



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

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

**Reporting Period:**  
**November 1, 2010 through January 31, 2011**

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 5th Quarterly Reporting Period:**
  - 3.1. **Planning**
    - 3.1.1. **Functional Requirements Specification (FRS) Development:** Final details of requirements are completed.
    - 3.1.2. **Meter Automation Plan**– The metering automation plan remains the same as in the 4<sup>th</sup> reporting period. Most meters are now automated.
    - 3.1.3. **Metering Automation Equipment** – Arrangements were made to purchase some additional wireless transmission devices (wireless gateways and repeaters) for completion of the more difficult metering locations.
    - 3.1.4. **Server Software** – Another virtual machine server (Rockwell FactoryTalk Historian) was added in December 2010 for the collection and storage of Heating/Electric Plant data.
    - 3.1.5. **Connection to BMS Systems** – We made and executed plans to solve some data polling issues between the Rockwell VantagePoint platform and the Honeywell BMS system database. Previously, the polling of Honeywell data by Rockwell was causing issues and resulted in the Honeywell/Rockwell data connection being disrupted on a number of occasions. These two system vendors are currently working together to solve these issues.
    - 3.1.6. **Connection to Heating/Electrical Plant SCADA Systems** – Plans for connection to data points in the Heating/Electrical Plant were put into play in December during the College's break period. As a result of ABB's work in the Heating Plant and Rockwell's work in installing a data historian to read the values, we now have real-time access of energy-production data (#6 fuel oil flows into each boiler, pressures, temperatures, cogeneration electrical production, main steam production and steam flows out to the campus, etc.).
    - 3.1.7. **Energy "Tiger Team"** - Our "Tiger Team" continues to meet with the campus Energy Program Manager on a regular basis. The meetings are held on weekly

basis, to address operational issues that are being detected via the Campus Energy and Sustainability Management System (CESMS). During the 5<sup>th</sup> reporting period, we continued our recommissioning program of the Berry Library air handling units and VAV boxes, using the CESMS as an essential trending tool to see the results of multiple changes made to VAV box minimum flow setpoints and AHU damper actuator replacements. This project is moving along faster than expected and we are beginning to see positive results.

- 3.1.8. **Beginning of Formal Academic Collaborative** – During the 5th Quarter, we continued our formal relationship with the Tuck School of Business and Lorie Loeb, Research Associate Professor in the Computer Science department. During this period, we energized and commissioned the 17 new electrical sub-meters on the electrical services serving the 7 residential spaces located within the Tuck LLC and Whittemore Hall buildings. The metering systems and the metering database are now collecting baseline information on energy use patterns for each of the 7 residential spaces. The “Tuck Sustains” graduate student group helping to coordinate the roll-out of this program met informally with the facilities group to discuss the details of metering installation and to better understand how the energy use baseline patterns will be collected.

The systems will be the subject of an academic study to monitor the results of real-time energy feedback. We will incorporate the results of this project into the actions of our ongoing CESMS work.

### 3.2. Execution

- 3.2.1. Execution of Task 1 through Task 3 items continued during the 5th quarter reporting period. Activities involved Task 1 items related to meter automation by Dartmouth’s internal Trade Shop labor force, bringing the Rockwell VantagePoint system on line for energy use and BMS point trending, and development of upload data sets that will allow us to capture the ongoing historical record of energy or other resources used or disposed of by the campus that do not have automated data feeds into the system. Examples include stand-alone electrical meters (non-automated off-campus meters), fuel oil, propane and diesel fuel drops, water and sewer use, gasoline use, solid waste, recycling, composting, etc. We also created an upload data set that includes all of the on-campus building-by-building energy use history for steam, electric and chilled water dating back to 1982.
- 3.2.1 We have made good progress in meter automation, now being able to see greater than 98% of the campus electrical load and approximately 98% of campus steam load. At this point, most all buildings have had their meters automated. 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.

