9) self-contained, water-cooled air conditioners with hot water heating coils. They are located in mechanical rooms at various locations throughout the building. The total nominal cooling capacity of all nine units is 147 tons. Each unit has its own stand-alone electronic temperature controls. A single 175 ton cooling tower and pump provide condenser cooling water for all nine of the air conditioners. The pump is sized for 369gpm at 43 feet head. The tower is located outdoors on the east side of the building, and the pump is in a ground floor mechanical room. A 1.2 million BTUH natural gas hot water boiler serves the heating coils in all nine A/C units. A single 1.5 hp inline pump circulates the hot water around the building.

Assessment Recommendations

This section is an Executive Summary of some of the Assessment Recommendations that were made following field measurement and verification.

1500 Eagle Building

Retrofit 1991 vintage water-cooled air conditioners with hot water reheat coils for its cooling and heating system which are old and very inefficient with geothermal ground source heat pump (GSHP) systems which is significantly more energy efficient than traditional water source heat pumps that employ a cooling tower and boiler. Loop temperatures for the traditional approach are typically in the range of 60 to 90^0F, while ground sources are typically in a tighter, 60 to 70^0F range (Table 12). The GSHP units investigated have an Energy Efficiency Ratio or EER of 17.5 at 68^0F loop temperature.

Table 12. Assessment and Recommendation – 1500 Eagle Building

Building	Recommendation	Current annual energy cost ($/yr)	Projected Cost Energy savings ($/yr)	%	Improvement cost($)	Payback (yrs)
1500	Retrofit Vintage WSHP with GSHP	220,391.32	61,352	27.8%	480,000	7.8

1506 Century of Flight Building

This is a large climate controlled aircraft hangar which houses historical aircraft displays, a large banquet area, classrooms, and offices. No construction drawings were found.

Overall dimensions are 200 feet by 300 feet. Its height at the peak of the roof is about 41 feet and 34½ feet at the side walls. The floor slab is actually two levels. The western most 70 feet is 60 inches higher than the rest. Above the higher slab area is a 2^{nd} story. All of the offices, classrooms, and restrooms are located in the two stories of the raised slab area. The banquet area is on the lower slab of the hangar. The entire building is metal construction. The white color metal roof has 8 inches of fiberglass blanket beneath the sheeting, and the white metal walls have 6 inches of fiberglass blanket on the inside. The insulation vapor barrier is exposed at both the roof and walls. An additional decorative skin has been added to the west exterior wall. The roof is slightly sloped and has an area of 60,000 square feet. The walls average about 34 feet high, so the total wall area is 34,000 square feet. The Century of Flight Hangar has no windows. The all glass entrance doors are on the west side and are the only fenestration. Total area is less than 100 square feet.

Lighting consists primarily of high bay HIDs (High Intensity Discharge) and incandescent for small perimeter displays in the hangar area. The offices, classrooms, and restrooms have fluorescent lighting. The wattage of the HID fixtures was not known. The fluorescent fixtures were the same as in the Eagle building. Therefore, lighting and non-HVAC equipment loads are estimated to be 0.5 watts per square foot.

It was recommended that the air cooled equipment remain for the time being especially considering the newness of the units. As needed, these units should be replaced with modern equivalents which will have higher energy efficiencies or also look into GSHP.

<u>1507 WW II Scott Exhibit Hangar Building</u>

This is another large climate controlled aircraft hangar constructed more recently which houses historical aircraft displays, and restrooms. Again, no construction drawings were found.

Overall dimensions are 200 feet by 300 feet. Its height at the peak of the roof is about 41 feet and 34½ feet at the side walls. As with 1506, the floor slab is two levels. The western most 70 feet is 60 inches higher than the rest. However, there are no offices, classrooms, conference rooms, banquet area, or 2nd story above the raised slab like in 1506. The entire 60,000 square feet of slab is used for aircraft display.

