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## Developing a State-Wide Energy Assurance Plan: Course + Work = Success

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## **Abstract**

The U.S. Department of Energy (DoE) mandates that each state prepare an energy assurance plan (EAP) which consolidates energy utilization snapshots for the state along with procedures and strategies to be employed to address a wide range of potential energy emergencies. Rowan University was contracted by the State of New Jersey to develop an EAP. In the spring of 2011 a multidisciplinary team of student engineers was formed as part of a project-based course to begin the EAP development. The result of the semester effort was a compilation of other existing state EAPs, an outline for the new document and initial development of portions of the EAP. During the summer of 2011 fourteen student engineers were hired to continue working on the EAP and the related energy monitoring systems. A significant portion of a draft EAP for the State of New Jersey was completed at that time. The following two semesters (Autumn 2011 and Spring 2012) had smaller engineering clinic teams continuing to refine the document. It was completed and shared with the State over the summer of 2012 by summer students and their professors when the document went through its final revisions.

This paper reports on general aspects of the EAP in order to provide the context and then focuses on the important relationship between project-based coursework and student employment opportunities. Some of the challenges in the academic environment include the sometimes competing goals of (1) providing relevant projects based upon real industry need, and (2) the accompanying expectations of professional deliverables, which are often well beyond the scope of a one- or two-semester project. Projects that provide sufficient funding for students (undergraduate and graduate) offer the best way to provide the sophisticated results that many sponsors expect. Having students continue the momentum developed in the in their class project-based learning experience often results in a corresponding step increase in their productivity when the summer project begins. The EAP team accomplished a significant amount of work as measured by the number of chapters, appendices and references completed, and the responses of the sponsor during regular project reviews.

This approach to the key project-based portion of our curriculum has become a model for how solicit and scope projects from outside sponsors. The paper will address other strengths and weaknesses of the approach.

## **Elements of an Energy Assurance Plan (EAP)**

The Federal government (under the direction of the US DOE) has encouraged, as well as provided funding for, states across the nation to develop useful energy assurance plans (EAPs). Their reasons for doing this are many. They include at a minimum: 1) to better prepare the state to deal with energy emergencies that may occur as the result of natural disasters, damage to

energy production sites, terrorist attacks, etc., 2) to provide insights into possible ways to reduce the risk of, number of, and extent of energy disruptions and speed their recovery, and 3) to assist state agencies in coordinating response efforts across many companies, jurisdictions and participants to address energy disruptions more effectively and efficiently.<sup>[1]</sup> Many EAPs follow a similar outline in achieving these purposes. They include an introductory section which presents an overview of total amounts of energy used in state and identifies key energy sources both within and imported into the state that make up the energy supply. Any related legal requirements (i.e., national, state, and local statutes) that affect energy production, usage, or emergency response requirements are typically identified and described in this overview as well. Typically, subsequent chapters focus on the state's primary energy supply infrastructures such as the electricity sector, (including sources of electricity production, the largest consumers and producers of electricity and the delivery assets), the petroleum sector (with a breakdown of how petroleum is used throughout the state along with the largest producers and consumers) and the natural gas sector (highlighting gas usage throughout the state along with the largest producers, pipelines and consumers). Obviously from state to state these sections will vary depending upon the amount of energy used/provided by each of these sectors to meet the state's needs. This focus on energy sources, flows and ultimate end-users gives a solid overview of the current energy dependence and vulnerabilities to state decision-makers and planning and emergency policy-makers. Since history has shown that energy crises can pose economic and security threats the benefits of well thought out EAPs include risk and vulnerability to energy disruptions regardless of the underlying cause. Hurricanes and other extreme weather also impact the State of New Jersey. In late August 2011, Hurricane Irene dumped more than 5 inches of rain throughout the entire state with some areas receiving more than 8 inches of rain. This caused widespread power outages in the region leaving over 1.2M customers without power, many for over a week. The most recent storm (Sandy – Autumn 2012) brought flooding and serious gas and electric outages to the state that persist months later. Based upon these and similar experiences, it is clear that the effectiveness of an EAP depends heavily on planning and practice before emergencies; in conjunction with clear coordination and communication linkages to integrate stakeholders during recovery.<sup>[1]</sup> It was this challenge that our student engineers faced when developing the first plan for New Jersey from scratch, assuring it would meet the specific needs of this coastal state.

