A New Energy/Education Partnership:

Shenandoah National Park and Energy-Oriented Students at JMU

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(*Editor's Note.* Energy engineering students need all the "hands on" experience they can get—and, unfortunately, few opportunities are available to them. This article describes a way for them to develop practical experience. The sponsor is a consortium of federal, nonprofit, and educational forces. This broad collaborative process is new. Hopefully, it will form a model for more educational programs to improve energy effectiveness. (Incidentally, lessons can be learned from the low-budget project described in this article which could be applied broadly, in far larger private or public efforts which must be built from the ground up.)

INTRODUCTION

Energy consumption at our national parks is a growing concern. Faced with tighter budgets, national parks are challenged with reducing energy consumption at their facilities. This is not an easy task. With some exceptions, energy managers at national parks, like many in the private sector, are occupied with day-to-day crises and have little time or resources available to analyze energy consumption data or develop strategic plans for implementing cost saving, energy conservation measures.

One currently unused resource that could provide assistance to park energy managers is local university students. Like James Madison University, many universities throughout the country have energy or environmental programs where large cadres of students are interested in obtaining "real world experience". These universities are often in close proximity to national parks. Students from these universities could assist park managers by conducting energy audits, assisting in data management, or designing renewable energy or energy efficiency projects.

The use of university students in assisting government or industry energy managers is not new. The DOE currently supports the Industrial Assessment Center Program (formerly the Energy Analysis and Diagnostic Center Program) where thirty universities throughout the country are funded to provide free energy audits to small and medium-sized industrial facilities. Also, from 1992-94 Nebraska Energy Office demonstrated a program where students conducted lighting audits on state buildings during summer breaks.[1] And, finally, some universities have internship programs where students can gain course credit, or at least experience, working for local companies on energy issues.[2]

However, as yet, the vast student resources of higher education have not been tapped by the National Park Service. Thus, in the summer of 1997, the following parties initiated a pilot project to develop a model for university-national park energy partnerships:

- National Park Service (NPS);
- U.S. Department of Energy's Federal Energy Management Program (FEMP);
- Alliance to Save Energy (ASK, a Washington, DC based non-profit organization devoted to improving energy efficiency throughout the public and private sectors);
- Shenandoah National Park (SHEN, located in western Virginia); and,
- James Madison University (JMU, located in Harrisonburg, Virginia)

Hopefully, other national parks and universities will be able to form mutually beneficial alliances like the one reviewed here.

THE PARTNERSHIP PROCESS

In order for NPS to meet the energy efficiency goals outlined in the Energy Policy Act of 1992 (EPACT), as well as various executive orders and internal directives, NPS would have to have help. Resources at the park service were limited, and many parks did not have the time, personnel, or budgets for conducting extensive energy analyses.

An idea was born to link university students and national parks in order to: (1) help the parks identify energy savings opportunities; (2) give students an opportunity to gain 'real world' problem-solving experience in the energy field; and, (3) provide public demonstrations of energy efficiency and renewable energy technologies at federal facilities. Maintaining a balance among these goals was a critical concern. For example, conducting a series of energy related activities that had no educational value to the university students would be a one-sided approach and not ideal; likewise, conducting activities that were solely academic and offered no practical benefits to the national park were also less than optimal.

In the pilot project, JMU students worked closely with energy managers, building managers, and various other personnel at SHEN. The JMU students were undergraduate students studying in the Integrated Science and Technology (ISAT) Program at JMU.[3] The ISAT program has at its core a science and technology curriculum, although students are taught many of the economic, political, and social issues that surround technical problems. In conducting the partnership activities, students used the full spectrum of ISAT skills; thus, many activities discussed in this report will likely be applicable not only to science and engineering departments, but also environmental studies, economic, political science, computer science, and education departments.

