On-going Commissioning for Outpatient Medical Facilities

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Definition of Terms and Acronyms

AMI – Advanced Metering Infrastructure

ASC – Ambulatory Surgical Center

ASHRAE – American Society of Heating, Refrigerating, and Air-Conditioning Engineers

CBECS – Commercial Building Energy Consumption Survey

CMS – Centers for Medicare and Medicaid Services

CUSUM – Cumulative Sum of the Savings

ECO – Energy Conservation Opportunity

EIS – Energy Information System

EMP – Energy Management Package

EUI – Energy Use Intensity

FGI – Facility Guidelines Institute

HVAC – Heating, Ventilation, and Air Conditioning

kWh – Kilowatt-hours

LBNL – Lawrence Berkeley National Laboratory

LED – Light-Emitting Diode

M&V – Measurement & Verification

MDH – Minnesota Department of Health

NFPA – National Fire Protection Association

RCx – Recommissioning or Retro-commissioning

RH – Relative Humidity

ROI – Return on Investment

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Executive Summary

Project Goals and Scope

Medical facilities are an energy-intensive market sector with unique space uses, equipment, and requirements compared to other commercial building classes. This project focuses on outpatient medical facilities, specifically medical clinics and ambulatory surgical centers (ASCs). These facilities, while smaller than hospitals, are still large energy users with efficiency opportunities. This project aims to recommend ways to help convert outpatient medical facilities from inactive or reactive energy users into proactive, energy-conscious participants in energy efficiency programs.

The project team investigated three specific opportunities to improve outpatient medical facilities' participation in energy efficiency. The team:

- piloted a contractor-led auditing approach with five medical clinics,
- piloted an on-going commissioning approach to assist facility staff in implementing and monitoring energy-efficiency projects,
- worked with the Minnesota Department of Health (MDH) to implement waiver procedures to relax specific operating requirements for surgical suites during unoccupied periods in order to save energy in surgical rooms.

Facility Benchmarking

The project team compiled a high-level benchmark for the outpatient medical facility market by investigating 17 ASC facilities and 5 medical clinics, collecting annual energy usage, and gathering basic demographic data for each. The team originally identified 20 ASCs for study, but determined later that three of those facilities were more appropriately designated hospitals and therefore removed them from the sample. The team calculated energy use intensity and generated ENERGY STAR scores for each facility. For comparison the team found data from the Commercial Building Energy Consumption Survey (CBECS)[1], ENERGY STAR, and the 2016 Chicago and 2015 Minneapolis commercial benchmarking studies.

The sample sizes generated during this study were not designed to be statistically significant. The project team gathered benchmark information to improve the team's understanding for energy use in this building sector, and to provide context for the pilot efforts. With a total of 2,298 ASCs in Minnesota, this study's sample reflects about 1% of the population.[2] Supplementing this anecdotal snapshot with

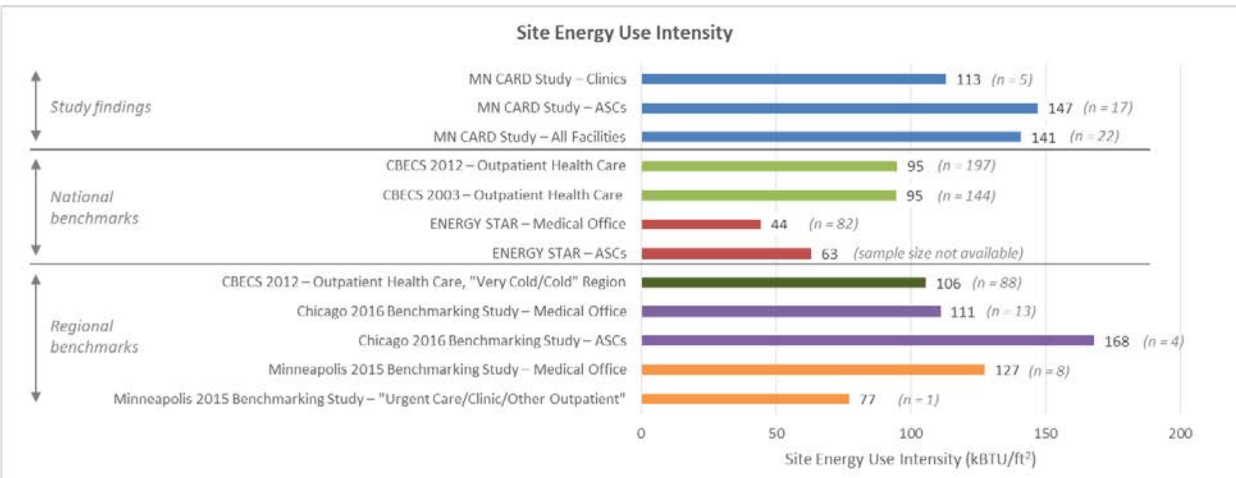
[1] The Commercial Building Energy Consumption Survey (CBECS) is a national survey of commercial buildings in the United States, which collects building data and energy use among several different facility types. Energy data is then reported in the aggregate, as well as broken out by facility type, fuel type, and end use.

[2] ReferenceUSA database, accessed on November 10, 2017. ASC count determined using NAICS code 621493 – *Freestanding Ambluatory Surgical & Emergence Ctrs* and filtering results for Minnesota businesses.

other data from national studies and regional benchmarking work provides insight into the state of out-patient medical facility energy use.

When compared to other regional and national populations, facilities in this study performed much worse than national averages and somewhat worse than regional benchmarks. Figure 1 shows overall average site energy use intensity (EUI) for all facilities in this study is 141 kBTU/sq ft. That average EUI is about 30% higher than the 2012 CBECS benchmark for outpatient medical facilities in the same climate. The 2016 Chicago data lines up more closely, as does the 2015 Minneapolis data, however it should be noted with both of those city data sets, sample size might be very small and facility type was self-reported.

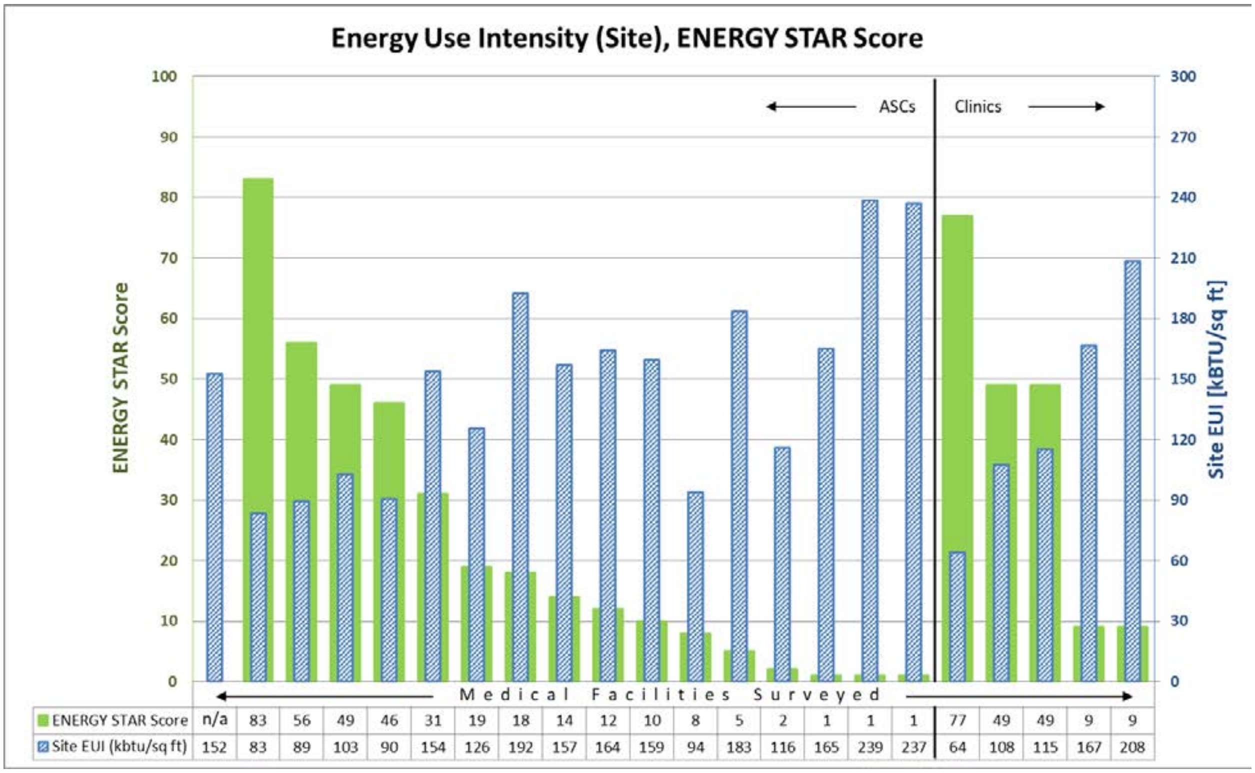
Figure 1: Site energy use intensity among various sources



Based on this study's sample medical clinics with no surgical capabilities had a slightly lower site EUI (113 kBTU/sq ft) than the overall average, and ASCs were higher (147 kBTU/sq ft). This trend is corroborated by both ENERGY STAR and Chicago benchmark data (Minneapolis benchmark data shows the opposite trend, but the "urgent care/clinic/other outpatient" category is based on only one site). ASUs would be expected to use more energy due to the presence of surgery suites, which tend to be energy-intensive areas of the facility.

Individual site EUI and corresponding ENERGY STAR scores for each eligible facility are shown in Figure 2. The median ENERGY STAR score for these facilities was 16, much less than the theoretical median score of 50. ENERGY STAR uses 1999 CBECS data as the foundation for their score.

Figure 2: Energy use intensity and ENERGY STAR score, all facilities



All three of the national benchmarks (2003 and 2012 CBECS and ENERGY STAR) come in well below any of the regional benchmarks. Part of the gap between data collected in this study and national data can be explained by climate. Additionally, there are unanswered questions around sample consistency among these benchmarks. Since 2014, the EPA discontinued the certification of Medical Office buildings as ENERGY STAR Certified because the foundational data was out of date.[3] In any case, the combined results from the energy use intensity benchmarking and ENERGY STAR scores indicate that, based on our sample, outpatient medical facilities in Minnesota can stand to improve when it comes to energy efficiency.

Contractor-Led Auditing for Small Facilities

In an effort to think outside the box for delivering energy management services to smaller medical facilities, the project team piloted a novel approach developed by the Lawrence Berkeley National Laboratory (LBNL). Their system, the LBNL Energy Management Package (EMP), focuses on low- and no-cost energy efficiency measures that can be identified during a short on-site walkthrough with an HVAC technician. This package of resources included some guides on benchmarking buildings, a walkthrough checklist, and a template report. The project team trained an HVAC technician to gather customer data,

[3] Can Medical Offices And Dormitories Get ENERGY STAR Certification?, https://portfoliomanager.zendesk.com/hc/en-us/articles/211698067-Can-medical-offices-and-dormitories-get-ENERGY-STAR-certification-

conduct a site visit, and produce recommendations for the customer. The project team also conducted energy audits at each facility to confirm the measure findings independently.

The EMP approach demonstrated some strengths. Through his site visits, the HVAC technician identified about the same number of measures as the Level II energy audit. The HVAC technician reported enjoying the site time with the customer, and that he learned some new skills for analyzing energy data. Additionally, this initiative served as an opportunity for the technician to identify some additional building control related opportunities for facilities that the LBNL EMP toolkit did not specify.

The EMP approach also demonstrated some weaknesses, especially in the context of serving the medical clinic market. For one thing, the technician reported being frustrated with the data-collection and analysis process. Getting signed utility release forms from customers was a challenge, and was made more difficult because the technician was usually in the field and didn’t have office hours to follow-up with customers. A small pilot, such as this one, doesn’t provide much time for training on tools like ENERGY STAR Portfolio Manager. If the contracting firm continued in this kind of effort, they stated that they would assign an office person to support the technician in collecting and processing data.

Additionally, the measures that the LBNL EMP identified, while similar in overall count, were not as comprehensive as the energy audit. The HVAC measures identified in the EMP tools didn’t leverage the customer’s Building Automation System, nor did they capture the variety of lighting opportunities (the only lighting measure in the package relates to T12 lighting).

Finally, the package did not inspire the contractor to build a new business model around using the tools after the pilot (one of the goals of the package). The HVAC contracting firm reports that providing energy services is a priority for them, but they feel they offer it already via installation of efficient equipment, programming energy efficient strategies into customer building controls, and conducting occasional recommissioning studies. For this medical clinic market sector and this specific contractor, the product did not add enough value to the contractor’s existing work to be adopted in their business.

On-Going Commissioning for ASCs

The project team also piloted a process for on-going commissioning of medical facilities, targeted for ASCs specifically. To implement on-going commissioning in a building, facility staff must utilize real-time energy data feedback to make adjustments in facility operations and track results from efficiency measure implementation. This approach should deliver more proactive engagement and better results.

In this pilot, three ASCs received recommissioning studies to identify energy-efficiency measures for facility staff to implement. These facilities had utility electric and gas pulse meters installed to track 15-minute interval data. That data was collected and stored in an Energy Information System (EIS). An EIS collects energy consumption information (ideally through interval meters and equipment sub-meters) then displays that data in a software interface (typically web-based). EIS products vary in features, but many have analytics built-in such as historical comparisons, benchmarking, reporting, and M&V of savings. These systems differ from Building Automation Systems (BAS) because they do not control specific equipment in the building; BAS systems needn't collect energy use information (although some do).