The entire building is metal construction. The white color metal roof has 8 inches of fiberglass blanket beneath the sheeting, and the white metal walls have 6 inches of fiberglass blanket on the inside. The insulation vapor barrier is exposed at both the roof and walls. An additional decorative skin has been added to the west exterior wall. The roof is slightly sloped and has an area of 60,000 square feet. The walls average about 34 feet high, so the total wall area is 34,000 square feet. The WWII Scott Exhibit Hangar has no windows. The all glass entrance doors are on the west side and are the only fenestration. Total area is less than 100 square feet.

Lighting consists primarily of high bay HIDs and incandescent for small perimeter displays in the hangar area. Restrooms have fluorescent lighting. The wattage of the HID fixtures was not known. The fluorescent fixtures were the same as in the Eagle Bldg. Therefore, lighting and non-HVAC equipment loads are estimated to be 0.5 watts per square foot. It consists primarily of four (4) rooftop type air conditioners with gas furnaces set on ground level pads around outside of the building. All have air-cooled condensers. The total cooling capacity of all the units is 110 tons. The total gas heating capacity is 1.2 million BTUH. Most of the HVAC equipment is less than 3 years old. So it is well within its useful life. Each air conditioner has its own programmable thermostat located inside the building near the return air intake grilles. Since the WWII Scott Exhibit Hangar does not have classrooms, conference rooms or a banquet area the number of people in the building will always be less than 50.

It was also recommended that the air cooled equipment remain for the time being especially considering the newness of the units. As needed, these units should be replaced with modern equivalents which will have higher energy efficiencies or also look into GSHP.

III. RENEWABLE ENERGY SOURCES: MOBILE SOLAR PANELS AND WIND TURBINES

Summer interns were instructed about various facets of Renewable Energy (via simulation), with special emphasis placed on solar and wind technology. However, the students did not collect and analyze data from the operations of solar panels and wind turbines during the reporting period due to delays in receiving approval from the Georgia Board of Regents to install solar panels and wind turbines on the Fort Valley State University campus. This project objective will be accomplished during the post-project period, which will be ongoing.

This project purchased three mobile solar power units (Mohave 3, 3.06 kW solar array; Alvord 2.0 kW solar array with an Air Dolphin Pro wind turbine attached; and an Alvord Drone 2.0 kW solar array) and paid a deposit on two 70 feet Skystream 2.4 kW wind turbines. The three solar panel arrays are shown in Figure 1. Although the project was unable to secure the two 70 feet Skystream 2.4 kW wind turbine due to the chosen vendor filing for bankruptcy, the Alvord 2.0 kW solar array is equipped with the Air-Dolphin wind turbine which will still permit the project to collect data on wind turbines.

Figure 1. Mobile Solar Units at Fort Valley State University (L-R) Mohave 3 solar array, Alvord Drone with Air Dolphin wind turbine, Alvord solar array

FVSU permitted the project to convert a room 24' X 24' into a control room. The control room is used to collect and process the real time data from solar panels and wind turbine(s) including power (wattage) voltage, and current (amperage). Also, the control room will measure in real time the impact of ambient environmental conditions such as temperature, cloud cover, and wind speed have on energy generation by solar panels and wind turbines.

Additionally, the control room will also serve as an Energy Education and Research Center (EERC). The EERC will provide FVSU and the external community with access to energy education and provide FVSU students and faculty with access to conducting energy research. The facility includes computer workstations, miniature wind turbines, miniature solar photovoltaic panels, data monitoring software, renewable energy monitors, educational wall displays, and LED smart monitors to display the real time data from solar panels and the Air Dolphin wind turbine attached to the Alvord Drone solar array in the field (Figure 2).

Figure 2. Student Interns Conducting Research in the Energy Education and Research Center

IV. STUDENT PARTICIPATION

This project was designed to involve students at every level of participation. Students participation included hands-on instructions on how to conduct energy and water audits, how to perform calculations, how to define and convert energy units, how to utilize benchmarking studies, how to analyze utility invoices (bills), how to evaluate energy systems (lighting, cooling, heating, etc.), and how to understand the many acronyms used in energy auditing such as HVAC, CFM, and VAV, to mention a few.

Students' participation consisted of Saturday sessions, summer internships, and fieldtrips.

