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ENVISION CHARLOTTE PROJECT FINAL REPORT

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CHARLOTTE

Envision Charlotte Project Final Report

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Executive Summary

The Envision Charlotte Project (EC Project), supported by partners at the Center for Climate and Energy Solutions, the University of North Carolina at Charlotte's Center for Sustainably Integrated Buildings and Sites and the City of Charlotte, has successfully demonstrated that existing buildings can benefit from operations improvements and low-cost efficiency upgrades, and that behavioral change campaigns can be effectively designed for measurability, longevity and impact.

Support from this grant gave Envision Charlotte and its partners the resources and flexibility to demonstrate a variety of approaches to improve coordination with stakeholders in the implementation of programs to reduce the consumption of energy, water and waste. The project team also gained insights into the motivations and abilities that influence stakeholder engagement in sustainability initiatives at multiple levels. Importantly, as this report describes, strong partnerships between nonprofits, industry partners and research institutions can produce tangible impacts and replicable results in building efficiency. Further, building operators working alongside student researchers can form productive relationships that can advance building energy management goals.

Key Findings of the EC Project

This project focused on advancing solutions to energy efficiency in U.S. commercial buildings. The Building Re-Tuning™ Training (BRT) developed by the U.S. DOE's Pacific Northwest National Lab (PNNL), designed to detect energy savings opportunities and implement improvements with resources and online tools, provided the starting point for the curriculum developed by stakeholders in the EC Project.

Although the project partners encountered some issues with data consistency, the overall project outcomes fell short of the energy savings stated in the original proposal, and the total participating building targets were lower than anticipated, important findings, outcomes and lessons learned were achieved.

EC Project grantees observed that the PNNL BRT, as currently written, was not compatible with the skills of average frontline mechanical personnel in the Charlotte region where the grant program was performed. Frontline staff are not, typically, energy managers, engineers or building commissioning agents, but they can play a key role in building performance. As detailed in this report, the grantees therefore focused on changes to the BRT that improved the level of training and competency of the frontline workers in this region.

Among the technical observations related to improving the BRT that were observed in the EC Project:

• centralized facilities management often has an impact on building performance;
• operators can be overly reliant on service contracts;
• individual behaviors matter, and technology cannot be viewed as a crutch;

• current Building Automation Systems (BAS) are often too complex to support building efficiency optimization, but BAS coupled with appropriate training can support better outcomes;
• the "perfectly optimized" building is not a near-term possibility, but better education, especially of executives and managers, on the role of behavioral intervention is a promising direction the building science community can and should pursue;
• a lack of standards and protocols, and competition between proprietary software from service contracts, remain challenges for this industry.

These technical observations, in turn, informed the EC Project's overall findings, which were:

1. Accomplishing building efficiency is a process of education for all involved in the building design, construction and operation supply chain.
2. Building operators, as a professional class, have an opportunity for further training and education that will lead to better on-the-job performance.
3. An updated Building Re-Tuning™ Training curriculum, based on the findings of this report, could be an avenue for these operators' professional development.

Energy Performance Results from the EC Project

In addition to the above findings, which have the potential to increase the efficacy and professionalism of the building energy management industry, the EC Project achieved significant energy and waste savings that are meaningful both to local building operators and their companies' bottom lines. These achievements are also important to the ongoing process of visioning and marketing the City of Charlotte as a national leader in sustainability.

The portfolio of buildings recruited for this project were organized in a cohort called the Energy Roundtable. These buildings were primarily located in Mecklenburg County, North Carolina. The overall portfolio included commercial office buildings in both uptown Charlotte as well as the surrounding areas, several institutional facilities on the campus of UNC Charlotte and several medical office buildings. Additional commercial office buildings were included from Spartanburg, South Carolina; Winston-Salem, North Carolina; and Greensboro, North Carolina.

The Energy Roundtable included a cohort of 142 buildings in total. Several additional buildings were recruited but did not complete the program. The cohort achieved an aggregate (area-based weighted average) energy savings of 13.1%.

Of the 142 buildings in the cohort:

• 19.1% energy savings was achieved by the 61 buildings that had previously committed to improvement goals through a pre-grant program administered by Envision Charlotte beginning in 2012. The baseline for these buildings was the energy consumed in the 12 months prior to interaction with Envision Charlotte.

• 8.6% energy savings was achieved for 81 new buildings serviced during the 2015-2018 EC Project period. The baseline used for each of these buildings was the energy consumed in the 12 months prior to interaction with the grant team. Because buildings were included in alignment with the university's semester-based calendar, each of the 81 buildings had a unique baseline period.

Finally, the EC Project also met other stated goals of successfully engaging more than 50 facility management professionals in Building Re-Tuning™ Training courses and registering more than 1,000 new participants in the ECO Network and through other engagement channels.

Grant Requirements

The EC Project proposed to integrate Department of Energy tools and strategies expected to result in reductions in the consumption of energy, water and waste into a city-wide project over a three year period. The project was to include a comprehensive behavioral change component to ensure model programs were permanently incorporated within a diverse portfolio of buildings from the commercial, real estate, hospitality, higher education, healthcare and retail sectors. As project lead, Envision Charlotte managed the implementation of the following four task areas:

Task 1: Develop a Project Management Plan

Task 2: Form a Data Foundation and Energy Roundtable Program that identified individuals to participate in training; achieved operational savings through DOE's Building Re-Tuning™ Training for facility managers; included student-led energy audits; ensured provider-agnostic improvement identification; and benchmarked the portfolio.

Deliverables for Task 2:
a) Course syllabus
b) Student enrollment records
c) Building audit plan
d) Evaluation reports
e) Milestone report

Task 3: Develop a Champions Program that included a comprehensive behavioral change component

Deliverables for Task 3:
a) Preliminary assessment
b) Resource development and communications plan
c) Promotion of new resources
d) Data collection and analysis
e) Final report

Task 4: Publicize best practices and lessons learned

Award Administration

Envision Charlotte performed all aspects of grant administration, including executing and maintaining sub-award agreements with all sub-recipients. Related to Task 1, developing a project management plan, brief profiles of the sub-recipients are listed below.

Envision Charlotte

Envision Charlotte's successful execution of its coordinating role in the EC Project supported the deepening of partner relationships and enhanced energy efficiency outcomes in the greater Charlotte region. In particular, Envision Charlotte coordinated the involvement of UNC Charlotte's Center for Sustainably Integrated Buildings and Sites (SIBS) program, facilitating introductions that led to the successful engagements and technical advancements outlined in this report. Envision Charlotte also elevated Carolinas HealthCare System's (now Atrium Health's) leading role in energy efficiency management in an institutional setting, which has since received international recognition. The organization also helped spur the City of Charlotte to creative engagement with community residents through education and outreach strategies that included a well-attended speaker series and networking events for industry professionals and the interested public.

UNC Charlotte Center for Sustainably Integrated Buildings and Sites (SIBS)

The SIBS program and its affiliates were instrumental to the overall project's success. SIBS supported curriculum development for students, managed student recruitment and enrollment, provided auditing and re-tuning training support for building operators, and completed annual energy guides and other reporting. (See appendix for Course Syllabus and the 2017 Energy Guide.) The program has been packaged for distribution, and inquiries from other municipalities and consultants about how to reproduce the program have been fielded by the SIBS team in recent months.

Center for Climate and Energy Solutions (C2ES)

Washington, D.C.-based C2ES served as the project's education and outreach lead. C2ES conceived of and designed the ECO Network program of work, which included outreach strategies newly developed for this project, including a speaker series and networking events. These programs were intended to cultivate robust engagement and encourage behavioral change. The organization supported general communications and a public awareness campaign, the Cut Back on Cups Challenge, and provided guidance on communication strategies and best practices for event planning and follow-up. Planning tools and campaign templates were developed to support these efforts. The organization served in a liaison role between the project team and the U.S. Environmental Protection Agency's Climate Leadership Conference and supported project marketing through press announcements and social media/Web tracking.

City of Charlotte

The City of Charlotte formed and managed a Smart City Council, which included a broad base of stakeholders, and produced a vision and mission statement that helped establish a community-wide orientation around the EC Project's goals. The City also coordinated the intervention of internal staff experts as the project was deployed and helped supply building/facility access.

Carolinas HealthCare System

Carolinas HealthCare System (CHS) provided exceptional value to the project with work entirely underwritten by the company's cost share. Led by its Director of Sustainability, CHS formed and managed a panel of project validators that helped shape an energy management plan and program execution. Leaders describe the six building pilot undertaken in the project's performance period as "transformational" – meaning the company is not expected to return to business as usual regarding energy management. This new way of doing business has been demonstrated, to date, by staff allocations, an increase in hiring for energy expertise, the participation of senior-level management in data tracking and reporting, training programs available to staff, and budget allocations for energy projects. In addition, CHS partnered with UNC Charlotte SIBS to produce the Energy Connect program, hosting quarterly meetings for the primary partners during the grant period.

Duke Energy

Duke Energy offered technical expertise to the UNC Charlotte SIBS student teams through their established building energy management program known as Smart Energy in Offices (SEiO). The utility helped promote participation in behavioral change campaigns at their own facilities and at project sites. (Duke Energy was not a funded or cost share participant in the grant. However, the company requested accommodation midway through this project to be the only partner to discuss energy-related behavior change with community members in order to simplify its required reporting to the North Carolina Public Utilities Commission.)

Charlotte Center City Partners

Charlotte Center City Partners (CCCP) was originally sub-contracted to provide marketing and branding support. Staff changes at the organization in the summer of 2016 led to the termination of their participation. Although EC took on many of these tasks, CCCP's departure eliminated a unique opportunity to boost engagement activities.

Data Foundation and Energy Program Initiatives for Students and Operators

To complete Task 2, project partners were to form a data foundation and Energy Roundtable program that identified individuals to participate in training; achieve operational savings through DOE's Building Re-Tuning™ Training for facility managers; include student-led energy audits; ensure provider-agnostic improvement identification; and benchmark the portfolio.

The student training program, known as the Energy Roundtable, and the operator training program, known as Energy Connect, were successful in achieving the objectives of Task 2. Findings and lessons learned are detailed below. *Note: The project team also collaborated with Duke Energy to ensure meaningful delivery of their overlapping but independent objectives.* (1)

Energy Roundtable (Student Program)

UNC Charlotte SIBS and Envision Charlotte worked together to identify partner buildings and determine the best course of action for providing these buildings with energy savings. Partner buildings were to be surveyed by students at UNC Charlotte. Most building stakeholders that were initially interested in partnering were managing buildings that were already high-performing. As a result, the initial buildings touched by the program required only minor activities focused on operational energy savings.

As the academic curriculum developed, however, the team discovered ways to both support student success as well as recruit greater need/higher impact buildings into the portfolio. By the fall 2017 enrollment class, students were able to complete evaluation of two buildings.

Among the additional findings as the project unfolded:

• Project leads learned that ASHRAE Level 2 energy audits could only be effectively completed if either (a) the faculty provided extensive and detailed guidance to each team or (b) expectations for students were elevated beyond the level required for a 3-credit course. (2) Given the constraints, the team adopted an approach focused towards retro-commissioning.

• Developing some level of continuity among the diversity of building types was a challenge. Many buildings had advanced automation systems in which trends for thousands of data points, going back years, were accessible. Others had limited data availability and could only store data for three days at a time. Others had no automation system. Some buildings had remote access while others could only offer Excel-based trend logs. The project team had to customize solutions to address all of these constraints.

1 Duke Energy was beginning a program focused on operational energy savings concurrent to the launch of the EC Project. This program, Smart Energy in Offices (SEiO), focused on both tenant and operator engagement activities, with the major focus on operators. Envision Charlotte, UNC Charlotte and Duke Energy were ultimately able to resolve the challenges of operating similar programs simultaneously.
2 ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) defines best practices for energy survey and analysis using audit levels that range from 1-3.

• Nomenclature is remarkably non-standard in this industry. SIBS faculty had to adapt and determine methods for normalizing the data so that students understood what they were looking at. To make this work, project leads provided in-depth intervention: setting up data trends, learning what systems were in place, and pulling data from various systems.

Energy Connect Training Program (Operator Training)

Carolinas HealthCare System joined this project in a cost-share capacity. The company collaborated with UNC Charlotte SIBS to implement a pilot training program with six pilot facilities. The program, which became known as Energy Connect, was based on the Department of Energy's Building Re-Tuning™ Training (BRT) protocol. Carolinas HealthCare System (now Atrium Health) is a large operation that includes 17.5 million square feet of facility space across 940 care locations staffed by 62,000 personnel. The annual utility expenditure is $37 million. An Energy Management program was initiated in 2012.

One of the EC Project's key contributions to the DOE's energy management program is its update to the BRT; specifically, the CHS team modified the BRT to better meet the energy literacy needs of frontline facilities staff. In carrying out this work, the CHS team focused on reducing energy use intensity; saving money; empowering building operators, mechanics and engineers; positively impacting hospital patient experience; and creating a culture of energy savings. More than 200 frontline staff participated in this curriculum.

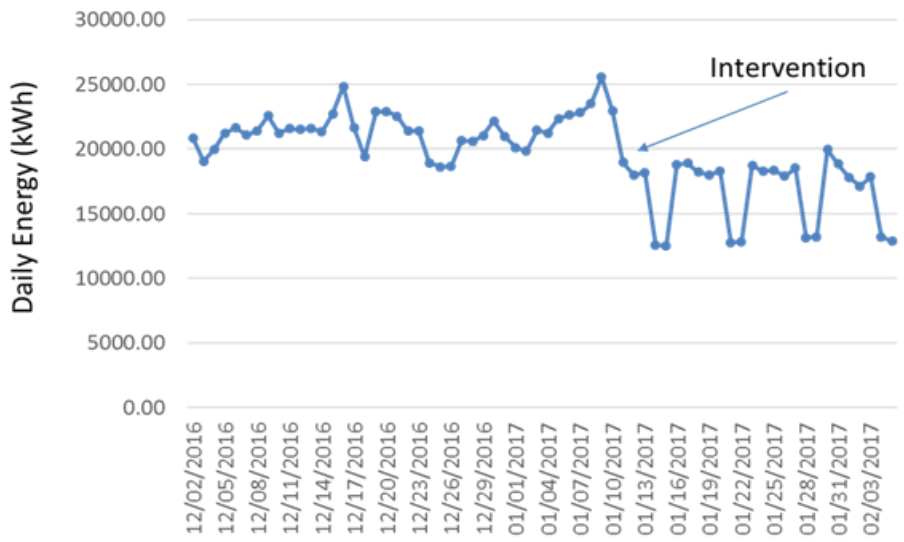


Figure 1: Daily energy profile in the first building receiving an "intervention" from the team at UNC Charlotte

Beyond these goals, the team collaboratively determined five key interventions that would come to change operator behavior in observable ways and, ultimately, the culture of energy management at CHS. (Figure 1 illustrates the intervention had a progressive impact on performance).

Based on set-point adjustments in the building automation system, the interventions included:

• creating a system for tracking relevant adjustments/overrides in buildings;
• creating a manual describing best practices/processes for addressing the most common maintenance issues;
• recruiting Building Automation System champions that would take responsibility for monitoring key performance indicators for their building, and encouraging others to take action to make their buildings more efficient;
• making energy data visible to site level staff with dashboards; and
• educating non-facilities staff about the role of frontline staff.

The CHS case provides evidence that operators are most empowered when they are offered a multi-stage training program. Survey results have shown that frontline facilities staff have a variety of different background experiences. Based on this pilot, it became evident that few operators have the prerequisite knowledge required to understand the higher-level technical concepts found in the DOE's Building Re-Tuning™ Training. SIBS therefore worked with the CHS team to update the BRT curriculum to encourage the development of new expertise among personnel with similar baseline competencies. Key focus areas included improving energy literacy, ensuring an understanding of and ability to optimize air-side energy use, and ensuring an understanding of and ability to optimize water-side energy use.

Also notable is that the BRT activities evolved over time to include two types of training: basic and detailed. Basic training was geared towards staff in acute-care hospitals and focused on basic energy awareness. Topics included energy basics, air-handling issues, central plants, zone-level issues and developing an action plan. In the detailed training program the focus was on implementation of the building re-tuning methodology, particularly at medical office buildings.

Applying the Energy Connect Toolkit at CHS for Behavioral Change

With strong leadership and technical knowledge from the company's Sustainability Director, CHS embarked on an ambitious program to remake the energy management culture within the corporate organization. The program was the first activity of an Energy Leadership Council appointed by the company in 2015.

Energy Connect was designed to be a platform for engaging energy management personnel, supplying a curriculum to train, making interventions and evaluating progress (Figure 2). For CHS, the goal was to help link human actions to energy savings, achieve natural resource conservation and enhance the patient experience.

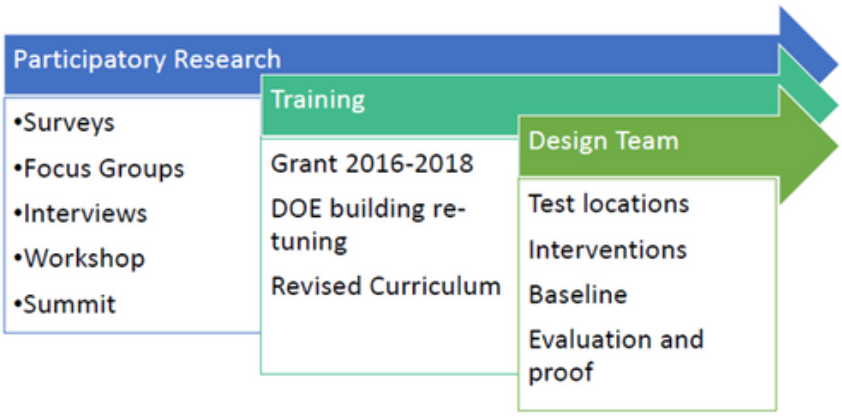


Figure 2: Energy Connect model

The following case study illustrates significant building performance results. Buildings such as this one were the beneficiaries of audits and process improvements by personnel trained in the Energy Connect CHS/SIBS curriculum.

Medical Center Plaza Case

A sample building from the cohort is the Medical Center Plaza. In year two of the program, the pilot achieved 11% energy savings and 3% cost savings (Figure 3). According to building staff, the energy use intensity (EUI) increased from 50k BTU/ft2 to approximately 100k BTU/ft2 prior to analysis in fall 2016. The building is conditioned using a central chilled water plant that feeds two air handling units (AHUs). The AHUs supply a common trunk that serves the entire building. Each AHU utilizes a fan wall consisting of multiple fan units, while the trunk line feeds series flow terminal units on each of the individual floors.

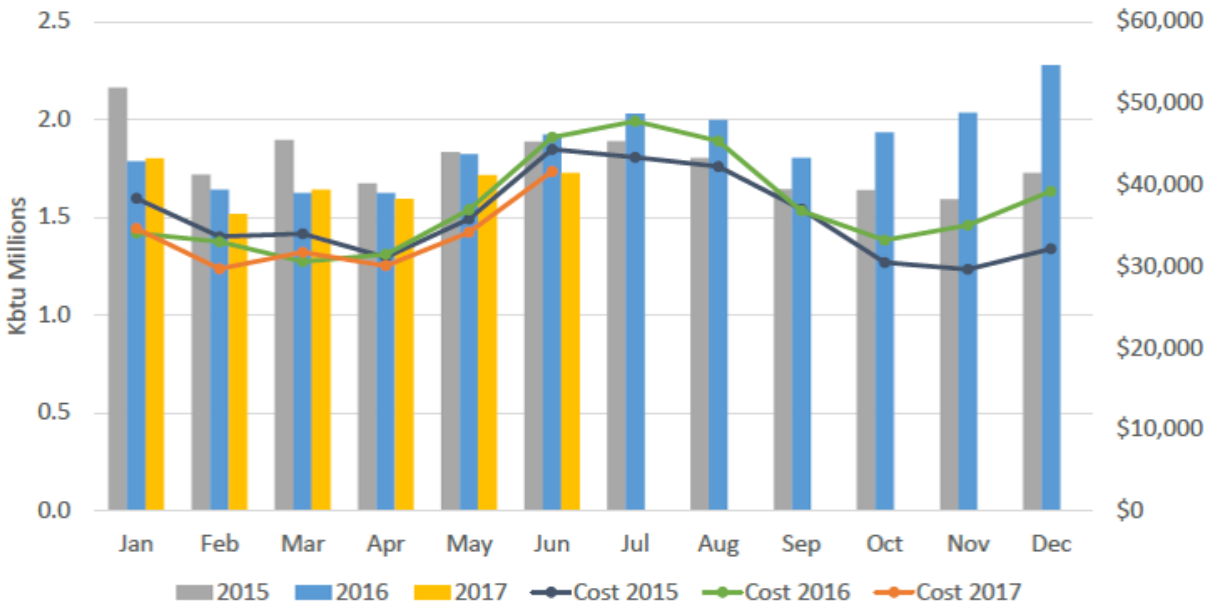


Figure 3: MCP cumulative energy and cost savings

During the analysis, the team discovered several major opportunities for energy savings. These included:

- opportunities to modify building schedules;
- opportunities to expand the use of economizing;
- addressing failed chilled water valve in AHU B; and
- opportunities for advanced resets.