The facility staff and the program team all had access to the EIS, and frequent check-in calls were planned with the customer to track RCx measure implementation and results. The project team used the interval data collected over a baseline period, to develop a weather-normalized daily energy use regression model to forecast future energy use based on specific energy drivers, such as weather and building occupancy.

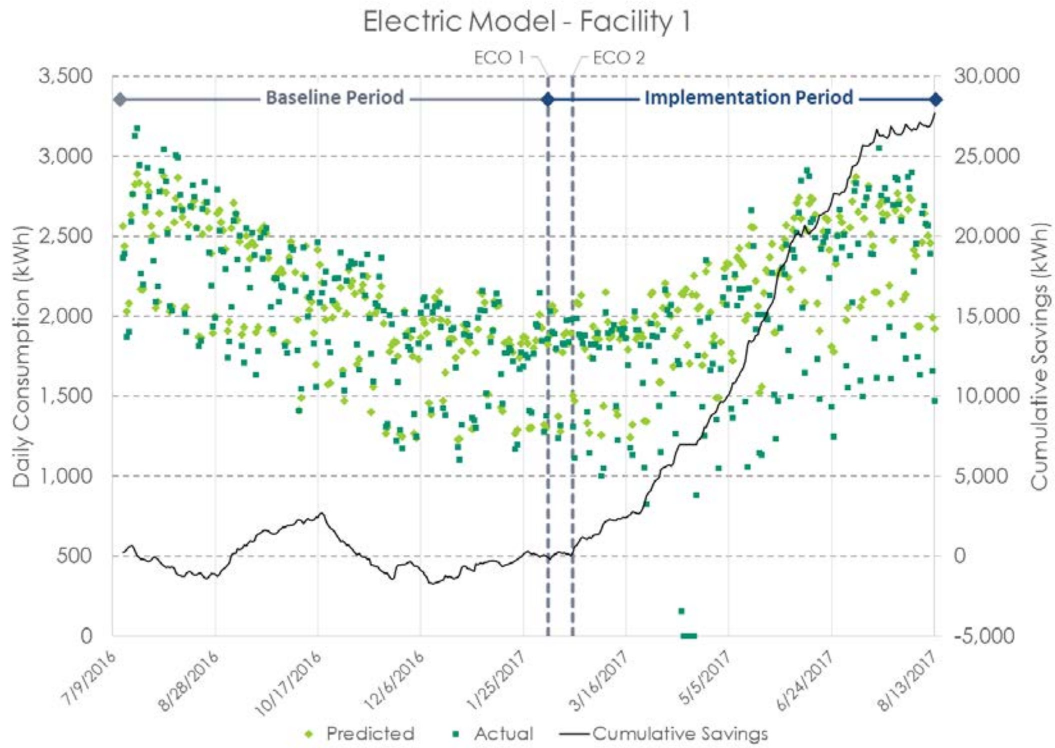
By comparing the measured energy use during the implementation period with a calculation of predicted energy use, the project team determined the energy savings during the implementation period. The results of the on-going commissioning process are shown in Table 1.

Table 1: Results of on-going commissioning and energy modeling process

Facility	Implementation Monitoring Period	Predicted Baseline Usage (during implementation)	Actual Usage (during implementation)	Savings % of Predicted Baseline (during implementation)
Facility 1	6 months (2/18/2017 – 8/13/2017)	386,233 kWh 24,060 therms	358,535 kWh 21,472 therms	27,698 kWh (7%) 2,588 therms (10%)
Facility 2	8 months (12/18/2016 – 8/9/2017)	998,264 kWh 22,535 therms	914,769 kWh 21,128 therms	83,495 kWh (8%) 1,407 therms (6%)
Facility 3	1-2 months Electric: 7/1/2017 – 8/13/2017 Gas: 6/1/2017 – 8/13/2017	606,705 kWh 22,887 therms	619,588 kWh 22,917 therms	-12,883 kWh (-2%) -29 therms (0%)

Facilities 1 and 2 both showed savings during the implementation period as a result of implementing RCx measures. Facility 3 did not implement any RCx measures. The project team used the data collected in the EIS and the energy model to identify savings and operational changes by developing a cumulative sum (CUSUM) of savings graph to share with facility staff. An example of a CUSUM from Facility 1 is shown in Figure 3. The CUSUM line for this facility, shows steady increase of cumulative savings after implementation of ECO 1 and ECO 2 (both measures related to scheduling air handling equipment).

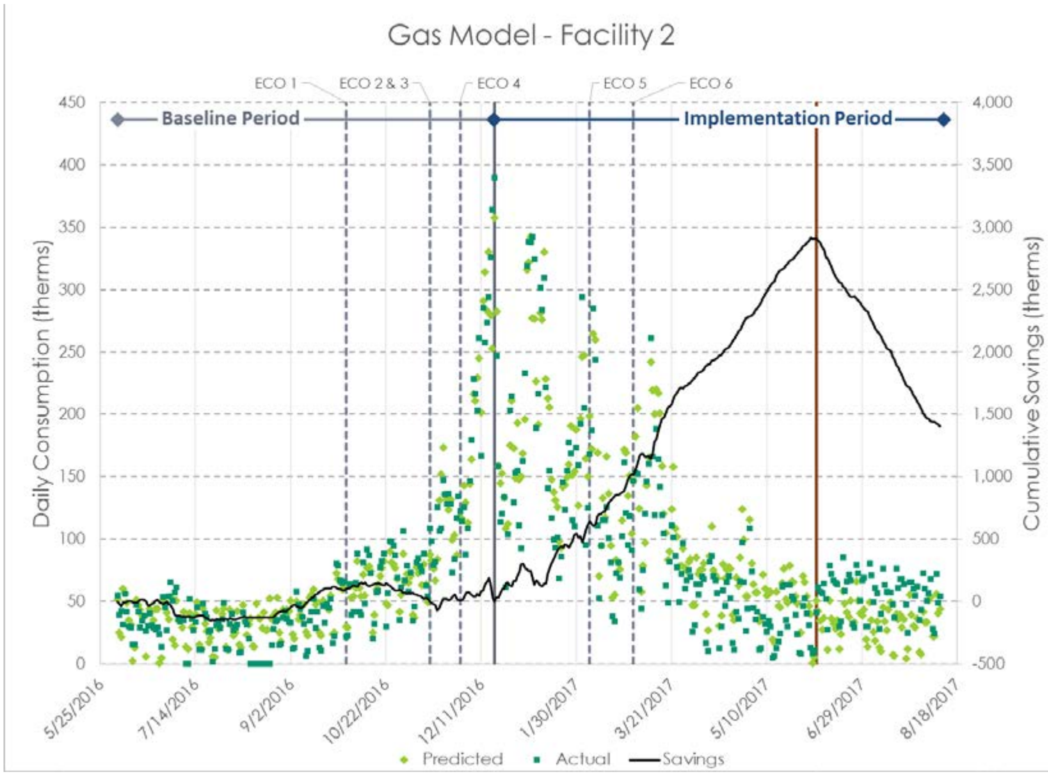
Figure 3: Electricity use, energy model, and savings CUSUM for Facility 1



This CUSUM chart enables on-going commissioning. If the savings trend plateaus or reverses, some action in the facility caused the change. Building management can then investigate what occurred. During the pilot, Facility 2 showed such a change in gas use, which lead to investigation of the cause and a correction of a Building Automation System setpoint. In Figure 4 below, the gas savings increased steadily over the course of the implementation period until around the beginning of June 2017[4]. At that time, actual energy use began to exceed the predicted baseline usage leading to a decrease in gas savings. It was discovered that in early July (corresponding with the peak of the savings CUSUM), Facility 2 staff effectively disabled the supply air temperature reset schedule in order to address high humidity issues in the building. Intended to be a temporary adjustment, staff never re-implemented the reset sequence. This led to excess reheat and an increase in gas usage. After learning of the issue, staff re-enabled the reset sequence.

[4] Facility 2's baseline period does overlap with implementation of ECOs 1-4. This is not ideal, since it results in understating the savings. However, the baseline period had to be extended to include some winter heating. Fortunately, ECOs 1-4 produce primarily savings in the cooling season; since they were implemented in the fall the savings would not have been realized yet.

Figure 4: Gas energy use, energy model and savings results for Facility 2



The case study from Facility 2 underscores the potential for real-time data and automated analysis to deliver on-going commissioning of energy performance. However, in this pilot, the on-going commissioning was neither real-time nor automated. The EIS platform used in this study didn't have the capability to produce the CUSUM chart automatically. Also, the facility staff rarely logged in to review their building's energy data. In this pilot the project team conducted analysis of the data and prompted engagement with the EIS from the facility staff.

Guidance for Regulatory Requirements

State regulations in Minnesota require specific operating conditions for surgical spaces in ASCs. In particular, surgical suites must be maintained at between 50% to 60% relative humidity and must be positively pressurized with respect to adjacent spaces at all times (Minnesota Statutes, chapter 4675, section 1600, subparts 1 and 4 respectively). Relaxing or clarifying these requirements could lead to opportunities for energy savings in ASCs. Table 2 shows a summary of the baseline and proposed conditions for ASCs, method for approval, and estimated savings calculated by the project team for both measures.

Table 2: Measures investigated with Minnesota Department of Health

	Baseline Conditions	Proposed Efficient Conditions	Process for Approval	Estimated Savings
Relative Humidity 20% Setpoint	50% to 60% relative humidity at all times	20% relative humidity at all times	Request for Equivalency	0.08 mmBTU/sf OR-yr[5]
Operating Room Airflow Setback	Full airflow at all times, continuous ventilation. Positive pressurization of surgical suites maintained at all times.	No ventilation while unoccupied. Supply airflow setback also possible as long as positive pressurization of surgical suites is maintained at all times.	Notification Letter	1.16 therm/sf OR-yr[6] 2.82 kWh/sf OR-yr[7] (ventilation savings only)

Guidelines for relative humidity requirements for ASCs have indicated that reductions can be achieved. Recent findings from a memorandum published by the Centers for Medicare and Medicaid Services ("CMS S&C-13-25-LSC & ASC") indicate that relative humidity levels of 20% are acceptable for surgical spaces. Subsequent notices advise that relative humidity levels must still comply with any requirements for supplies stored in surgical areas. Reducing humidity requirements to fall in line with these published guidelines will lead to humidification energy savings for facilities, provided they continue to comply with posted humidity requirements for stored supplies. According to the Minnesota Department of Health, the process for relaxing humidification requirements for ASCs will be implemented via a "request for equivalency" as a formal waiver process does not exist for ASCs.

Reduction of ventilation and air change rates also show potential for energy savings. The project team found that surgical suites in ASCs are typically ventilated at all times at full supply airflow to the spaces. Guidelines published in ASHRAE 170 indicate that while these critical spaces do need to stay pressurized

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[5] Savings provided as equipment load saved, in mmBTU (millions of BTUs), per square foot of operating room (OR) space per year. Equipment efficiencies and conversions must be used to determine net energy savings. Savings estimate based on: 1) Minneapolis, MN weather data; 2) reduction from 50% relative humidity to 20% relative humidity; 3) five air changes per hour of outside air and 12 air changes per hour total, per Minnesota Statutes; and 4) 60°F maximum outside air temperature for humidification.

[6] Savings provided in therms per square foot of OR space per year. Savings estimate is based on: 1) Minneapolis, MN weather data; 2) 80% efficient heating equipment; 3) reduction from continuous ventilation to 12 hours per weekday ventilation; 4) five air changes per hour of outside air and 12 air changes per hour total, per Minnesota Statutes; and 5) 60°F building balance point.

[7] Savings provided in kWh per square foot of OR space per year. Savings estimate is based on: 1) Minneapolis, MN weather data; 2) 12 EER cooling efficiency; 3) reduction from continuous ventilation to 12 hours per weekday ventilation; and 4) five air changes per hour of outside air and 12 air changes per hour total, per Minnesota Statutes.

at all times, they do not need to be ventilated continuously. Moreover, as long as the spaces are positively pressurized, air change rates can be reduced. Implementing both measures will lead to fan, heating, and cooling savings for ASCs. No waiver is necessary to implement airflow setbacks or ventilation reductions for surgical suites, as the only code requirement is that they be positively pressurized at all times. MDH will publish a “notification letter” to help broaden knowledge of this measure, which facilities staff will sign and return to demonstrate their understanding of the code requirements before implementing the measure.

Conclusions

As a result of this research, there are a few key conclusions.

1) The comparison of building benchmark data shows that Minnesota’s outpatient health care market may contain untapped potential for energy efficiency. In addition to the benchmark data, the facility studies conducted during this research, found that all the facilities had opportunity to save energy with cost-effective measures.

2) Surgical suites, with their specific demands for humidity and fresh air, present opportunities for strategic energy reduction. As a result of this research, protocols have been developed with the Minnesota Department of Health. As of publication of this report, the required form for relative humidity reduction is available on its website[8], and the letter for ventilation adjustments in the process of being published.

3) Data-based on-going commissioning can play a role in improving facility performance. The technology to implement this strategy via an EIS exists and is affordable.

4) Data is not a panacea. Access to data was not enough during this pilot to motivate engaged use of data. And raw data without analysis is not valuable to facility staff. Vet EIS tools carefully before selecting one. EIS companies should be able to demonstrate the features in advance. Be aware that installation and tuning of the EIS can take quite a long time, perhaps as long as a year.

5) Organizations need to pair an EIS with a holistic approach to managing energy. Facilities need to make a commitment to managing energy, set goals, assign staff to the task, and then use the EIS tool to track outcomes and conduct on-going commissioning. Without this strategic commitment to energy efficiency, the data collected in an EIS will be neglected.