Saturday Sessions

Instructors from VTDS conducted five Saturday sessions each year from October 2011 to April 2012 & October 2012 to April 2013. Each session consisted of a 3 hour classroom session where the students were taught fundamentals of performing energy audits on buildings. The goal was to provide the students with classroom exposure to introductory level energy auditing and to prepare students for hands-on energy auditing that they would receive during their summer internships. The topics covered during the Saturday sessions included:

- Unit Conversion

- Understanding Utility Bills Benchmarking Studies
- Lighting System Audit
- Introduction to HVAC (Heating Ventilation & Air Conditioning) Systems

Summer Sessions

VTDS provided a 9 weeks internship experience consisting of classroom as well as field training on energy auditing to 28 CDEP students between the periods of October 2011 to July 2012 (15 students) and from October 2012 to July 2013 (13 students).
The Robins Air Force Museum Buildings as well as the FVSU buildings were used for training in field measurement & verification. The interns developed an audit process to identify the most effective energy savings opportunities and prioritized them according to shortest payback period. The following steps were taken for the auditing process:

- Application of benchmarking techniques to compare/contrast from typical commercial buildings of its size, location, and age in the region using Commercial Building Energy Consumption Survey (CBECS)
- Regression analysis of utility bills using Energy Explorer (Univ. of Dayton IAC software)
- Energy modeling using eQUEST (buildings on group metering system)
- Onsite walk through of facility to identify target areas of cost savings
- Calculation of possible energy savings highlighting those with immediate or shortest payback
- Presentation of written audit report detailing savings, maintenance recommendations as well as a precise description of audit findings

Before the audits were performed, the students spent the first half of the internship in the classroom where they were taught basic principles of energy engineering and how to do calculations, some of which included;

- Electricity rate structures
- Utility Analysis & Regression analysis
- Benchmarking studies using CBECS & RECS
- Load Characterization
- Building loads (Heating & Cooling) Calculations
- Degree day method & Bin Method
- Building Envelope
- HVAC Systems
- Codes & Standards (ASHRAE 62.1.& 90.1)

- Water Heaters
- Pumps
- Fans
- Lighting
- Energy Audits & Instrumentation
- Energy Accounting & Economics

Field Trips

To allow the students to observe how energy is produced and transferred as well as have an in-depth understanding of LEED design, field trips were taken to the following facilities:

- Plant Hatch (Nuclear power plant – Baxley, GA)
- Georgia Power Plant Scherer (Coal-fired power plant – Juliette, GA)
- Kinder Morgan/Southern Gas Compressor Station (Natural gas transporter – Thomaston, GA)
- Marathon Petroleum Company (Wholesale oils/fuel company – Columbus, GA)
- Wind Power Conference (Illinois State University – Bloomington, IL)
- Georgia Department of Fish and Game Education Center (**L**eadership in **E**nergy & **E**nvironmental **D**esign - LEED Facility – Perry, GA)
- The Museum of Aviation – Robins Air Force Base
- Florida Solar Energy Center (Cocoa, FL)
- Houston County Solid Waste Disposal Facility (Kathleen, GA)

Certification

CDEP interns each successfully completed 330 hours of classroom and on-the-job training in the subjects of energy auditing/energy management. The internship qualifies each student to conduct energy analysis field investigations of buildings, perform energy audit/ savings calculations, and make sound recommendations.

At the completion of the nine week course, the students presented (via a seminar) recommendations to the project staff and VTDS instructors potential energy savings for the FVSU buildings based on audit data. In recognition of their accomplishments, each student was presented with a Certificate of Completion.

V. CHALLENGES

A. Board of Regents Site Preparation Plan Approval

FVSU is a public funded institution of higher education for the state of Georgia and is governed by a Board of Regents (BOR) appointed by the Governor. Because FVSU is a public institution, a number of on-campus and off-campus projects must receive prior approval to the implementation of a project. Because the solar panels were scheduled to be placed on campus, it was considered a construction project. Also, all construction projects, regardless of funding source, must be authorized by the BOR and/or the Vice Chancellor for Facilities.