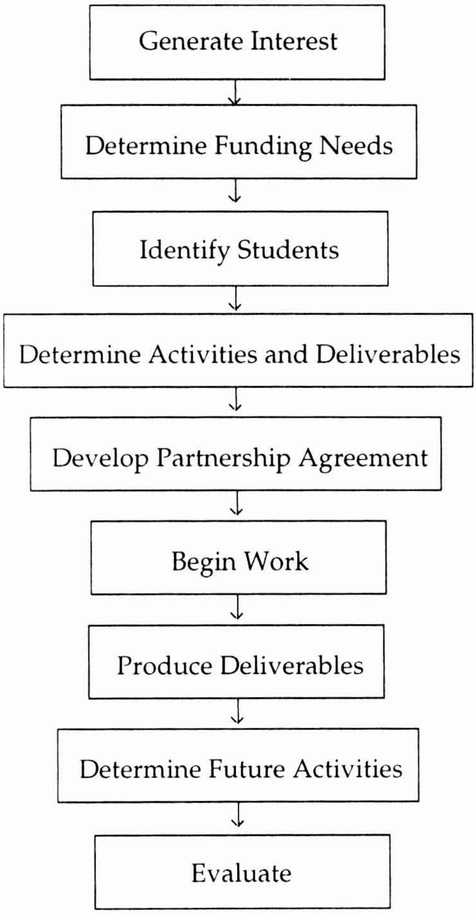
While JMU students and energy managers at SHEN worked on energy projects, ASK, FEMP, and NPS assisted the project through technical assistance, funding, and operational support. In particular, ASK acted as a liaison between the project and other public/private entities, primarily through the Federal Energy Productivity Task Force. ASK also provided critical data analysis and technical information on a variety of topics. NPS and FEMP offered guidance on how such a pilot project could be expanded and improved in order to incorporate its lessons into other parks and federal facilities.

The JMU-SHEN project proceeded along a course depicted in Figure 1.

Generate Interest and Make Contact

The first step in any partnership project is to contact potential part-

Figure 1. Stages of the Partnership Development Process



ners and gauge interest in the idea. In this case, the parties mentioned above met with energy managers at SHEN to discuss the idea. At these initial meetings much of the time was spent becoming acquainted with each other's skills and needs and building a comfortable working relationship. Subsequent meetings were used to delineate individual goals.

Pilot Project Funding

The JMU-SHEN pilot project included funding to provide income for three students for a summer, a stipend for the faculty member advising and training these students, supplies, and travel. The entire budget was less than $16,000. This budget includes efforts to record and develop the partnership as a model for other universities and parks. Thus, a budget of $10,000 may be a good target for summer-long partnership projects. This can fund 1-3 students for a summer, can provide some faculty support, and can assist in purchasing supplies and/or travel services.

Funding can come from a variety of sources. Certainly, each of the partners can contribute to the project. In addition, local utilities or other energy service companies, state governments, and private foundations may be tapped for financial support.

Identify Students

Arguably the most important ingredient in the energy partnership idea is the role the students play. Since the students will be doing the bulk of the analytical and energy-related work (with faculty guidance), they need to be responsible and skilled in the area they will be exploring. For the JMU-SHEN pilot project, an application process was conceived whereby ISAT students at JMU applied for the three summer positions.

Identify Activities and Deliverables

In early discussions about developing a model partnership, several activities emerged as good candidates for illustrating in a pilot program. The JMU-SHEN pilot project wanted to identify and 'test-drive' activities that could be adopted by typical universities and national parks nationwide. Having limited time and resources, the JMU-SHEN team tested activities that were applicable to a broad range of parks and universities, offered mutually beneficial experiences for students and parks, and covered a diverse range of skills and applications.

These activities (and others) were discussed extensively at initial meetings between SHEN and JMU. Activities needed to meet the following criteria:

(1) served the needs of the park;
(2) served the needs of the students;
(3) were not beyond the skill level of the students;

(4) did not require continual and comprehensive oversight by park personnel;
(5) could be done at the park and at the university;
(6) could be practicably completed over a given time frame; and,
(7) had the potential for actualization and implementation.

There are a variety of energy activities that can be carried out by students, ranging from data input to comprehensive building audits. From our discussions, the list in Table 1 was identified. This list is by no means complete, but merely presents some ideas that other partnerships may wish to pursue. Activities are grouped into four broad categories:

(1) Data Collection, Management and Analysis;
(2) Auditing and Use Assessment;
(3) Needs Assessment; and,
(4) Public Awareness.

The JMU-SHEN pilot project chose three activities to "test-drive": (1) conduct a Federal Energy Decision System (FEDS) analysis on several SHEN buildings; (2) conduct a renewable energy design analysis for several photovoltaic (PV) applications within SHEN; and (3) design and populate a database system for SHEN's utility bills. Again, these activities were chosen for their diversity, their relationship to student skills, and the practical benefits their results could provide to both SHEN and the students.