[8] MN Department of Health, Engineering Services Checklists and Waivers, http://www.health.state.mn.us/divs/fpc/engineering/documents.html

Utility Program Recommendations

Given the potential for energy efficiency, health care sector needs and opportunities must be considered in the design and implementation of energy efficiency programs. However, dedicated programs for the sector are probably not necessary. ASCs can be well served in programs designed for all commercial customers. Some end-uses are unique, like MRIs and operating rooms, but programs like recommissioning and custom efficiency will be able to capture those savings opportunities.

The LBNL EMP approach for small business energy efficiency has some strengths, but based on this pilot it doesn't seem likely to take off among contractors serving the medical sector. Nor is there a specific un-met need among medical clinics. These facilities are more sophisticated energy users than the program was designed to serve. Clinics are also usually part of a larger network and have access to knowledgeable staff and resources beyond the norm for small businesses.

Since initiating this pilot study, a large utility in Minnesota launched an EIS program pilot that covers many of the recommendations of this report. The pilot program includes an emphasis on strategic energy management so that the customer has organizational support for using the EIS. The program pre-qualifies EIS vendors to ensure that the tools can provide necessary analysis. The program also offers consulting support so that customers have a supplemental source of energy analysis, coaching, and project tracking.

One barrier in this pilot was access to data and speed of meter installation. Both of those elements delayed parts of this study. Utilities could support customers by making access to interval data the default. One solution to this problem would be installation of advanced metering infrastructure (AMI). Fortunately, the largest of the state's utilities do plan to install AMI in the near future.

As that data becomes more accessible, utilities should not assume that the presence of the data alone will be sufficient to save energy. In reality, in this project, most facilities did not look at their data without project team prompting. And leveraging insight from the data took additional support. So, utilities considering an on-going commissioning oriented program should be sure to include help for the customer in learning how to manage energy as an organization. That means learning how to utilize an EIS, but it also means learning how to create management structure around their use of energy. Development of leadership within the organization to create and achieve energy objectives, plus access to and analysis of data, will produce the best results for the customer.

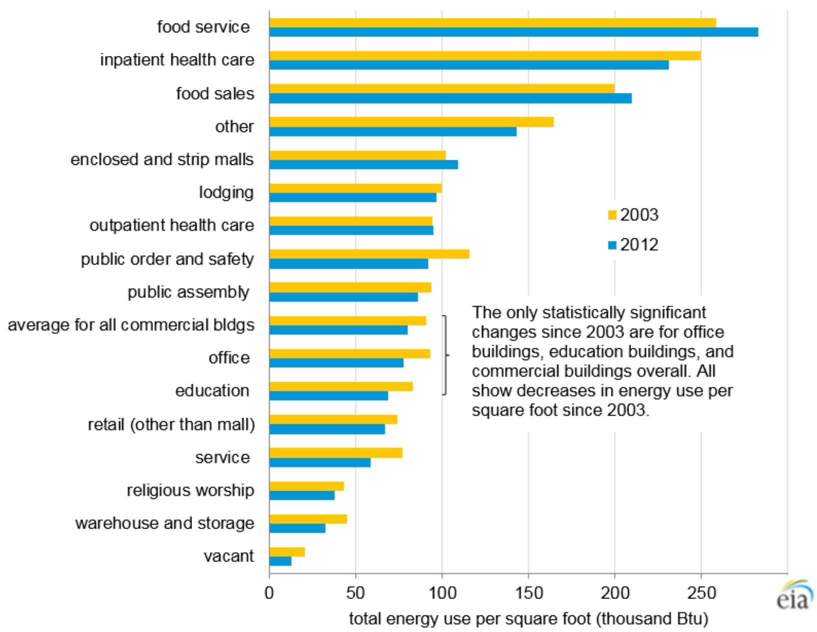
Introduction and Background

Background

Medical facilities are energy-intensive buildings. Long hours of operation, high standards for occupant comfort and indoor air quality, and energy intensive procedure spaces such as radiology, laboratory, diagnostic testing, and surgery, contribute to energy use. Among medical facilities, hospitals have the highest energy intensity. Smaller, more focused facilities, such as medical offices and ambulatory surgical centers (ASCs), have lower energy intensities, but are growing in market share. This research project focused specifically on ASCs and medical clinics (called medical offices by ENERGY STAR).

These facilities have specific energy efficiency opportunities because they are not generally occupied 24 hours per day yet often do not get scheduled into unoccupied modes. Scheduling systems to reduce energy consumption during unoccupied hours presents opportunity to save energy without impact on patient comfort or business operations because no one is present in the building.

Figure 5: Energy use intensity (EUI) data among facilities types.



Source: U.S. Energy Information Administration, Commercial Buildings Energy Consumption Survey.

While addressing energy use in health care, one encounters several barriers. First, for medical facilities, patient health outcomes and experience trump any energy consideration. Energy costs are considered a fixed and increasing operating expense for many facilities. Second, medical code compliance and internal safety protocol make adjustments to the facility operation difficult. Finally, outpatient medical facilities, as an industry, don't have a track record of improving efficiency. According to data from CBECS shown in Figure 5, energy use for outpatient health care stayed the same between 2003 and 2012.

Ambulatory Surgical Centers

Ambulatory surgical centers have several characteristics that make them unique. By definition, ASCs have one or more surgical suites within the facility. They provide same-day surgeries for procedures that do not require hospital admission. Stringent HVAC requirements and plug loads related to surgical services tend to increase the overall energy intensity of these facilities.

ASCs offer a variety of services to patients, many of which are energy intensive. Radiology, laboratory, procedure rooms, and standard examination rooms can be found in nearly every facility. Depending on the services offered, buildings can be occupied up to 7 days per week for much of the day. In addition, due to medical code requirements in Minnesota, HVAC systems serving surgical suites in ASCs must operate 24 hours per day to maintain pressure relationships. For surgical suites, use of flammable anesthetics necessitated a code requirement for high relative humidity, which persists despite the industry's elimination of flammable anesthetics. Combined, the varied end uses of these facilities and long hours present multiple traditional and unique opportunities for energy efficiency.

Medical Clinics

Medical clinics offer outpatient diagnostic and treatment services, typically on a scheduled basis. Medical clinics do not provide any overnight or inpatient care, which is usually reserved for surgical centers or hospitals. As such, while medical clinics include many of the services offered by standalone ambulatory surgical centers, a few key differences leads to a lower energy footprint on average.

Medical clinics often include radiology and laboratory areas in addition to standard examination and even basic procedure rooms. However, with no surgical suites on site, HVAC in a clinic can be scheduled based solely on building occupancy. Ventilation can be scheduled off at night and weekends if unoccupied, and heating and cooling setpoints can be setback during unoccupied periods.

Despite the less stringent energy requirements, many medical clinics rely on outdated or poorly-tuned systems to manage HVAC, lighting, and other building functions. Combined with the fact that medical clinics far outnumber ASCs, significant energy efficiency opportunities exist for this building sector.

On-going Commissioning

On-going commissioning, as proposed in this research, includes implementing recommissioning-type energy improvements at a facility and using energy data feedback to refine the implementation and improve the performance. Ideally, this approach should deliver more proactive engagement and better results for the facility team than standard recommissioning.

Building Recommissioning + Continuous Monitoring

The process of recommissioning a building identifies opportunities for operational improvements to save energy, improve occupant comfort, and address operational issues in the building. In particular, recommissioning focuses on how the building automation system manages energy consumption. Building recommissioning can typically reduce energy use by 10-20%. Furthermore, costs for implementation are generally low because the existing control system provides the foundation of the improvements.

Critics of recommissioning identify a lack of persistence of savings as a key shortcoming. Through recommissioning, engineers capture energy savings in buildings as easily as re-programming some control setpoints. Unfortunately, that ease also makes it easy for careless or unconvinced facility staff to un-do the savings after the implementation.

Introducing continuous monitoring of energy use into a facility after the completion of a recommissioning study can help improve the persistence of energy savings. Energy monitoring through 15-minute interval pulse meters would give the facility real-time access to their energy use data, which could drive further measure identification, staff training and engagement, and verifying and reporting of energy savings. In order to use this data, the facility needs an Energy Information System (EIS).

An EIS consists of energy metering equipment installed in a facility, some means of storing that data, and a software interface to display and analyze the energy data. EIS tools vary greatly, it is difficult to pin down one specific archetype[9]. For the purposes of this report, an EIS would require a minimum of daily energy consumption data for the building's main meter. That data would be stored in the cloud. The software would provide a web-based interface to review consumption and trends in near real-time.

On-going Commissioning for Smaller Buildings

Recommissioning doesn't work for small buildings. It requires knowledgeable and experienced engineers, who are expensive, so the savings potential needs to be large. It requires a Building Automation System (software which can directly control building operation) which most small buildings don't have. And recommissioning is slow; it can take many months to identify and achieve savings.

For smaller buildings, most utility energy efficiency programs instead focus on energy audits or direct install of energy saving equipment. In past CARD research, an innovative approach by the Lawrence Berkeley National Laboratory was identified as an opportunity to better serve smaller buildings[10]. The LBNL approach seemed well aligned with the goals of this project and the idea of on-going

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[9] For a much more detailed look at definitions and taxonomy of EIS, review LBNL's comprehensive web-archive on the topic. http://eis.lbl.gov/emis.html

[10] Kelly, N. and C. Samuelson. 2015. Cost-effective Recommissioning of Restaurants. Minneapolis, Minn: Minnesota Department of Commerce, Division of Energy Resources. Available at: https://www.cards.commerce.state.mn.us/CARDS/security/search.do?method=showPoup&documentId=%7B44ECFDC5-283A-455F-A4E1-6122450D6E43%7D&documentTitle=384566&documentType=6)

commissioning, because of its strategy to equip contractors to help customers develop an energy management system for their business.

Research Focus

This research project sought to identify the best approach to achieve energy savings in ambulatory (or outpatient) surgical centers and medical clinics. This research had three key goals:

1) Pilot and evaluate the Lawrence Berkeley National Laboratory's Energy Management Package on small medical clinics without surgical suites;
2) Pilot and evaluate on-going commissioning in facilities with surgical suites by conducting a recommissioning study and implementing an Energy Information System;
3) Document and share the Minnesota Department of Health (MDH) approval process for changing HVAC schedules and reducing relative humidity settings in surgical spaces.

The project team for the research consisted of Michaels Energy, an energy efficiency consulting firm, and Gilbert Mechanical, a mechanical and controls contractor specializing in the health care sector. Many medical facilities participated in this research, providing energy use history, access to their facilities, and implementing energy efficiency projects in their facility. The Minnesota Department of Health (MDH) was also an active participant in this research.

Methodology

This research project involved multiple approaches for evaluating the current state of energy efficiency and potential for energy savings among medical clinics. The facility pool was comprised of 25 different facilities with varying capabilities. 20 of these facilities had surgical suites (ASCs), and 5 facilities were stand-alone medical clinics with no surgery capability (referred to simply as clinics). Using all facilities, the team developed a robust benchmarking pool and energy use profile for the sector.

Energy Benchmarking

The project team performed basic energy benchmarking on all 25 facilities. The team collected monthly energy data and basic demographic information on each building from the facility staff. This demographic information includes building details such as size and age, building operating hours, number of staff, and medical equipment on site. With this information the project team also generated an ENERGY STAR score for each qualifying facility, inputting facility-provided data along with 12 months of energy use history to generate scores. In return for staff assistance, the team also generated a high-level benchmarking report to share with each clinic.

Several clinics evaluated in the study occupy one or multiple suites within much larger office buildings. Depending on the granularity of energy data available, the project team attempted to isolate only the medical clinic for the analysis.

Using the data gathered, the project team compared overall energy use among the facilities, and developed metrics such as energy use intensity (EUI) for each site. The team also drew comparisons between facilities with and without surgery suites, and reviewed each facility's ENERGY STAR score compared to its respective EUI.

LBNL Energy Management Package for Small Commercial Buildings

The Lawrence Berkeley National Laboratory (LBNL) developed a novel method for delivering energy services to small commercial buildings. The system, called LBNL Energy Management Package (EMP), focuses on low- and no-cost energy efficiency measures that can be identified during a short on-site walkthrough with an HVAC technician. According to the LBNL team, the multi-step process can be completed with results in six hours or less, contrasted with the 15 to 30 hours required for a standard ASHRAE Level II audit. LBNL describes their objective in developing this approach this way:

> *"The goal of this project is to develop a packaged Energy Management solution for small commercial buildings, with sufficiently low transaction costs in terms of both skills and level of effort to meet the needs of target audiences. In this context, the term 'Energy Management Systems' refers to the use of energy information and continuous improvement principles (Plan,*

Do, Check, Act) to continually identify efficiency opportunities and maintain energy performance. In recent years, this has been demonstrated fairly well for larger buildings and portfolios, and numerous Energy Information System (EIS) products are commercially available to support continuous energy management. However, it appears that there has been little if any application of Energy Management to small buildings."[11]

LBNL has developed guidance materials and analysis tools for this program, which were made available to the project team during the project. The package includes tools for benchmarking, interval data analysis, site walkthrough, impact tracking, and owner communication. Gilbert Mechanical identified a field technician to be trained on the energy management package and deliver it in this pilot. Michaels Energy conducted a training on the approach and evaluated it. Five standalone medical clinics (with no outpatient surgery capability) were selected for the pilot. It was determined that buildings without surgical facilities would more appropriately fit the small business market segment for which LBNL designed the package. A factsheet from LBNL is included in Appendix A.

The LBNL Energy Management Package is a multi-step process. First, the contractor establishes an energy use baseline by analyzing the facility's previous 12-month energy use. The contractor also benchmarks the facility, comparing energy use to other building of the same use type. If the facility is ranked below the 75th percentile of the benchmark group, interval data is collected (if available) to further analyze the energy of the building. Following the benchmarking process, the contractor conducts an on-site walkthrough of the building to identify possible energy efficiency opportunities.

