



**Dartmouth College
Campus Energy and Sustainability Management System**

**Quarterly Progress Report for
New Hampshire Greenhouse Gas Emission Reduction Fund**

**Reporting Period:
October 21, 2009 through January 31, 2010**

1. **Program Title:** Campus Energy and Sustainability Management System (CESMS)
2. **Program Type:** The Campus Energy and Sustainability Management system will reduce energy use and associated greenhouse gas emissions at Dartmouth College by using a web-based interface to track, report, and optimize building energy performance. The project supports items **5, 7, 8, 10 and 11** in the Public Utilities Commission's Request for Proposals issued February 23, 2009.

3. Overview of Progress During the 1st Quarter:

3.1. Planning

3.1.1. **Functional Requirements Specification (FRS) Development:** A large kickoff meeting was held with all stakeholder groups in attendance. This session was held to introduce system and program concepts to each party and to create a supportive collaborative environment within the Dartmouth community. Following the kickoff meeting, a number of subsequent in-depth interviews and follow-up sessions were held with individual stakeholder groups during throughout the first quarter. The purpose of these meetings was to finalize system connectivity and functionality requirements and to develop concepts and details of system data availability and outputs including reports, graphs, metrics, and dashboard elements. Our primary system subcontractor, Rockwell Software, was in attendance for each of the detailed sessions and developed a Functional Requirements Specification from the results of the sessions. This document is serving as a guide to the deliverable, and is periodically updated to reflect system changes in functionality requirements or improvements as they occur.

3.1.2. **Stakeholder Groups - Include:**

- Facilities Operations – Building Management System team, Heating/Electric Plant team, Energy Engineering Team, top Planning, Design, Operations and Administrative team
- IT and Networks – Network communications and Administrative Computing Team
- Sustainability Initiative – Sustainability Manager and sustainability intern
- Financial – Facilities Operations Financial team
- Academic Departments – Faculty representatives from Thayer Engineering School, Tuck School of Business, Dartmouth Medical School, Computer Science Department, Environmental Studies Department, Dean of Faculty administrative office

- 3.1.3. **Meter Automation Plan**– A detailed review of all building-level utility meters was completed to finalize the automation plan. In consultation with Rockwell Automation we decided that the most strategically advantageous method of polling and store all meter data would be to put everything in the Rockwell RSEnergyMetrix database. This would involve moving the relatively few existing BMS-connected metering points over to the Rockwell System, via Spinwave wireless pulse transmitters.
- 3.1.4. **Metering Automation Equipment** – Meter automation equipment was ordered for the entire project. This consisted of approximately 40 IP-addressable electrical meters to replace old-style analog meters, and approximately 200 Spinwave wireless pulse transmitters to connect to existing condensate, chilled water and electrical meters.
- 3.1.5. **Server Equipment and Software** – Two network servers were ordered and installed in Dartmouth’s remote data center. These host several database programs which support the metering and operational software for the Rockwell CESM solution.
- 3.1.6. **Connection to BMS Systems** – Plans were made for connection to over 30,000 Building Management System points via Rockwell Software connectors to Dartmouth’s Honeywell and Johnson Controls systems. Initial trials by Rockwell demonstrated the capability to pass the 30,000 points between the BMS and Rockwell systems. Upgrades to several Johnson Controls building automation systems were underway to allow for connectivity to these legacy systems in important high energy-use science facilities.
- 3.1.7. **Connection to Heating/Electrical Plant SCADA Systems** – Plans and technical details were developed for connection to the Heating/Electrical plant control systems. It was decided to add a data historian computer and data historian software for a security separation between the Rockwell Campus Energy and Sustainability Management system and the Heating plant controls systems. As of the end of the 1st quarter, plans were being finalized for the connections.
- 3.1.8. **Establishment of Energy “Tiger Team”** - A team of internal technical specialists was established to begin development of methods and practices for use of the Campus Energy and Sustainability Management System (CESMS) as a tool for building system Continuous Commissioning, energy system alarming, energy system optimization strategies, and other operational activities that will help drive campus energy usage downward. The team consists of Building Management System (BMS) specialists, electrical system specialists, mechanical system specialists, and the campus Energy Manager. New roles are being created within the Facilities Operations department as a result of bringing the CESMS system on line. The intention is for the Tiger Team to meet weekly and use the new CESMS tool to evaluate the operational efficiency of specific high-energy-use buildings. Knowledge embedded within the team about the individual building systems and the history of system operational issues will be helpful to the team as they discover and solve operational issues and find new ways to optimize building system performance.
- 3.1.9. **Establishment of Academic Collaborative** – The beginnings of a Facilities/Academic collaborative was established during the first quarter to develop and execute methods of evaluating the impact of feedback and social networking tools on occupant behavior via use of the CESMS. We intend on developing case studies for buildings or spaces where occupant behavior accounts for a relatively high proportion of total building energy use.

3.2. Execution

3.2.1 Execution of Task 1 through Task 3 items began during the 1st quarter reporting period. Activities principally involved Task 1 items related to ordering, setup and installation of computer servers, installation of operating software by Rockwell Automation, and beginning of meter automation activities by Dartmouth’s internal Trade Shop labor force. In some instances in the tables below, the % complete values are subjective rather than quantitative due to differences in the line item descriptions between the budget prepared and submitted by Dartmouth with its RFP submission and the listing of Tasks prepared by the NHGGER Fund. These tables are presented to indicate general progress in each of the task areas. The Detailed Cost vs. Estimated Budget form attached as a PDF file, presents the financial comparison between the project budget and the 1st Quarter costs.