Table 1. Energy Activity Option List

Data Collection, Management, and Analysis

- Develop database system for utility/consumption data
- Collect data on maintenance for energy systems
- Develop and maintain database of equipment inventory and replacement
- Conduct trend analysis to determine consumption patterns
- Conduct analysis to determine seasonal patterns of consumption
- Conduct analysis to determine environmental problems associated with energy usage

Auditing and Use Assessment

- Conduct lighting audits
- Conduct comprehensive energy audits
- Survey personnel to determine energy use behavior patterns

Needs Assessment

- Conduct FEDS/FRESCA analysis to identify possible energy conservation measures
- Conduct economic analysis to determine costs/benefits of energy efficiency and renewable energy projects
- Provide engineering design analysis for implementation of renewable energy technologies

Public Awareness

- Create public outreach documents, web pages, multimedia pieces that educate the public about energy consumption, energy conservation, and renewable energy technologies
- Organize special events (e.g., energy awareness week) for park visitors
- Provide educational workshops to personnel and visitors at interpretation centers

Develop Partnership Agreement

Partnerships work best when all partners are aware of their mutual contributions to the project. Even though the university and national park may have a close working relationship, it is recommended that some written agreement be developed among the partners. The JMU-SHEN pilot project used Memorandum of Agreement as its tool for identifying the activities, expectations, deliverables, and timelines for the partnership work.

Begin Work/Reporting

After partners agree on the tasks that students will perform, the work begins. Faculty involvement is necessary in order to ensure that the students are conducting themselves professionally and that they receive the technical help they need. Because park personnel are often already over-burdened, students have to balance working independently with their reliance on park personnel for information and data. The JMU-

SHEN pilot project addressed these issues through weekly meetings with faculty, regular meetings (approximately every three weeks) with park personnel, extensive use of electronic communication, and regular (monthly) reporting of activities. This communication allowed park personnel to monitor student progress and intervene when necessary and when time allowed.

Produce Deliverables

It is highly recommended that concrete deliverables be identified and defined in writing. Both the park and students need to know each other's expected deliverables at the end of the work cycle. Often these deliverables will be in the form of written documentation, likely to include recommendations for energy efficiency or renewable energy opportunities; but deliverables could also be software systems, public relations products, databases, or survey studies.

Evaluate and Determine Future Activities

One activity that emerges from an energy partnership is the implementation of a recommended work project. By implementing a student recommended idea, students feel that their work was justified. In addition, the park feels that their contribution to the student work will pay off through energy savings.

However, implementation requires foresight. Partnerships that will likely have an implementation component (for example, a solar energy installation or an energy efficient retrofit) need to consider funding opportunities for implementation. Park personnel and universities should be exploring funding opportunities throughout the project work cycle. Non-traditional funding mechanisms should be heavily considered—for example, performance contracting by energy service companies. In such cases, these companies should become involved in the project during the time at which students are working. Companies may be able to advise or direct students to focus their work on areas that the companies will be willing to support in the future.

Evaluation Process

Lastly, an evaluation process is needed. During this process the park and the university (and others involved) should meet to discuss the entire project and review the results. This evaluation should not only be focused on the particular recommendations or accomplishments of the students; it should also include evaluation of the entire partnership process, the 'lessons learned' from the project, and the educational value for both the students and park.

These evaluation sessions will help foster the future development of other partnership projects. In fact, the university-park relationship would best be viewed as a long-term relationship instead of just a summer or semester of work. With a long-term perspective, universities and parks are more willing to tackle larger projects and to consider evaluation ideas in future projects.

FEDS AND ENERGY AUDIT STUDY

Background

The first activity performed through the JMU-SHEN pilot project was an analysis using the Federal Energy Decision System (FEDS) software. FEDS is a product of the DOE's Federal Energy Management Program (FEMP). Based on energy audit data, FEDS can suggest energy retrofits, along with economic and environmental impact assessments. FEDS is often used with the DOE Save Energy Audit program whereby federal facilities are audited by professional auditors. FEDS provides those auditors with another level of analysis not normally conducted by standard audits.

Activities

JMU students conducted FEDS analyses on five park buildings. The first step of this process was training. Although the students had conducted basic energy analyses before, there was a fair amount of 'real world' training that was needed in order for the students to feel comfortable conducting their own FEDS analysis. Training took the form of practice audits on school buildings and sample FEDS computer runs using that data. Thus, both auditing principles and use of the FEDS software were taught using practice and hypothetical buildings. This practice was performed at the university campus.

Students then worked with SHEN to identify a list of buildings that SHEN wanted analyzed. From this list, five buildings were chosen. The buildings represented a host of new and old vintage buildings; buildings also represented various functionality, including administration, housing, and maintenance.