Previous Project Progress Reports have documented the delays in getting the approval to proceed with locating the solar panels and wind turbines on campus. On June 20, 2014, the Vice Chancellor for Facilities, Mr. Jim James, of the University System of Georgia gave approval to the President of Fort Valley State University, Dr. Ivelaw Griffith, to proceed with the project (Attachment #1). The Project PI and project team moved forward by constructing and completing the location site for the solar panels by October 29, 2014.

B. Bankruptcy of Wind Turbine Vendor

During the early stages of the project, the CEO of SOENSO Energy Company, Mr. Roger Cone, submitted a proposal to install two Skystream 3.7 wind turbines on 70' monopoles (Attachments #2 and #3). On July 20, 2012, the contractual agreement to install the two wind turbines was signed by appropriate Fort Valley State University officials (Attachment #4). On August 6, 2012, Mr. Cone sent a copy of a Certificate of Liability Insurance (Attachment #5) in support of his contractual agreement. In accordance with the contractual agreement, SOENSO received $40,500.00 to order the equipment. However, action to install the wind turbines was delayed due to Board of Regents approval for a site to place the structures. The project PI informed Mr. Cone that he would be contacted once the site was confirmed.

On August 15, 2013, Mr. Cone sent an email to inform the PI and staff that his company, SOENSO Energy Company, had filed a petition for bankruptcy (Attachment #6). The PI sent a copy of the email and the contractual agreement to Fort Valley State University's Legal Officer, Attorney Charles Jones, and asked him to follow up. Attorney Jones notified the PI that the debt for SOENSO was discharged in bankruptcy on November 7, 2013 (Attachment #7). According to Attorney Jones, since the debt was discharged, law provides that the University cannot attempt to collect monies paid to SOENSO for the wind turbines. Unfortunately, this financial loss for the project was an unforeseen event that could not be controlled by the project team.

Despite the challenges encountered, the overall project has been very successful. Additionally, it is with great joy that the PI and project staff are able to report that the campus site has been constructed and the SolaRover solar panels were installed on October 28-29, 2014. Also, the PI is happy to report that one of the SolaRover panels has a wind turbine attached which will enable the project team to collect data on the proficiency of both the use of solar panels and wind turbines in Georgia. The project team received training on the SolaRover units on October 29, 2014 and data collection is planned post project 2015.

VI. GLOSSARY

HVAC	Heating Ventilation & Air Conditioning
HID	High Intensity Discharge
MBH	Thousands of British Thermal Unit per Hour
ASHRAE	Association of Heating Refrigeration & Air conditioning Engineers
LEED	Leadership in Energy & Environmental Design
AHU	Air Handling Unit
CFM	Cubic Foot per Minute
VAV	Variable Air Volume
IESNA	Illuminating Engineering Society of North America
CBECS	Commercial Buildings Energy Consumption Survey
RECS	Residential Energy Consumption Survey
EER	Energy Efficiency Ratio
GSHP	Ground Source Heat Pump
kW	Kilowatt hour; 1000 watt hours
BTU	British Thermal Unit
BTUH	British Thermal Unit Per Hour
DDC	Direct Digital Control

VII. APPENDICES/ATTACHMENTS

ATTACHMENT #1

BOARD OF REGENTS OF
THE UNIVERSITY SYSTEM OF GEORGIA

JIM JAMES, VICE CHANCELLOR
270 WASHINGTON STREET, S.W
ATLANTA, GEORGIA 30334

PHONE: (404) 962-3155
FAX: (404) 962-3188
JIM.JAMES@USG.EDU

June 20, 2014

Ivelaw Lloyd Griffith, Ph.D.
President
Fort Valley State University
1005 State University Drive
Fort Valley, Georgia 31030-4313

Re: **BR-64-1204 - Energy Audit and Renewable Energy Program**

Dear President Griffith:

Your letter dated May 19, 2014 regarding construction of an area containing solar panels on the Fort Valley State University campus has been received and reviewed. As you note, a project concept proposal was initially submitted for integrated review in December 2011. The review considered the entire grant-funded project totaling $1.552M. Construction of a renewable energy park containing wind turbines and solar panels, and including lab space and connection to an existing facility to offset power usage, was one component of the project. The review was completed in March 2012 and the project approved by Chancellor Huckaby under his delegated authority from the Board in June 2012.