The purpose of EAPs was established by multiple Federal entities who created a set of helpful and prescriptive guidelines to assist states in creating their custom EAP. The lead agency was the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability (OE). Other key entities who aided in the guideline creation were the National Association of State Energy Officials (NASEO) and the National Association of Regulatory Utility Commissioners (NARUC). Their explicit rationale for this effort is stated in their guidance to states as they develop EAPs: "Since the September 11, 2001 attack on the nation, the Northeast Blackout of 2003, the devastation caused by Hurricanes Katrina and Rita in 2005, and the petroleum supply disruptions caused by the Hurricanes Gustav and Ike in 2008 in the Southeastern states, federal, state and local governments have placed greater emphasis on assurance and included within it the

need to address the protection of energy infrastructure”<sup>[2]</sup> The purpose of the New Jersey Energy Assurance Plan (NJEAP) being developed by our student project team was “to facilitate the rapid response and resolution of energy emergencies, to strengthen the resiliency of critical energy infrastructures, and to improve the efficiency of New Jersey energy usage. The means by which the students would accomplish this was through working on paid internships funded by the grant and the novel engineering clinic of Rowan University’s College of Engineering briefly highlighted in the following section.

### **The Engineering Clinic at Rowan University**

The Rowan University undergraduate engineering program offers an inter-disciplinary clinic program which runs throughout all of the four years of the degree program. This eight-semester sequence is required of all engineering students in every discipline. The final four semesters of engineering clinical practice are designed to provide junior and senior students with the opportunity to collaborate on real world projects for real world clients or sponsors and to develop and present solutions by applying multi-disciplinary engineering concepts.<sup>[3,4,5]</sup> These real world projects are typically sponsored by industry partners or government agencies for either research and/or design purposes. Over the past few years, sponsored projects within the Electrical & Computer engineering department have ranged from the research and development of smart PV module topologies to the system design and monitoring of multiple, cutting-edge solar PV module types. Clinic projects in other disciplines, such as the civil & environmental engineering or mechanical engineering departments have ranged from aquifer recharge and recycled concrete aggregate feasibility studies to fatigue and fracture research. A typical set of activities in the clinic sequence includes: information search and review; development of a clear and concise problem statement; research and/or design and testing activities; and presentation of results via written report and presentation.<sup>[5]</sup> Within the engineering curriculum these projects help to develop many important engineering skills often inadequately addressed in the more formal elements of the student’s educational experience through giving them hands-on practice, real-world application of their core engineering skill set and experiential learning. The engineering clinic program experience has been described in many different conferences and publications as well.<sup>[5,6,7,8,9]</sup> Rowan University’s junior and senior year clinic projects guide students to fulfill their progression from developing basic problem solving techniques and improving technical writing/presenting skills to delivering finished products and effectively reporting all relevant data and studies to a project sponsor or client. It was the excellent fit that this educational model provided to the project requirements of the state’s Board of Public Utilities Division of Reliability and Security that led them to approach the university to see if the work required for the state’s EAP could be accomplished with a multiple year engineering clinic and summer internships.

### **Course Accomplishments**

An agreement was reached early in the process of discussing the State's needs and the requirements of the College for its engineering clinic. By the spring of 2011 the first clinic team of multidisciplinary student engineers was created to undertake the tasks of outlining the customer's needs for the project and commencing the work. Since a contract and agreement had been forged between the university and state these formed a large part of the work specification. The initial clinic teams working in their project-based course began the development of the outline for the overall EAP. The results created by the first semester efforts of the clinic team was a compilation of the federal guidelines for the development of EAPS as well as an inventory of other existing state EAPs. This enabled the clinic students to create a clear and complete outline for the new document and initially create some portions of the EAP (specifically background data for the State of New Jersey). During the summer of 2011 fourteen student engineers were hired as interns to continue working on the EAP and the related energy monitoring systems. This summer effort was to yield significant results as will be described in the section below. A significant portion of a draft EAP for the State was completed at that time. The following two semesters (Autumn 2011 and Spring 2012) engaged smaller engineering clinic teams who were charged with continuing the work of refining and completing the document while assuring linkages with all emergency management plans and procedures within the State could be provided seamlessly in this one document. A key challenge to the students was learning how to take hundreds of pages of critical information and organizing it in a manner that would make it simple to access and clear to follow in the event of an emergency. The student team completed these tasks and shared the document with the State. It was over the summer of 2012 when summer student interns and their professors working on the project brought the document and its inherent plans, procedures and strategies into its final form. The success of the engineering clinic in performing this work was significant, but the complete success of this project would not have been possible were not the summer and semester work by interns able to complete the lion share of the research and tasks required extra-curricularly. This portion of the student contribution to the project success is described in the section which follows.