3.2.2 A summary of Task 1 Progress follows:

Task 1: Connection of Dartmouth College Facilities to the System.		% Complete
Subtask 1.1:	Automate meters for all buildings and connect them to the system.	5%
Subtask 1.2:	Connect to BMS and Boiler Plant systems for real-time efficiency monitoring.	25%
Subtask 1.3:	Link live weather feeds and 24-hour energy projections by meter.	5%
Subtask 1.4:	Develop real-time energy alarms (actual use vs. projected use)	2%
Subtask 1.5:	Install Sustainability Indicators.	5%
Subtask 1.6:	Develop Building Performance Metrics (actual vs. design).	2%

3.2.3 A summary of Task 2 Progress follows:

Task 2: Feedback, Behavioral Change, and Education & Outreach.		% Complete
Subtask 2.1:	Connect energy data from dormitories into the energy feedback display system and add additional feedback displays to buildings on campus.	0%
Subtask 2.2:	Evaluate the impact of feedback and connected social networking tools on occupant behavior through separate research-funding.	0%
Subtask 2.3:	Conduct outreach to students, staff and faculty about recommended conservation measures.	0%
Subtask 2.4:	Develop case studies in areas where occupant behavior accounts for a relatively high proportion of total building energy use.	0%
Subtask 2.5:	Share findings with state officials and colleagues.	0%

3.2.4 A summary of Task 3 Progress follows:

Task 3: System Monitoring, Verification and Reporting.		% Complete
--	--	------------

Subtask 3.1:	Ensure that the meter automation program provides accurate results.	5%
Subtask 3.2:	Establish a rigorous program to verify the polled data from the building management systems.	20%
Subtask 3.3:	Set target energy reductions on a building-by-building basis once building energy baseline performance has been established.	0%
Subtask 3.4:	Monitor the financial expenditures and performance of the program.	5%
Subtask 3.5:	Use the system to assess the effectiveness of behavior change campaigns and social learning experiments	5%
Subtask 3.6:	Share the results of the measurement and verification program in an annual summary report.	0%

4. Work to be Completed During the Next Quarter:

4.1. Planning

- 4.1.1. **Finalization of Sustainability Indicators:** We will finalize the format, methodology and visual displays for tracking the initial Sustainability Indicators to be monitored by the CESMS. These will include GHG's, solid waste, recyclables and water use.
- 4.1.2. **Facilities/Academic Collaboration:** We hope to formalize the collaboration between the Facilities Operations Department and several academic departments in developing the scope and methodology of feedback systems and social networking tools to be developed to determine the behavioral effect of energy use based upon feedback from the Campus Energy and Sustainability Management System. Departmental collaborators will likely include Computer Science, Engineering, Sociology, and Business. We will select buildings to receive kiosk displays of energy and sustainability indicators. We hope to develop case studies for buildings where occupant behavior accounts for a relatively high proportion of total building energy use.

4.2. Execution

- 4.2.1. **Metering Automation:** We will continue with the metering automation program, intending to finish all of the high-energy-use buildings. When these are complete we will start into the lower-energy-use buildings.
- 4.2.2. **Establish Building Energy Baselines:** We will develop building energy baselines as additional building energy meters are brought on line. This will allow us to set target energy reductions vs. baselines. We will concentrate on the high-energy-use buildings as these are the first meters being brought on line.
- 4.2.3. **Connection to Heating/Electrical Plant SCADA Systems:** We hope to complete the process of connecting to the Heating and Electrical plant control system data via a data historian.
- 4.2.4. **Activation of Energy “Tiger Team”:** We will set our energy “Tiger Team” into action, beginning by commissioning several high-energy-use buildings, including the Berry Library complex and the Science Complex.

- 4.2.5. Kiosks:** We will complete the first of several building energy and sustainability information kiosks. The first of these will be installed in McNutt Hall, Dartmouth's admissions office. Future kiosks will be considered for Collis Student Center, Hopkins Center for the Performing Arts, Berry/Baker Library, Tuck School of Business and additional dormitory buildings.
- 5. Jobs Created** – No jobs were created from this project during the 1st quarter reporting period. Establishment of the Tiger Team, however, may draw a controls position away from general maintenance duties due to the focus of the CESMS on energy reductions. Dedication of a technician to this endeavor may result in creation of an opening in the controls shop for a controls maintenance technician.
- 6. Obstacles Encountered** – No significant obstacles were encountered during the quarter, nor were any milestones missed.
- 7. Beyond the Contract** - Publicity surrounding the Campus Energy and Sustainability Management System and the NHGGER Fund award to Dartmouth, has lead to significant interest our program from other institutions. We are also collaborating with other colleges and universities who are in the process of installing systems quite similar to ours. In Dartmouth's case, our internal collaboration with academic departments appears to be a unique situation. We are pleased with this relationship which we see as providing additional leverage toward the outcome of the program.
- 8. Related Materials** – To date, several articles have been published about our program in the *The Dartmouth*, our daily campus newspaper. This has helped to keep the campus community informed of the intentions of the program and its progress. Examples of the articles are attached to this quarterly report. The program has also been highlighted in a number of PowerPoint presentations prepared and presented by to various administrative and academic departments on campus and also to college and university facilities conferences in the New England.

Respectfully submitted,

Stephen R. Shadford, P.E., LEED AP

Dartmouth College

Energy Manager

Principal Investigator for NHGGER Fund Grant Project