Based on your most recent letter, it is our understanding that you are ready to proceed with construction of a stand-alone, fenced gravel area to house solar panels for student access and study, at an estimated cost of $15,000 from the grant funds. Thank you for this update, and please continue to keep FVSU's assigned Program Manager, Samson Oyegunle, informed as to the specific siting of the area, necessary security measures, and any future construction plans relating to this approved project.

Sincerely,

Jim James
Vice Chancellor for Facilities

cc: Lynn Hobbs, Vice President for Business & Finance, FVSU
Govindarajan Kannan, Interim Provost & Vice President for Academic Affairs, FVSU
Dwayne Crew, Associate Vice President for Business & Finance, FVSU
Melissa Lee, AVP for Business & Finance & Controller, FVSU
Dr. Isaac Crumbly, Director CDEP, FVSU
Samson Oyegunle, Program Manager, BOR
Sharon Pope, Assistant Vice Chancellor, BOR
Sandra Neuse, Assistant Vice Chancellor, BOR

soenso energy
Renewable Energy Integrators

PROPOSAL

July 11, 2011

Dr. Isaac J. Crumbly
Fort Valley State University
1005 State University Drive
Fort Valley, GA 31030-4313

Re: Skystream Windturbine

We propose to furnish and install a Skystream 3.7 at the FVSU campus. The Skystream is normally available with three different self supporting monopole towers. Until 7/19/11, the prices are as follows. We must take delivery prior to the 8/1/11 price increase. After 7/19/11 there will be a 10% price increase from Southwest Windpower. Documentation included.

Skystream with 45' tower - $24,000.00

Skystream with 55' tower - $27,000.00

Skystream with 70' tower - $30,000.00

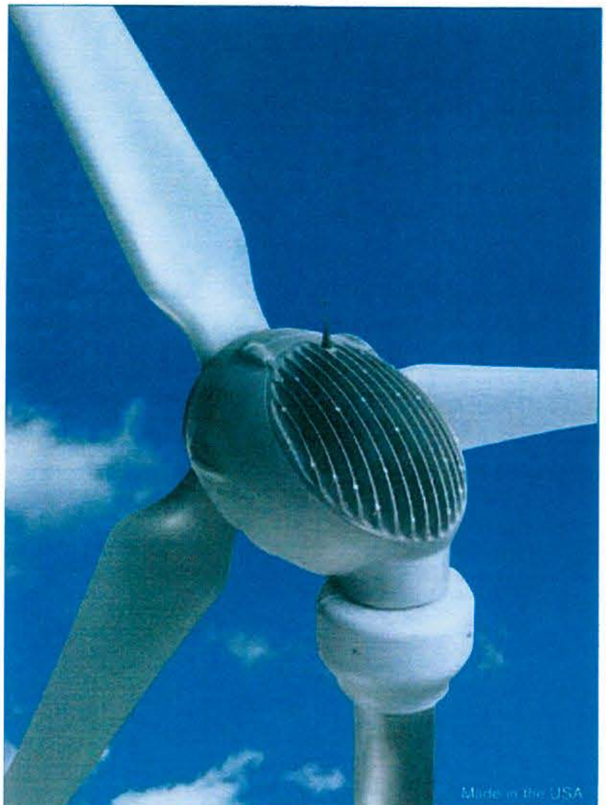
These prices do not include any sales tax or freight. Freight will be approximately $1,000.00 per system. Prices do include trenching and running the wiring to the electrical panel in the Mathematics and Computer Science building. This is from any of the three locations discussed during our site visit.

If we install at least two Skystreams at the same time there is a deduct of $500.00 off the total cost of the two systems. If we install at least three Skystreams at the same time there is a deduct of $750.00 off the total cost of the three systems.

The payment terms of this proposal are 60% on order entry; 30% upon shipment of the systems and the final 10% upon completion and commissioning.