The data gathered by the engineering team suggested that there were opportunities to improve "economizing" within the facility as well. Figure 4 shows performance of the economizer over the

second half of 2016. The economizer was set up so that it would not be disabled until the outside air temperature dropped below 25 degrees Fahrenheit, but in late June operators raised the economizer shut-off to 48 degrees.

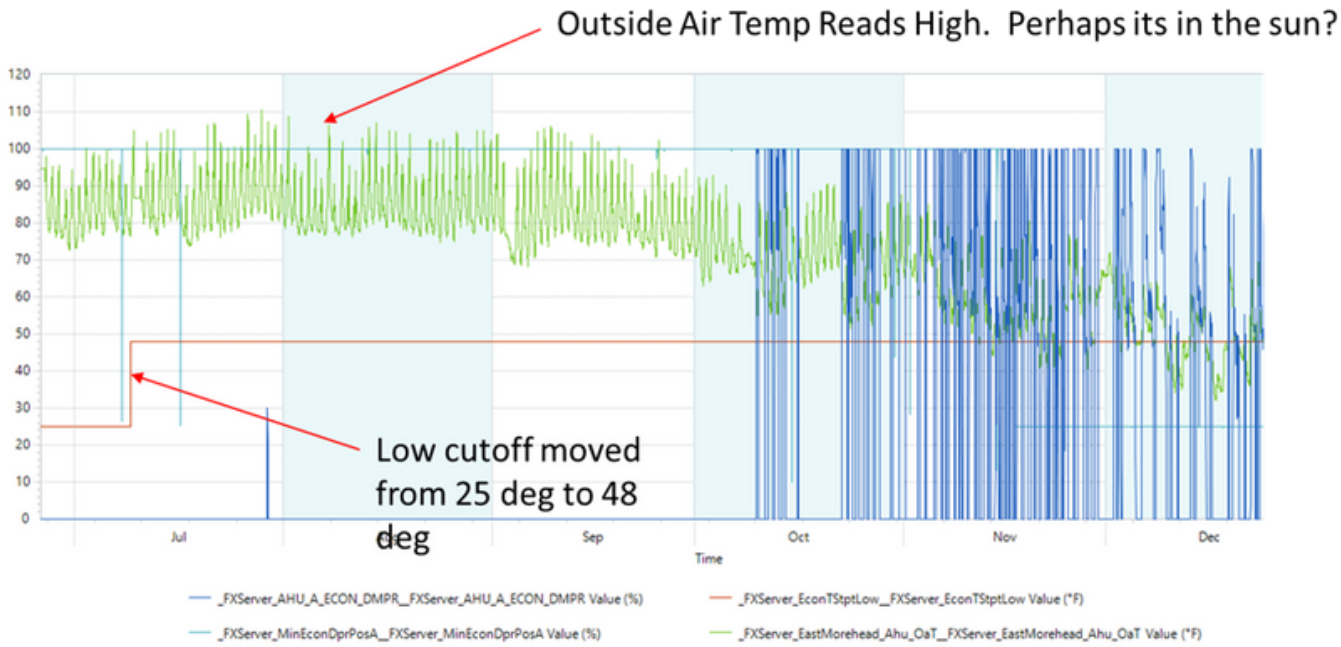


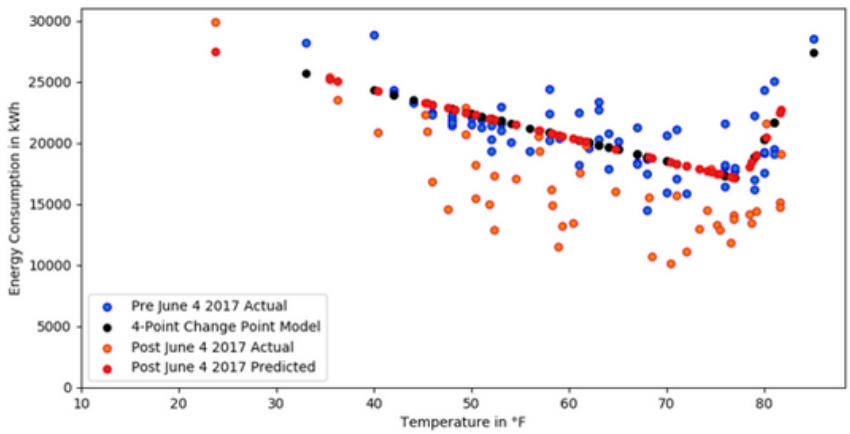
Figure 4: Economizer data at MCP

A close day-by-day comparison of the outside air temperature sensor versus historical records shows that the data presented above are approximately 20 degrees above the actual readings on those days. It is likely that an operator increased the low temperature cut-off by approximately 20 degrees. The data show the economizer functioned well at temperatures above 48 degrees.

This case was typical of those encountered in the project. As shown in the complete building analysis in the appendix, the project team offered customized analysis like this for each participating building.

Data Foundation: Building Analysis Methodology

In addition to custom analysis, the SIBS-led team modeled actual and predicted energy usage for all buildings in the portfolio. By comparing predictions from the models to what actually occurred, energy savings could be achieved. Figure 5 illustrates a predicted model for a sample commercial building that achieved a remarkable 19.36% savings. The appendix includes a complete energy report for a sample building.



Total Square Footage: 67,670

Savings (%): 19.36

Weeks used to predict change point model: 67

Weeks used to calculate prediction: 47

Figure 5: SIBS predicted energy savings model

Working with Student Teams

Student-led audits were a key component of Task 2. SIBS far exceeded expectations in the area of student enrollment with 83 students engaged through the spring 2017 semester. Several students informed the project leads after graduation that completion of the course was the key experience that stood out on their resumes. Several other students reported that the course should be required for undergraduates because it synthesizes material learned in the classroom and allows for more opportunities to apply knowledge in the real world. (UNC Charlotte does not anticipate mandatory enrollment because of ABET-related requirements, but was pleased by the positive feedback.)

Over the grant period enrollment totals were:
Spring 2016: 26 total students
ECGR 4090: 23 students
ECGR 5090: 3 students

Fall 2016: 15 total students
ECGR 4090: 9 students
ECGR 5090: 6 students

Spring 2017: 42 total students
ECGR 4090: 31 students
ECGR 5090: 11 students

Fall 2017: 35 total students
ECGR 4090: 24 students
ECGR 5090: 11 students

Spring 2018:18 total students
ECGR 4090: 14 students
ECGR 5090: 4 students

In Summary: Energy Performance of the Cohort

The EC Project achieved significant energy and waste savings that are meaningful both to local building operators and their companies' bottom lines. These achievements are also important to the ongoing process of visioning and marketing the City of Charlotte as a national leader in sustainability.

The Energy Roundtable included a cohort of 142 buildings in total. Several additional buildings were recruited but did not complete the program. The cohort achieved an aggregate (area-based weighted average) energy savings of 13.1%.

Of the 142 buildings in the cohort:

• 19.1% energy savings was achieved by the 61 buildings that had previously committed to improvement goals through a pre-grant program administered by Envision Charlotte beginning in 2012. The baseline for these buildings was the energy consumed in the 12 months prior to interaction with Envision Charlotte.

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Finally, the EC Project also met other stated goals of successfully engaging more than 50 facility management professionals in Building Re-Tuning™ Training courses and registering more than 1,000 new participants in the ECO Network and through other engagement channels. Community engagement was the primary objective of Tasks 3 and 4 and is discussed in detail in the following section.

Developing a Champions Program with a Comprehensive Behavioral Change Component

The key objectives of Tasks 3 and 4 involved work that would achieve ongoing energy and resource conservation, beyond the performance period, that was driven by a comprehensive behavioral change component.

Led by C2ES and Envision Charlotte, the tasks undertaken were designed to build capacity and value for the organization's voluntary behavior change Champions Program (later renamed the ECO Network) and grow the number of participants by 50% (more than 1,000 individuals). (3) The project also sought strategic alignment of owner-tenant activities.

An initial work plan was developed in late 2015 to guide the development and implementation of the engagement strategy. These efforts, focused on behavioral change campaigns and resources, were intended to complement the Energy Roundtable and Building Re-Tuning™ Training work streams, and, when possible, support them.

Throughout the course of the project, partners managed staff changes, emerging constraints, new partner wishes, etc., by making necessary adjustments to the original project plan. For example, in the spring of 2016, Duke Energy requested to be the only partner to discuss energy-related behavior change with community members to simplify reporting to its state regulator. C2ES had expected to develop signature campaigns and materials around energy conservation; in response to this decision, the organization turned its focus to water conservation, air quality and transportation and waste reduction.

Staff changes at Charlotte Center City Partners in the summer of 2016 meant that the organization was unable to participate as originally planned. Although Envision Charlotte took on many of these tasks, CCCP's departure did remove a partner uniquely positioned to boost engagement activities.

While these changes impacted the strategies and scope, they did not stop the project team from achieving the grant goals. Project partners utilized a variety of engagement tactics to reach Charlotte citizens and encourage behavior change in energy, water and waste consumption. The engagement tactics included e-newsletters, the Cut Back on Cups Challenge, and events like happy hours, ECO Network programs, a recurring speaker series and development and deployment of the Happen App.

C2ES provided on-going guidance on communication strategies, best practices for event planning and follow-up, and created planning tools and campaign templates for these activities. The efforts were designed to motivate behavior change, reinforce sustainability values, create excitement and build the reputation of Envision Charlotte. C2ES also sought opportunities to promote lessons from the project to a national audience.

Preliminary Assessment

At the time of the grant award, EC surveyed existing participants in the Champions network (made up of EC listserv subscribers and corporate “green teams”) as part of the grant’s required preliminary assessment. Twenty-three people from 13 companies responded. While this small sample size did not allow for rigorous analysis, the responses did help guide future decisions.

Survey respondents were interested in receiving ongoing communications and engagement from EC, specifically around activities and educational options that would allow a deeper dive into sustainability issues. Participants were interested in a variety of topics; highest ranked was sustainability and energy conservation, followed by waste management, water conservation, general news and events, and climate change and greenhouse gas emissions. Respondents wanted to see more visible results and recognition from their participation in the Champions Program.

3 In the years preceding the grant, Envision Charlotte developed a “Champions” program for building tenants in Charlotte’s uptown district. The program included a variety of engagements with employees of Bank of America, the City of Charlotte, Mecklenburg County, Childress Klein Properties and Wells Fargo. Envision Charlotte hosted numerous happy hours and “town-hall” - type events that attracted average participation of 30-40 participants and helped establish some name recognition among uptown employees.

Resource Development and Promotion

Resulting from the discovery phrase, Envision Charlotte launched an ECO Network in 2016 intended to create a thriving, sustainable Charlotte by fostering collaborative action and leadership among citizens. Education, networking and action campaigns formed the core agenda of the ECO Network, which was open to the public, but recruitment was focused on city and private sector employees, facilities managers, Envision Charlotte Board members, the City of Charlotte's Smart City Council members and local university students.

As a component of the behavioral change program concurrent with the launch of the ECO Network, Envision Charlotte opted to use the smartphone app, Happen, that Duke Energy had previously developed in support of its Smart Energy in Offices (SEiO) program. This collaboration allowed the project team to engage a growing audience of uptown building tenants.

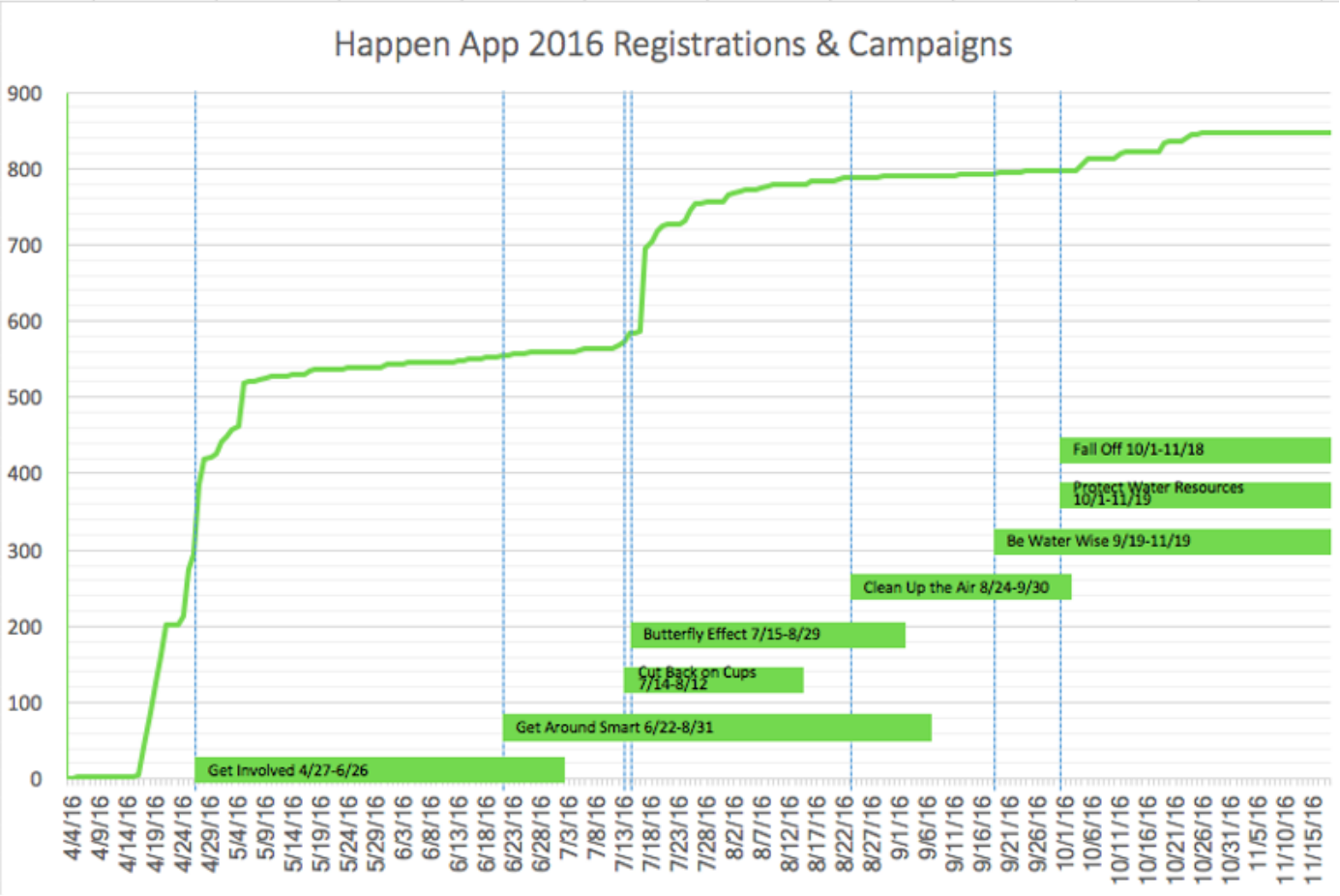


Figure 6: Happen App campaign increases public engagement

Envision Charlotte also amplified ECO Network app challenges through e-newsletters and leveraged them to foster unique connections with community organizations. C2ES also actively facilitated the development of new relationships with the Charlotte Public Tree Fund and the bike share company, BCycle.

Behavioral Change Campaign

Between April 2016 and November 2016, both app participants and newsletter subscribers increased at a rate sufficient to eventually achieve the project's goals. By overlaying total Happen App registrations on top of the campaign calendar for Envision Charlotte and Duke Energy, the data show that engagement grew during the more interactive behavior change campaigns (Figure 6).

In mid- 2016, Envision Charlotte sought to develop programming and activities that would introduce the ECO Network to the community and support measurable behavior change, which led to the Cut Back on Cups waste challenge. This was a "Bring-Your-Own-Cup" (BYOC) challenge where individuals reduced their disposable cup usage in order to win prizes.

The challenge was promoted via workplace emails, newsletters and social media, and via signage in high traffic office locations (Figure 7).

Employees at the Charlotte Mecklenburg Government Center were given free, stainless steel ECO Network-branded reusable tumblers.

Figure 7 Cut Back on Cups promotional poster

The behavior change was further incentivized through to a partnership with a local restaurant, which provided discounts for customers that used reusable cups. Participation was partly tracked through the Happen app.

The four-week challenge resulted in cup reuse greater than 1,800 times by more than 100 participants.

Promotion of New Resources

C2ES also supported the development of a speaker series as an additional initiative in Envision Charlotte's engagement portfolio. The series featured a keynote, panel discussion, and relevant personal "take action" opportunities for attendees with the aim of integrating individual behavior change and engagement components alongside educational information and networking.

The series launched on April 18, 2017 during Earth Week and featured the Dutch Ambassador to the United States, Henne Schuwer, as keynote. Additional sessions featured expert speakers on air quality and on "equity by design." C2ES offered guidance on potential topics, speaker invitees, behavior change tips, subject matter framing, promotional opportunities, speaker briefing memos and event planning.

Throughout the project period, C2ES identified opportunities and strategies to promote Envision Charlotte and the ECO Network. Where possible, content would connect readers to upcoming events and relevant behavior change ideas.

Connecting Training Programs to the Community Engagement Portfolio

The community engagement and behavior change efforts were intended to complement the Energy Roundtable and Building Re-Tuning™ Training work streams led by UNC Charlotte SIBS, and, when possible, support them. To facilitate this, the entire project team established communication processes to promote awareness of new activities and opportunities between the partners.

Throughout the project, C2ES maintained connections to other grant work streams. C2ES coordinated with UNC Charlotte and Carolinas HealthCare System to discuss ways to support the building energy efficiency efforts. These conversations focused on opportunities to increase engagement within organizations and locally among Charlotte building tenants and managers, as well as among the broader building energy efficiency and community engagement audiences. For example, the team applied to host a panel at the Behavior Energy and Climate Conference. C2ES provided input to frame the updated Building Re-Tuning™ story, noting what insights might be most meaningful to a variety of external audiences.

C2ES helped place a case study about the Duke Energy/EC partnership in *American Mayors and Businesses: Building Partnerships for a Low-Carbon Future*. This publication was distributed to city leaders nationwide by the Alliance for a Sustainable Future, a partnership of C2ES and The U.S. Conference of Mayors.

C2ES also oversaw and supported the placement, development and delivery of a pre-conference workshop on public private-plus partnerships at the 2018 Climate Leadership Conference in Denver, Colo. This was the most highly attended workshop at the conference, and it provided an opportunity for the Executive Director of Envision Charlotte to introduce her organization to key constituencies.

Analysis and Final Evaluation

C2ES and EC succeeded in using a multi-pronged strategy to increase public engagement and behavioral change. Data show that list-serv subscribers and newsletter open rates increased, and open rates outperformed industry averages. Engagement levels were generally sustained compared to pre-grant activities. Given EC's small staff and resulting bandwidth, external funding and partnerships may prove critical to ensuring continued engagement. In addition, although engagement with the Happen app was modest, it may have been greater following design improvements.

Publicize Successes, Best Practices and Lessons Learned

Envision Charlotte and the sub-grantees sought and secured multiple outlets to promote all components of the project, especially best practices. The highly successful behavioral change program at CHS/Atrium Health was described in publications for leading research organizations including the International Energy Agency and the American Council for an Energy-Efficient Economy, as well as in presentations for the Behavior, Energy & Climate Change conference and the World Energy Congress. The 2016 ACEEE *Summer Study on Energy Efficiency in Buildings* publication, describing the CHS case, is included in the appendix.

Envision Charlotte produced factsheet-style case studies of two of the most successful projects in the portfolio (for which the participants approved of public recognition), Foundry Commercial and Flagship Healthcare Properties. These are also included in the appendix. Finally, UNC Charlotte SIBS has been and continues to be approached by consultancies and other cities across the country that would like to adopt this program model.

Direction of Future Work

The EC Project has inspired two key directions for future work. Envision Charlotte and SIBS are jointly exploring how to scale this project's "learning and doing model," among other city-university partnerships. Established conveners like the MetroLab Network and Envision Charlotte's annual conferences can help promote and facilitate the opportunity for learning exchange.

Following the success of this project, Envision Charlotte has championed the development of a Strategic Energy Action Plan as part of the City of Charlotte's commitment to the Global Covenant of Mayors. A key component of the Plan is to target energy efficiency measures that can drive down air and water emissions in the built environment. The Plan will be adopted by City Council in fall 2018 and implementation is expected to begin in early 2019. A recommendation currently written into the draft Plan is to expand on the outcomes of the EC Project, especially in the municipal building portfolio.