Students visited the five buildings and conducted FEDS audits approximately once a week for five weeks. Audits took on average a day to perform. The remainder of the week was used to input this data into FEDS and conduct and interpret the FEDS analysis. A final FEDS report was written by the students and submitted to the park. This report identified a number of energy retrofits that would result in energy and cost savings for the park.

Lessons Learned

There were a number of lessons learned from the FEDS component of this project. The two most important lessons are listed below with a short description of each.

- *Flexibility is important.* The JMU-SHEN pilot project conducted a FEDS study as a way to demonstrate how this software would work in a university-national park partnership situation. FEDS entails a comprehensive approach that requires students to understand auditing guidelines and the operation of the FEDS software. Here, a team approach may work best (e.g., one student could become the 'lighting expert', another the 'HVAC expert', another the 'software expert', etc.). The important lesson is that one should maintain flexibility in the study design so that it can be tailored to the skills and interests of the students, while still meeting the needs of the park.

- *Training is important.* No matter what level of depth is desired, most students would benefit from undergoing a professional training program before work commences. In the JMU-SHEN case this training was provided by faculty; however, government and industry may be willing to offer such training at little or no cost.

RENEWABLE ENERGY DESIGN ANALYSIS

Background

The second project that was conducted by the JMU-SHEN team was a design analysis for several potential photovoltaic (PV) sites within the park. SHEN had been considering PV in the park for some time, but had not been able to conduct the appropriate analyses for their applications. This activity provided the pilot program with an example of a quantitative renewable energy analysis project. Lessons learned from this example could be applied to similar projects at SHEN and other parks.

Activities

Students at JMU evaluated four sites where PV may potentially be used to supply remote power. The evaluation consisted of (1) conducting a load analysis based on the equipment that was to be powered; (2) determining the PV modules, batteries and balance of system that was needed to power this equipment; and (3) determining the costs, based on vendor communication, for installing the PV system. The projects included the following:

- Transmissometer receiver (used for measuring visibility);
- Transmissometer transmitter;
- Radio repeater station; and,
- Web-camera (used to transmit live pictures of the park over the Internet).

Students conducted research on PV technologies and developed spreadsheets to assist in the load and module calculations. Much of the vendor information was found electronically on the Internet and through telephone communication.

A final report was written by the students and submitted to the park, along with the spreadsheet software system that will allow future PV analysis at the park. This report identified the equipment needs and costs of each PV project, as well as advice on installation, operation, and maintenance.

Lessons Learned

PV design analysis is a concrete project that university students can perform for parks. Students at both the undergraduate and graduate level can perform these analyses, since they require only basic math skills and a knowledge of PV and electrical systems, which can be obtained from a variety of sources. Several lessons learned from this component of the project are listed below:

- *Project should use resources of laboratories and vendors.* There is a substantial amount of information about PV and renewable energy technologies available. In addition, there are services, such as Sandia National Lab's PV Design Assistance Center, that students should access throughout their project.

- *Results should be presented in clear fashion for purpose of discussion.* Many park personnel are not familiar with renewable energy technologies. Therefore the reports must be concise and clear and the student must be able to effectively communicate both the basic concepts behind the renewable energy technology and the specific operational aspects of that technology in the context which it will be used.

- *Visit the potential renewable energy site.* Many renewable energy projects look good on paper, but may in fact be impossible to implement for other reasons. For example, tree overhangs may disrupt a PV project, or poor water flow at certain times of the year may affect a hydro project. Students should visit the sites, with appropriate park personnel, to explore these issues.

- *Consider the users of the renewable energy equipment.* Sometimes the energy manager at the park is not the user of the equipment that will be powered by renewable energy. One needs to ensure that the user is comfortable with the decision to use renewable energy technologies and that maintenance and operational issues are discussed.

UTILITY BILL DATA ANALYSIS

Background

Analyzing energy data for trends and peaks is a well-known way to identify potential energy savings opportunities. Parks typically have large quantities of energy data that exist in files, folders, and energy bills. But park personnel do not necessarily have the software systems or the time to digitize these data and conduct appropriate analyses. Such analyses are important for park energy managers who need to manage and monitor their energy systems for optimal operation. The last activity of the JMU-SHEN pilot project was the development of a utility bill database system that allows the park to input energy data and produce reports that track energy use and costs.