Regards,

Roger K. Cone
Soenso Energy
Marietta, GA
770-973-6298
404-372-1797 cell
www.soenso.com



Technical Specifications

Model	Skystream 3.7
Rated Capacity	2.4 kW
Weight	170 lb (77 kg)
Rotor Diameter	12 ft (3.72 m)
Swept Area	115.7 ft^2 (10.87 m^2)
Type	Downwind rotor with stall regulation control
Direction of Rotation	Clockwise looking upwind
Blades	3-Fiberglass reinforced composite
Rated Speed	50 - 325 rpm
Maximum Tip Speed	216.5 ft/s (66 m/s)
Alternator	Slotless permanent magnet brushless
Yaw Control	Passive
Grid Feeding	Southwest Windpower inverter 120-240 VAC 50-60 Hz
Battery Charging	Battery sensor available for battery charging systems
Braking System	Electronic stall regulation with redundant relay switch control
Cut-in Wind Speed	8 mph (3.5 m/s)
Rated Wind Speed	29 mph (13 m/s)
User Control	Wireless 2 way interface remote system
Survival Wind Speed	140 mph (63 m/s)
Warranty	5 year limited warranty

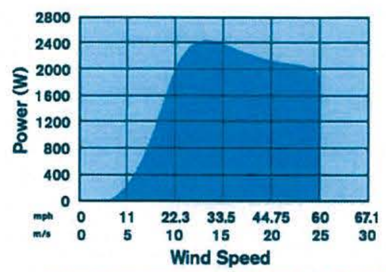
SKYSTREAM 3.7®

2.4 KW RESIDENTIAL POWER APPLIANCE

Skystream 3.7 is a breakthrough in a new generation of RPAs (Residential Power Appliances) that is changing the energy landscape of how homes and small businesses receive electricity. Skystream is the first fully integrated system that produces energy for less than the average cost of electricity in the United States and it produces usable energy in exceptionally low winds.[1]

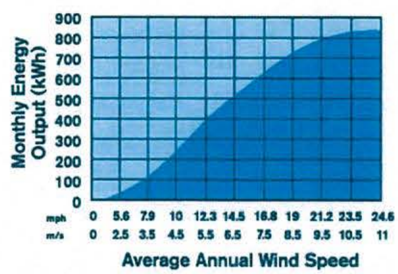
Skystream is available on towers ranging from 33 feet (10.2 m) to 110 feet (33.5 m)[2] tall. Its universal inverter delivers power compatible with any utility grid from 110-240 VAC. Skystream efficiently and quietly provides 40-90% of the energy needs for a home or small business. Any extra energy is fed into the grid spinning the meter backward.[3]

POWER



Data measured and compiled by USDA-ARS Research Lab, Bushland, TX

MONTHLY ENERGY



FIVE YEAR WARRANTY

1. Based on a 12 mph (5.4 m/s) wind and utility energy cost of $.09/kWh
2. Taller towers are available
3. Assuming the Skystream 3.7 is producing more energy than the load is consuming

Printed on recycled paper using vegetable inks.

ATTACHMENT #4

CONTRACTUAL AGREEMENT

This is a contractual agreement for the attached invoice #SS-85.

This contract covers furnishing, installing and commissioning a quantity of two Skystream Windturbines with 70' self supporting monopole towers. This includes the foundation, trenching and running the wiring to the electrical panel in the Mathematics and Computer Science Building.

The total amount of this contract is $67,500.00 to be paid as follows:

60% on order entry - $40,500.00

20% upon shipment - $13,500.00

20% upon completion - $13,500.00

With a copy of this signed contract and a check for $40,500.00, we will place the equipment on order and schedule installation.

Roger K. Cone
President
Soensa Energy

(Proposer Signature)

7/19/12
(Date)

Isaac Crumbly, PhD
Director C.D.E.P.
Fort Valley State University

(Acceptance Signature)

7/20/2012
(Date)

Julius Scipio, PhD
V.P. for Academic Affairs
Fort Valley State University

(Acceptance Signature)

7/20/12
(Date)

Crumbly, Isaac

From:	Roger Cone <roger@soenso.com>
Sent:	Monday, August 06, 2012 10:36 AM
To:	Crumbly, Isaac
Subject:	Insurance Certificate
Attachments:	Ins Cert.pdf
Importance:	High

I know the insurance company sent you this but just in case I have attached another copy.