EC PROJECT
FINAL REPORT

APPENDIX

ENVISION
CHARLOTTE

Example New Course Syllabus

New Course - ECGR 4090/5090: Energy Data Analytics
Instructor: Dr. Robert Cox

Buildings consume approximately 40% of the primary energy in the United States. Case studies show that consumption can be reduced by as much as 20% through improved operations. To help achieve this efficiency, many buildings have been turning to the promise of Big Data Analytics and the Internet of Things. Data from distributed sensors can now be analyzed in real time using advanced algorithms to help determine opportunities for savings.

This new project-based course offers an opportunity for a hands-on exploration of a major new area of job growth. Students will be partnered with a major building in the Charlotte region and will help to apply the materials learned in class to find energy savings.

Topics include:

- Understanding of the role of energy efficiency to electric utilities
- Understanding of building systems & controls
- Introduction to industrial automation & control
- Introduction to demand response
- Introduction to data algorithms applied in fault detection and diagnosis

Specific topics:

- January – February: Energy fundamentals & Control of building systems:
    - Energy fundamentals – analogues between electrical circuits and fluid, thermal, mechanical systems
    - Adding and removing heat energy from buildings
    - Local controls for fans, chillers, and other equipment
    - Supervisory controls for energy savings (set point resets, etc.)
- March-April: Analytical tools in energy conversion
    - Inverse modeling – Developing models from data
    - Process control models
    - State-space models
    - Rules engines for fault detection and diagnosis
    - Clustering algorithms applied to energy data
- The last two weeks of April are focused on project completion, and will primarily focus on office hours and one-on-one team meetings

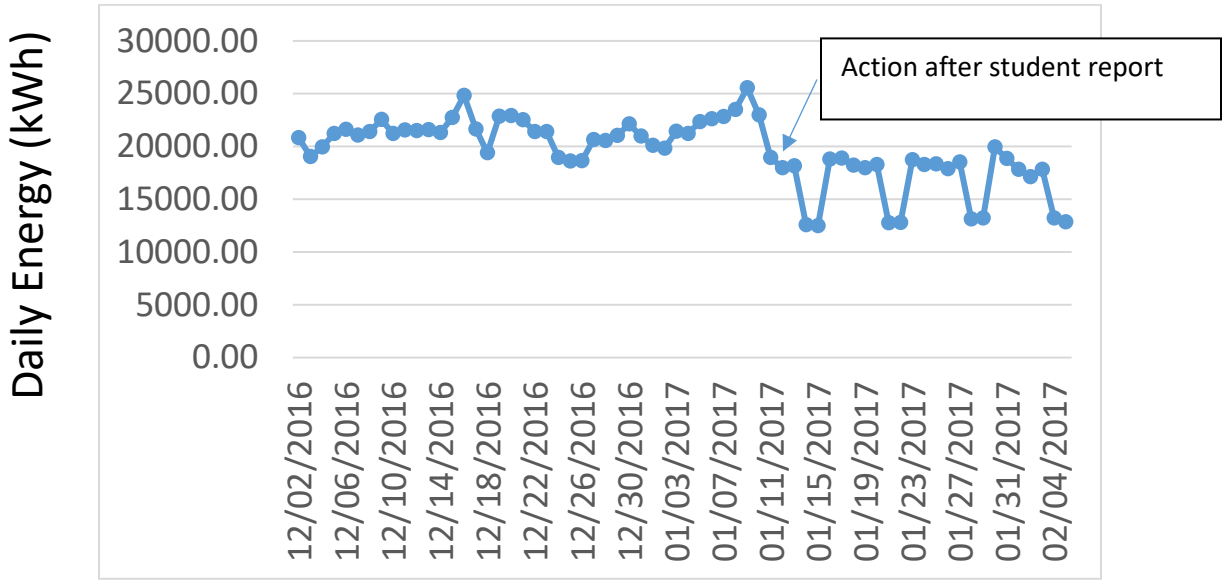
Course Project:

Each team of two students will be assigned to a building. They will work with this building for one-half of the semester. This project requires the following components:

- Tour of your building and access to all automation system data

- Initial report to be submitted 3 weeks after building tour for discussion. This report will focus on the following:
    - Improperly tuned control systems
    - Faulty equipment detection
    - Predicted opportunities for savings
- Final report to be delivered to the property manager at each building during last week of class

The reports you write can have a big impact. Last semester, students worked with a large medical office building here in Charlotte. Below is the daily energy usage trend. Right after the New Year, the building acted upon the student recommendations. The change is obvious. The building is now using approximately 40% less energy each month.



Grading:

Grades are decided on a 10-point scale (90-100 A, 80-90 B, etc.) and are based on the following assignments:

- Course project: 60%
- Mini-projects 1 and 2: 20% each

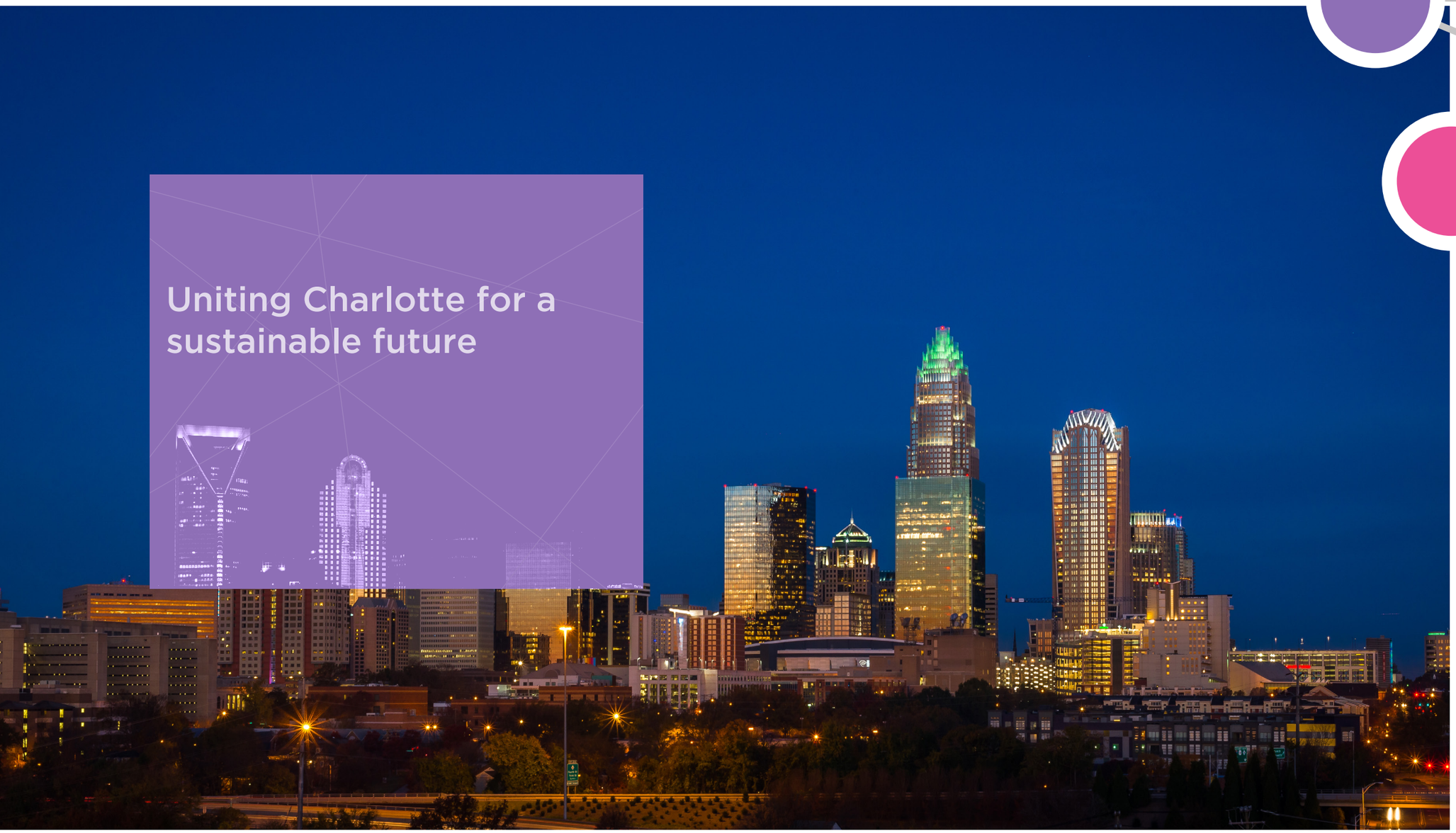
Offered with Involvement and Assistance from These Partners

DUKE ENERGY

U.S. DEPARTMENT OF ENERGY

ENVISION CHARLOTTE
UNITING FOR A SUSTAINABLE CITY

ENERGY REPORT 2017



Uniting Charlotte for a sustainable future

Envision Charlotte is a public private plus collaborative that leads Charlotte's progress as a global Smart City through innovations that strengthen economic competitiveness, environmental sustainability and positive community impacts.

This report was funded as part of a grant from the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy Building Technologies Office

ENVISION
CHARLOTTE

320 E. Ninth Street
Suite 404-A
Charlotte, NC 28202
www.envisioncharlotte.com

As of early 2017, the participating buildings saw a 19% reduction in energy consumption. This reduction of kWh represents a savings of $26,000,000.

ENVISION
CHARLOTTE

Energy Report

Charlotte, North Carolina has been emerging as an energy hub and Envision Charlotte has been one of the groups in the forefront. In 2011, a group of city leaders led by then Duke CEO Jim Rogers came together to form what is now Envision Charlotte – a non-profit focused on increasing sustainability in our urban core. The first initiative launched focused on energy efficiency.

In this endeavor, Envision Charlotte created a public-private-plus partnership, which included both the utility and university. The group started with a narrow focus – large commercial buildings that were greater than 10,000 square feet and located in Charlotte's Uptown. At that time, 64 buildings met that criteria. The group secured agreements with 61 of those buildings that included: an energy pledge to reduce energy by 20%, installation of shadow meters and placement of kiosks in building lobbies.

Over the next several years, many actions were implemented to achieve this goal. Duke Energy launched Smart Energy in Offices, a program designed to focus on the behavior piece of the puzzle. This program empowers property managers to educate tenants about simple changes to their daily routine which can add up to big energy consumption savings.

In addition, a program called the Energy Roundtable was designed to work with building operators and property engineers to identify and better understand the best path towards energy efficiency through equipment upgrades. The University of North Carolina at Charlotte (UNCC) brings in students and professors for an unbiased look at the buildings with recommendations for equipment updates, with a focus on the return on investment.

This program was both an innovative approach to driving energy efficiency in commercial buildings and a great vehicle for engaging students in practical applications.

Department of Energy Grant

Envision Charlotte's initial energy programming was so successful in its ability to reduce energy consumption, that Envision Charlotte applied for, and was successfully awarded, a grant from the **U.S. Department of Energy's Office of Energy Efficiency & Renewable Energy (EERE) Building Technologies Office (BOT)** to build upon the success of the original energy reduction initiative. The three-year (2015-2018) grant provided funding to develop and implement Energy Roundtables (ERT) and Building Performance Training (BPT), and to develop an Eco-Network, all while expanding the program enrollment to include an additional 200 buildings outside of the Uptown area. The grant also expands the targeted building sectors to include: real estate, hospitality, higher education, healthcare and retail.

In addition to Envision Charlotte's original partners, this grant allowed the organization to collaborate with additional partners including UNC Charlotte's Center for Sustainably Integrated Buildings and Sites (UNCC SIBS), Center for Climate and Energy Solutions (C2ES), Charlotte Center City Partners (CCCP), the City of Charlotte, and Carolinas HealthCare System (CHS).

Like the original energy program, the grant focuses on a two-tiered approach that first targets operational energy savings and then seeks to determine capital improvements, while also incorporating a behavioral change component as a vehicle for broad sustainability messaging and engagement to ensure that investments achieve their full potential over the long-term. In other words, to sustain building operator-implemented energy savings over the long-term, it is essential that there be a component of education and behavioral change on the tenant side.

The grant has three goals: 1) to realize a 20 percent aggregate energy savings across more than 200 buildings in the Greater Charlotte region; 2) Develop and implement a comprehensive behavioral change component to ensure sustainable energy savings beyond the period of the project; and, 3) Utilize smart city initiatives to create a scalable, replicable model for market transformation.

Energy Roundtables

Once buildings are recruited into this program, the student teams, led by Dr. Rob Cox and Dr. Ben Futrell, pair with a building and that building's operator for a semester. The students then work through a three-step process:

1. **Identify opportunities for improved schedules and removal of manual overrides**
2. **Identify opportunities to optimize air distribution**
3. **Identify opportunities to optimize the central plant and economizing**

Each student team is given access to the building automation system (BAS) and interval data through the Energy Charting and Metrics Tool (ECAM) tool. By working through the ERT process, the students develop recommendations and final summary reports that ultimately provide the participating building operators with a third-party, vendor-neutral set of recommendations for the building to reduce their energy use. Most importantly, for the students this experience is invaluable as they are growing their network of contacts and gaining real world learning experiences in the local community.

83

Number of students that have participated in the program since the start

26 Original class size

42 Current class size

Majors that can participate: Engineering

Undergraduate and graduate students participating

Through participating in the DOE Grant, a building within Carolinas HealthCare System's portfolio was able to see a 40% energy savings. The Building Operator made recommended operational changes resulting in an immediate 30% energy savings, and repaired a broken valve which achieved an additional 10% energy savings.

Building Performance Training (BPT)

Another key component of the DOE grant is utilizing the Building Re-tuning Training (BRT) program and materials out of DOE's **Pacific Northwest National Lab** (PNNL) to help drive energy efficiency efforts in buildings. Focusing on the Carolinas HealthCare System's portfolio of buildings, Dr. Cox and Dr. Futrell are working closely with Carolinas HealthCare System (CHS) leadership and building operators to develop and refine a process that teaches operators how to understand building performance. UNCC has held several training rounds utilizing BRT materials and conducted meetings with building operators to refine the designed curriculum and interventions.

The BRT is a structured process for investigating building/ HVAC system operations to identify and correct common faults that lead to energy waste. By using the BRT approach, UNCC can detect energy savings opportunities and implement improvements. The building performance training provided by the UNCC team, with support from the DOE grant, provides the building operators with the valuable in-depth understanding of how commercial buildings operate, and empowers them with the skills to identify and fix no- to low-cost operational problems that are endemic to commercial buildings.

"Energy savings and occupant comfort are achieved quickly and permanently when building operators and engineers are empowered and given the chance to solve building performance issues as part of the building management team."

Kady Cowan
Acting Assistant Vice President
Environmental Sustainability Solutions
Carolinas HealthCare System

	PROGRESS (month 20)	GOAL (month 36)
Buildings reached with ERT/BPT	116	200
Operators Enrolled in BPT	46	50
Individuals engaged through EcoNetwork	847	1000

ECONETWORK
ENVISION CHARLOTTE

Envision Charlotte, with support from Center for Climate and Energy Solutions, developed the EcoNetwork - a community engagement initiative focused on establishing and supporting efforts that reduce energy use, reduce waste, conserve water, and improve air quality in Charlotte. The inclusive network welcomes all Charlotte citizens and works closely with Charlotte employers.

The EcoNetwork has a mission to create a thriving, sustainable Charlotte by fostering collaborative action and leadership among our community's unique citizens. Through education, networking, and action campaigns, Envision Charlotte's EcoNetwork continues to provide opportunities for individuals, businesses and communities to work together to reduce environmental impacts and make Charlotte a truly remarkable city.

All Charlotte citizens can be EcoNetwork members, including city and private sector employees, facilities managers, Envision Charlotte Board members, Smart City Council members, local university students, and more.

The EcoNetwork is built on the idea that connecting motivated individuals with larger collaborative efforts will spur positive and sustained change in Charlotte. With that in mind, Envision Charlotte continues to be committed to collaboration within the network and beyond. In this way, the EcoNetwork supports and amplifies community initiatives hosted by complementary Charlotte organizations.

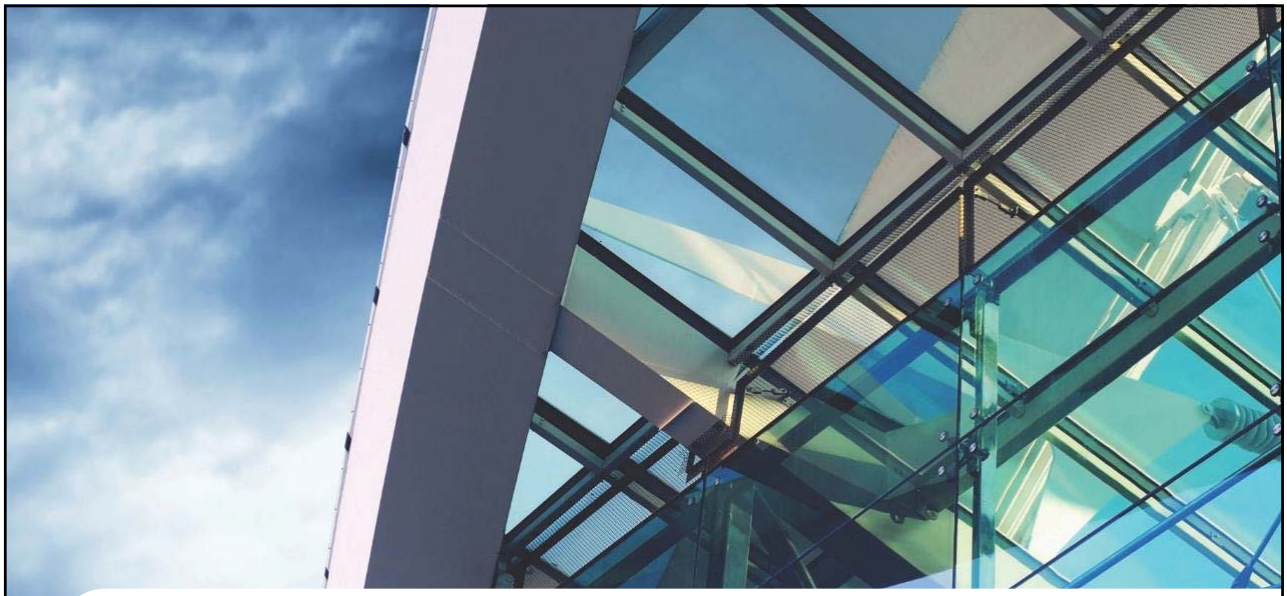
EcoNetwork Speaker Series

Envision Charlotte is developing a quarterly speaker series that will create a platform for quality engagement of citizens throughout the city and county on sustainability and smart cities topics. Envision Charlotte is leveraging their global and local network to identify speakers and presenters that can speak to how local acts of sustainability can address global challenges. By facilitating a robust dialogue locally, Envision Charlotte hopes to create more systemic and sustainable change to help make Charlotte a more sustainable and smart city.

The speaker series launched in April 2017 with much excitement as Envision Charlotte hosted his Excellency, Henne Schuwer, Ambassador of the Netherlands to the United States. His keynote address spoke to the ever-increasing importance of global engagement and transatlantic partnerships as cities strive to become more sustainable. Following his address, Amy Aussieker interviewed him to explore how transatlantic partnerships at the local level can help facilitate the exchange of best practices and to learn more about the concept of a circular economy. The event wrapped up by opening it up to the audience for Q+A.

One of the things we have learned at Envision Charlotte is that there are a lot of solutions for buildings in their quest for energy efficiency. It can be overwhelming and confusing to sort through all of them, so this program was really designed to help figure out best options depending on the buildings goals. This partnership between UNCC, Envision Charlotte and the buildings has been very beneficial for all parties and we look forward to continuing and expanding this program.

Amy Aussieker
Executive Director
Envision Charlotte



SEiO / Envision Charlotte / UNCC Collaboration

EXAMPLE BUILDING REPORT

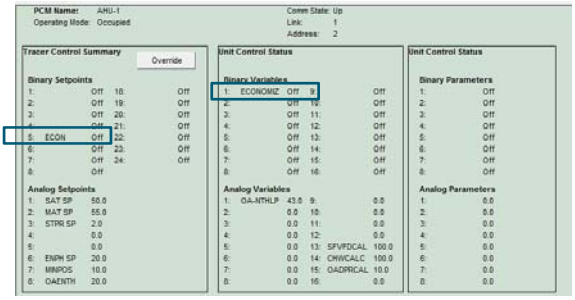
UNC CHARLOTTE

DUKE ENERGY

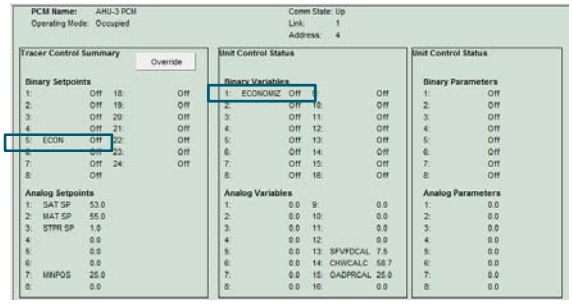
Summary of Findings

- Issue #1: Air-Side Economizing Appears Disabled
- Issue #2: Air-Side Energy Distribution Not Optimized
  - 2.1: Static-pressure optimization not enabled or not possible given current zone conditions
  - 2.2: Low load in many zones or (possibly) artificially high load in some zones because of low cooling setpoints
  - Example review: First floor
- Issue #3: Chilled Water Plant
  - 3.1: No chilled water reset appears to be in place

Issue #1: Economizer Operation Appears Disabled



AHU 1



AHU 3

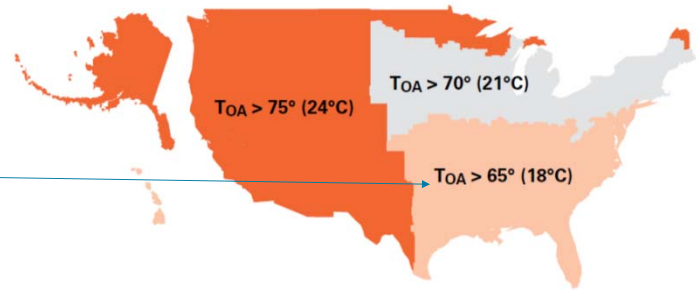
Economizing can likely be used

What is Economizing and What is Required?