Finally, the contractor shares the results of the benchmarking study and on-site walkthrough with facility management. The facility team selects and implements desired efficiency measures. The benchmarking process is then repeated after 6 months to identify the effect of the efficiency measures and quantify the savings.

EMP Evaluation

In order to evaluate the effectiveness of the LBNL EMP approach, the project team performed an ASHRAE Level II audit on each of the five standalone medical clinics. The energy audit included baseline energy benchmarking, end use analysis, identification of energy efficiency opportunities, and a written report, which was shared with each facility. The project team compared the results of each LBNL analysis to the opportunities identified in the respective Level II audit to understand the thoroughness of the LBNL approach. The level II audits also served to inform other aspects of this project – such as measure identification, facility end-use, and facility benchmarking.

[11] (Building Technology and Urban Systems Dept, Environmental Energy Technologies Division, Lawrence Berkeley National Labratory, 2017), Small Commercial Energy Management Package summary of work, http://eis.lbl.gov/smallcomm.html

On-Going Commissioning of ASCs

Three of the ambulatory surgical centers included in the benchmarking group underwent an on-going commissioning process during the project.

The project team conducted a recommissioning (RCx) study for each of the selected facilities. The recommissioning process included energy use analysis and a comprehensive review of the facility's energy-using equipment, including lighting, HVAC, and miscellaneous process loads. The reports identified several energy deficiencies and recommended areas for energy efficiency improvement. This list of energy efficiency measures quantified project energy savings and cost to implement.

After the RCx study was complete, the project team worked with the facilities to install interval meters for both gas and electric fuels at the facility. Energy data was recorded in 15-minute intervals in an Energy Information System (EIS). In this case, the project team used Alerton's Energy Manager as the EIS.

Once the EIS was in place, the project team met with each facility to review the RCx report results and train the facility staff on the use of the EIS. The EIS functionality includes energy monitoring and cost tracking. Each facility was asked to identify their measure implementation plan and schedule, so that implementation results could be tracked with the EIS.

On-going Commissioning Evaluation

To evaluate the savings each facility achieved during the pilot period, the project team developed a baseline energy model for each of the three facilities. An energy model is a mathematical equation that relates predictive energy drivers with overall energy use. For most facilities, drivers include variables like weather and occupancy. The goal of this model is to produce an equation using those driver variables and their coefficients that can reasonably predict the energy consumption on any given day. By comparing the actual energy use to this calculated baseline, the project team could see the savings generated by the facility as well as specific points of inflection, where savings increased or decreased.

The program team monitored implementation through regular follow-up calls with each facility contact. The overall project timeline was extended by approximately 18 months to allow for additional project monitoring and implementation in the facilities. At the conclusion of the monitoring period, the project team met with the facility contacts and reviewed savings results and gathered their feedback.

Results and Findings

Energy Use Intensity

Energy use intensity shows how much gas and electricity facilities use annually per square foot. It allows for meaningful comparison of different sized buildings. In this study, data for 25 buildings was collected. Five of those buildings were medical clinics. Twenty of those buildings were ASCs. Of the 20 ASCs collected, the project team determined that three were more appropriately classified as hospitals because they had some kind of 24-hour services, those three buildings were removed from the analysis. Table 3, shows average energy consumption for the five medical clinics and 17 ASCs investigated.

Table 3: Energy use statistics for medical facilities

Facility Type	# of facilities	Average annual electric usage (kWh)	Average monthly electric demand (kW)	Average annual gas usage (therms)	Electric/Gas Split	Average annual energy spend	Average Facility Site EUI (kBTU/sq ft)
Clinics	5	429,886	85	19,747	44% / 56%	$58,434	113
ASCs	17	1,256,591	271	25,979	70% / 30%	$138,790	147

It's interesting to note that, while ASCs have higher energy use intensity compared to clinics in our sample, the majority of the additional usage is dedicated to electricity. On average, gas use in ASCs is 30% higher than clinics, but electric use in ASCs is nearly three times that used in clinics. At least one of the ASCs had electric heat, which contributes to the difference.

Other research efforts have gathered data on energy intensity and energy consumption in medical facilities. Figure 6 shows how this study's data compares to data available through the EPA's ENERGY STAR and through the DOE's Commercial Building Energy Consumption Survey (CBECS) from 2003 and 2012[12]. Additionally, energy intensity data from recent benchmarking studies in Minneapolis and Chicago are included as local points of comparison.[13] All sources, except for CBECS, differentiate

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[12] CBECS 2012 data, http://www.eia.gov/consumption/commercial/reports/2012/energyusage/xls/table2_total%20energy.xlsx

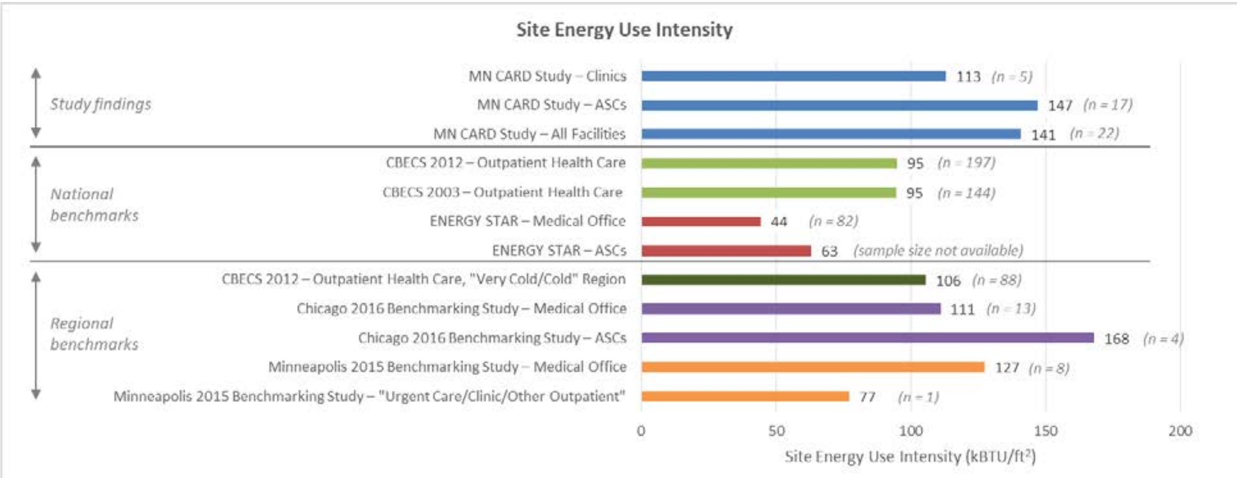
CBECS 2003 data, http://www.eia.gov/consumption/commercial/data/2003/pdf/e02a.pdf

ENERGY STAR data, https://portfoliomanager.energystar.gov/pdf/reference/US%20National%20Median%20Table.pdf

[13] Minneapolis benchmarking data, http://www.ci.minneapolis.mn.us/www/groups/public/@health/documents/images/wcmsp-194743.pdf

between ambulatory surgery and medical clinic facilities. CBECS does provide regional data, and their Very Cold and Cold regions are included separately for comparison.

Figure 6: Site energy use intensity among various sources



Data collected in this project indicates ASC energy use intensity (EUI) is about 30% higher than energy intensity for medical clinics. Similarly, the ENERGY STAR and Chicago benchmark data sets show that the EUI for ASCs is 42% and 51% higher than that for medical clinics, respectively. The Minneapolis benchmark data shows the opposite trend, but only includes one facility in the sample population for the "urgent care/clinic/other outpatient" category, and is most likely an outlier. All the regional data, except for that outlier, show EUI exceeding the CBECS benchmark data for the sector. Of note, the ENERGY STAR benchmark is based on 1999 CBECS data.

End Use Analysis

The project team wanted to understand which medical facility functions required the most energy. Facility managers can use this knowledge to target energy efficiency efforts. Additionally, this research aims to understand if there are any differences between the energy end use of clinics as compared to ambulatory surgical centers.

The results of the end use investigation are presented in Figure 7 and Figure 8. The project team performed an end use analysis for five of the 17 ASCs in the project sample, due to the effort involved. All five clinics received an end use analysis.

As with many facility types, the majority of the energy used in clinics and ASCs is devoted to building HVAC and lighting. While the exact split between end use categories is different between clinics and ASCs, in both building types the combined HVAC and lighting usage makes up roughly 75% of electric

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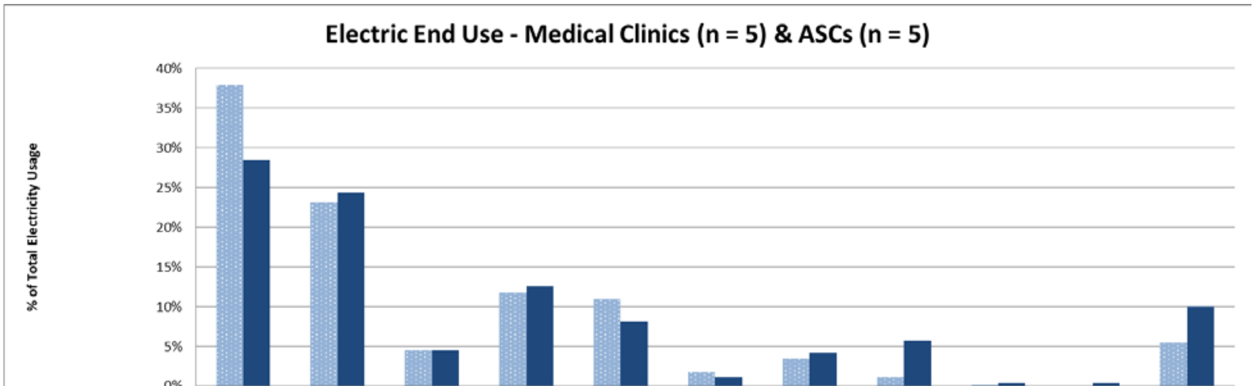
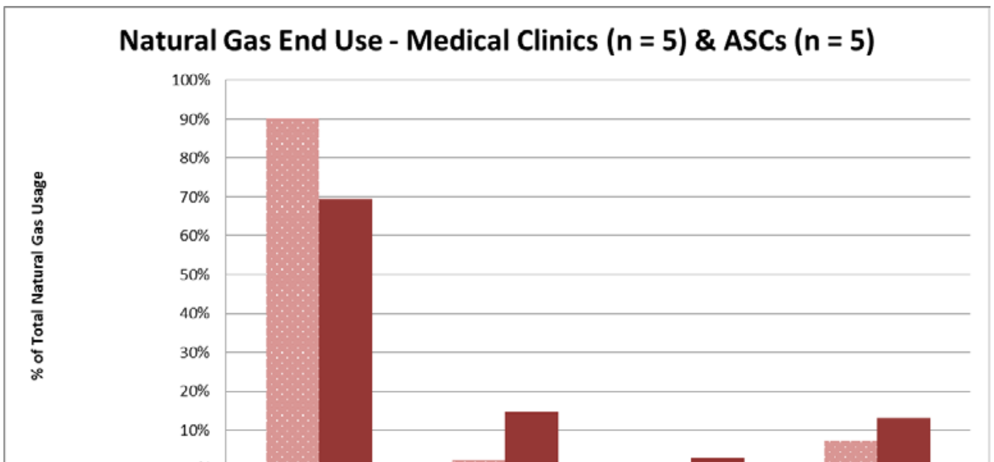
Chicago benchmarking data, https://www.cityofchicago.org/content/dam/city/progs/env/EnergyBenchmark/2016_Chicago_Energy_Benchmarking_Report.pdf and nearly all of the gas use. Differences between individual facilities are more pronounced; end use is clearly dependent on operating hours, services offered, and age of facility. In particular, the use of an MRI on site can dramatically increase the use for medical equipment. Overall, however, there are no major differences in end use between clinics and ASCs.