Regards,

Roger K. Cone
soenso solar
Marietta, GA
770-973-6298
404-372-1797 cell
www.soenso.com

SITE HOSTED WITH
100% SOLAR ENERGY

ATTACHMENT #5

ACORD®

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 7/31/2012

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER FOSTER & WITMER 911 Duluth Highway, Suite D1 Lawrenceville, GA 30043	CONTACT NAME: PHONE (A/C, No, Ext): 770-717-7380 FAX (A/C, No): 770-717-7482 E-MAIL ADDRESS:
	INSURER(S) AFFORDING COVERAGE — NAIC #
	INSURER A: The Hartford
INSURED Soenso Energy Inc. Southern Environmental Solutions Inc DBA, 2010 Country Squire Rd. Marietta, GA 30062	INSURER B:
	INSURER C:
	INSURER D:
	INSURER E: The Hartford
	INSURER F:

COVERAGES CERTIFICATE NUMBER: REVISION NUMBER:

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	GENERAL LIABILITY COMMERCIAL GENERAL LIABILITY CLAIMS-MADE / OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: POLICY / PRO-JECT / LOC			20SBMEZ6635	10/31/11	10/31/12	EACH OCCURRENCE	$ 1,000,000
							DAMAGE TO RENTED PREMISES (Ea occurrence)	$ 300,000
							MED EXP (Any one person)	$ 10,000
							PERSONAL & ADV INJURY	$ 1,000,000
							GENERAL AGGREGATE	$ 2,000,000
							PRODUCTS - COMP/OP AGG	$ 2,000,000
								$
	AUTOMOBILE LIABILITY ANY AUTO ALL OWNED AUTOS / SCHEDULED AUTOS HIRED AUTOS / NON-OWNED AUTOS						COMBINED SINGLE LIMIT (Ea accident)	$
							BODILY INJURY (Per person)	$
							BODILY INJURY (Per accident)	$
							PROPERTY DAMAGE (Per accident)	$
								$
	UMBRELLA LIAB / OCCUR EXCESS LIAB / CLAIMS-MADE DED / RETENTION $						EACH OCCURRENCE	$
							AGGREGATE	$
								$
E	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) Y/N: Y If yes, describe under DESCRIPTION OF OPERATIONS below	N/A		SWEZS6521	11/05/11	11/05/12	✓ WC STATU-TORY LIMITS / OTH-ER	
							E.L. EACH ACCIDENT	$ 100,000
							E.L. DISEASE - EA EMPLOYEE	$ 100,000
							E.L. DISEASE - POLICY LIMIT	$ 500,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

Solar Power Systems

Project: Skystream Windturbines
email: crumbli@fvsu.edu & roger@soenso.com

CERTIFICATE HOLDER	CANCELLATION
Fort Valley State University Attn: Isaac Crumbly, PhD Director CDEP 1005 State University Drive Fort Valley, GA 31030	SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS. AUTHORIZED REPRESENTATIVE Vicki Strickland

Crumbly, Isaac

From:	Roger Cone <roger@soenso.com>
Sent:	Thursday, August 15, 2013 9:16 PM
To:	Crumbly, Isaac
Cc:	Hodges, Jackie; Rashidi, Lisa D.
Subject:	Status
Importance:	High

Dr. Crumbly, Jackie and Lisa,

I hope you are all doing well and about to get back into the swing of a new year.

I am sure that by now the school has gotten a letter about my status. Soenso Energy is no longer and I have filed a petition for bankruptcy. We tried to make it for almost nine years but when Southwest Windpower went out of business and Schüco Solar (our solar supplier) left the US, we were unable to recover.

I have never taken a salary from Soenso but invested all my life savings, retirement account and much debt, sweat and tears to promote renewable energy. Obviously my timing was off or I did not have the right connections.

I think about you everyday but I have been too embarrassed to call. I like all of you a lot and have really enjoyed our time together. We have not talked since March so I don't know what your plans are for the project but if you decide to go forward I will help you in any way I can. I no longer have installers or insurance or money but I could possibly help with finding a different windturbine manufacturer and assisting in lining up the other trades necessary for the install.