Economizing is “free cooling”

ASHRAE 90.1 requires economizing as of 2013 for units larger than 4.5 tons

Figure 2. Required high-limit shutoff setpoints for an economizer with fixed dry-bulb temperature control



Issue #2: Air-Side Energy Distribution Not Optimized

- Issue #2: Air-Side Energy Distribution Not Optimized
  - 2.1: Static-pressure optimization not enabled or not possible given current zone conditions
  - 2.2: Low load in many zones or (possibly) artificially high load in some zones because of low cooling setpoints
- Example review: First floor
  - Step 1: High-level review
  - Step 2: Examine system load
    - Review fluid-system load:
      - Damper positions – these provide guidance on required static pressure
    - Review setpoints
      - These indicate potentially arbitrarily high load
    - Review thermal-system load
      - Zone-level airflow

Understanding Air-Side Optimizations

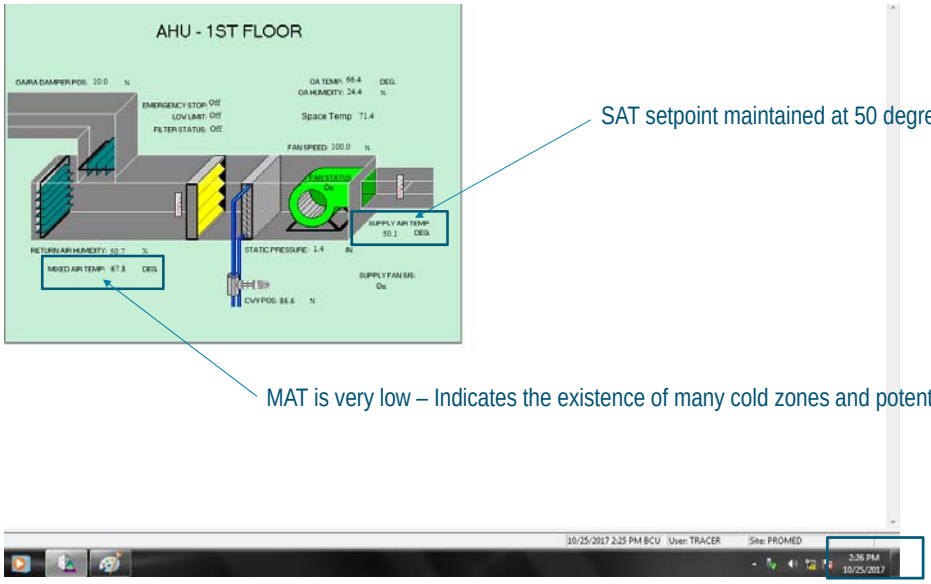
existing requirements

Fan Pressure Optimization

- Required by ASHRAE 90.1 since 1999
- Goal:
  - Control system static pressure to the lowest level while maintaining zone airflow requirements; thereby minimizing fan energy consumption
- What is needed to implement?
  - Communicating controls on the VAV boxes
  - Static pressure sensor
  - Building automation system

From Trane Engineering Newsletter, 2010

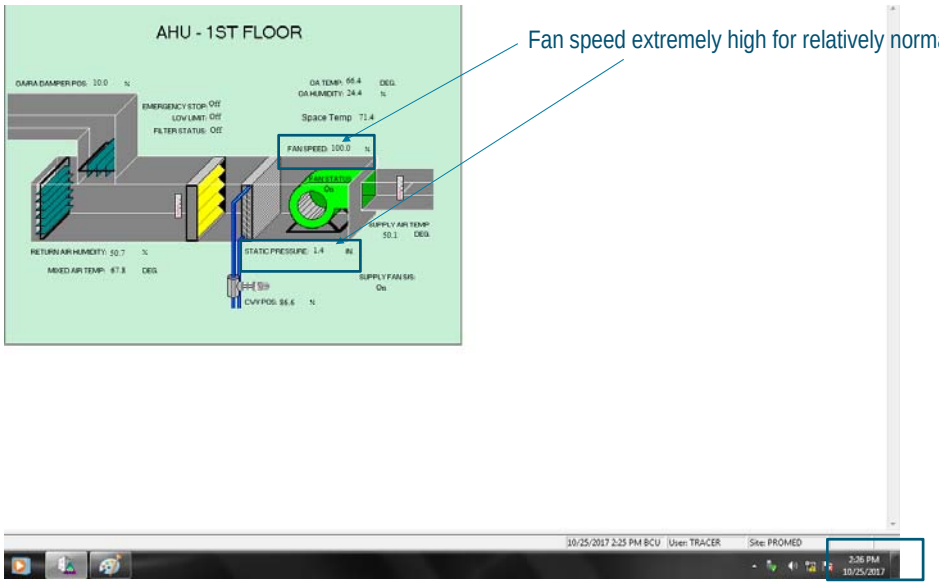
Example: First-Floor AHU on October 25th, 2017



SAT setpoint maintained at 50 degrees

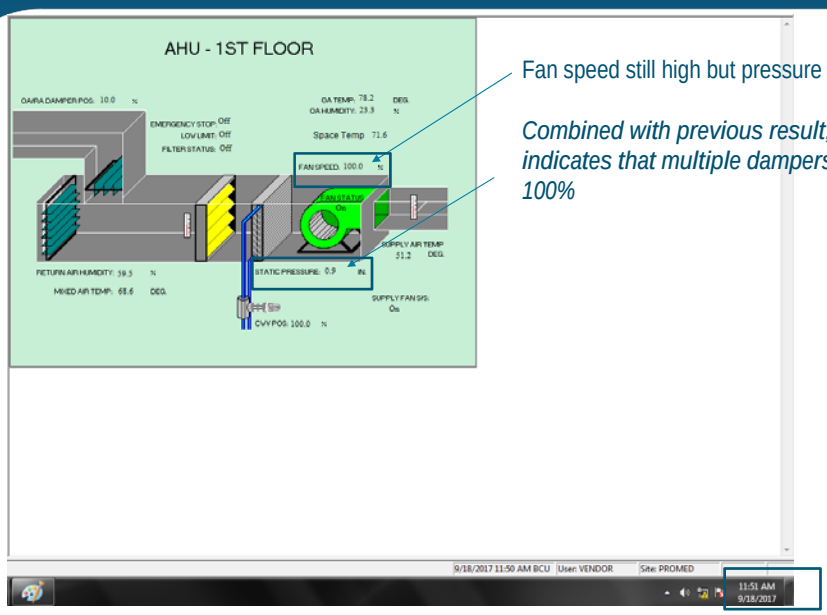
MAT is very low – Indicates the existence of many cold zones and potentially "light" load

Example: First-Floor AHU on October 25th, 2017



Fan speed extremely high for relatively normal static pressure

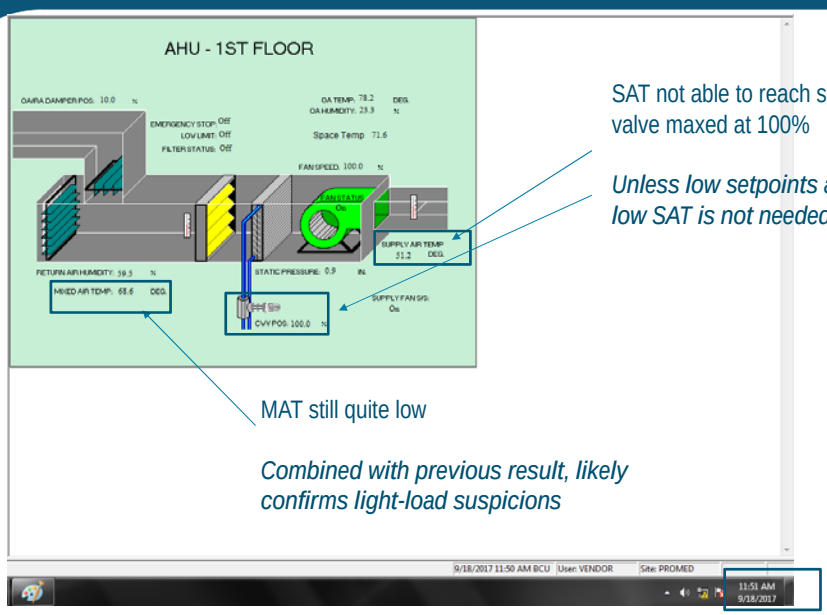
Example: First-Floor AHU on September 18th, 2017



Fan speed still high but pressure much lower

Combined with previous result, likely indicates that multiple dampers stuck at 100%

Example: First-Floor AHU on September 18th, 2017



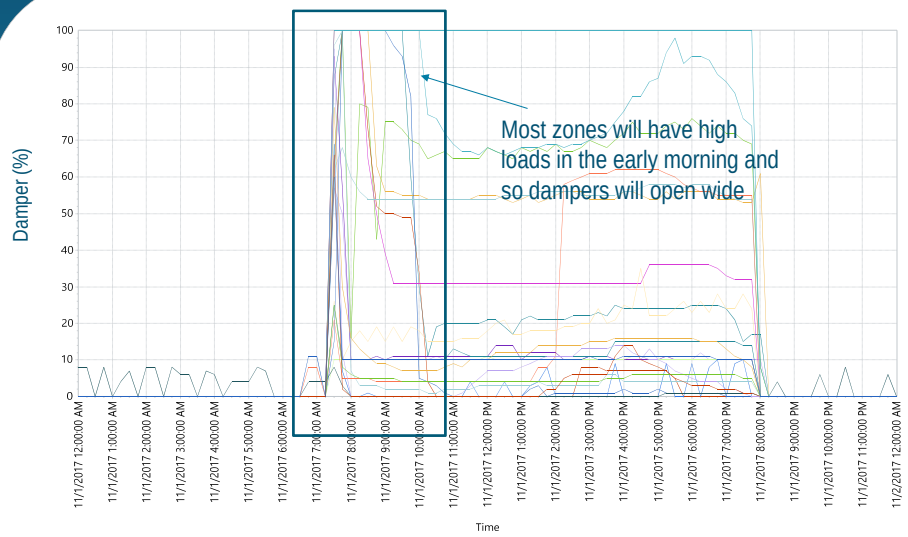
SAT not able to reach setpoint even though valve maxed at 100%

Unless low setpoints are required, such low SAT is not needed

MAT still quite low

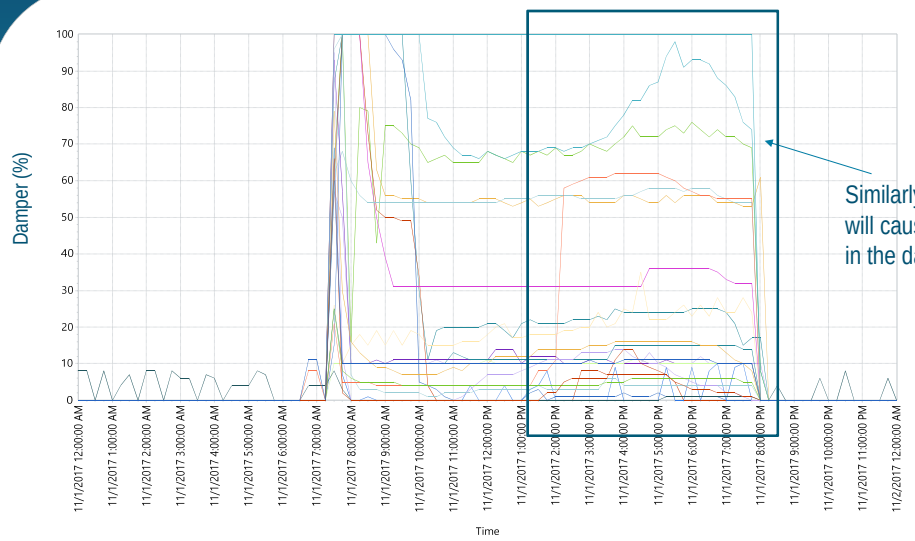
Combined with previous result, likely confirms light-load suspicions

Damper Positions



Damper positions provide a good indication of space load

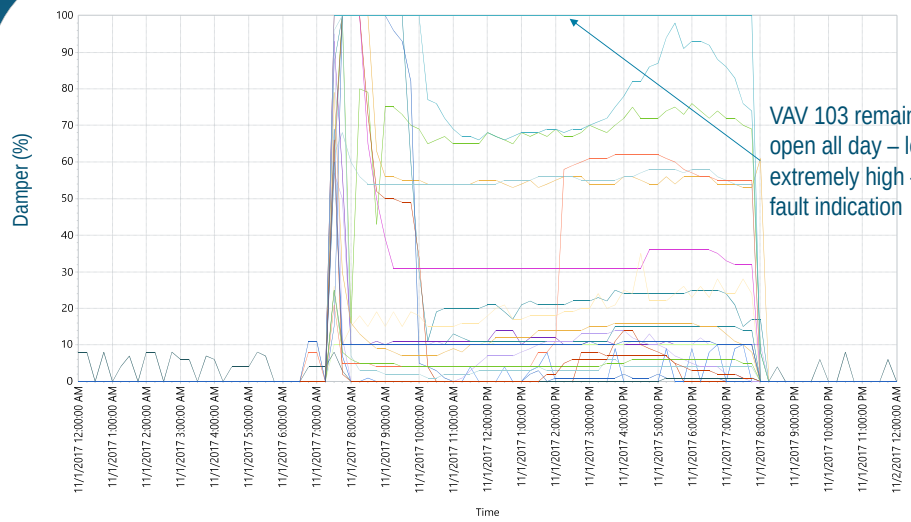
Damper Positions



Similarly, high afternoon loads will cause wide opening later in the day

Damper positions provide a good indication of space load

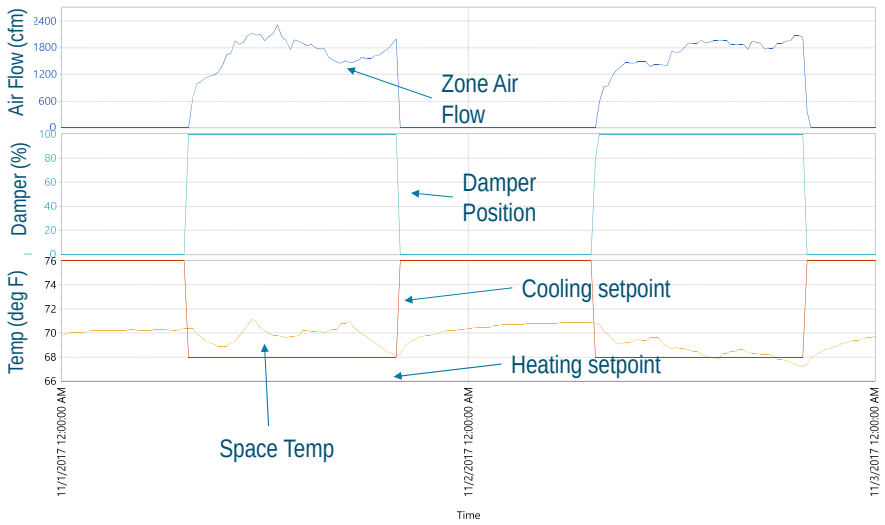
Damper Positions



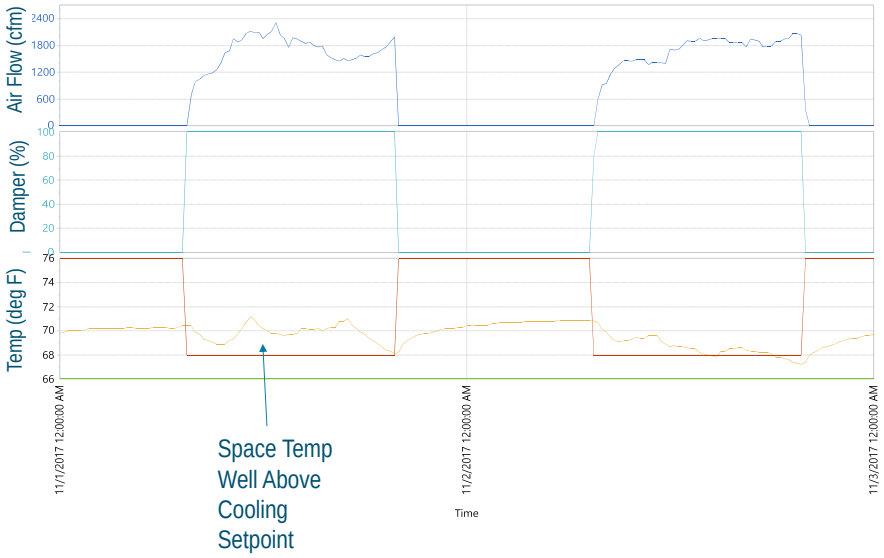
Damper positions provide a good indication of space load

VAV 103 remains 100% open all day – load must be extremely high – potential fault indication

Deep Dive: VAV 103



Deep Dive: VAV 103

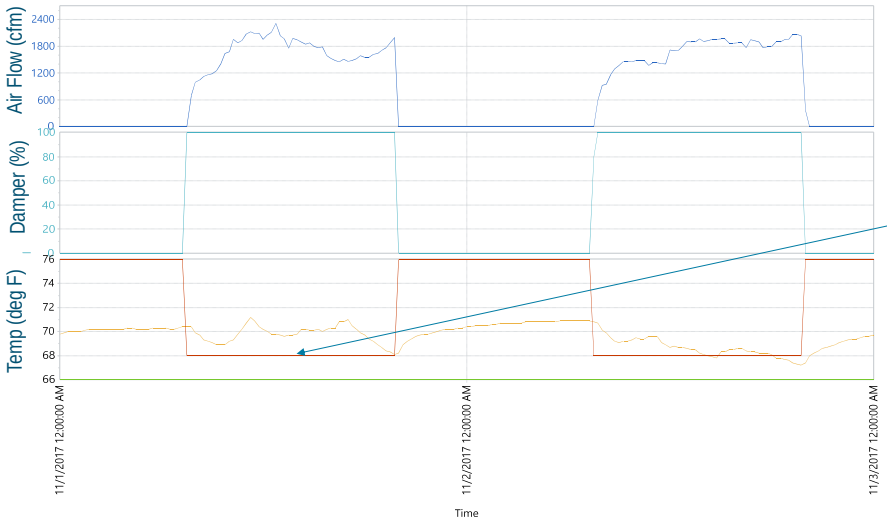


Space Temp Well Above Cooling Setpoint

With zone temp above cooling setpoint:

- Terminal unit commands high air flow
- Damper opens to a position that ensures flow is met given the existing static pressure

Deep Dive: VAV 103



In this case, the zone tries all day to reach 68 degrees

If setpoint was raised (perhaps even to 70) the flow request would reduce and the damper would close

This could allow us to reduce static pressure and hence fan speed

Zone Summary: "Rogue" Zone

Analysis for Wednesday 11/1/2017			
Zone	Cooling Setpoint	Damper (Outside of Morning Cooldown)	Additional Comments
101	70	<20%	In deadband the entire day
102	71	< 20%	Cooling for approximately 3 hours between 1P and 4P
103	68	100%	Above cooling setpoint all day
104	74	<10%	Below heating setpoint all day
105	71	<20%	Hovers near cooling setpoint
106	70	<20%	Cooling from about 11A to 4P
107	74	<20%	Below heating setpoint all day
108	74	~60% from 2P-7:30P	Cools for a short time in the afternoon
109	72	<10%	Hovers near heating setpoint all day
110	73	<10%	Maintains heating setpoint all day; Strange air flow sensor behavior
111	73	<10%	Hovers near heating setpoint all day
112	76	10%	Below or near heating setpoint all day
113	70	<20%	In deadband the entire day
114	70	60%	Cooling from about 1:30P to 7P
115	72 / 74	~20%	Maintains heating setpoint all day; Heating and cooling setpoint move together
116	68	<40%	In deadband the entire day
117	No data		
118	68	<10%	Minimal cooling in afternoon; Longer cool down than other zones (i.e. zone heats up at night)
119	68	<10%	In deadband or heating the entire day
120	68	>60%	Cools from about 2P to 7:30P
121	68	~70%	Maintains heating setpoint
122	68	60%	In deadband the entire day
123	70/72	10%	Maintains heating setpoint all day; Heating and cooling setpoint move together
124	68	20%	Hovers near cooling setpoint