Activities

The JMU-SHEN pilot project developed a database management system that would allow the park to input and track energy data taken from utility bills (primarily consumption and cost data). The system also allows the park to collect and report bill accounting information (such as check numbers and payment dates). To demonstrate the usefulness of such a system, JMU students created a database management system for park electricity consumption data. Additional systems for gas, propane, steam, water, or oil could be developed using the electricity version as a template.

Students began to populate the database with data from park electricity bills. This was a formidable task. For the JMU-SHEN project, students input data for five buildings to demonstrate the usefulness of the database system. Future population of the database may occur during later phases of this project.

Lessons Learned

Database-related projects are useful tasks that students can perform for national parks. These projects relieve the park of a tedious and sometimes daunting workload that is often necessary for reporting purposes. In addition, these projects provide an opportunity for students not studying in the energy field to work in this area (for example, computer science majors). Nevertheless, there were several lessons learned on this project:

- *Big projects need big time commitment.* Database management projects are time consuming by nature. For instance, the development and population of a large database system will likely require several students working full-time through a summer.

- *Commercial software packages may be best.* Although JMU developed its own database system, it is recommended that partnerships first research commercial packages that perform similar functions. As mentioned above, building a database system from scratch is time-consuming; this time could instead be used to populating a commercial database. Of course, budgets must be able to support the purchase of a commercial product.

- *Accounting features are important.* In the JMU-SHEN database system, features were included that allow the user to track bill payments (namely, check number and pay date). This feature was not found in commercial packages; yet, the park (and others) suggested that such a feature was critical.

- *Address metering and bill payment concerns.* One problem that became apparent as database population occurred was that not all bills corresponded to a particular building; that is, some groups of buildings were collectively metered and billed with one utility bill. This makes tracking energy consumption for particular buildings difficult. In addition, bill dates and payments are not always on a consistent monthly basis. These issues do not present insurmountable problems, but should be considered when developing a database system.

ADDITIONAL LESSONS LEARNED

In addition to the lessons learned in each of the individual projects presented above, there are some lessons learned that apply to the entire partnership process. These are discussed below.

- *On-site activity is not required, but regular communication is.* The JMU-SHEN project tried to conduct activities that consumed the least amount of time from already over-burdened park staff. Of course, different parks will have different constraints on their staff time. Although the work conducted at SHEN did not always require students to be at the park, they communicated frequently by phone, e-mail and regular meetings.

- *Include training in the project budget.* Partnerships should not forget that a major component of the partnership is the real-world education of university students. Because of this, partnerships are encouraged to include training activities in project workplans. This, of course, means budgeting for these activities. Students should be trained by a faculty member or by another professional.

- *Communicate continuously throughout the project period.* Faculty advisors to the students should accept the role as liaison among students and park personnel. JMU kept in constant communication with SHEN and others, mostly by e-mail and monthly reports.

- *Media activities are important.* When possible, partnerships should take advantage of the media resources at their respective organizations. Media releases, press conferences, or other media events can help generate interest in the project and bring needed attention to a serious problem (energy consumption in our national parks).

CONCLUSION

The JMU-SHEN Energy Partnership Project represents the first step in a new way for reducing our national parks' energy costs. This is critical in today's era of tighter budgets and more demands on park personnel. In addition, these partnerships provide students with 'real-world' experience in the energy field. Thus, University-National Park Partnerships provide opportunities that will benefit both the students and the parks—clearly a *win-win* proposition.

The next steps of the JMU-SHEN pilot project exist at both a micro- and macro-level. At the micro-level, the partnership hopes to implement some of the renewable energy and energy efficiency projects identified at the park and to evaluate the students' role in this implementation. At the macro-level, the partnership hopes to develop a'tool-kit' and marketing plan based on its experiences that will encourage other universities and national parks to create their own energy partnerships.

Government, industry, universities, and non-profit organizations need to begin to take strong positions in encouraging partnerships like the one demonstrated by JMU-SHEN. This can be done in a variety of ways. First, federal agencies should establish budgets for such projects. Since these projects fulfill two missions of most agencies (i.e., reducing energy costs and educating the public), these budgets could be justified on multiple grounds.

Second, industry needs to reach out to universities to develop relationships that benefit both parties. Industry should take on as part of its corporate responsibility the education and training of America's future leaders. Third, universities need to resist the 'ivory tower' mentality, and begin to move learning away from the classroom and into the 'real world'. The understanding gained by a student working on a real problem oftentimes far exceeds that gained from a text book.

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[3]Readers can contact the primary author for more information regarding any documents or programs discussed in this article. Dr. James J. Winebrake, (540) 568-3203, winebrjj@jmu.edu

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