**3.2.2** A summary of Task 1 Progress follows:

<b>Task 1: Connection of Dartmouth College Facilities to the System.</b>		<b>% Complete</b>
Subtask 1.1:	Automate meters for all buildings and connect them to the system.	95%
Subtask 1.2:	Connect to BMS and Boiler Plant systems for real-time efficiency monitoring.	85%
Subtask 1.3:	Link live weather feeds and 24-hour energy projections by meter.	100%
Subtask 1.4:	Develop real-time energy alarms (actual use vs. projected use)	20%
Subtask 1.5:	Install Sustainability Indicators.	50%
Subtask 1.6:	Develop Building Performance Metrics (actual vs. design).	30%

**3.2.3** A summary of Task 2 Progress follows:

<b>Task 2: Feedback, Behavioral Change, and Education &amp; Outreach.</b>		<b>% Complete</b>
Subtask 2.1:	Connect energy data from dormitories into the energy feedback display system and add additional feedback displays to buildings on campus.	50%
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:

<b>Task 3: System Monitoring, Verification and Reporting.</b>		<b>% Complete</b>
Subtask 3.1:	Ensure that the meter automation program provides accurate results.	70%
Subtask 3.2:	Establish a rigorous program to verify the polled data from the building management systems.	60%
Subtask 3.3:	Set target energy reductions on a building-by-building basis once building energy baseline performance has been established.	20%
Subtask 3.4:	Monitor the financial expenditures and performance of the program.	25%
Subtask 3.5:	Use the system to assess the effectiveness of	10%

	behavior change campaigns and social learning experiments	
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. **Heating/Electric Plant Monitoring Points:** We will develop energy efficiency calculations for supply side of steam and electric production in the Central Heating & Electric Plant and determine overall system energy efficiencies.
- 4.1.2. **Fault Detection Algorithms:** We will continue working with Rockwell on development of fault detection algorithms that will analyze energy system performance in the background while we are using the system for other functionality. The result will be a series of exception reports targeted specifically at the systems which appear to be operating inefficiently according to rules which we develop and input to operating models of various system types.

##### 4.2. Execution

- 4.2.1. **Metering Automation:** Finish automating the remaining approximately 20 metering locations, picking up the remaining electrical, steam and chilled water meters.
- 4.2.2. **Establish Building Energy Baselines:** We will continue developing building energy baselines as additional building energy meters are brought on line during the 6th quarterly reporting period.
- 4.2.3. **Execute Heating/Electrical Plant Efficiency Calculations and Indicators:** We will activate energy efficiency calculations for supply side steam and electric production in the Central Heating & Electric Plant.
- 4.2.4. **Refine Efforts of Energy “Tiger Team”:** We continue with our energy “Tiger Team” meetings and will move several recommissioning projects further forward. These will include:
- Recommissioning of individual building CHW distribution system controls to improve overall Central Chiller Plant differential temperatures
  - Investigation phase Recommissioning of large energy-consuming buildings, including the Moore Psychology, Hopkins Center, Hood Museum of Art and Alumni Gym.
- 4.2.5. **Facilities/Academic Collaboration:** We will continue in our collaboration with the Tuck GreenLite project and will monitor the impact of real-time energy displays for the Business School residential living facilities. Our plan is to develop case studies for these buildings where occupant behavior accounts for a relatively high proportion of total building energy use.
- 4.2.6. **Kiosks:** We will work with our Office of Sustainability and continue detailing content for the building-level energy display kiosks.

- 4.2.7. **Implementation of Additional Sustainability Indicators:** We are beginning to provide web-based visual displays for tracking Sustainability Indicators on the CESMS. These include GHG's, solid waste, recyclables and water use. Methods for easily inputting data into the CESMS will continue to be developed during the 5<sup>th</sup> quarterly reporting period.
- 4.2.8. **Fault Detection Software:** We will roll out fault detection software as part of the CESMS for background monitoring of system energy performance. We have included high energy-use systems such as the Berry Library complex as part of the first roll-out.
5. **Jobs Created** – No additional jobs were created from this project during the 5th quarter reporting period.
6. **Obstacles Encountered** –
- 6.1.1. **Meter Automation Labor** – Labor costs for automation of the metering infrastructure is running over our original budget, partially due to the degree of difficulty encountered in setting up the wireless infrastructure and partially due to having added a number of meters to the automation list. We are committed to completing the process because it is essential to the successful outcome of the project and will provide other important business benefits to the College.
7. **Beyond the Contract** – Rockwell Automation has continued a keen interest in our project and, is using the Dartmouth Vision Client relationship to help them develop new input and output strategies, including use of the data for automated fault detection services.
8. **Related Materials** – The Campus Energy and Sustainability Management System is currently being utilized to track the energy collection capabilities of the new Solar Domestic Hot Water preheating system installed in the early summer at the Sustainable Living Center. We also completed installation of another solar DHW preheating system, this time for the College President's house. This, too, will be monitored via the CESMS.

Respectfully submitted,



Stephen R. Shadford, P.E., LEED AP  
Dartmouth College  
Energy Program Manager and Principal Investigator for NHGGER Fund Grant Project