VAV 103 remains 100% open all day:

- Zone cannot reach a 68 degree setpoint, but can reach about 70 degrees
- Having a setpoint too low is like having a load that is very high
- *If setpoint can be raised to at least 70 degrees, this could greatly reduce energy consumption*

Zone Summary: Light Loads and Low Setpoints

Analysis for Wednesday 11/1/2017			
Zone	Cooling Setpoint	Damper (Outside of Morning Cooldown)	Additional Comments
101	70	<20%	In deadband the entire day
102	71	< 20%	Cooling for approximately 3 hours between 1P and 4P
103	68	100%	Above cooling setpoint all day
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120	68	>60%	Cools from about 2P to 7:30P
121	68	~70%	Maintains heating setpoint
122	68	60%	In deadband the entire day
123	70/72	10%	Maintains heating setpoint all day; Heating and cooling setpoint move together
124	68	20%	Hovers near cooling setpoint

Cooling setpoints generally very low. *Is this needed?*

Zone Summary: Zones Requiring Cooling

Analysis for Wednesday 11/1/2017			
Zone	Cooling Setpoint	Damper (Outside of Morning Cooldown)	Additional Comments
101	70	<20%	In deadband the entire day
102	71	< 20%	Cooling for approximately 3 hours between 1P and 4P
103	68	100%	Above cooling setpoint all day
104	74	<10%	Below heating setpoint all day
105	71	<20%	Hovers near cooling setpoint
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119	68	<10%	In deadband or heating the entire day
120	68	>60%	Cools from about 2P to 7:30P
121	68	~70%	Maintains heating setpoint
122	68	60%	In deadband the entire day
123	70/72	10%	Maintains heating setpoint all day; Heating and cooling setpoint move together
124	68	20%	Hovers near cooling setpoint

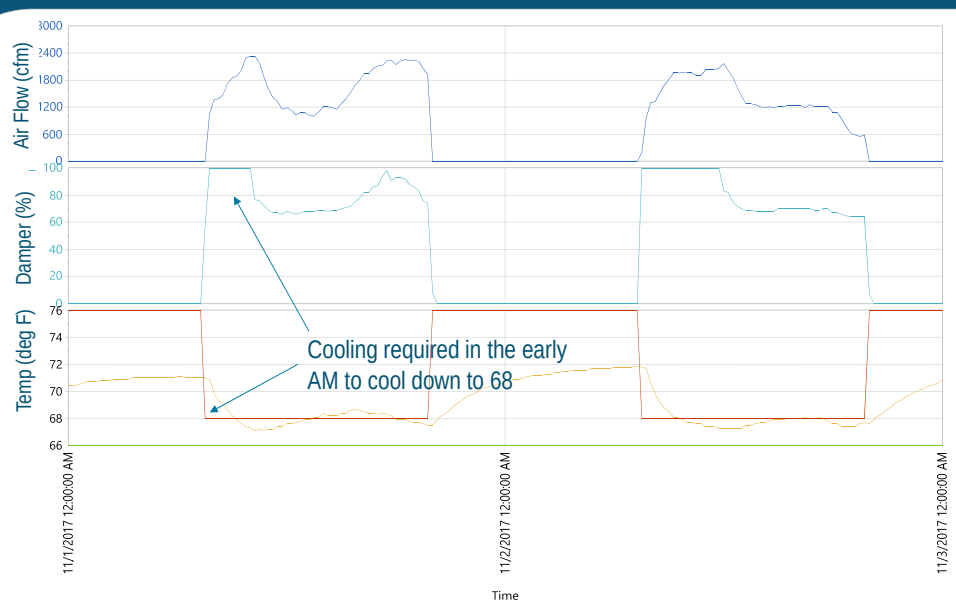
5 zones display *some* amount of cooling

Zone Summary: Zones With Light Loads

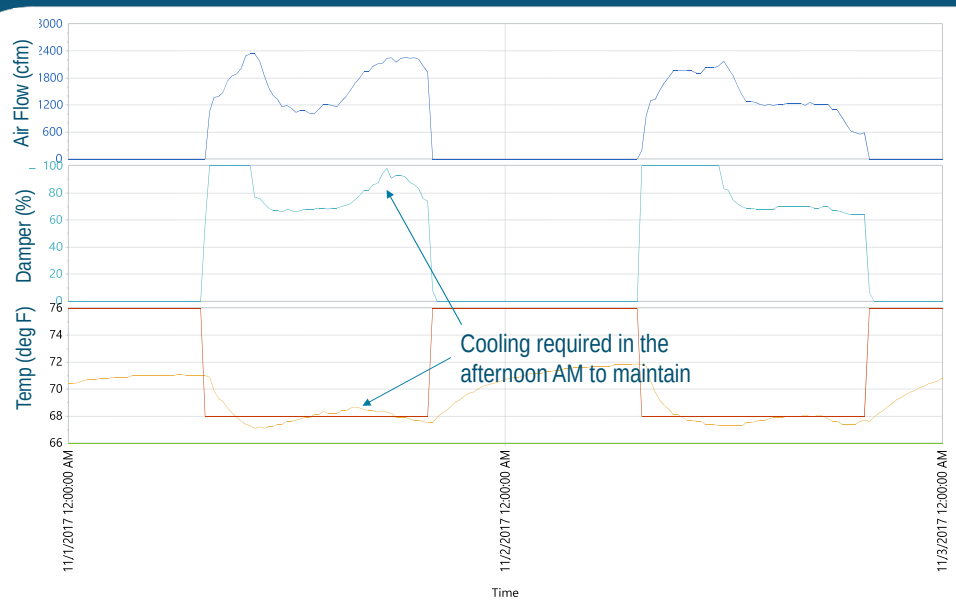
Analysis for Wednesday 11/1/2017			
Zone	Cooling Setpoint	Damper (Outside of Morning Cooldown)	Additional Comments
101	70	<20%	In deadband the entire day
102	71	< 20%	Cooling for approximately 3 hours between 1P and 4P
103	68	100%	Above cooling setpoint all day
104	74	<10%	Below heating setpoint all day
105	71	<20%	Hovers near cooling setpoint
106	70	<20%	Cooling from about 11A to 4P
107	74	<20%	Below heating setpoint all day
108	74	~60% from 2P-7:30P	Cools for a short time in the afternoon
109	72	<10%	Hovers near heating setpoint all day
110	73	<10%	Maintains heating setpoint all day; Strange air flow sensor behavior
111	73	<10%	Hovers near heating setpoint all day
112	76	10%	Below or near heating setpoint all day
113	70	<20%	In deadband the entire day
114	70	60%	Cooling from about 1:30P to 7P
115	72 / 74	~20%	Maintains heating setpoint all day; Heating and cooling setpoint move together
116	68	<40%	In deadband the entire day
117	No data		
118	68	<10%	Minimal cooling in afternoon; Longer cool down than other zones (i.e. zone heats up at night)
119	68	<10%	In deadband or heating the entire day
120	68	>60%	Cools from about 2P to 7:30P
121	68	~70%	Maintains heating setpoint
122	68	60%	In deadband the entire day
123	70/72	10%	Maintains heating setpoint all day; Heating and cooling setpoint move together
124	68	20%	Hovers near cooling setpoint

17 zones show relatively light loads

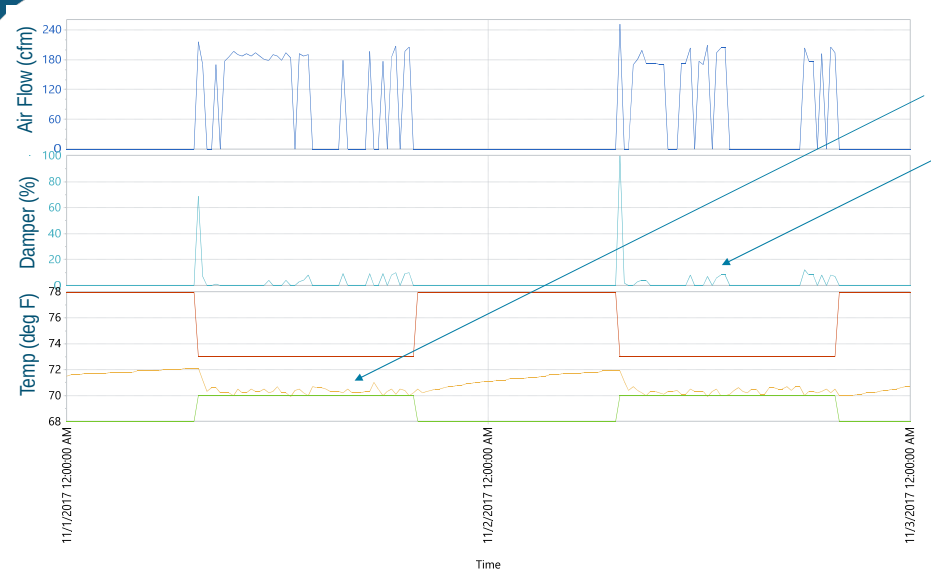
VAV 120: Example Zone Requiring Some Cooling



VAV 120: Example Zone Requiring Some Cooling



VAV 111: Lightly Loaded Zone

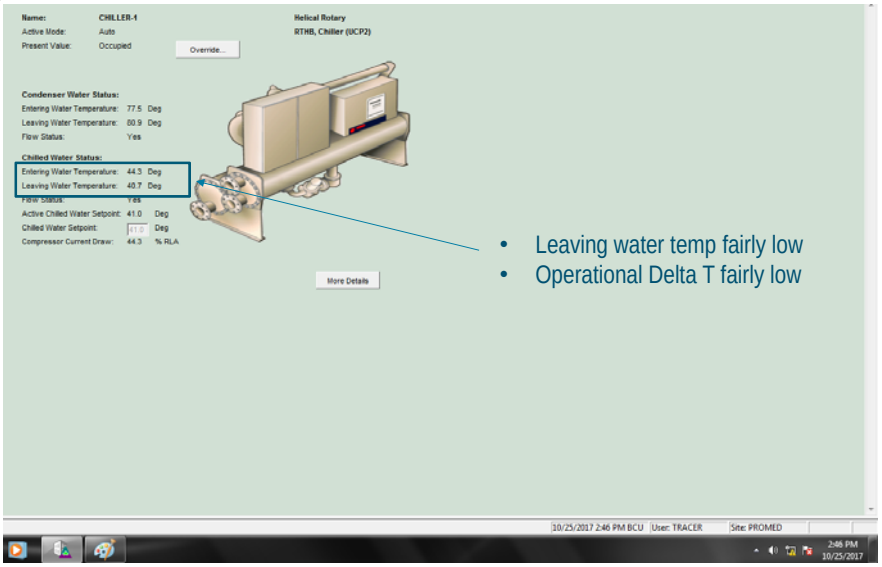


- Space Temp remains in deadband, nearing heating setpoint
- Damper barely opens
- *A much lower static pressure (and fan speed and power) would open this damper more and satisfy the load*

Summarizing Air-Side Optimizations

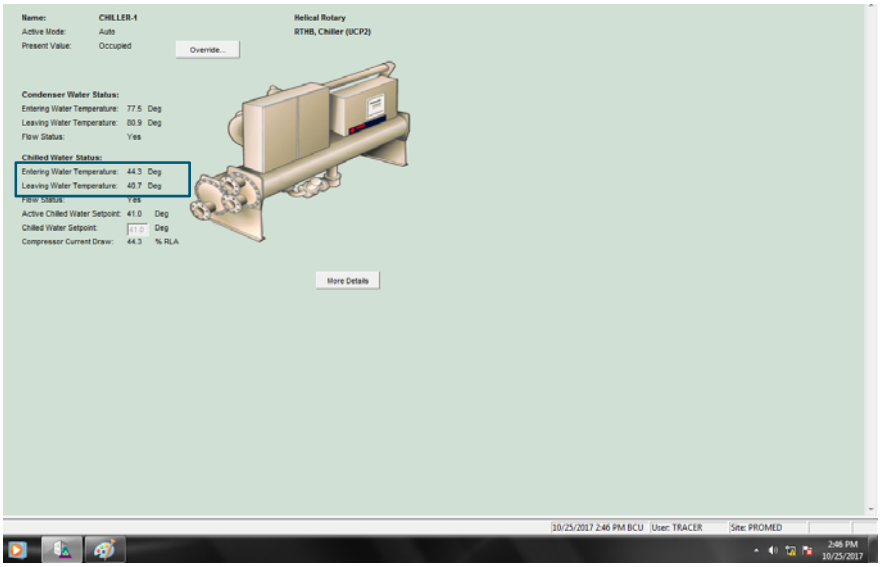
- Address zone level setpoints?
  - *This could potentially have a significant impact on fan and chiller energy*
- Optimize fan-pressure settings:
  - Fix issues that would prevent effective use of static-pressure optimization
  - Implement static-pressure optimization and monitor zone behaviors
  - *This could potentially have a significant impact on fan energy*
- Raise discharge air temperature setpoint
  - This will force more zones to actually cool
  - *This will reduce chiller energy*
  - *This may reduce comfort complaints*

Issue #3: No Chiller Water Temperature Optimization



- Leaving water temp fairly low
- Operational Delta T fairly low

Issue #3: No Chiller Water Temperature Optimization



- Low Chilled Water Temp may seem necessary right now because:
  - Low supply air temps require more chilled water
  - Low zone temp setpoints require low supply air temps

Next Steps

- Address zone level setpoints?
- Optimize air-side energy distribution:
  - Fix issues that would prevent effective use of static-pressure optimization
  - Implement static-pressure optimization and monitor zone behaviors
  - Implement discharge-air temperature reset to fix zone issues
- Chilled water reset
- Develop effective monitoring approach using SEiO campaigns
- MORE???

Ongoing Commissioning Opportunities

Time Frame	Jan-Feb	Mar-Apr	May	Jun-Jul	Jul-Aug	Sep-Oct	Oct-Dec
Target Systems or Functions	Economizer Operation	Terminal Units	Catch Up	Space Cooling Systems	Lighting systems & equipment load	Review documentation & policies	AHUs
SEiO Operator Campaigns	Temp Check	Zone Defense		Cooling Check	Unplug	Commission Mision	Get a Handle on Ventilation

Annually check to see if:

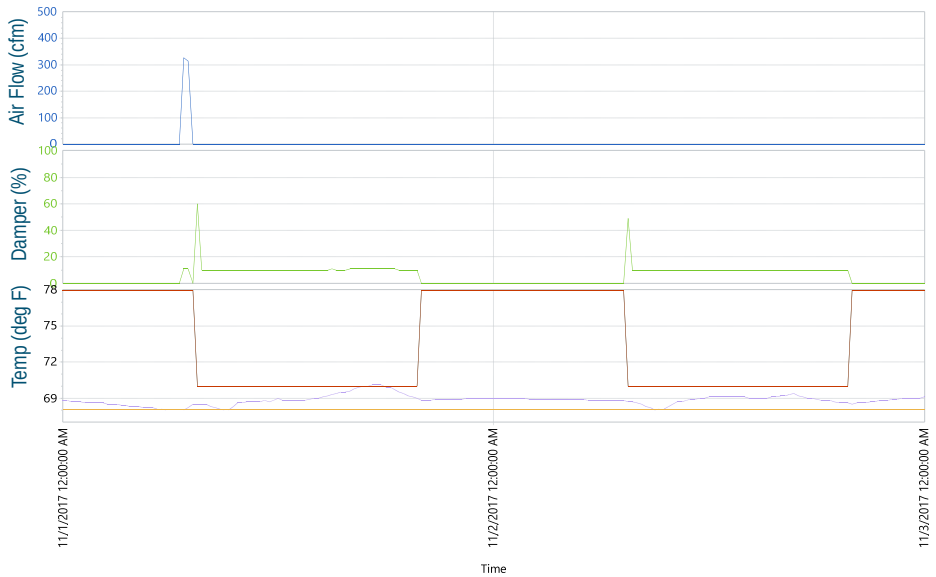
- Static pressure reset is functioning properly
- Discharge air settings are appropriate

Ongoing Commissioning Opportunities

Time Frame	Jan-Feb	Mar-Apr	May	Jun-Jul	Jul-Aug	Sep-Oct	Oct-Dec
Target Systems or Functions	Economizer Operation	Terminal Units	Catch Up	Space Cooling Systems	Lighting systems & equipment load	Review documentation & policies	AHUs
SEiO Operator Campaigns	Temp Check	Zone Defense		Cooling Check	Unplug	Commission Mision	Get a Handle on Ventilation

Annually check about 10% of your zones

VAV 101



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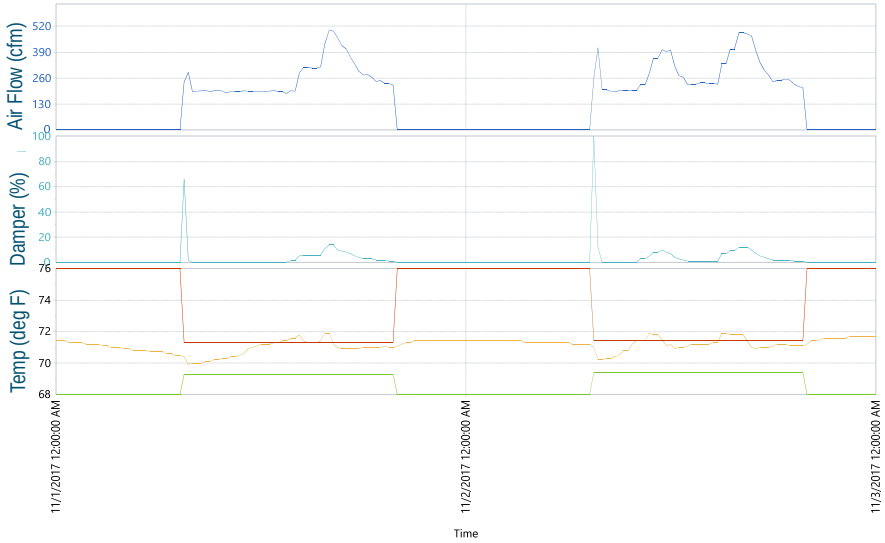

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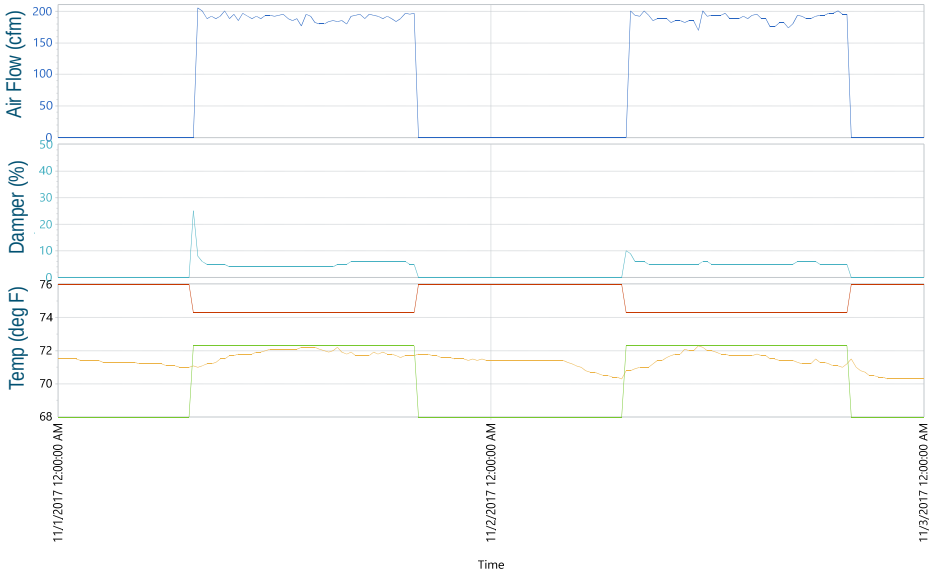