Figure 7: Electrical energy end use, medical clinics and ASCs



	Lighting	Fans	Pumps	Air Conditioning	Office Equipment	Laboratory	Medical Equipment	Electric Reheat	Electric Domestic Hot Water	Humidification	Plug Loads & Misc.
MN CARD - Clinics (n=5)	38%	23%	4%	12%	11%	2%	3%	1%	0%	0%	5%
MN CARD - ASCs (n=5)	29%	24%	5%	13%	8%	1%	4%	6%	0%	0%	10%

Figure 8: Natural gas energy end use, medical clinics and ASCs



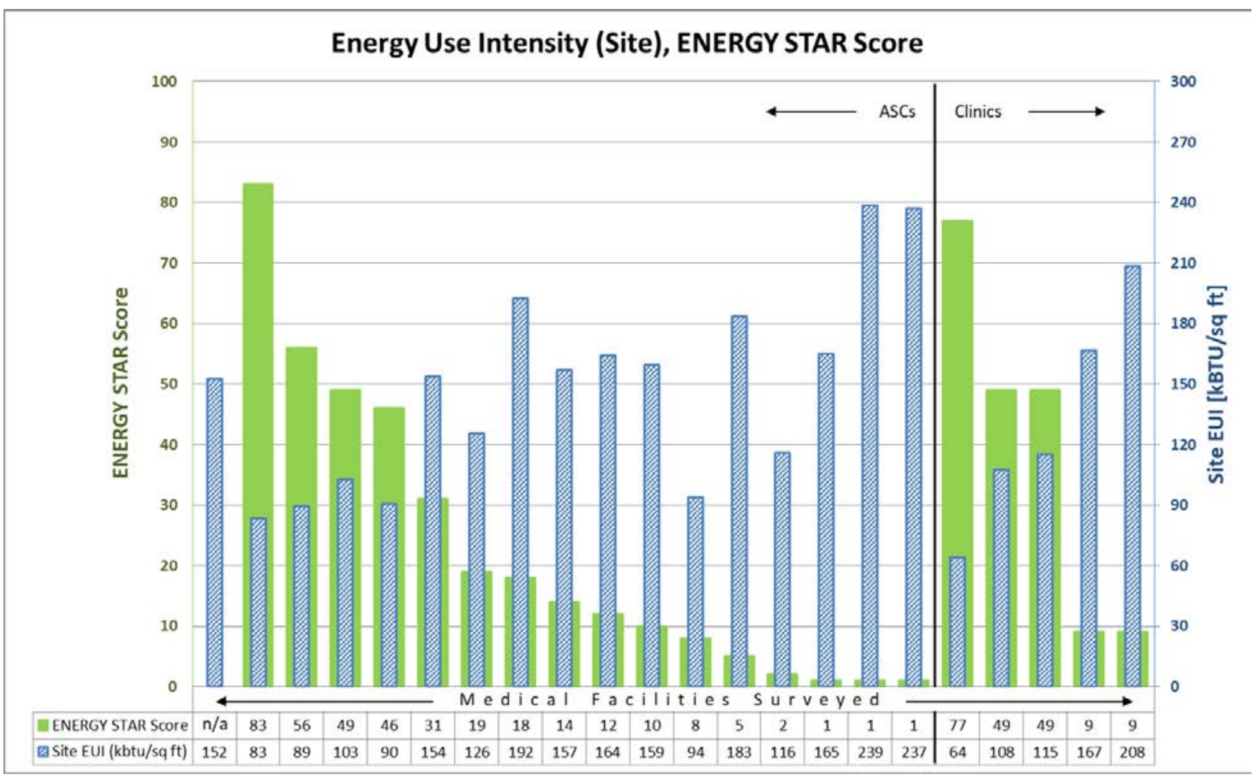
	Heating & Ventilation	Gas-Fired Domestic Hot Water	Humidification	Sterilization & Misc.
MN CARD - Clinics (n=5)	90%	2%	0%	7%
MN CARD - ASCs (n=5)	69%	15%	3%	13%

ENERGY STAR Benchmarking

In addition to energy and end use metrics, the project team also generated a benchmarking score for all qualifying medical facilities using the ENERGY STAR Portfolio Manager. ENERGY STAR maintains a database of energy use characteristics for various building types populated by historical CBECS energy survey data. The baseline data is regressed against key "demographic data," which includes high-level building and operating characteristics such as building size, hours of use, and number of staff. Benchmarked facilities submit the same demographic data, as well as their annual energy use, and the Portfolio Manager tool compares the actual EUI against what the regression "expects" using the baseline survey data. A facility that uses less energy than the baseline is given a higher score, and a facility using more energy a lower score. The scores are normalized on a median scale, meaning theoretically half of the facilities will earn a score of above 50 and half below 50.

The resulting ENERGY STAR scores are displayed in Figure 9. The figure includes both energy use intensity and corresponding ENERGY STAR score for each qualifying facility. One facility benchmarked was not large enough to be eligible for a score because it was smaller than 5,000 square feet, and only shows data for EUI.

Figure 9: Energy use intensity and ENERGY STAR score, all facilities



ENERGY STAR includes building types for both clinics (which they call "Medical Office") and ambulatory surgical centers, however only Medical Office building types generate an ENERGY STAR score. The demographic data for Medical Offices does include data entry for surgery center area and number of operating beds, but this information does not have any bearing on the ENERGY STAR score.[14] As such, the project team defined all facilities as Medical Offices in order to generate ENERGY STAR scores, and included surgical areas for reference only.

With a few exceptions, the relative ENERGY STAR score corresponds fairly well with the respective energy intensity of the facility. This trend is stronger for medical clinics than with ASCs, though there is a smaller pool of clinics. In this sample only three facilities score above 50. This is notable considering the ENERGY STAR score is normalized on a median basis, as described above. Classifying ASCs as Medical Offices may have depressed the scores. As discussed previously, on average the EUI of ASCs is 30% higher than that of medical clinics examined in this project. The metrics published by ENERGY STAR also lists an EUI for ASCs about 40% higher than Medical Offices. A regression that only includes ASCs would likely have a higher baseline energy use, and it is possible that the corresponding scores for these facilities would increase.

For many building types, a score of 75 or higher makes the building eligible to be ENERGY STAR Certified. However, Medical Office buildings cannot receive building certification as of 2014. The EPA discontinued certification because the score is based only on 1999 CBECS data and was felt to be out of date. The EPA indicates that building certification may be available again after reviewing the most recent 2012 CBECS survey data.[15]

ASC Regulatory Requirements

Existing Code Requirements

Chapter 4675 of the *Minnesota Administrative Rules* governs the operation of "outpatient surgical centers." Within this chapter, section 1600 dictates the rules for HVAC equipment. Specific rules for temperature and relative humidity setpoints described in Subpart 1:

> *Subpart 1. Temperature and humidity range. The systems shall be designed to provide temperatures and humidities as follows:*
> *A. operating rooms: 70 to 76 degrees Fahrenheit (variable range), 50 to 60 percent relative humidity;*
> *B. recovery rooms: 75 degrees Fahrenheit (variable range), 50 to 60 percent relative humidity; and*
> *C. other areas: 75 degrees Fahrenheit (winter design condition).*

Additionally, Subpart 4 dictates the pressure requirements for ASCs:

[14] The independent variables used to generate the score for a Medical Office facility include: 1) gross square footage; 2) number of workers on site; 3) weekly operating hours; 4) percent of the building that is heated; and 5) percent of the building that is cooled

[15] Can Medical Offices and Dormitories Get ENERGY STAR Certification?, https://portfoliomanager.zendesk.com/hc/en-us/articles/211698067-Can-medical-offices-and-dormitories-get-ENERGY-STAR-certification-

Subp. 4. Pressure. The ventilation systems shall be designed and balanced to provide the pressure relationships as shown in part 4675.2800.

Finally, the table given in 4675.2800 highlights the specific requirements for ventilation and pressure relationships:

Table 4: Code requirements for ambulatory surgical centers

Area Designation	Pressure Relationship to Adjacent Areas	Minimum Air Changes of Outdoor Air Per Hour	Minimum Total Air Changes Per Hour	All Air Exhausted Directly to Outdoors	Recirculated Within Room Units
Operating Room	Positive	5	12	Optional	No

Ventilation Scheduling and Relative Humidity Reduction

Per Minnesota code requirements, all facilities in this study ventilated 24 hours per day and maintained 50-60% relative humidity (RH) at all times. Both of these operational characteristics offer an opportunity for ASCs to reduce energy consumption. From a ventilation perspective, surgical suites in ASCs are only occupied for scheduled outpatient surgeries, mostly during the day. This provides an opportunity for setting back ventilation at night. On the humidity side, the industry's elimination of flammable anesthetics has led ASHRAE and other standards bodies to advise reducing relative humidity requirements for surgical spaces. Both measures would require gaining approval from the Minnesota Department of Health. Table 5 shows a summary of these two measures and estimated savings for implementing each.

Table 5: Measures investigated with Minnesota Department of Health

	Baseline Conditions	Proposed Efficient Conditions	Process for Approval	Estimated Savings
Relative Humidity 20% Setpoint	50% to 60% relative humidity at all times	20% relative humidity at all times	Request for Equivalency	0.08 mmBTU/sf OR-yr[16]
Operating Room Airflow Setback	Full airflow at all times, continuous ventilation. Positive pressurization of surgical suites maintained at all times.	No ventilation while unoccupied. Supply airflow setback also possible as long as positive pressurization of surgical suites is maintained at all times.	Notification Letter	1.16 therm/sf OR-yr[17] 2.82 kWh/sf OR-yr[18] (ventilation savings only)

Clarifying or loosening these ventilation and conditioning requirements imposed by the *Minnesota Administrative Rules*[19] present a potential opportunity to save energy, while also maintaining patient safety. Significant energy savings could be obtained if ASCs reduced the number of outdoor air changes when the surgical suites are unoccupied, provided that the positive pressure relationship with respect to adjacent areas is still maintained. The facility would be required to then ramp back to occupied standards upon reopening.

This recommendation matched several guidelines that describe the recommended ventilation of surgical suites. The 2010 edition of Guidelines for Design and Construction of Health Care Facilities by The Facility Guidelines Institute addresses HVAC requirements for operating rooms. Specifically, section 3.1-8.2.2.5(2)(b) denotes that:

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[16] Savings provided as equipment load saved, in mmBTU (millions of BTUs), per square foot of operating room (OR) space per year. Equipment efficiencies and conversions must be used to determine net energy savings. Savings estimate based on: 1) Minneapolis, MN weather data; 2) reduction from 50% relative humidity to 20% relative humidity; 3) five air changes per hour of outside air and 12 air changes per hour total, per Minnesota Statutes; and 4) 60°F maximum outside air temperature for humidification.

[17] Savings provided in therms per square foot of OR space per year. Savings estimate is based on: 1) Minneapolis, MN weather data; 2) 80% efficient heating equipment; 3) reduction from continuous ventilation to 12 hours per weekday ventilation; 4) five air changes per hour of outside air and 12 air changes per hour total, per Minnesota Statutes; and 5) 60°F building balance point.

[18] Savings provided in kWh per square foot of OR space per year. Savings estimate is based on: 1) Minneapolis, MN weather data; 2) 12 EER cooling efficiency; 3) reduction from continuous ventilation to 12 hours per weekday ventilation; and 4) five air changes per hour of outside air and 12 air changes per hour total, per Minnesota Statutes.

[19] Chapter 4675 of the *Minnesota Administrative Rules*, https://www.revisor.mn.gov/rules/?id=4675.2800

"…[d]uring unoccupied hours, operating room air change rates may be reduced, provided that the positive room pressure is maintained as required in Part 6 (ASHRAE 170)."

ASHRAE 170 recommends that operating rooms be positively pressurized with respect to the adjacent areas (as does the Minnesota Administrative Rules), further noting that:

"…for spaces that require a positive or negative pressure relationship, the number of air changes can be reduced when the space is unoccupied, provided that the required pressure relationship to adjoining spaces is maintained while the space is unoccupied and that the minimum number of air changes indicated is reestablished anytime the space becomes occupied."

Use of these published resources is endorsed by the State of Minnesota. Appendix L of the State Operations Manual, Q-0101, §416.44(a) states that "national organizations, such as the Facilities Guidelines Institute, may be used as a source of guidance to evaluate OR design and construction in an ASC," going on to mention that "the FGI 2010 Guidelines for Design and Construction of Health Care Facilities… has been approved by the American Society for Healthcare Engineering of the American Hospital Association and the American National Standards Institute."

Relative humidity has also been examined by the industry, specifically regarding recommendations of acceptable humidity levels for operating rooms. The National Fire Protection Association (NFPA) advised in the 1999 edition of the Health Care Facilities Code (NFPA 99) that operating rooms should be conditioned to a minimum of 35% relative humidity, contrasting with the State's requirement of 50-60% RH (NFPA, NFPA 99 1999, 5-4.1.1). Furthermore, the Centers for Medicare and Medicaid Services (CMS) published a memorandum ("CMS S&C-13-25-LSC & ASC") advising a minimum acceptable level of relative humidity of 20% rather than the 35% required in NFPA 99 (1999), 5-4.1.1[20]. A subsequent memorandum was published in 2015, advising that some supplies and equipment used in operating rooms may require minimum relative humidity of 30%. If no such supplies are stored in the surgery, relative humidity can be reduced to 20%.

With the preliminary review of current requirements and alternative supporting documentation, the project team pursued the development of a waiver process for Minnesota ASCs with the existing waiver letters for hospitals as a guideline. With input from the Minnesota Department of Health, the team drafted two forms for ASCs: a "request for equivalency" to reduce relative humidity to 20% in operating rooms, and a "notification letter" for airflow setbacks during unoccupied hours. Neither form is a true waiver letter, as this process does not actually exist for ASCs in Minnesota. Additional details and results of this development are discussed in the Recommendations section.

Evaluating the LBNL EMP Approach

To test the low-cost, contractor implemented LBNL EMP approach, Gilbert Mechanical assigned a controls field technician to implement the approach with five medical clinics. Michaels Energy followed

[20] CMS S&C-13-25-LSC & ASC, https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/Survey-and-Cert-Letter-13-25.pdf

that site visit with a standard ASHRAE Level II energy audit to confirm the savings opportunities in the building and evaluate the effectiveness of the LBNL EMP approach at capturing the majority of savings opportunities in these small customers.

