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Inquiry Journal

Spring 2010

“Taking STOCC”: Tracking Environmental and Financial Footprints Associated with Municipal Energy Use

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Johnson, Corey, "“Taking STOCC”: Tracking Environmental and Financial Footprints Associated with Municipal Energy Use" (2010). *Inquiry Journal*. 8.
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research article

“Taking STOCC”: Tracking Environmental and Financial Footprints Associated with Municipal Energy Use

—Corey Johnson (Edited by Jennifer Lee)

Both the United State and countries worldwide are increasingly concerned with climate change driven by anthropogenic emissions. Of great concern are rising global temperatures and changes in weather patterns, attributed in part to increased concentrations of greenhouse gases in our atmosphere. In much the same way that a blanket keeps you warm on a cold night, greenhouse gases trap heat in the air surrounding the Earth. Increasing concentrations of these gases in the atmosphere over the past several decades originate primarily from the burning of fossil fuels (coal, oil, and gas) and land use changes. The most significant of these gases is carbon dioxide, and concentrations have increased to levels unseen in over 800,000 years (Luthi et al., 2008). New England has experienced considerable changes in its climate over the past four decades and will likely experience significant impacts if we continue to rely upon fossil fuels as our main source of energy (Hayhoe et al., 2007; Wake et al., 2008). In order to slow the rate of human driven climate change, it is essential to reduce the amounts of carbon dioxide emitted by all our energy sources, large and small.

One source of emissions needing attention in New England is small municipal operations that use energy to heat the town halls, power streetlights, and plow the roads. The first step towards reducing greenhouse gas emissions is tracking them. Small towns across New England have expressed the need for an easy and effective tool to track both the environmental and financial costs of their energy use. In the past, these tools have typically been available only to larger municipalities. With the creation of the Small Town Carbon Calculator (STOCC) in the spring of 2009, towns were provided with a simple tool to assist with tracking their greenhouse gas emissions. STOCC is a simple excel spreadsheet that provides small municipalities with an energy inventory, or summary, of their energy use, costs in dollars, and associated greenhouse gas emissions.

During the spring semester of 2009 I worked as a sustainability intern in collaboration with Carbon Solutions New England (CSNE) and Clean Air–Cool Planet (CA–CP) to bring STOCC to its final form. (See Appendix) Originally the brainchild of Bill Burtis, manager of communications and special projects at CA–CP, STOCC became publicly available just before the onset of summer. Building on my experience with creating STOCC, I helped small municipalities across New Hampshire complete energy inventories using the tool in the summer of 2009.

This was the first time that STOCC was used on any significant scale and provided a unique opportunity to implement a tool I had helped develop. The creation of STOCC was an interesting experience, but using it to tackle a real world issue was a valuable learning experience. I actually felt as if my efforts were making a measurable impact. I certainly encountered problems along the way, but solving them taught me useful lessons and eventually led to a second, more user-friendly version of STOCC that is being used across New England.



The author investigating a local energy source.

Selecting Towns to “Take STOCC”

The first step in my research was contacting towns to offer my assistance. Following conversations with scientists and organizations working on this issue across the state, partners at CA–CP and I determined to first contact the New Hampshire Regional Planning Commissions for help in identifying towns willing and able to work with us. We told seven planning commissions that we were looking for towns with well-established, active energy committees and a committed town administrator, who could collect the necessary energy data. Following these conversations, we contacted twenty-one towns to offer our assistance.

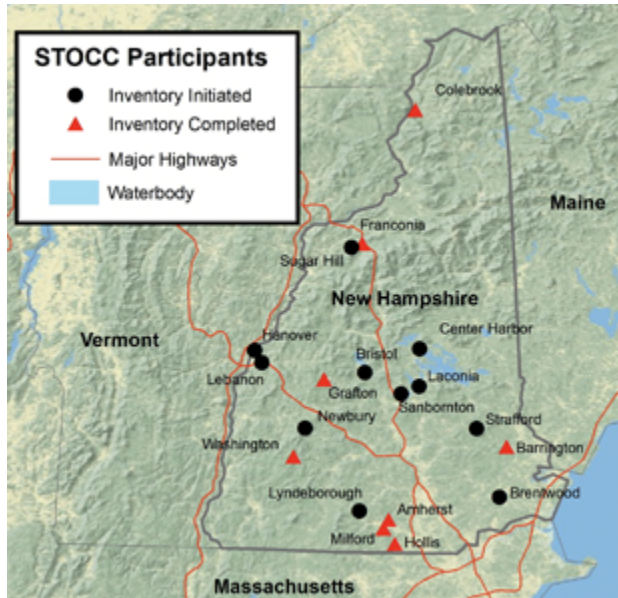


Fig. 1: Map of New Hampshire showing towns which initiated and completed a STOCC inventory.