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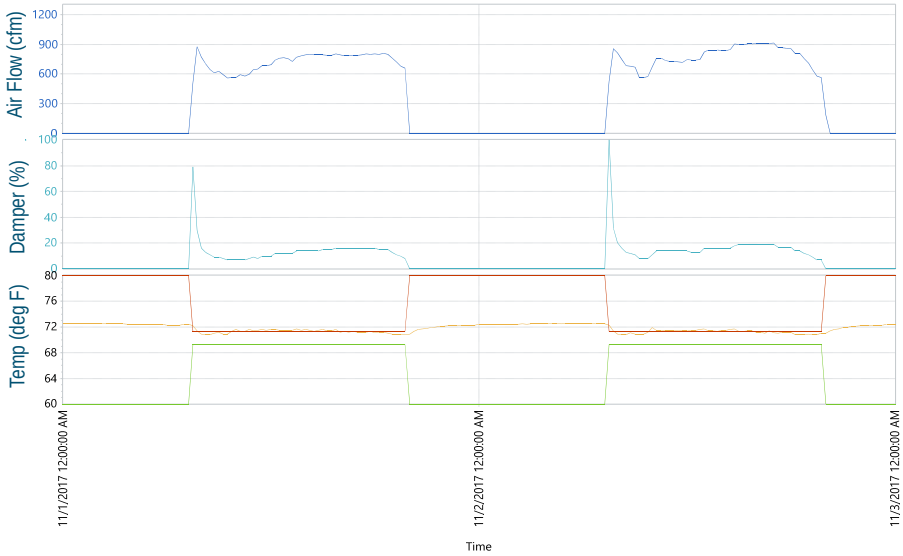

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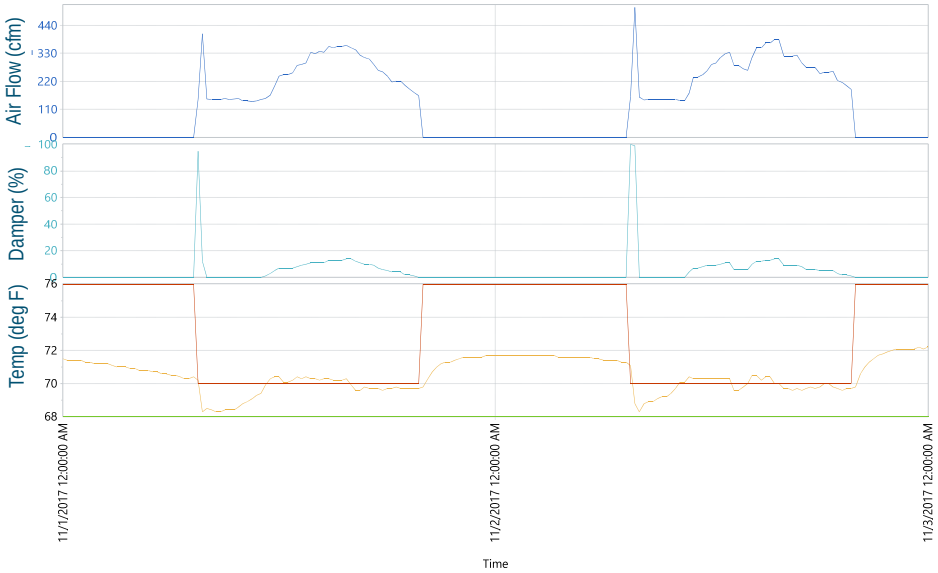

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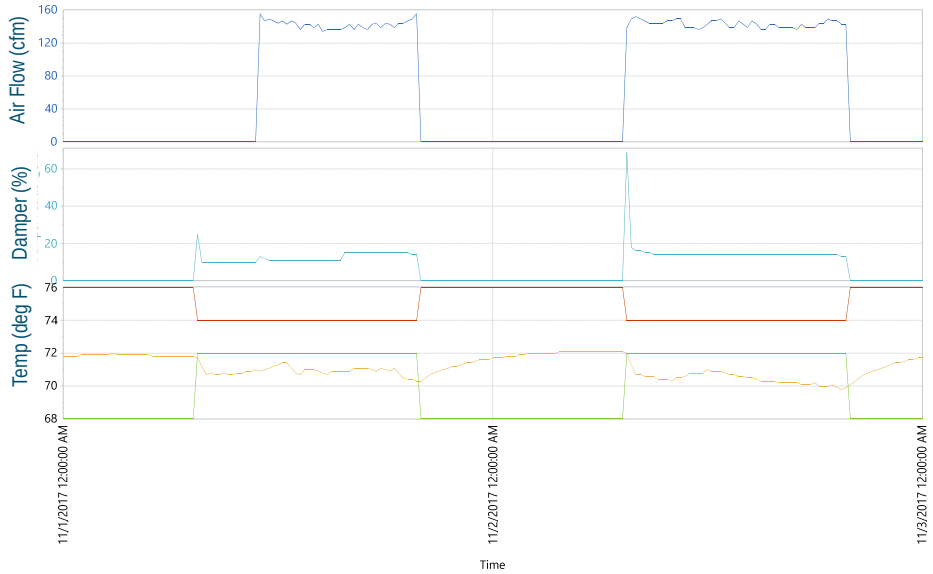

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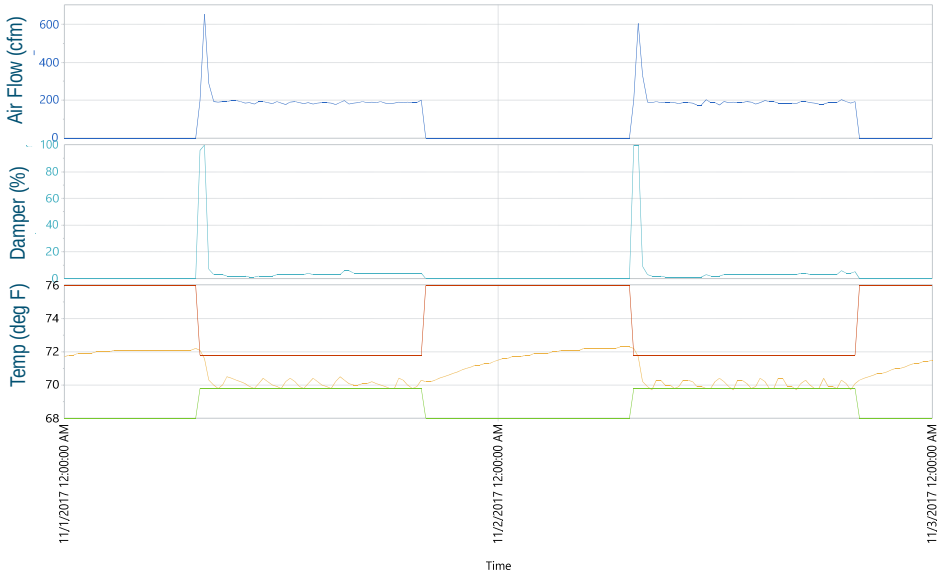
VAV 109



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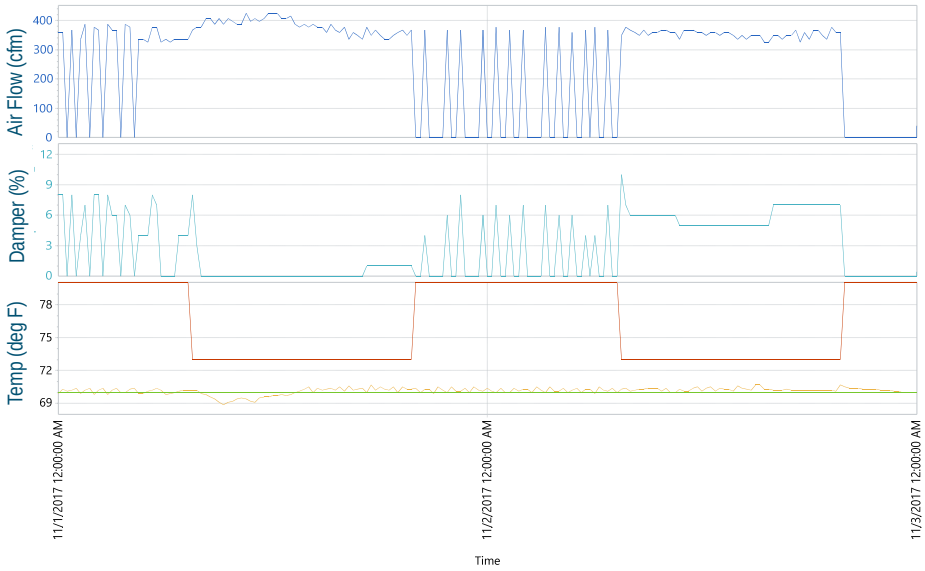

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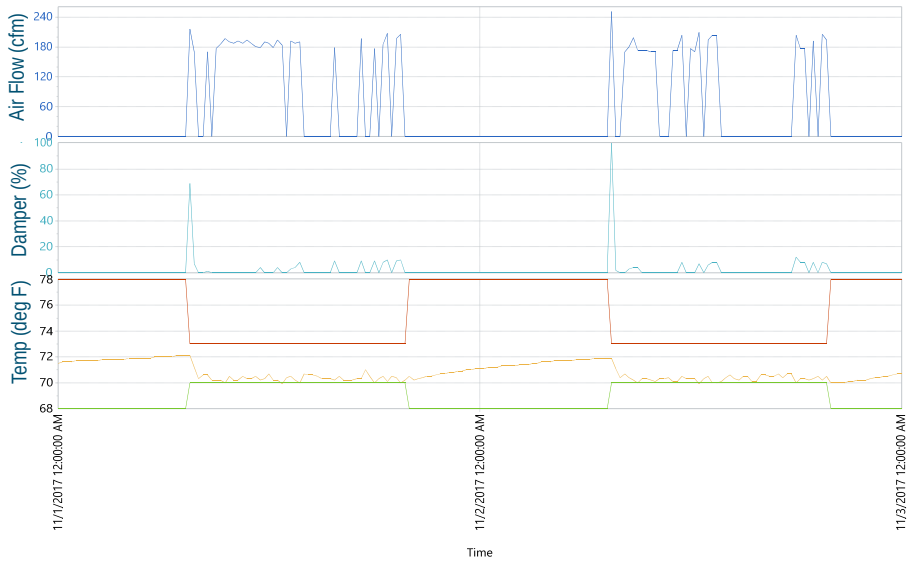

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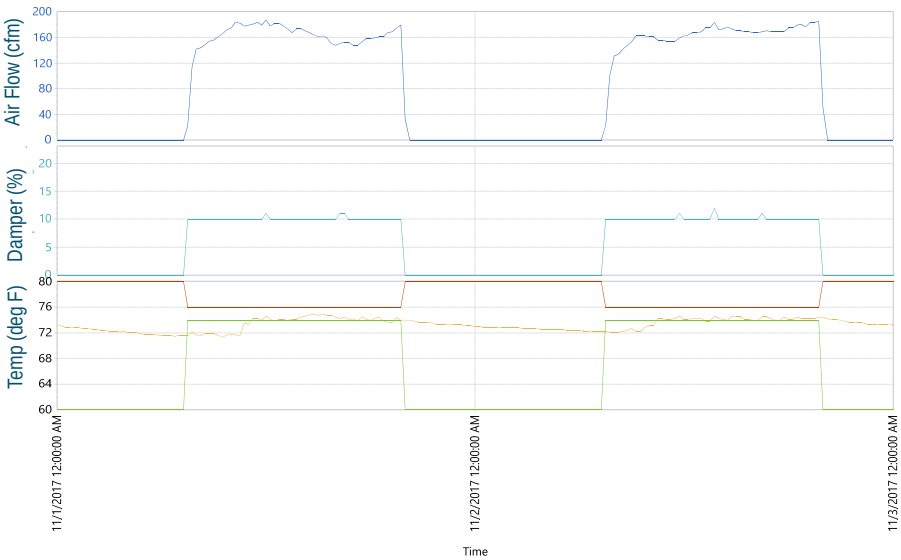

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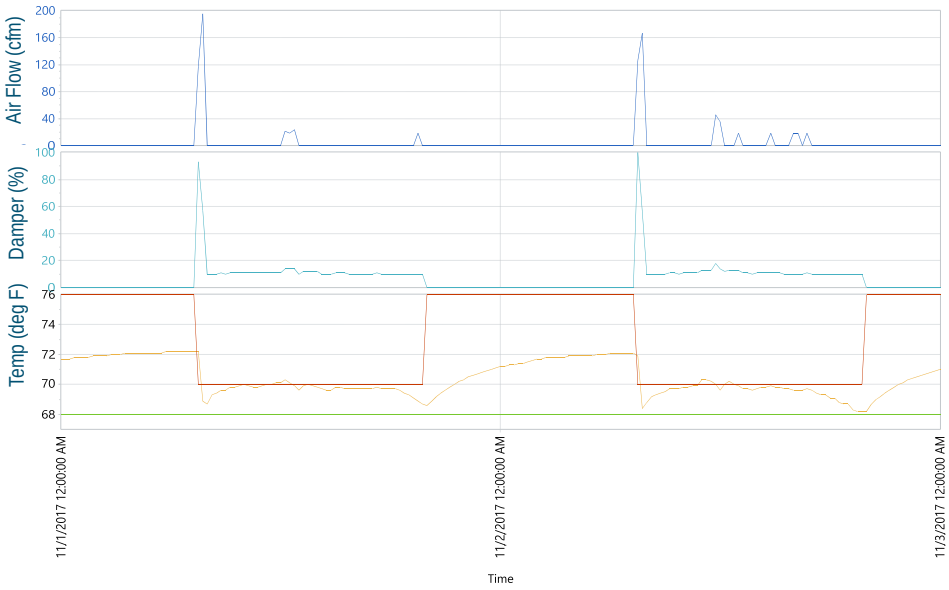

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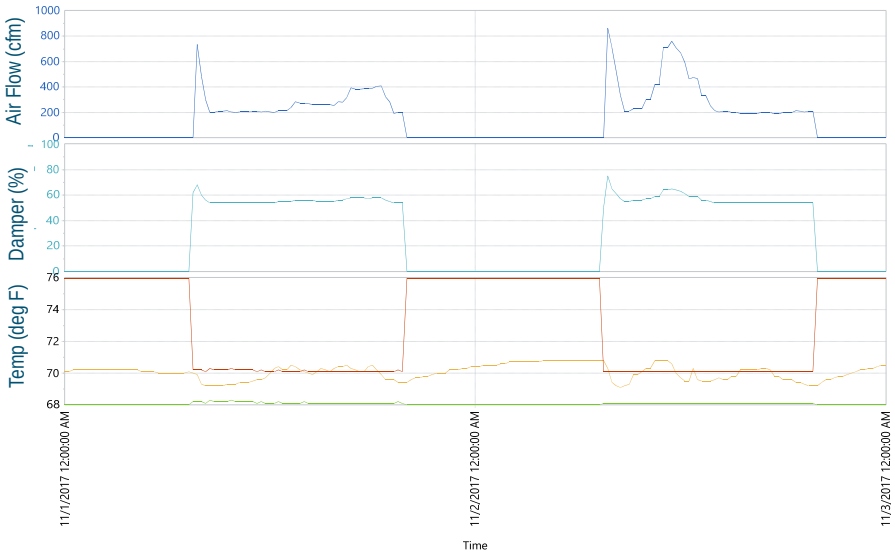

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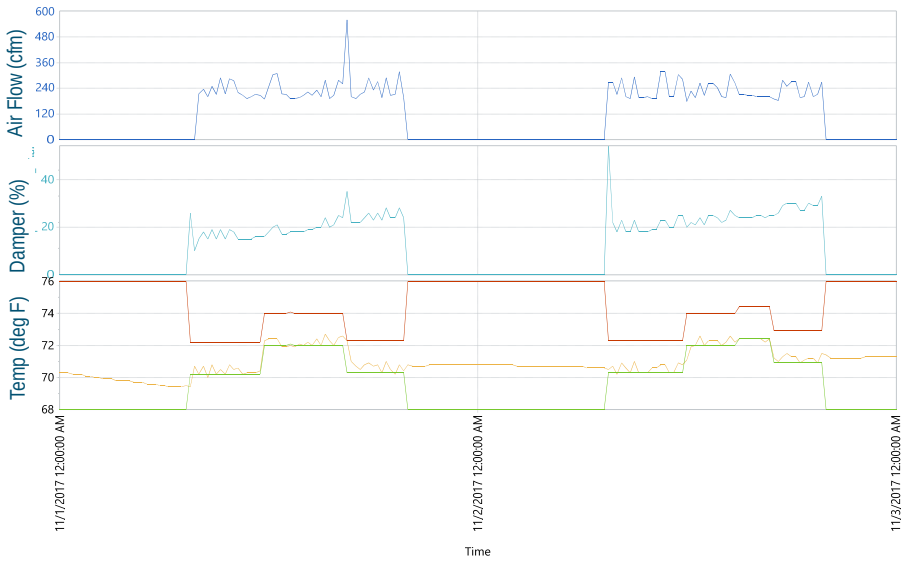

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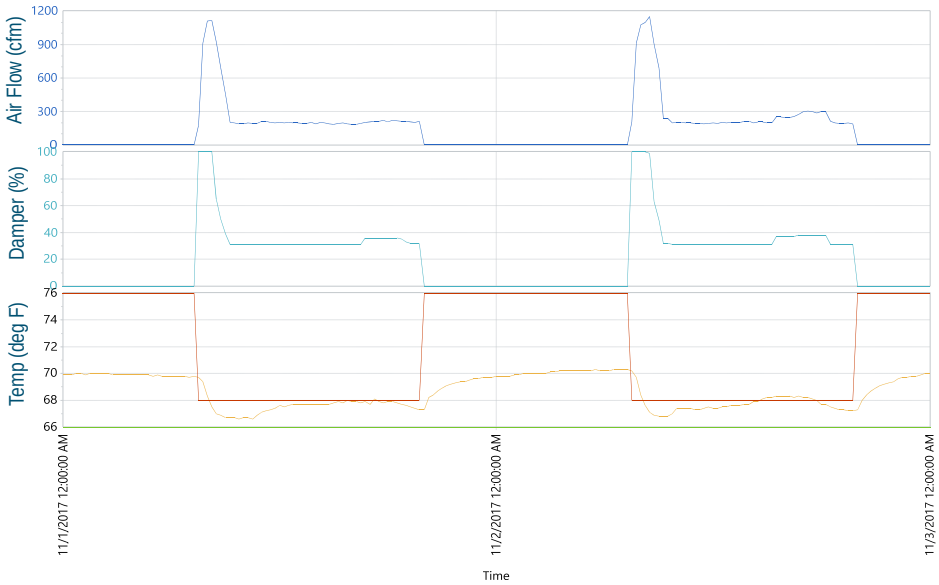

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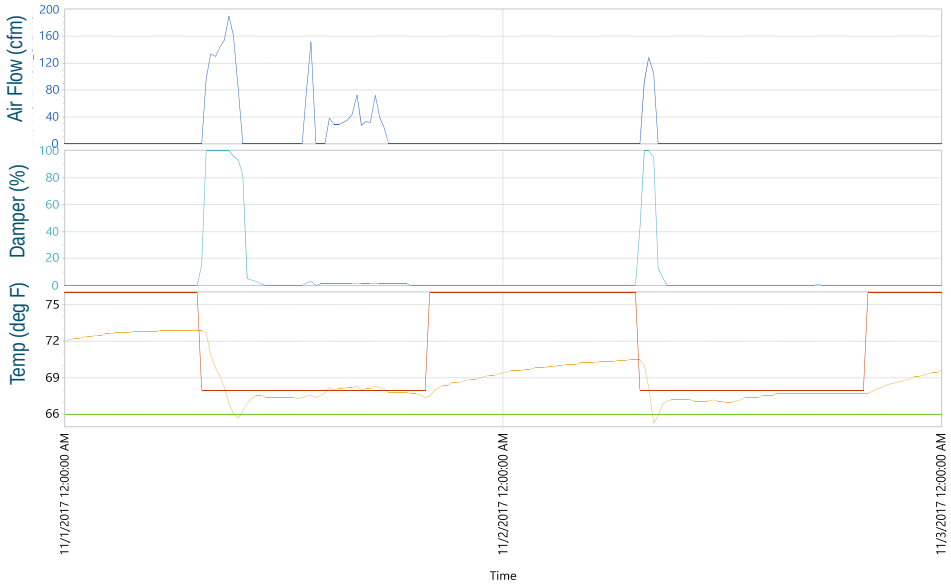

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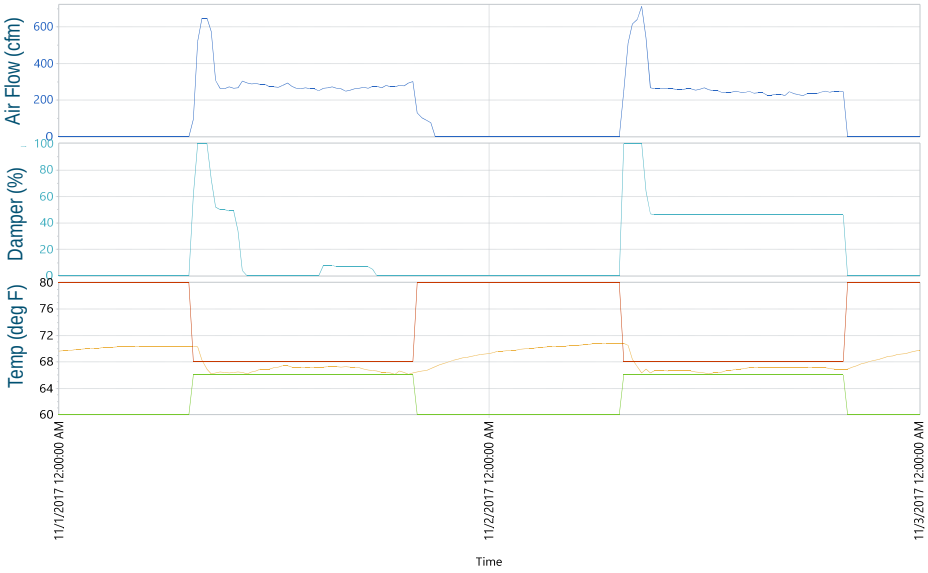