Measure Identification

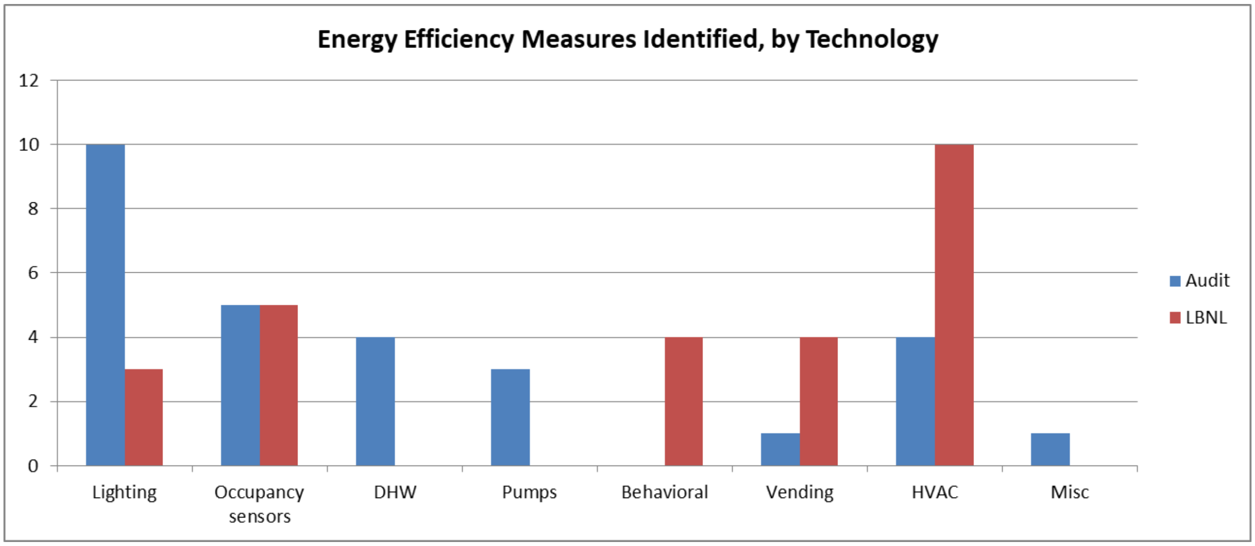
The LBNL EMP site walkthrough checklist covers 15 specific measures. There are an additional five sub-measures relating to HVAC setpoints. These measures are intended to be identifiable by someone without an energy auditing background. They identify a set of high-priority, low-cost opportunities common in small commercial buildings. This measure list was not tailored for medical clinics, so some of the opportunities were not relevant. Table 6 shows the measures included in the LBNL EMP checklist, sorted by end-use category. The full LBNL EMP questionnaire can be found in Appendix B.

Table 6: Count and description of LBNL EMP walkthrough assessment measures

Measure Category	Measure Count	Description of Measures
HVAC	5	Are fans or space heaters being used? Are radiator and air vents obstructed? Are doors and windows closed in heating season? Are thermostats programmed? What is the most common HVAC complaint?
Lighting	2	Are there incandescent or T12 fixtures? Are lights scheduled?
Occupancy Sensors	1	Are occupancy sensors installed?
Kitchen	3	Is there an equipment start-up/shutdown schedule? Is there a service maintenance schedule? Are dishwashers run only when full?
Vending	1	Are vending machines set to turn off at off hours?
Behavioral	3	Are employees trained in energy conservation? Are computers/monitors set to sleep at night? Are copy machines & printers set to sleep at night?

In order to quantify the results, the project team tallied the measures identified via the LBNL checklist and compared them to the measures identified in the Level II energy audits. Figure 10 displays the results. The LBNL EMP approach did not quantify the magnitude of savings from any measures, so only number of recommendations can be compared, not magnitude of impacts.

Figure 10: Total number of measures identified for all clinics

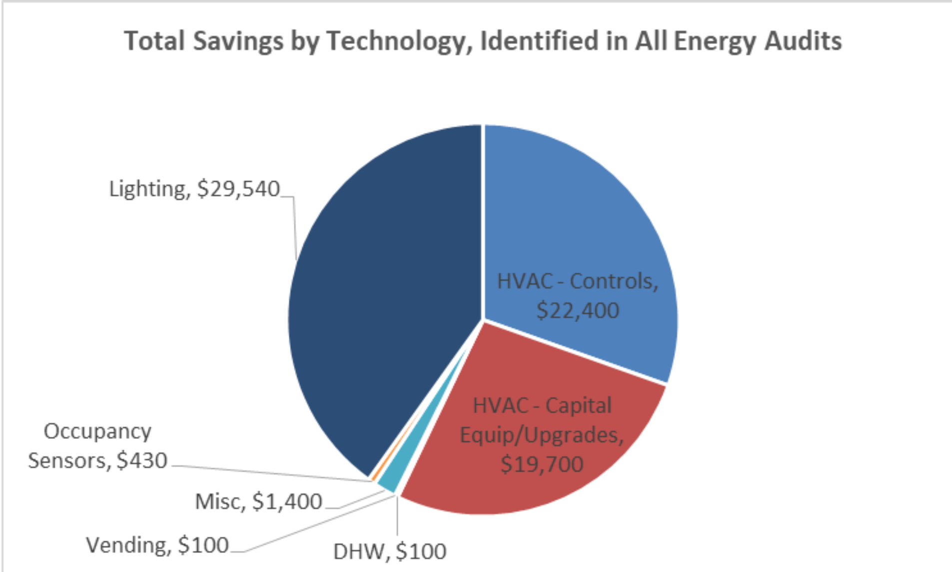


The LBNL process managed to identify a similar volume of measures as the energy audits. Measures identified in the LBNL process leaned toward HVAC opportunities, because that topic was treated in the questionnaire in a way that produced a higher measure count but not necessarily more energy savings. For example, the LBNL EMP questionnaire asked five thermostat setpoint questions. In this pilot, every facility was identified as having a setpoint opportunity. For the purpose of this analysis, setpoint measures were recorded as one measure. In addition, the LBNL questionnaire asked about HVAC complaints, which was included in the count shown in Figure 10, but doesn't produce a specific recommendation. By comparison, the Level II energy audits tended to provide a single recommendation regarding more advanced HVAC measures like equipment scheduling or temperature limits/resets.

The LBNL methodology incorporates lighting efficiency into the questionnaire through one question pertaining to T12 fixtures and another pertaining to occupancy control. The energy audit recommended many more lighting measures because of breaking down fixtures into specific groups (common areas, exam rooms, exterior) and recommending LED lighting.

The LBNL process identifies a set of high-level energy efficiency opportunities, but does not produce any specific information regarding energy savings, costs, or measure implementation. Prioritizing measures is done in the template report by an indication on 12 of the 15 measures that they are a priority. The implementer or customer might be able to further prioritize. In the Level II energy audits, the project team identified that lighting and HVAC controls and upgrades accounted for the vast majority of the savings potential – totaling over $40,000 of savings in the five facilities. Figure 11 below shows the breakdown of that cost savings.

Figure 11: Annual cost savings identified in all audits by technology



Qualitative Feedback

During interviews with the HVAC technician who implemented the LBNL EMP process at the participating facilities, the project team collected some qualitative feedback that helps inform the successfulness of this methodology.

Data access and data processing posed a challenge. The contractor was required to collect data release forms from the customer, process them through the utility protocol, and then enter the data into both a spreadsheet and ENERGY STAR Portfolio Manager for analysis. Collecting the data proved time intensive, and required a lot of phone calls to customers to follow-up on the status of their signature on the release form. In particular, the contractor reported that “Portfolio Manager was confusing.” And that the negative issues using the software platform cloud his impression of the overall approach. He says, “if I could get over the software issues, I think I could get to a point where I could deliver something good to the customers.”

The technician enjoyed being onsite with customers and discussing energy efficiency. He specializes in programming HVAC controls. His advanced knowledge base allowed him to identify a number of opportunities for control modifications at facilities that were not able to be recorded in the LBNL EMP template. He thought a shortcoming of the tool was that there wasn’t a way to quantify those creative measures he identified.

He recognized that some buildings had significant opportunity and that other buildings were being run pretty efficiently. He reported spending about 45 minutes on-site per facility, but that the overall process took way too much time because of data collection and software challenges. His manager reports that it’s really difficult to dedicate a skilled tech’s time to collecting and inputting utility data. In the future that data collection work would need to be done by an office personnel.

The contractor did see value in offering customer energy management services, even if the response to this specific package was mixed. In fact, the manager felt like it was the kind of thing their company already did without getting paid for it. “Energy efficiency is a key component of how we help our customers run their buildings. We want to solve problems for the customer.”

On-going Commissioning and ASCs

For three ASCs in the benchmarking group, the project team conducted RCx studies and installed electric and gas interval meters feeding information into an EIS at each facility. The EIS, and the associated access to real-time energy information, was intended to promote real time adjustment of facility operation, empower facility managers to implement additional measures, and engage staff in the process of energy management.

Each of the three facilities committed to implementing a set of RCx measures identified in their RCx study. Of the three facilities, one facility failed to implement any of the recommendations during the study period. After the staff implemented the selected projects, the EIS continued to collect energy data during an implementation monitoring period.

The team used the data from the EIS to develop an energy model for each facility and document actual savings following project implementation. The project team used data collected before implementation to establish a baseline period. The baseline period ideally spanned at least six months and some heating and some cooling operation. The project team compared the post-implementation energy data to predicted baseline energy data from the energy model for each building to evaluate the resulting savings for the projects implemented. These results were then shared with the facility staff at the end of the project.

Results of Implementation

The following sections present the results of the energy data collection and energy modeling efforts for each facility. Results were presented to the customer, so their feedback regarding facility operational changes informed this section. To track savings following measure implementation, the project team developed electric and gas energy models for each facility. Savings graphs for each facility include actual energy data recorded by the EIS along with predicted energy data from the models. Additionally, the graphs overlay the savings “CUSUM” or the cumulative sum of savings accrued over the implementation period. By definition, the CUSUM over the baseline period equates to zero as the model seeks the best fit with zero change over that time. An upward sloping line over the implementation period indicates the facility saved energy, and a downward sloping line indicates that some change in facility operation increased energy use.

The RCx studies provided a baseline of measure suggestions for each facility. However, facilities implemented only their desired subset of the measures. The project team kept in close communication with each facility manager during implementation. This communication was intended to track operational changes made at the facility, but ultimately the level of communication was not good enough to capture changes made at the facility during the implementation time that were not part of the RCx study scope. Therefore, these whole building results are not being compared back to measure-specific savings projections made in the RCx report. When the project team made that comparison, the input data and results were far enough apart as to be not conclusive. Because of delays in getting interval meters installed and delays with customer measure implementation, the implementation period only covers half a year, while RCx projections assumed a full year of operation. In a few instances, the team was able to review the six-month implementation data with each facility and identify some key operational changes that affected the data.

Facility 1

Energy Savings

The staff at Facility 1 implemented two measures identified in the RCx report around the beginning of February 2017. Savings accumulated over approximately six months. Table 7, Figure 12, and Figure 13 present results from the on-going commissioning process for Facility 1.

Table 7: Results of data collection and energy modeling for Facility 1

RCx Measures Implemented	Implementation Monitoring Period	Predicted Baseline Usage (during implementation)	Actual Usage (during implementation)	Savings % of Predicted Baseline (during implementation)
ECO 1 (2/6/2017): Schedule non-surgical AHUs ECO 2 (2/18/2017): Airflow setbacks for surgical AHUs	Six months (2/18/2017 – 8/13/2017)	386,233 kWh 24,060 therms	358,535 kWh 21,472 therms	27,698 kWh (7%) 2,588 therms (10%)

Figure 12: Electric model for Facility 1

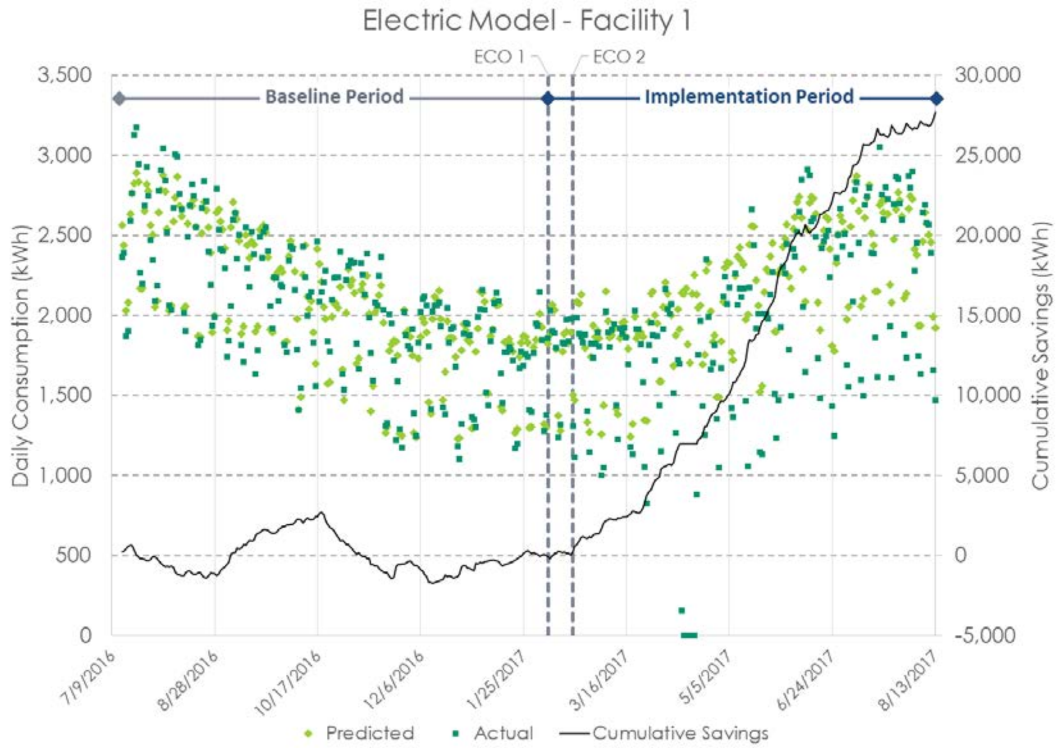
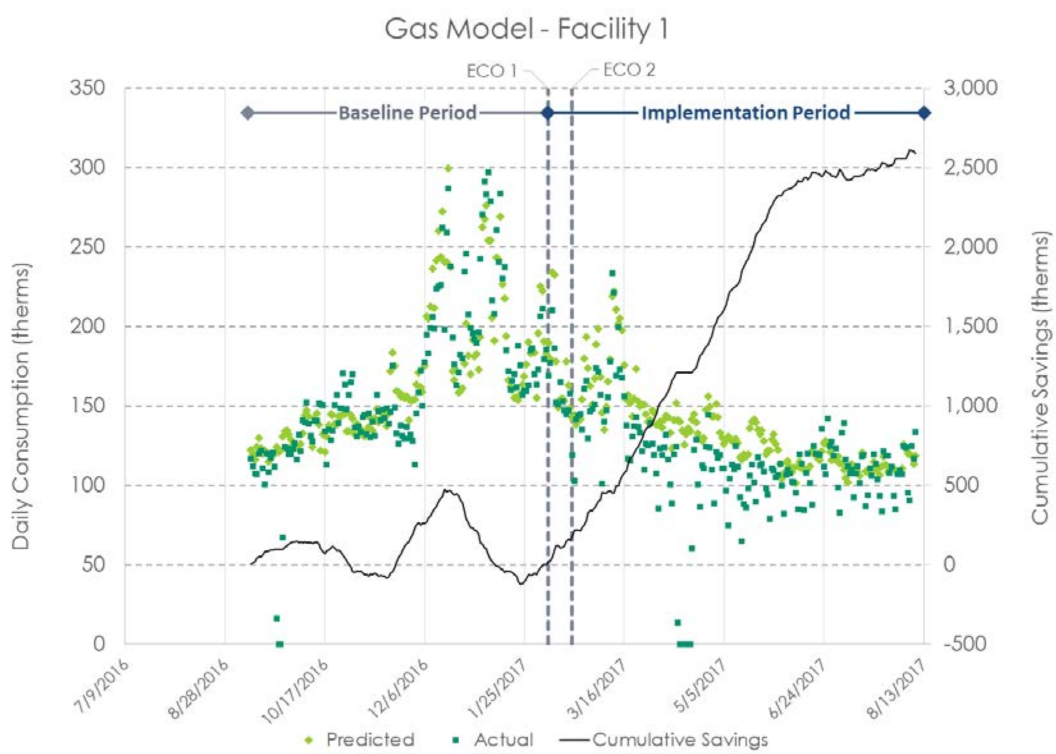