In our initial email contact with the chairs of these local energy committees, we described STOCC and explained how the town could benefit from completing an energy inventory. In particular, we emphasized the cost-savings that could result from tracking energy use because we recognized that in the budget-focused world of small town politics, cost effectiveness reigns supreme. We also outlined what our role would be in the process. While the town would be primarily responsible for data collection, we would input the data into STOCC, produce a report, and offer to present the results to the town’s board of selectmen. While email was our primary method of contacting towns, I also presented the STOCC program at the New Hampshire Local Energy Solutions conference in June 2009 in order to reach a wider audience.

Of the twenty-one towns that we contacted, eighteen expressed some level of interest. Of these, ten initiated the process but did not eventually complete an inventory. This can be attributed to the fact that many town committees are not very active during the summer. The following eight towns were actively engaged throughout the entire summer and completed inventories: Amherst, Hollis, Milford, Colebrook, Franconia, Barrington, Grafton, and Washington. (See Figure 1)

Data Collection: Bills, Bills, Bills

Data collection, the first step, was the most time consuming and complicated aspect of this research project, both for me and for the towns. In order to complete an inventory, we asked each town to collect a year’s worth of energy data (or multiple years, if possible) for their municipal operations. This included the amount and cost of fuel used by all municipal buildings, vehicles, and streetlights. STOCC required that data be separated by fuel type, meaning that if a building used electricity and oil, each fuel needed to be reported separately. This was due to the fact that every type of fuel results in a different amount of carbon dioxide emissions when burned.

Although most towns completed their data collection independently and in three to four weeks, I spent much of the summer answering questions and guiding them through the process. I found that energy data is not always well documented in small towns. The energy committees often would have to contact numerous sources to compile the needed data. Sometimes the fuel bills were so unorganized that it took weeks to sort through them. Almost all towns had some trouble understanding the bills and what they were actually paying for. This process even helped some towns realize that they were paying for electricity they were not even using!

From Data to Results and Issues along the Way

Once a town completed data collection, I entered the data into STOCC, which was formatted to accept data by fuel type, e.g., electricity, oil, gas. All electric usage was then put in one category, all oil in a second, and so on. One building might use electricity for lighting but oil for heat. Then total amount and cost of each fuel type could be added up. Each type of fuel has an emissions factor which is the average amount of CO₂ emitted per one given unit.

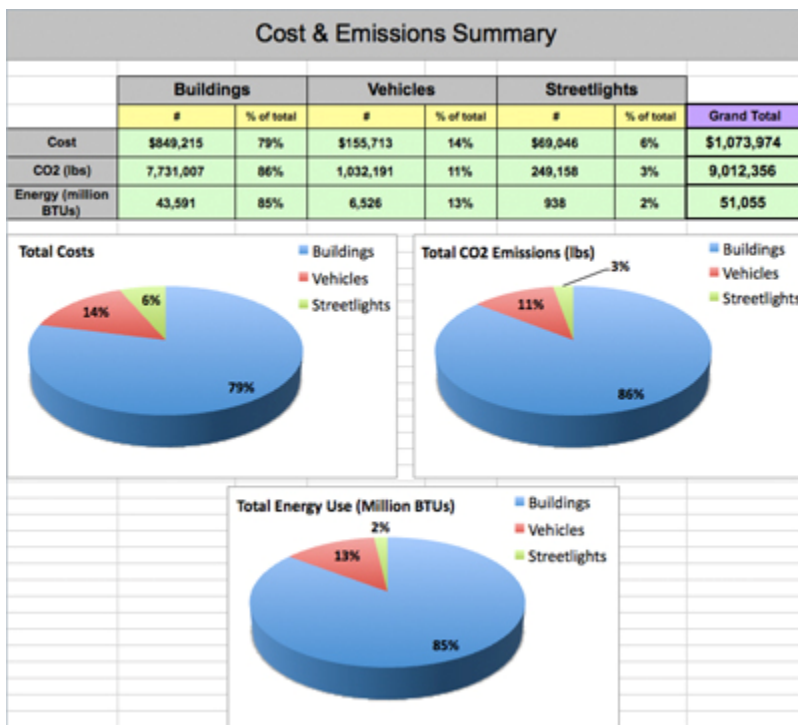


Fig. 2: A summary screen from STOCC showing a town's energy costs, CO2 emissions, and energy use by sector.