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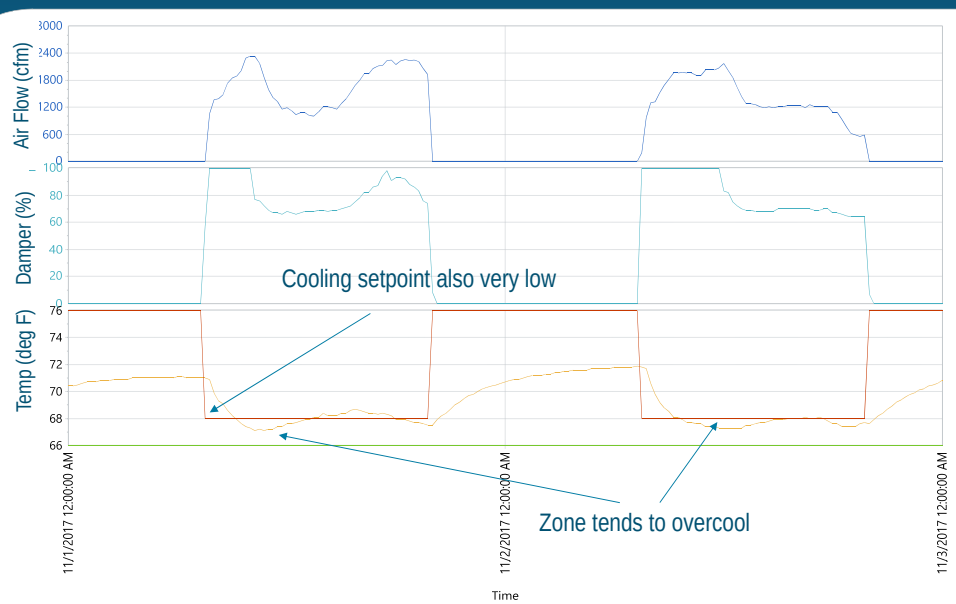

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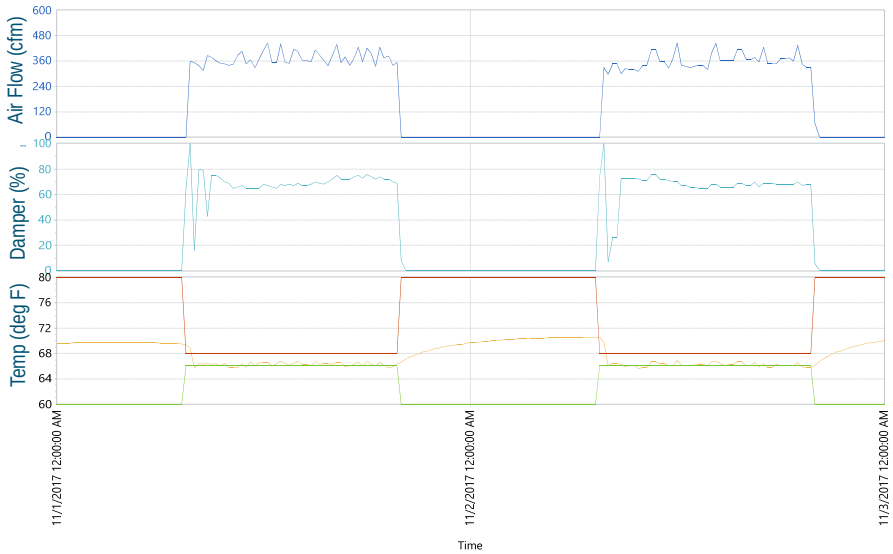

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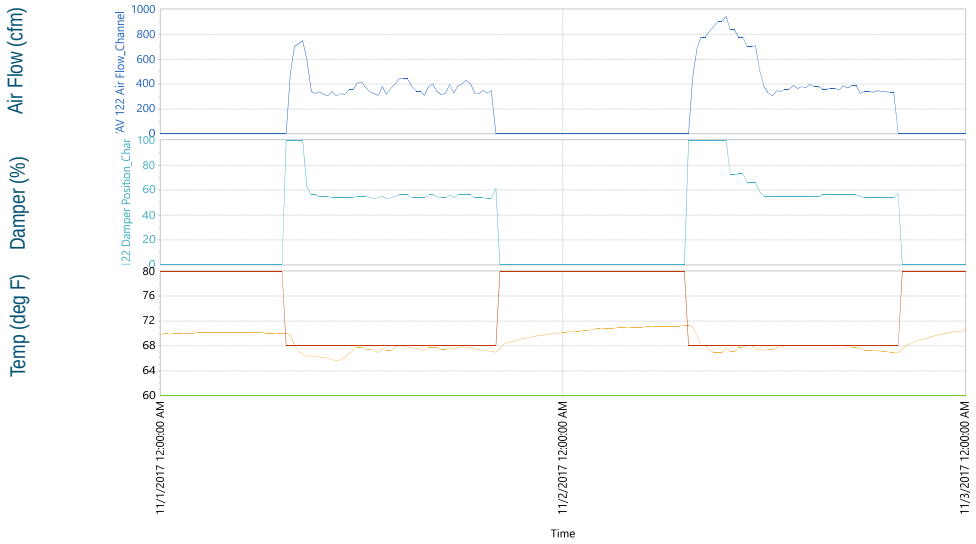

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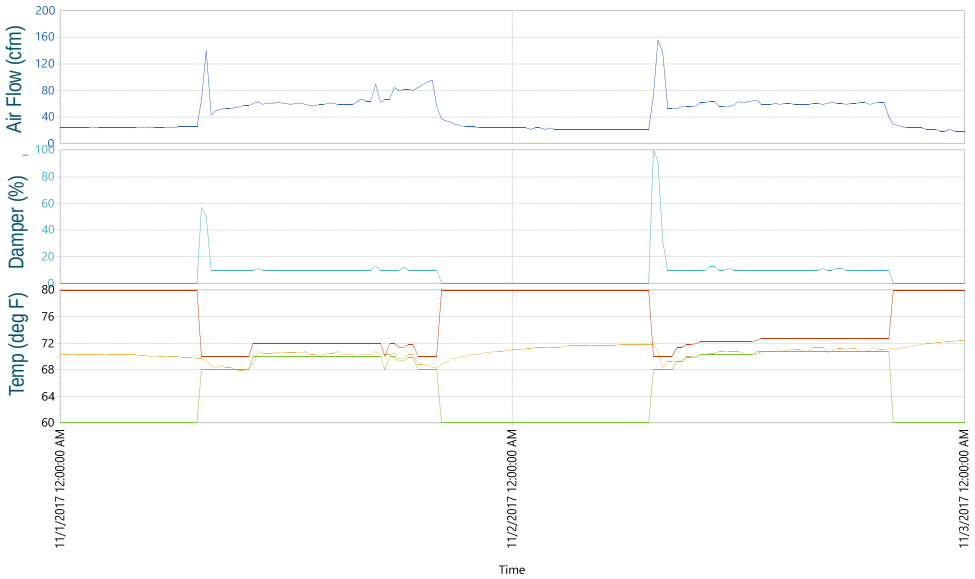

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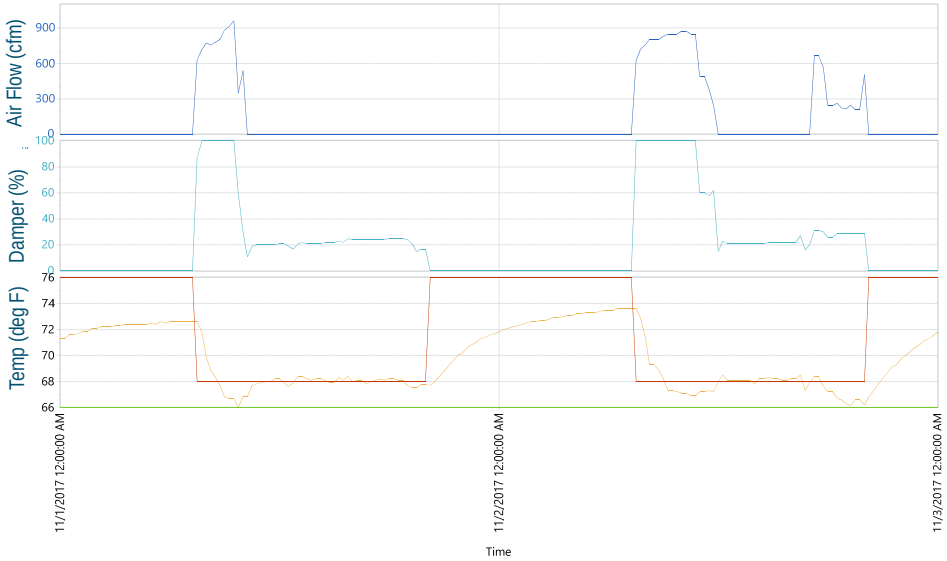
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600
300
0
Damper (%)
100
80
60
40
20
0
Temp (deg F)
76
74
72
70
68
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Time

Designing Energy Behavior – Leading Change
Carolinas HealthCare System

Kady Cowan, Carolinas HealthCare System

ABSTRACT

Carolinas HealthCare System (CHS), one of the nation's leading and most innovative healthcare organizations, provides a full spectrum of healthcare and wellness programs throughout North and South Carolina. Hospitals are among the most resource-intensive commercial buildings. They have strict requirements for temperature, humidity and air quality, meaning they need sophisticated HVAC systems, and they include nonclinical functions that have high energy demands, such as food services and information technology.

The CHS Office for a Healthy Environment designed and implemented a new Energy Behavior program in 2015 specifically for healthcare. Our design approach, grounded in putting humans at the center of the energy system incorporates insights from organizational strategy, behavior, operations, technology and investment. Our work is based on research from social marketing, collective impact, cognitive science, behavioral economics and ethnography. Our tactics include actors from diverse disciplines and departments coming together to co-create the most appropriate solutions for specific energy efficiency and conservation problems. Our methodology has been field tested in various socio-technical hospital environments, with diverse target audiences and target behaviors.

We will showcase how moving energy to the center of organization-wide planning and decision making can be barrowed across healthcare enterprises and commercial sectors. Our ability to iterate quickly by collecting energy and behavioral data shows successful long-term change and many co-benefits of energy efficiency and conservation interventions. Some of the biggest wins from the Energy Behavior program come directly from making facility managers more comfortable with adopting energy efficient solutions. We will present a summary of the specific energy issues that impact energy management in healthcare and the unique design approach we use to collect and document change and organizational commitment.

Introduction

Healthcare sector in the United States is the second largest commercial user of energy (Practice GreenHealth 2015). In 2013 there were 5,686 hospitals nationwide with 914,513 licensed beds. U.S. hospitals use more than 8% of the nation's energy (Healthier Hospitals Initiative 2012). The last comprehensive international inquiry into hospital energy intensity was completed over a decade ago reports the approximate annual energy consumption of American hospitals at 269 kBtu/ft^2. The portion of electrical energy consumption being 240 kWh/M^2 (75 kBtu/ft$^{2)}$ and the portion of thermal consumption being 610 kWh/M^2 (194 kBtu/ft$^{2)}$ (Umwelt *no date*).

As a sector healthcare facilities and hospitals in particular have a wide range of operating profiles with respect to energy consumption. This fact is generally attributed to the variability in number of beds and full-time staff per square foot, service intensity (patient days), quantity of imaging equipment, number of operating rooms, and finally, energy efficiency and adoption of energy management practices (ENERGY STAR 2015).

Over the last decade hospital administrators, hospital engineers and frontline staff have realized that moving attention for energy management from the realm of unknown to central operating practice has important savings potential through cost avoidance. Hospital CFO's rule of thumb is every $1 not spent; for example, on utilities, eliminates the need to earn $20 in revenue (ENERGY STAR no date). Dr. Herbert Pardes, President and CEO, New York Presbyterian Hospital simplifies this idea by saying; "Every dollar saved on energy costs is a dollar that is devoted to improving medical care for our patients."

Hospitals across the country have implemented energy management to varying degrees with guidance, assistance and recognition from groups such as ENERGY STAR, Practice GeenHealth, Healthier Hospitals Initiative, and ASHE (American Society for Healthcare Engineering). In general, hospitals tackle technical changes alone without consideration for process or behavioral changes because the expertise for implementing and tracking energy behavior change is limited or non-existent.

Two hospital systems have approached energy management differently. University Health Network (UHN) in Toronto, Canada and Carolinas HealthCare System (CHS) in Charlotte, United States. Both systems have accounted for human behavior early on and have integrated process change to compliment and improve the energy savings achieved with technical changes such as retro-commissioning and retrofits. This paper will outline how an environmental sustainability practitioner employed by the hospital used design and culture to influence these large complex organizations to prioritize energy management resulting in multi-million-dollar annual utility savings.

Relevance of Institutional Actors

For many hospitals and healthcare institutions energy management is a relatively new program area. Staffed with small teams, and required to communicate with senior leadership and financial decision makers new to the field of energy finance; energy managers traditionally select technical projects that can be easily measured, meet the demands for high ongoing annual savings and quick payback. Lack of familiarity with social and system science prevent many organizations from embracing the powerful low-cost approach of behavior change.

University Health Network (UHN) first embraced energy management in 1999, and as a result is home to a mature and robust energy management strategy where the investment of time and innovation to simultaneously integrate human behavior into process and technical energy management projects had resulted in persistent, transferable, scalable, self-sustaining, and fun energy management models.

Carolinas HealthCare System (CHS) on the other hand is just beginning on the energy management journey. CHS has the advantage of implementing advanced practice, including the use of tools and techniques grounded in social and system science. CHS is targeting three specific behavioral and cultural factors that compliment and reinforce more conventional building commissioning and technical retrofits.

- Raise the profile of energy for staff in their day-to-day work lives.
- Help facility managers and building operators be more comfortable recognizing, adopting and eventually suggesting energy efficient solutions.
- Demonstrating the role of senior leadership in energy conservation.

Why Are Hospitals Different?

Healthcare landscape. Hospital culture and healthcare workforce are tasked with ensuring accurate patient outcomes and experiences. Hospitals function in a highly regulated and scrutinized landscape bridging complex medical treatments with complex human needs. Hospitals have adapted over the decades to exist in almost constant change. This is only compounded by characteristics such as infinite competing priorities, fluctuating fiscal environments and an extremely risk averse default culture. These boundaries have shaped the time-poor, reactive, and treatment focused mindset that hospitals use and at which they have become expert. In contrast, energy behavior program design imposes a prevention mindset that may seem uncomfortable in this landscape.

Energy behavior research focuses on residential sector. Although the institutional and commercial sectors have significant energy savings potential, the majority of research focuses on residential consumers (Mourik and Rotmann 2013). This requires energy behavior practitioners working in the institutional sector to translate insights from the research to fit the workplace context. One individual at work may have different perceptions, attitudes and possibly even values compared to the same individual at home. The required actions at work are different from those common at home. Using a combination of research including residential focused energy behavior, pro-conservation behavior at work (Hargreaves, 2008) and environmental psychology (McKenzie-Mohr 1999) helps to bridge this gap.

Feedback. In many workplace settings the feedback mechanisms are unclear because the relationship to monthly bills is eliminated. Only in unique circumstances are institutions or commercial building equipped with sufficient sub meters to be able to view who is responsible for which energy impact. To deliver the much sought after feedback participants' request, workplace energy behavior programs rely on labor intensive audits, observations and calculations to discover relationships between actions and impacts. Co-benefits such as employee engagement, participating in something good, living values at work and sense of pride also play an important role in feedback, helping to demonstrate the value of collective impact[1].

Hospitals have unique operating profiles. Insights generated from personal interviews and focus groups exploring the meaning of energy use and management in hospitals conducted at University Health Network in Toronto in 2015 and Carolinas HealthCare System in Charlotte in 2016 with energy engineers and frontline facilities staff are summarized in Table 1. These insights expose some of the complexity of the operating landscape in healthcare.

[1] Collective Impact is a framework to tackle deeply entrenched and complex social problems. It is an innovative and structured approach to making collaboration work across silos to achieve lasting social change. *Source: accessed on May.5.2016 http://www.collaborationforimpact.com/collective-impact/*

Table 1. Energy Insights about Hospitals

Theme	Examples
Extreme operational demands	- Operations are 24/7 with limited to no downtime. - A massive base load must run all year round in healthcare.
Decision making and financial silos	- Healthcare operations and capital budgets are allocated and can be controlled by different entities making it difficult to justify operational savings to groups responsible for capital costs. - There is financial incentive for equipment to be replaced on 'like' for 'like' basis which can result in overlooking important energy savings. - Conflicting requirements coupled with poorly understood impacts of policies can result in energy waste based on untested assumptions (i.e. Infection prevention control vs energy vs comfort). - Procurement requirements can increase complexity and confusion which results in higher costs.
Standards not consistent nor consistently implemented	- Hospitals often use vague building codes and not the highest level design standards such as ASHRAE 189.1. - Many different space types in one building requiring great variation in ventilation, capacity and redundancy. - There are regular changes in form and function of spaces (i.e. clinics convert to office) which may have different requirements for energy services that are not included in the re-design.
Risk aversion	- Over engineering or oversizing equipment to accommodate multiple safety factors is common. - Slow uptake of new technology results in legacy technologies staying in use longer than required.
Frontline staff not engaged in energy actions or decision making	-There is a lack of access to energy training for operators with no incentive for operators to take training or to use it. - A common energy language is missing which makes providing meaningful feedback about energy consumption and energy services difficult or impossible.
Getting the right information to the right people at the right time	- Standard metrics are lacking for building operators and management to be able to understand and react to energy information. -It is difficult to communicate all the system requirements to consultants responsible for completing projects on site which results in a lack of consistency across the organization.
Documenting information	-Poor information and systems for maintaining or tracking information.

Collecting insights such as the ones listed in Table 1 from the individuals closest to the work can quickly reveal barriers and priorities for an energy behavior program. Accounting for the context of energy use in hospitals leads to the appropriate selection of target audience, target behaviors and indicators of success.

Energy Behavior Program Design

This section will outline the genesis of the lead author's energy behavior program design methodology for hospitals as well as describe how this methodology is being used in a fresh hospital setting with specific attention on scaling-up energy behavior programs through intentional design, implementation and impact analysis.

At the helm of internal organizational energy behavior programs is either an energy behavior practitioner or a certified energy manager. The role of these leaders is to make an appropriate determination regarding where an energy behavior program should intervene in the energy ecosystem[2] landscape. Their roles are different but complementary.

An energy behavior practitioner is unique in the field and rare in any sector. Practitioners are equal parts researcher, coach, presenter, storyteller, evaluator, and futurist. Familiar with the context and culture of their organization allows a nimble response to change. As practitioners, the aim is to answer the perplexing question of how humans fit into the energy system and how to design for human behavior. Practitioners are successful when energy program gain acceptance and energy impacts persist over the long term.

On the other side, certified energy managers more commonly lead organizational energy management programs with a particular focus on engineering, building science and technology. However, for the first time since publication, the Association of Energy Engineers text book *Guide to Energy Management* (eds. Capehart, Turner, Kennedy 2015) have included a new chapter called "Human Behavior and Facility Energy Management". This is a dominant signal in the energy field that human behavior is integral to the energy system and certified energy managers can learn to integrate this powerful force into energy management plans.

Both the practitioner and the manager are interested in targeting action that will impact consumption of energy in the organization. They can do this by working with the target audience to design appropriate and meaningful interventions.

Behavioral Interventions

The range of interventions possible is almost endless. Popular schemes in the energy behavior space include; benchmarking, social norms, pledges, competitions, policy changes, mentorship and incentives. No matter which intervention is ultimately selected, at a minimum the intervention must have a **baseline**, appropriate **goals** that are meaningful to participants and a **feedback** mechanism so participants know how they are doing, how those around them are doing and how they are contributing to the overall organization target. Interventions vary, but one tool that seems to translate across groups is **commitment**. Participants who make a public commitment to their peers that they will take action helps them see them self as "the kind of person that would save energy" and therefore more likely to actually do it. This also puts their

[2] Energy Ecosystem is the interaction of all processes, actors and technical parts of the energy landscape. It acknowledges and accounts for the variability and unpredictability that is unique to each context specific socio-technical environment.

integrity at stake; to do what they said they would do. The last minimum program requirement is **celebration** and recognition. Acknowledging that individuals and teams are making progress and working toward their goals helps to keep momentum going and reinforces that they are not alone.