Figure 13: Gas model for Facility 1



The key energy drivers and the associated regression coefficients for the energy models for Facility 1 are given in Table 8. Seven key energy drivers have the strongest correlation to daily electrical consumption (in addition to an intercept variable), and only two are needed to correlate gas consumption.

Table 8: Energy drivers and coefficients for energy model for Facility 1

Key Energy Drivers	Regression Coefficients – Electric Model	Regression Coefficients – Gas Model
Monday	501.81	-
Tuesday	588.80	-
Wednesday	613.14	-
Thursday	587.29	-
Friday	508.29	-
Adjusted Temperature >BP	21.26	-111.23
Adjusted Temperature <BP	9.18	308.04
Intercept	*1228.47*	*15578.99*

The day of the week variables are either "1" or "0". For example, if a day is a Tuesday, then it has a "1" for the Tuesday variable and all others days of the week are "0". The Adjusted Temperature >BP and Adjusted Temperature <BP variables are calculated by taking the daily average temperature and subtracting the balance point (BP) temperature, or subtracting the average temperature from the balance point. Negative values for either of these differences are set to zero. The balance point temperature in the electric model is 34°F, and 35°F in the gas model.

With these coefficients, the electric energy model for Facility 1 is given in Equation 1 and the gas energy model in Equation 2. The correlation coefficient for the electric model is 0.90, and 0.85 for the gas model. A value of 0.75 is considered by ASHRAE to be a good fit. The higher the value, the better the fit.

Equation 1: Electric model equation for Facility 1

$$\begin{aligned}\text{Daily kWh} = {} & 1228.47 + 501.81 \times \text{Monday} + 588.80 \times \text{Tuesday} + 613.14 \times \text{Wednesday} + 587.29 \\ & \times \text{Thursday} + 508.29 \times \text{Friday} + 21.26 \times \text{Adjusted Temperature} > 34°\text{F} + 9.18 \\ & \times \text{Adjusted Temperature} < 34°\text{F}\end{aligned}$$

Equation 2: Gas model equation for Facility 1

$$\text{Daily therms} = 15578.99 + -111.23 \times \text{Adjusted Temperature} > 35°\text{F} + 308.04 \times \text{Adjusted Temperature} < 35°\text{F}$$

The baseline period spanned from July 14th 2016 to February 5th 2017. A full year baseline period would be ideal, but due to delays in meter installation, only a shorter baseline was available. Outlier points, caused by meter reading errors and faults in the data collection from the EIS, were removed from both the baseline and implementation periods.

This facility saw significant savings from only implementing two measures. Total facility savings compared to the estimated baseline for the implementation period were 7% reduction of electricity and a 10% reduction of natural gas usage. However, this measured savings was less than the engineer's calculation of energy savings in the RCx report for the implemented measures. This is partly due to the fact that some fans were not completely disabled at night (as specified by the RCx report), but rather slowed down to achieve an airflow setback. Positive pressures in surgical suites must be maintained at all times though air change rates can be reduced during unoccupied periods. Facility staff therefore reduced fan speeds for the unit serving surgical suites and shut down all other units at night.

Facility 2

Energy Savings

The staff at Facility 2 implemented six measures identified in the RCx report starting in early October 2016. Savings accumulated over approximately eight months. Table 9, Figure 14, and Figure 15 present the results of the on-going commissioning process for Facility 2.

Table 9: Results of data collection and energy modeling for Facility 2

RCx Measures Implemented	Implementation Monitoring Period	Predicted Baseline Usage (during implementation)	Actual Usage (during implementation)	Savings % of Predicted Baseline (during implementation)
ECO 1 (10/1/2016): Reduced humidification load ECO 2 (11/14/2016): Reset supply air temperature ECO 3 (11/14/2016): Chiller lockout during unoccupied periods ECO 4 (11/30/2016): AHU airflow setbacks during unoccupied periods ECO 5 (2/6/2017): 3rd floor AHU setbacks during unoccupied periods ECO 6 (3/1/2017): Install new VFD chiller	Eight months (12/18/2016 – 8/9/2017)	998,264 kWh 22,535 therms	914,769 kWh 21,128 therms	83,495 kWh (8%) 1,407 therms (6%)

Figure 14: Electric model for Facility 2

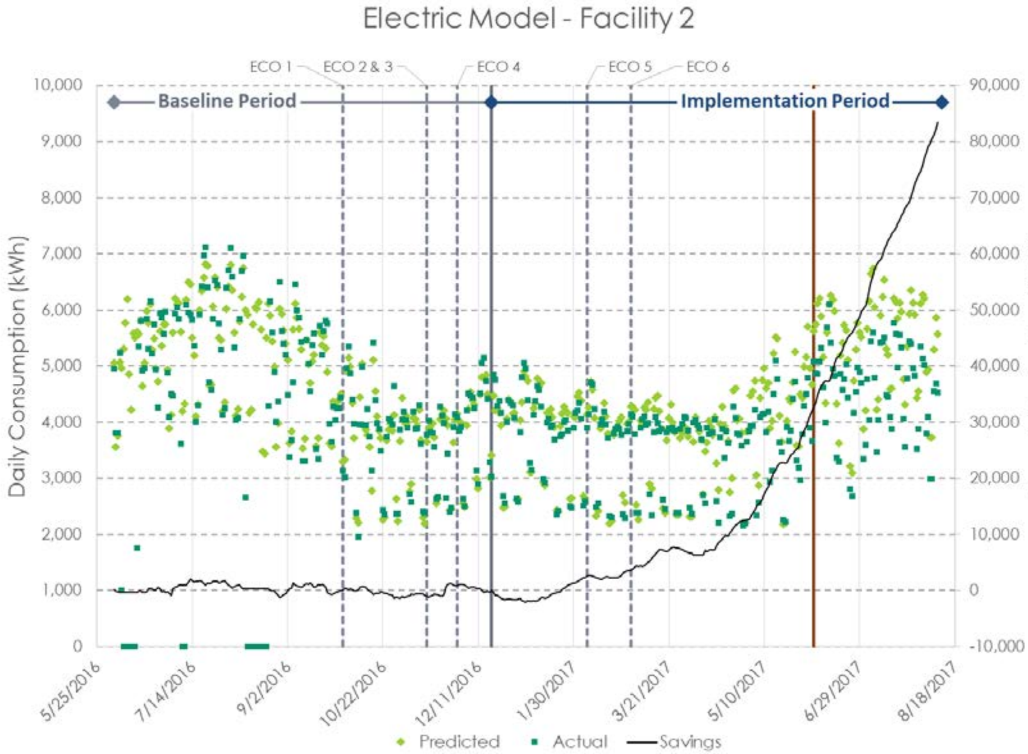
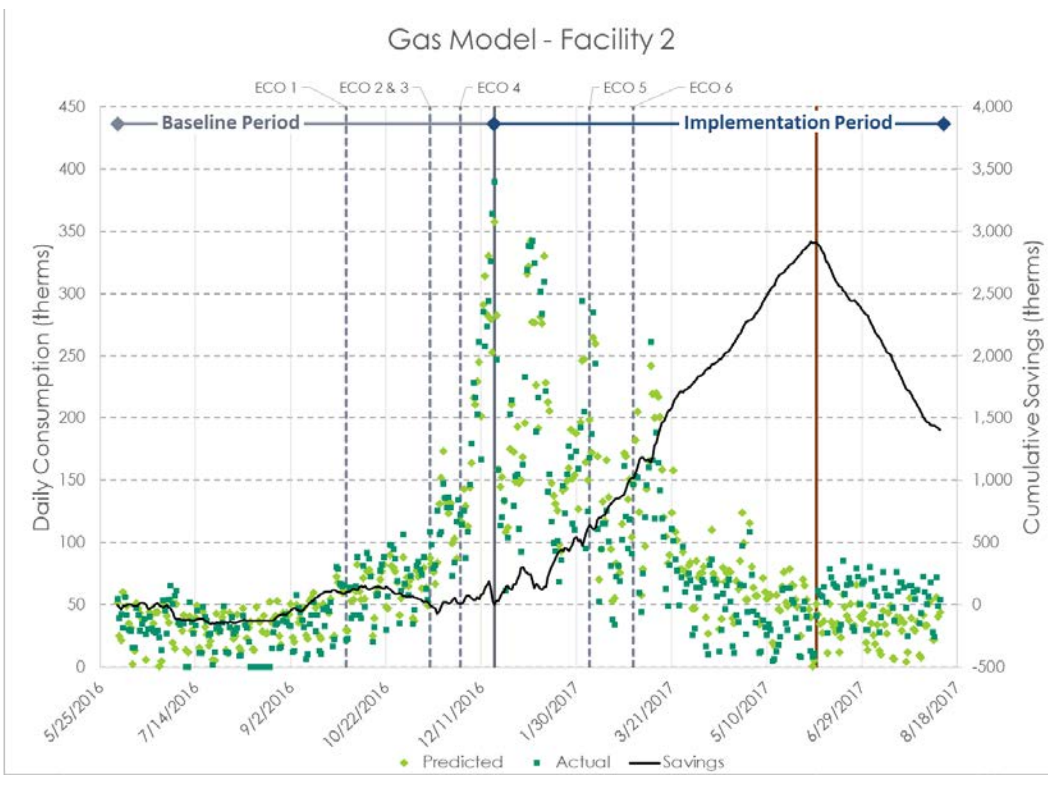


Figure 15: Gas model for Facility 2



The key energy drivers and the associated regression coefficients for the energy models for Facility 2 are given in Table 10. Seven key energy drivers have the strongest correlation to daily electrical and gas consumption, in addition to an intercept variable. The balance point temperature in the electric model is 49°F, and 43°F in the gas model.

Table 10: Energy drivers and coefficients for energy model for Facility 2

Key Energy Drivers	Regression Coefficients – Electric Model	Regression Coefficients – Gas Model
Monday	1470.13	3575.87
Tuesday	1652.21	2678.38
Wednesday	1745.08	2379.60
Thursday	1608.43	2086.51
Friday	1481.70	2674.54
Adjusted Temperature >BP	86.01	-151.96
Adjusted Temperature <BP	20.80	545.12
Intercept	*2154.88*	*5917.95*

With these coefficients, the electric energy model for Facility 2 is given in Equation 3 and the gas energy model in Equation 4. The correlation coefficient for the electric model is 0.94, and 0.93 for the gas model.

Equation 3: Electric model equation for Facility 2

$$\begin{aligned}\text{Daily kWh} = {} & 2154.88 + 1470.13 \times \text{Monday} + 1652.21 \times \text{Tuesday} + 1745.08 \times \text{Wednesday} \\ & + 1608.43 \times \text{Thursday} + 1481.70 \times \text{Friday} + 86.01 \times \text{Adjusted Temperature} > 49°\text{F} \\ & + 20.80 \times \text{Adjusted Temperature} < 49°\text{F}\end{aligned}$$

Equation 4: Gas model equation for Facility 2

$$\begin{aligned}\text{Daily therms} = {} & 5917.95 + 3575.87 \times \text{Monday} + 2678.38 \times \text{Tuesday} + 2379.60 \times \text{Wednesday} \\ & + 2086.51 \times \text{Thursday} + 2674.54 \times \text{Friday} + -151.96 \\ & \times \text{Adjusted Temperature} > 43°\text{F} + 545.12 \times \text{Adjusted Temperature} < 43°\text{F}\end{aligned}$$

The baseline period spanned from June 3rd 2016 to December 18th 2016. A full year baseline period would be ideal, but due to delays in meter installation, only a shorter baseline was available. Outlier points, caused by meter reading errors and faults in the data collection from the EIS, were removed from both the baseline and implementation periods.