For example, the production of 1 kilowatt hour of electricity in New England releases approximately 1 pound of carbon dioxide, while burning a gallon of gasoline emits roughly 20 pounds. STOCC multiplies the amount of each fuel by its emission factor to calculate the total carbon dioxide the fuel emitted. STOCC, using the amount and type of fuel, can also calculate the total amount of energy that was consumed in British thermal units, or BTUs. All this information is then summarized in charts and graphs in the spreadsheet. (See Figure 2)

The application of STOCC in several towns allowed broad testing and the identification and correction of minor problems in its format. Most notable was the way building fuel data was entered. STOCC was designed to analyze total carbon dioxide emissions by each fuel type, rather than by fuel used by each

building. It turned out that the municipalities did not need comparison of fuel types; rather they wanted to compare the energy performance among buildings.

A second problem was that STOCC wasn't best formatted to accept the type of data that towns could provide. It was originally designed to list fuel use data for each individual vehicle; however, towns can typically provide fuel usage only by department or, in many cases, by total fuel consumption for the entire town. While this is trivial from a data entry standpoint, it limits a town's ability to track emissions of individual vehicles. When tracking energy use, being as specific as possible helps identify where energy may be wasted.

The third problem was somewhat more pressing. Sometimes the towns could provide only fuel costs rather than consumption. Without consumption data, STOCC cannot calculate emissions. Having no better alternative, I resorted to estimating annual consumption based on average fuel prices for the year being analyzed. While this approach introduces some uncertainty, it still provides a usable estimate. Each of these issues was addressed in STOCC version 2, which was released in the fall of 2009. The most recent version of STOCC is available free of charge for download on the CA-CP Web site. (See Appendix) At one point in the summer the accuracy of the automated calculations in STOCC came into question. STOCC can be used in conjunction with the Environmental Protection Agency's (EPA) Portfolio Manager, a tool that analyzes building energy performance on a more detailed level. After comparing STOCC results with Portfolio Manager results for a small sample of buildings, I realized that STOCC used slightly different emission factors for different types of fuel compared to Portfolio Manager. This presents a problem for towns that want to use both tools. However, after contacting the EPA and analyzing the discrepancies, it was determined that the differences were not significant enough to warrant major changes in STOCC. (Most discrepancies were less than 1%.) Given the fact that STOCC was designed to provide a general estimate of a town's carbon dioxide emissions, such a small margin of error is not perceived as a significant issue.

Throughout the process, my colleagues at CA-CP and I were often torn between adding advanced capabilities to STOCC and keeping it simple. One example of this struggle was our decision to omit weather normalization from STOCC. Towns use varying amounts of energy from year to year, depending on the harshness of winters and the heat of summers. Consequently, energy inventories for some years may differ significantly solely due to variations in weather. These differences can make it difficult for towns to track accurately their progress towards reducing energy use. Weather normalization would have solved this problem by adjusting the results to account for weather fluctuations. However, STOCC was created to be a simple tool to help towns track their *total* carbon emissions. By normalizing for weather, STOCC would become slightly more complicated for towns to use and go beyond its intended purpose. So in the end, weather normalization never found its way into STOCC as a standard feature, but we chose to offer this service to those towns that requested it.

Making Sense of the Inventory

Once data had been collected and entered, the next step was to prepare reports for the towns. These reports explained the results of the inventory in plain language and provided recommendations for improving the town's energy efficiency. By November of 2009, reports for the eight participating towns had been completed, and I had time to personally present two of the reports to town energy committees.

Towns able to provide two years of data could see in their reports if their energy usage was increasing or decreasing. Towns which could not provide complete data did not receive as detailed a report. Several towns used the EPA Portfolio Manager along with STOCC. The reports for these towns were especially strong because they combined detailed building performance analysis with the STOCC inventory.

A Step in the Right Direction

Long weeks of collaborative work with the towns resulted in eight finished STOCC inventories. While this is well short of my original goal, it is a number of which I am very proud. After all, these eight inventories represent 27 million pounds of CO₂ emissions (a weight equivalent to 1,200 school busses) and \$3.8 million in energy expenditures for 2008 alone! The number of these inventories may be small, but the amount of energy use they account for speaks for itself.