This has been a long and stressful process for all of us. I am very sorry it turned out this way.

Sincerely,

Roger K. Cone
Marietta, GA
770-973-6298

UNITED STATES BANKRUPTCY COURT

Northern District of Georgia

In Re: Debtor(s)
Roger Keith Cone
2010 Country Squire Road
Marietta, GA 30062

xxx–xx–9551

Case No.: **13–65970–bem**
Chapter: **7**
Judge: **Barbara Ellis–Monro**

DISCHARGE OF DEBTOR

It appearing that the debtor is entitled to a discharge,

IT IS ORDERED that the debtor is granted a discharge under § 727 of title 11, United States Code, (the Bankruptcy Code).

Barbara Ellis–Monro
United States Bankruptcy Judge

Dated: November 7, 2013

Form 7do

SEE THE BACK OF THIS ORDER FOR IMPORTANT INFORMATION REGARDING THE BANKRUPTCY DISCHARGE IN A CHAPTER 7 CASE

FORM 7do continued (10/05)

EXPLANATION OF BANKRUPTCY DISCHARGE IN A CHAPTER 7 CASE

This court order grants a discharge to the person named as the debtor. It is not a dismissal of the case and it does not determine how much money, if any, the trustee will pay to creditors.

Collection of Discharged Debts Prohibited

The discharge prohibits any attempt to collect from the debtor a debt that has been discharged. For example, a creditor is not permitted to contact a debtor by mail, phone, or otherwise, to file or continue a lawsuit, to attach wages or other property, or to take any other action to collect a discharged debt from the debtor. [In a case involving community property: There are also special rules that protect certain community property owned by the debtor's spouse, even if that spouse did not file a bankruptcy case.] A creditor who violates this order can be required to pay damages and attorney's fees to the debtor.

However, a creditor may have the right to enforce a valid lien, such as a mortgage or security interest, against the debtor's property after the bankruptcy, if that lien was not avoided or eliminated in the bankruptcy case. Also, a debtor may voluntarily pay any debt that has been discharged.

This discharge does not affect any property of the estate as defined by section 541 of the Bankruptcy Code, and the automatic stay of section 362(a) of the Bankruptcy Code continues to apply to any property of the estate unless and until the automatic stay has been terminated by order of the court or expires pursuant to section 362(c) of the Bankruptcy Code. Such property remains subject to administration by the trustee on behalf of the bankruptcy estate.

Debts That are Discharged

The chapter 7 discharge order eliminates a debtor's legal obligation to pay a debt that is discharged. Most, but not all, types of debts are discharged if the debt existed on the date the bankruptcy case was filed. (If this case was begun under a different chapter of the Bankruptcy Code and converted to chapter 7, the discharge applies to debts owed when the bankruptcy case was converted.)

Debts that are Not Discharged.

Some of the common types of debts which are not discharged in a chapter 7 bankruptcy case are:

a. Debts for most taxes;
b. Debts incurred to pay nondischargeable taxes (in a case filed on or after October 17, 2005);
c. Debts that are domestic support obligations;
d. Debts for most student loans;
e. Debts for most fines, penalties, forfeitures, or criminal restitution obligations;
f. Debts for personal injuries or death caused by the debtor's operation of a motor vehicle, vessel, or aircraft while intoxicated;
g. Some debts which were not properly listed by the debtor;
h. Debts that the bankruptcy court specifically has decided or will decide in this bankruptcy case are not discharged;
i. Debts for which the debtor has given up the discharge protections by signing a reaffirmation agreement in compliance with the Bankruptcy Code requirements for reaffirmation of debts.
j. Debts owed to certain pension, profit sharing, stock bonus, other retirement plans, or to the Thrift Savings Plan for federal employees for certain types of loans from these plans (in a case filed on or after October 17, 2005).

This information is only a general summary of the bankruptcy discharge. There are exceptions to these general rules. Because the law is complicated, you may want to consult an attorney to determine the exact effect of the discharge in this case.

This Bankruptcy Discharge is an important document that you should retain in the event a copy is needed in the future. If you request a copy from the Clerk's Office at a later date, you will be required to pay a fee.