### **Work Accomplishments**

It was at the beginning of the summer of 2011 when the successful fourteen (14) student engineering interns first came together as a team to continue working on the EAP and the related energy monitoring systems. We had made a broad announcement of the summer internships available and were able to interview over two dozen qualified students for the research positions. Most of the students who had made the successful contributions to the first semester (Spring 2011) clinic project development of the EAP outline were hired to work as interns. The most significant portion of a complete draft of the EAP was completed during that intensive summer effort. There were a few key reasons for the high degree of success. These included continuity, level of effort, leadership, and focus. As we reflected upon the primary elements of the summer project work experience we noted that the team achieved such highly successful results at that time because of all of these factors. We also note that not all of these factors can be achieved in a

limited curricular setting of the engineering clinic due to the students' multiple academic and other responsibilities during the normal semester. If we look at each of them individually we can see the benefits the extra-curricular experience provides.

***Continuity*** – We were able to hire a critical mass of students for the summer internships who provided continuity between the accomplishments of the Spring clinic team and the tasks remaining for the summer. They were already prepped on the key project requirements, client expectations, databases, etc. and had sufficient skills to hit the ground running and to serve as mentors for new student workers.

***Level of Effort*** – The students who were hired were aware of the amount of work that would be necessary to complete the tasks over the limited summer recess period. The 32 hour weeks were a critical amount of time on task to assure efficiency in the task completion and the quantity of student hours available was sufficient to meet the project goals by the correct hiring of enough workers.

***Leadership*** – The students who had previous experience on the project not only provided critical continuity but quickly rose as natural leaders of the key project task elements. This was a critical supplement to the leadership provided by the professors for whom this project was just one of many they were responsible for over the summer period.

***Focus*** – The ability of the student interns to focus on a few critical project elements and not to be drawn away by the many academic and extra-curricular distractions of a typical semester was a key ingredient in the team's efficiency and high productivity over the 12 week summer internship. We observe that students can achieve a very high level of commitment to clinic projects during the semester but have little opportunity to achieve great success in the 2-credit course due to competing priorities and other course requirements. Many students actually work part time while completing their engineering degrees which leads to further dissipation of focus and limits on their achievement of excellence.

While it is clear that we are able to develop leadership skills and even project continuity (multiple clinics on same project) in the engineering clinic curricular experience it is also obvious, for the reasons previously stated, that it is more challenging to make available adequate time for strong focus to be developed and a high level of effort to be put forth in the midst of a crowded and challenging engineering semester when the clinic course counts for only one-quarter of the student's credit load. By default most students are challenged to make more than 10-12 hours available per week for their clinic projects and many seek to pass by putting in the minimum of 6 contact hours that are requisite. It often takes a summer internship/research work opportunity to provide the student with sufficient time to complete professional engineering project requirements at a high level of excellence.

## **Student / Sponsor Reactions**

The students indicated that the summer research experiences was a valuable one where they believed they increased the strength of their research and engineering skills and learned how to better meet customer needs and expectations. They further developed many strong communication, professional and interpersonal team skills during the project experience.

The client was extremely pleased with the success and detail of the EAP and its supporting technology which made it one of the most cutting-edge EAPs to as yet be developed in the US.

### **Strengths and Weaknesses of Approach**

As earlier described, one of the key challenges in the academic environment include the balancing of the sometimes competing goals of (1) providing students with relevant, real-world, engineering projects that meet a real industry need, and (2) meeting the accompanying high client expectations of professional quality deliverables from a student team, which are often well beyond the scope of a one- or two-semester project of two credits per course. We have observed that research and development projects which can provide sufficient funding for students extra-curricularly (undergraduate and graduate) offer a best way forward to provide the sophisticated results that many project sponsors expect. Having students continue the momentum developed in their semester class project-based learning experiences in clinic often results in a corresponding step increase in their productivity when the summer project begins. The EAP team accomplished a significant amount of work as measured by the number of chapters, appendices and references completed, and the responses of the sponsor during regular project reviews.

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