I learned a great deal about municipal operations and energy use over the course of the summer. Most notably, I learned how far we have to go towards making our municipalities more energy efficient. Local energy committees are a wonderful step in the right direction, but it is going to take commitment on the part of the entire town itself to make serious change. This change is also going to require time and up-front financial investment, but the payoff is lower energy costs in the future. I also learned that towns need better ways of tracking their energy use. Towards the end of the summer I developed a Data Tracking Spreadsheet to accompany STOCC, which has been made available to the public. Hopefully this will enable towns to shorten the tedious process of data collection and complete future inventories in a timely fashion.

Lastly (and sadly), I learned that people are typically unwilling to invest themselves in a project unless there is a visible benefit for them. In relation to STOCC, towns were more interested in the cost-saving aspect of energy efficiency than in the environmental ramifications. This classic controversy between economics and the environment is a real issue in municipal operations. Fortunately, with the help of STOCC, we have shown that environmental stewardship and economic success can go hand in hand. By tracking improvements in energy efficiency, towns can indeed save taxpayer money while reducing their emission of heat-trapping gases.

Addressing climate change must occur at all levels of society—from federal to states to towns to individuals. Municipal operations are often overlooked amidst the push to increase federal spending on renewable energy and to turn off the light when you leave the room. I believe that the specific results of the energy inventories I conducted don't speak as loudly as the fact that they were conducted in the first place. This movement to take account of greenhouse gas emissions at a local level is critical. After all, it is the end user, not the oil companies or the power plants, who is responsible for energy-related carbon dioxide emissions. Once we, as a society, begin to understand and act upon the combined economic and environmental benefits associated with improving the efficiency with which we use energy, I am confident that we will be better able to reduce significantly our greenhouse gas emissions.

The development of STOCC and its implementation could not have been completed without the assistance of several individuals and organizations. I would like to thank Julia Dundorf and Christa Koehler of CA-CP for lending their expertise throughout this process. Their willingness to offer their time and resources truly made this project a success. Thank you to Cameron Wake, my mentor, who initially offered me the opportunity to develop STOCC. His guidance and scientific know-how significantly strengthened the tool and made it something that towns will greatly benefit from. He has become a mentor not only in my research but also in my professional, academic, and personal development. I would also like to extend my gratitude to Liz Burakowski for her assistance with creating the map included in this article. Finally, STOCC's implementation was made possible largely through funding provided by the Hamel Center for Undergraduate Research at the University of New Hampshire. Thank you for your continued commitment to making undergraduate research such an accessible option for students at UNH.

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Appendix: Organizations involved in the development of STOCC

Carbon Solutions New England (<http://carbonsolutionsne.org/>) is a public-private partnership based out of the University of New Hampshire to promote collective action to achieve a clean, secure energy future. Cameron Wake, my mentor throughout the research process, serves as its director.

Clean Air–Cool Planet (<http://www.cleanair-coolplanet.org>) is a non-profit organization dedicated to finding solutions to global warming. Among other tasks, they partner with communities, companies, and universities to achieve this goal.

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Author Bio

*A course on global environmental change in his freshman year, taught by Dr. Cameron Wake, got **Corey Johnson** interested in climate change and environmental sustainability. He subsequently worked with Dr. Wake on the Small Town Carbon Calculator and says the most satisfactory aspect of his summer project “was implementing a tool I had helped develop.” Although working with towns to gather data took longer than expected, he found it a valuable experience in developing useful skills for the future. From Amherst, New Hampshire, Corey expects to graduate in May 2011 with a Bachelor’s of Science degree in Business Administration, information systems management, and is enrolled in the Honors in Major program of the Whittemore School of Business and Economics at the University of New Hampshire. After graduation he hopes to work for a few years in Boston before going on for a Master’s in Business Administration.*

Mentor Bio

***Cameron P. Wake** is a research associate professor in the Institute for the Study of Earth, Oceans, and Space, and the Department of Earth Sciences, at the University of New Hampshire as well as the director of Carbon Solutions New England. He has been on the UNH faculty for fourteen years and has been chair of the Planning Committee of the Undergraduate Research Conference for the past five years. In his teaching and research he specializes in paleoclimatology, regional climate change, engaged scholarship, and sustainability. Corey joined him in his research on tracking carbon emissions for UNH and the state of New Hampshire. Dr. Wake has long believed in mentoring student research and has found this mentoring experience rewarding. He praises Corey’s work and notes that “his project has developed an important tool for tracking energy use, costs and greenhouse gas emissions for communities around New England.”*