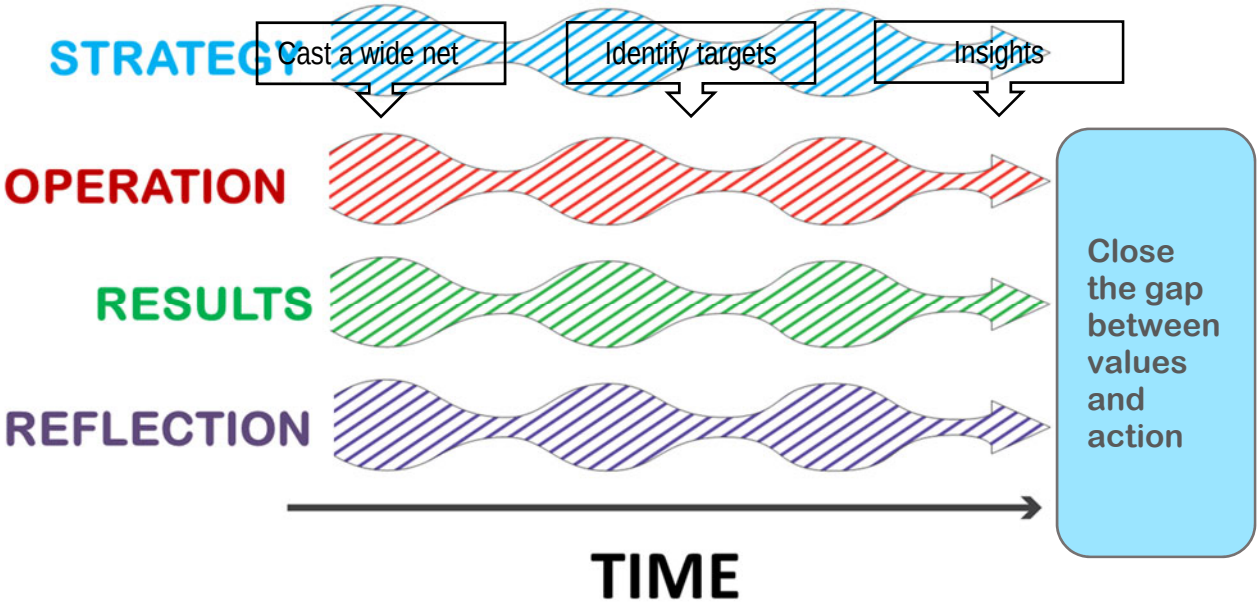

Figure 1. Energy Ecosystem Program Design Framework. *Source*: Cowan, K. 2014

An Energy Behavior Design Framework

To help interpret the stages of program design the Energy Ecosystem Program Design Framework (Figure 1) was developed based on the energy behavior program called Operation TLC in Toronto at the University Health Network. Program designers must balance movement between abstract and tangible in four program areas simultaneously. Thus, capturing and using the feedback from various design stages for continuous improvement and not one particular outcome. The Energy Ecosystem Program Design Framework is an iterative cycle that can be conceptualized as four waves. The process begins with the abstract and moves toward the tangible over time gaining insight along the way. This is done by collecting information, leveraging influence and understanding interactions in each program area: strategy, operation, results, and reflection. An example of how this model was used for energy behavior program design will be summarized in the next section.

Hospital with Mature Energy Management System

University Health Network (UHN) in Toronto, Canada spent over a decade embedding energy management into day-to-day operations and decision making. UHN has a robust energy behavior program called Operation TLC (Turn off Lights and Computers) that has influenced thousands of staff actions toward energy conservation by elevating the importance of little energy saving habits.

Being the program designer of Operation TLC between 2007 and 2015 was the catalyst for the development of the Energy Ecosystem Program Design Framework. Use and refinement of the model over time resulted in shifting the energy culture of the 4 large hospitals in the network from a "lights *on* kind of place" to a "lights *off* kind of place" realizing $3.5 million (CND) or 10% in annual utility savings. Other indicators of success and clear signals of culture change include:

- The CFO routinely asks for energy impact analysis on all capital projects
- 100 departments decreased their excess use of electricity between 30% to 100%
- Facilities staff accept and often suggest energy efficiency measures
- Of the total organization wide energy conservation goal of 10% between 1-3% can be attributed to the no cost energy behavior program Operation TLC
- Over 60% of the 14,000 staff were familiar with Operation TLC and over 25% worked directly with the program

Using the framework. By using the framework several things about program design became clear. People and technology were valued equally and behavior was seen not as an add-on but as a resource that could be managed. The framework helped to differentiate the need to develop a process to set the course for the future instead of creating a universal solution. This feature of the program acknowledged that solutions for specific energy problems would be discovered by participants themselves to fit their unique context.

Iterative cycle. Moving from imprecise phases of hunch to proof along the waves of the framework grounds the process. An iterative cycle of casting a wide net and asking what is possible then analyzing the results to identify the most appropriate target moves the program from abstract to tangible over time. Useful tools to the program designer vary; at a minimum process flow, documentation, utility data, sub meters, sensors, audits, observations, interviews, surveys, and reports help the program designer separate signals from the noise to make more meaningful programming decisions as well as demonstrating program impact. The useful insights that keep Operation TLC moving have been generated this way and result in embedding energy more deeply into the fabric of the organization through every action, intention and decision.

Operational insights that have been most useful include; creating an organizational echo[3] so all participants feel they are part of something bigger than themselves and using existing networks, trusted individuals and social cohesion to make energy conservation matter. Operation

[3] Organizational echo is heard when many different individuals, units, divisions or departments across and up and down the silos do their unique part in the energy efficiency and conservation playbook. Each participant can "hear" their contributions echoed across the organization and be reassured that others are working toward the same goal, albeit in different ways. Organizational echo is both a motivational tool and feedback mechanism for program participants and is central in creating a culture of energy management.

TLC resulted in an energy behavior program that is simple and compelling enough that anyone in the organization is comfortable talking about it, which results in keeping it top of mind.

Formal evaluation of institutional energy behavior programs is difficult to obtain so the framework recommends that regular cycles of reflection are completed by the program design team. This encourages double-loop learning to ensure that assumptions and values are checked on a regular basis. Program designers must be ready and willing to release program elements that are in decline and observe trends that are emerging from the noise. In the case of Operation TLC a lighting audit that was too difficult for program champions to complete on their own was revised so it could be completed in groups or in buddies.

Energy co-benefits. Another large hospital system in London England called Barts Health NHS Trust has documented a long list of accomplishments since Operation TLC – UK began in 2013. They astutely collected metrics that are central to the hospital's core mission; patients. This illustrates the value of looking for co-benefits in addition to energy savings. Barts Health has reported the following successes;

- 38% fewer patients request to change room temperature
- Staff report feeling proud to improve patient care
- $600,000 USD financial savings per year, enough for 18 new nurses
- Patients report 30% fewer sleep disruptions (Global Action Plan 2016)

Energy successes that have merit to the organization overall are more likely to persist for the long-term compared to a program that does not find a way to fit in.

Hospital with Emerging Energy Management System

In 2012, Carolinas HealthCare System (CHS) adopted a goal to reduce energy use intensity (EUI) 20% from a baseline of 295 kBtu/ft^2. This goal applies across a selection of the owned acute care[4] hospital facilities and will be accomplished in 2017. Success will align CHS with other top energy performing hospitals in the United States who report EUI closer to 230 kBtu/ft^2 (Practice GreenHealth 2015).

Occupant energy behavior pilot at CHS. The return on investment for energy management is exciting. However once initial savings have been achieved and accounted for seeing them decline over time can be frustrating. Attention to this detail motivated Carolinas HealthCare System in 2015 to link human behavior to the capital projects underway at 6 acute hospitals. To estimate the savings opportunity from behavior a research project lead by Emilie Greene, then Program Manager for a Healthy Environment at Carolinas HealthCare assisted by Khiry Sutton, alumna of Wake Forest University's Sustainability Graduate Program tested the impact of prompts for healthcare staff at CHS Lincoln Hospital. The target behaviors, intended for unoccupied patient rooms are easy to do in under two minutes and include: 1) turn off lights 2)

[4] "Acute care is a branch of secondary health care where a patient receives active but short-term treatment for a severe injury or episode of illness, an urgent medical condition, or during recovery from surgery. In medical terms, care for acute health conditions is the opposite from chronic care, or longer term care." (wikipwedia)

turn off televisions 3) power down computer monitors 4) reset thermostats and 5) close window blinds (Sutton 2015).

In addition to visual prompts energy behavior programs targeting frontline workers; nurses, housekeeping and security were supported by ongoing education and endorsed by department specific leadership. If those factors are in place rooms with visual prompts had a 42% higher chance of being in compliance with the target behaviors than rooms with no prompt. (Sutton 2015).

In order to estimate the amount of electricity produced by each room and the amount of savings possible with compliance researchers developed a unique energy behavior measurement equation "By applying the compliance rates and vacancy rates observed through the study, the electricity costs at CHS Lincoln Hospital could be reduced by as much as $50/day on peak, and $27/day off peak when 4 or more behaviors were performed. If the hospital can sustain its current energy efficiency behavior compliance rate, it can achieve an estimated monthly savings of approximately 15,896 kWh." (Sutton 2015).

The results of this study demonstrate that integrating occupant behavior change into capital energy efficiency investments offers potential to improve energy performance and generate ongoing savings at a relative low cost of implementation. When each actor in the energy ecosystem is aware of and can act in their own role to contribute to energy savings the spectrum of energy efficiency becomes visible and indicates a shift to a culture of conservation.

Operator energy behavior pilot at CHS. To test the transferability and scalability of the Energy Ecosystem Program Design Framework a comprehensive energy behavior program is being conceptualized at Carolinas HealthCare System to complement technical upgrades supported through capital investments. Capital projects at 12 hospital facilities have been allocated for retro-commissioning, conversion from pneumatic to digital (DDC) controls, chilled water system optimization, operating room ventilation schedule set-backs and BAS fault analytics. Customizing the energy behavior program for facilities staff, the target audience in tandem with capital investments will increase efficiency, reduce building scale complications and retain energy savings over the long term by building a culture of trust, engagement, pride and embedding energy management into the fabric of the organization.

This program is starting with energy management training for frontline facility staff. Using this pause from day-to-day tasks to learn about energy decisions that they can control will be the first formal introduction to energy management for this group at CHS. As well this training will be used to initiate a formal dialogue on how to spot energy opportunities and give the frontline the support and/or permission needed to resolve these issues. As the dialogue regarding energy matures the energy behavior program will begin to take shape in a collaborative design process targeting simple energy saving actions that frontline staff can take. The first energy behavior intervention with this target audience will be launched in Summer 2016 with the first cohort of trainees.

Design for Impact

Drawing a straight line between energy behavior and energy impact is time consuming and difficult. Most targeted interventions like the ones in hospitals are too small to impose a randomized controlled trial or quasi-experimental design. In the quest to know and ultimately predict what savings can be expected from behavioral interventions good pilot design is essential (Dunn, Dethman, Bean 2016).

Large utilities that do have the capacity to conduct experimental research to link interventions to savings have found anywhere from 1-3% of utility wide savings can be attributed to behavior. Utilities purposefully keep their estimates low because of the difficultly in attributing savings to energy behavior alone. However, in 2015 BC Hydro evaluated their popular and successful Workplace Conservation Awareness program to quantify the energy savings from this behavior based program and found results in the 1-2% range. Including retro-commissioning (RCx) as a behavior based approach increases savings by an additional 16% at the facility level (Mills 2009). Similar findings have been reported by Opower a customer engagement platform that represents a wide range of utilities in the U.S. (Opower 2013).

The energy behavior program at CHS will not only set a course toward a culture of conservation but will help to advance information that links interventions to energy savings through intentional program design. Attributing energy savings to behavior based programs is not only valuable to CHS but the energy behavior program planners.

Insights and Conclusion

The ultimate success in energy behavior programing is a shift in energy culture from negligent to mindful with interventions that encourage actions that are at first persistent then habitual. Although it seems possible that program designers will eventually have enough tools, feedback, and insight to be able to predict the outcome of an intervention given the context. For now, program designers must cycle through iterative phases to make sure the interventions and programs result in the intended outcome and the culture is moving in the direction of conservation.

Hospitals are among the most resource-intensive commercial buildings. They have strict requirements for temperature, humidity and air quality, meaning they need sophisticated HVAC systems, and they include nonclinical functions that have high energy demands, such as food services and information technology. Organizational structure is complex which can make finding access points to elevate energy conservation unclear. For large hospital systems, annual energy costs can reach into the tens of millions of dollars. Yet most health systems still don't make energy investments a priority.

Some of the biggest wins from the energy behavior program come directly from making facility managers and building operators more comfortable with recognizing, adopting and eventually suggesting energy efficient solutions. Targeting actions and actors who have the most control over energy decisions is the most rewarding part of energy behavior programming. With an energy conservation mind-set large scale energy projects can increase energy efficiency and conservation; reduce building scale complications; retain energy savings over the long-term; move faster and more smoothly and be more cost effective.

In addition to these successes energy behavior programs also attribute value to employee co-benefits such as engagement, job satisfaction, pride and respect, working to your highest skill set and camaraderie. For hospitals there are potential co-benefits for patients as well; quiet at night, improved patient experience through comfort and cohesive staff teams. The community benefits are even farther reaching; hospitals are seen as leaders in the community acting on community values. Most broadly the impact of increased energy literacy – that ability to understand and talk about energy creates meaning so impacts become clearer to a wider audience.

While CHS actively manages energy costs by implementing opportunities as they are identified, by acting more strategically, CHS can significantly improve its energy-related

performance. Internalizing energy management into every-day decision-making, and operating procedures helps assure substantial and long-lasting reductions in energy use throughout CHS.

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FLAGSHIP HEALTHCARE

Envision Charlotte – June 2018

PROJECT SNAPSHOT

Company: Flagship Healthcare Properties

Lead Engineer: Dan Maples

Number of Buildings: Over 100

Date of Retuning: 2017

Buildings Audited: 9

Average Savings: 6.75%

Highest Individual Building Savings: 17.2%

Flagship Healthcare Properties

Mint Hill, NC

INTRODUCTION

Flagship Healthcare Properties is a real estate firm that focuses on healthcare properties. It manages over 100 properties from Louisiana to Pennsylvania, and these properties are under the watchful eye of Dan Maples, the chief engineer at Flagship Healthcare. Maples is responsible for the daily operation and management of the Flagship engineering department and oversees three engineers and operators who help operate all of Flagship's buildings. As Flagship Healthcare continues to expand and add new properties to its portfolio, Maples and his team must adapt to the changing landscape of the firm. With so many properties to manage, and more being added, Maples and his team's time and talent is spread thin. By participating in the Duke Energy's Smart Energy in Offices Program (SEiO) and the University of North Carolina at Charlotte's Sustainability and Integrated Buildings and Sites (SIBS) programs, Maples saw an opportunity to alleviate his team's workload and improve the efficiency and economic savings of his buildings at the same time.

> *"Dan saw UNCC as a resource. An extra set of hands."*
>
> *–Dr. Robert Cox*

UNCC AUDIT

Ultimately, it was up to the individual owners of each of the Flaghsip properties to pursue savings and efficiency and allow the UNCC program access to their buildings. Because of that, Maples could only allow access to nine properties in the Charlotte area. But that was enough for the UNCC team to prove the effectiveness of their process. They worked with the building managers at all nine of the locations and collected data. By working closely with the building managers, the UNCC team was able to use their in depth knowledge of their building to develop more effective solutions. "Building operators know the personality of their building," explained Dr. Ben Futrell. Throughout the process, "general knowledge from us and specific knowledge of their building from them come together to solve a problem."

Once the data was collected, they brought it back to UNCC to analyze. From there they were able to develop a plan to increase savings and decrease inefficiencies in the building with no cost to the company.

ISSUES UNCOVERED

The UNCC team encountered a similar set of problems in nearly all nine of Flagship's properties. For example:

Weekend Schedule Readjustment

The UNCC team discovered that the systems in most of the buildings were running at the same intensity on the weekends as the weekdays. This is massively inefficient, but very simple to fix.

Static Pressure Reset

The UNCC team also found that fans were running in the system as if it were 100 degrees Fahrenheit outside. They optimized fan speeds to meet heating and cooling needs with no reduction in comfort for the individuals inside.

None of the issues they found were difficult to identify and fix, but many of the operators were simply unaware they were occuring. Altogether, these changes were made at no cost to Flagship Health and minimal time investment from Maples and his team.

"Our presence has made them aware of things they [Building Managers] may have known about, but didn't quite understand."

–Dr. Robert Cox

Student teams at work

RESULTS

For the nine buildings involved, Flagship Healthcare achieved an average savings of 6.75% at no cost other than what was already budgeted for the buildings. The success of this program wassubstantial: UNCC and Maples's team were able to find and implement savings in nearly all of the nine Flagship buildings.

Maples is eager to scale the program up and start using it to improve the efficiency of more of his buildings in the future. Altogether, the program successfully explained and helped implement something that was very valuable to Flagship Healthcare without selling them anything, a success that they may see replicated in the future.

"They spend their whole career serving, but finally someone comes and serves them."

–Dr. Ben Futrell

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FOUNDRY COMMERCIAL

Envision Charlotte – June 2018

PROJECT SNAPSHOT

Company: Foundry Commercial

Chief Engineer: Lee Biggerstaff

Number of Buildings: 12

Date of Retuning: March, 2017

Buildings Audited: 12

Average Savings: 6.2%

Nine Water Ridge Commercial Building

INTRODUCTION

Lee Biggerstaff is the Chief Engineer for Foundry Commercial, a company based out of Orlando, Florida that specializes in a variety of real estate and investment services such as brokerage, leasing, project management and property management services. With over 400 properties in locations spanning Florida to California, Foundry Commercial is responsible for maintaining and monitoring all of them, including a 12 building portfolio in Charlotte, N.C.

Biggerstaff and his team focus on ensuring the safety and functionality of the buildings in the Water Ridge Office Park near the Charlotte Douglas Airport. Maintaining buildings is a difficult --nearly endless--job, so when the University of North Carolina at Charlotte's Sustainability and Integrated Buildings and Sites program approached the company with potential savings and a reduction of time-consuming tasks, Biggerstaff was immediately on board.

> *"We didn't do anything they couldn't already do, and it didn't cost any money."*
>
> *–Dr. Robert Cox*

ENTER UNCC SIBS

Biggerstaff and his team opened up all of their buildings to the UNCC team, consisting of the two professors, Dr. Robert Cox and Dr. Ben Futrell, and a handful of their students, and asked: "How can we get savings?"

Beginning in March 2017, the UNCC team began collecting large swaths of data. Biggerstaff and his team went through the buildings with the students guiding and aiding them as they audited – and learning alongside them.

The vast amount of data was mainly harvested from the Building Automation System, an automatic central control mechanism, and included information ranging from heating and cooling to ventalation and lighting. A sometimes complicated system, Dr. Futrell would sit down with members of Biggerstaff's team and his own students and thouroughly explain how to decipher the information displayed by the system.

From there, the students took the information that they had gathered back to the university where they analyzed it and worked with the professors to develop energy-saving solutions.

STRATEGY

In the lab, the UNCC team uncovered various issues that repeated themselves in almost all of the Water Ridge properties. They were simple problems, oftentimes the result of issues in the cooling and heating of the building or simply the schedule that the system was set to run on. The UNCC team took their solutions back to Biggerstaff and his team, and together they made the necessary changes to get the desired savings.

The first thing they changed was the weekend schedule. Many of the buildings were running in the same manner on the weekends as they were during the rest of the week. The teams fixed this issue by changing the system's run schedule. They then optimized the fan speed in the heating and cooling system to meet the actual demand in the building. Finally, "free cooling" was implemented, a process that uses outside air to cool a building.

"In the end it's all remarkably simple. We just enlighten them on what they can do."

–Dr. Robert Cox

Real-world learning for student teams.

RESULTS

By implementing these solutions, Biggerstaff and his team were able to see an average savings of 6.2% across the Water Ridge portfolio – all with minimal investment of time from Lee and his team at no increased cost to Foundry Commercial. Dr. Cox and Dr. Futrell are convinced that the reason that their work with Foundry Commercial was so successful is because of how willing Biggerstaff and his team were to work with UNCC to find and create savings.

In the end, the entire process was beneficial to all parties involved. The students from UNCC were given an opportunity to work in the field and see first hand how engineers and operators work from day to day, while the management company's personnel increased their knowledge and skills to more effectively monitor their buildings systems, prevent potential issues in the future, and generate energy and economic savings for their company. All this was made possible by the willingness of both the UNCC team and the Foundry team to cooperate towards a common goal: energy savings through education.

"Success comes down to the human element."

–Dr. Robert Cox

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