Facility 2 saved 8% electricity and 6% natural gas as compared to the baseline projection. Facility 2's staff implemented a number of measures to achieve that savings. Unfortunately, some of that implementation happened before the completion of the baseline data collection. There wasn't sufficient data to build a baseline prior to the measure installation, so the energy saving total for this facility is depressed.

In addition to tracking savings achieved by a given facility, an energy model that updates in real-time can also perform a role in fault detection and diagnosis or supporting preventative maintenance. The project team experienced this situation firsthand with Facility 2. When examining the gas energy model for Facility 2, it is immediately apparent that an operational change was made around the beginning of June 2017, leading to increased gas use and is shown by the CUSUM line reversing direction. When the project team brought this issue to the attention of facility staff, the facility staff identified that during the period they had been attempting to correct issues related to high humidity. To do that, they temporarily overrode the supply air temperature reset sequence to provide cooler air at all times, instead of resetting based on zone demand. However, this "temporary" modification was never changed back, effectively disabling the reset sequence for much of the summer. This lead to increased reheat load in the facility in zones where cold air was not always needed. The energy savings model shows that over the summer that temporary setpoint adjustment cost the facility at least 1,500 therms of extra natural gas consumption (if no additional savings were accrued).

Facility 3

Table 11, Figure 16, and Figure 17 present the results of the on-going commissioning process for Facility 3. As mentioned previously, Facility 3 did not implement any RCx measures during the monitoring period. Facility 3 staff identified some measures they intended to implement, but nothing was completed during this implementation monitoring period. Part of this delay was caused because the facility staff expanded the scope of work to include a thorough rebalancing of the building HVAC system. This delay plus a lack of prioritization by the staff resulted in no implementation.

Table 11: Results of data collection and energy modeling for Facility 3

RCx Measures Implemented	Implementation Monitoring Period	Predicted Baseline Usage (during implementation)	Actual Usage (during implementation)	Savings % of Predicted Baseline (during implementation)
None	1-2 months Electric: 7/1/2017 – 8/13/2017 Gas: 6/1/2017 – 8/13/2017	606,705 kWh 22,887 therms	619,588 kWh 22,917 therms	-12,883 kWh (-2%) -29 therms (0%)

Figure 16: Electric model for Facility 3

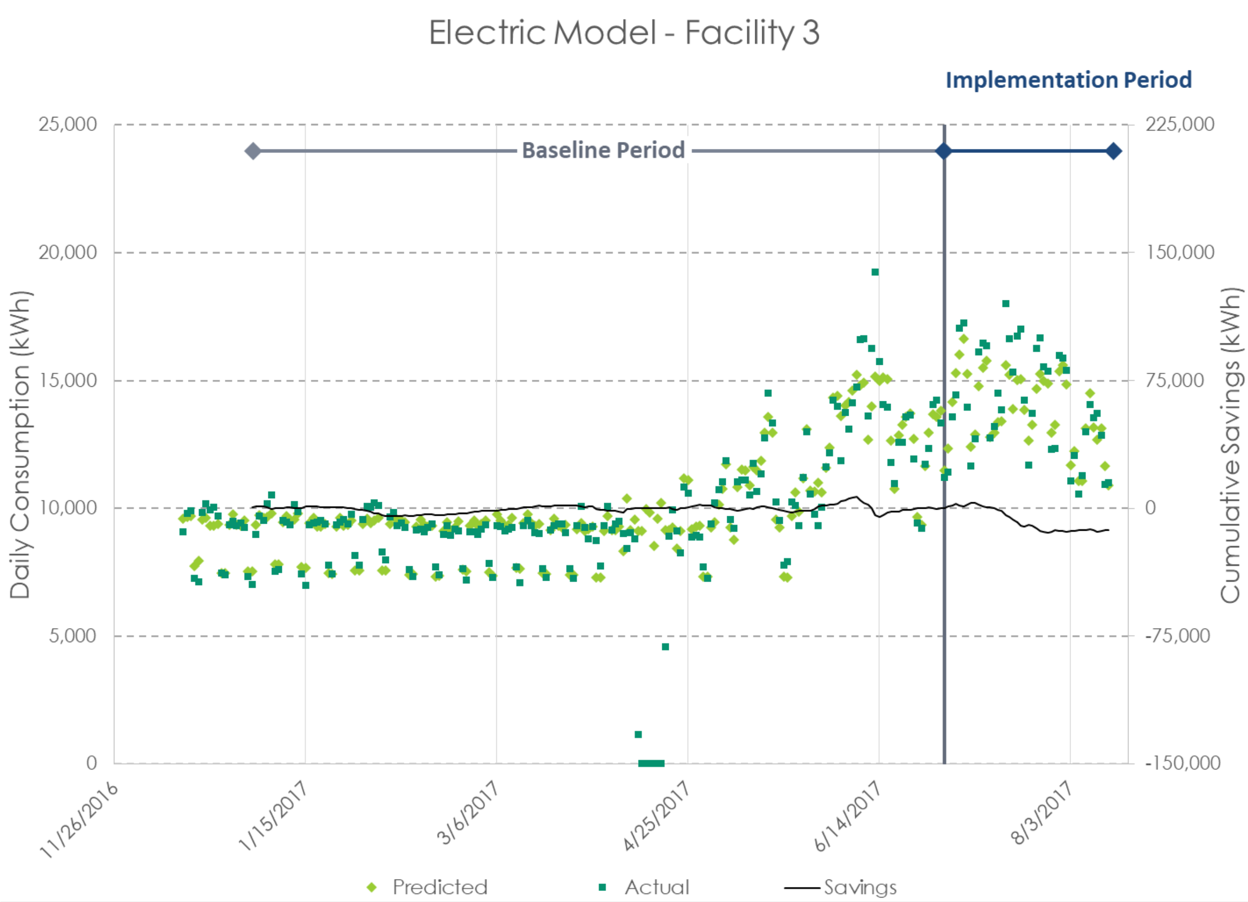
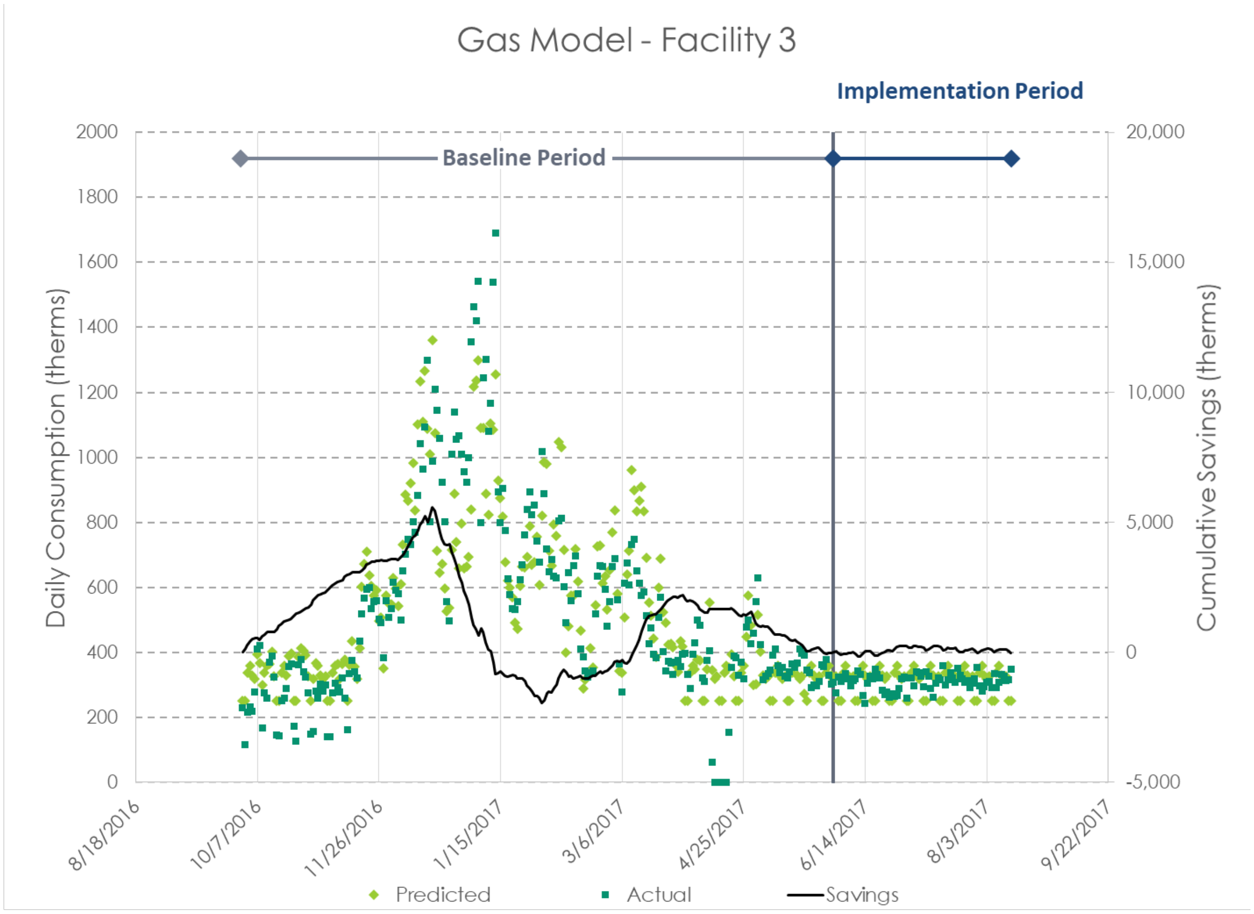


Figure 17: Gas model for Facility 3



The key energy drivers and the associated regression coefficients for the energy models for Facility 3 are given in Table 12. Seven key energy drivers have the strongest correlation to daily electrical consumption (in addition to an intercept variable), and only six are needed to correlate gas consumption. The balance point temperature in the electric model is 51°F, and 49°F in the gas model.

Table 12: Energy drivers and coefficients for energy model for Facility 3

Key Energy Drivers	Regression Coefficients – Electric Model	Regression Coefficients – Gas Model
Monday	1821.45	8566.06
Tuesday	2131.14	10911.05
Wednesday	1813.58	7799.63
Thursday	1810.00	6679.02

Key Energy Drivers	Regression Coefficients – Electric Model	Regression Coefficients – Gas Model
Friday	1933.92	7651.71
Adjusted Temperature >BP	231.90	-
Adjusted Temperature <BP	-10.72	-1826.83
Intercept	*7285.86*	*25112.74*

With these coefficients, the electric energy model for Facility 3 is given in Equation 5 and the gas energy model in Equation 6. The correlation coefficient for the electric model is 0.91, and 0.77 for the gas model.

Equation 5: Electric model equation for Facility 3

$$\begin{aligned}\text{Daily kWh} = {} & 7285.86 + 1821.45 \times \text{Monday} + 2131.14 \times \text{Tuesday} + 1813.58 \times \text{Wednesday} \\ & + 1810.00 \times \text{Thursday} + 1933.92 \times \text{Friday} + 231.90 \\ & \times \text{Adjusted Temperature} > 51°\text{F} + -10.72 \times \text{Adjusted Temperature} < 51°\text{F}\end{aligned}$$

Equation 6: Gas model equation for Facility 3

$$\begin{aligned}\text{Daily therms} = {} & 25112.74 + 8566.06 \times \text{Monday} + 10911.05 \times \text{Tuesday} + 7799.63 \times \text{Wednesday} \\ & + 6679.02 \times \text{Thursday} + 7651.71 \times \text{Friday} + -1826.83 \\ & \times \text{Adjusted Temperature} < 49°\text{F}\end{aligned}$$

The baseline period for the electric model spanned from January 1st 2017 to June 30th 2017, and from October 1st 2016 to May 31st 2017 for the gas model. A full year baseline period would be ideal, but due to delays in meter installation, only a shorter baseline was available. Outlier points, caused by meter reading errors and faults in the data collection from the EIS, were removed from both the baseline and implementation periods.

The lack of implementation does allow for a chance to check the validity of the energy model. If the model is performing as desired, zero projects implemented would equal zero change in energy consumption. In this case the model shows a negligible -2% change in electric consumption and no change in gas consumption.

Discussion and Conclusions

Below-Average Benchmarking

Outpatient medical facilities are poor energy performers. The benchmarking results in this study show that facilities in in the upper-Midwest use more energy than the national averages for the outpatient medical sector (as provided by ENERGY STAR and CBECS data). This sample population of ASCs consumed on average 33% more energy per year than the CBECS benchmark for the same climate zone. CBECS does not distinguish between ASCs and medical clinics, their data only separates outpatient and inpatient facilities. However, this project's sample of medical clinics still consumed 7% more energy on average than the CBECS population.

In addition, the energy intensity for these facilities nationally, seems to be trending the opposite direction of other commercial buildings. The most recent CBECS data showed a statistically significant improvement in their sample population of the average commercial building – led by performance in office and education sectors. Outpatient medical facilities are not keeping up with this trend. [21]

ENERGY STAR data for this sector is flawed and should be taken with a grain of salt. Most recently, ENERGY STAR has stopped providing ENERGY STAR certification for buildings in the medical sector because of their lack of confidence in the data. However, there is stark contrast between the performance of large commercial buildings benchmarked publically in Chicago (among other cities) and the data the project team collected on outpatient medical facilities. City-wide benchmarking efforts in Chicago show a *median* ENERGY STAR score for office buildings of 74 in 2015 and 79 in 2016. Medical facilities did improve, but scored far lower: 35 in 2015 and 41 in 2016.[22] That median data corresponds to the data collected in this study. The median facility benchmarked in this population was 16, whereas the trend in commercial building benchmarking shows that most buildings are scoring above average. The medical sector persistently scores below the 50% mark as a group.

Involving Contractors in Energy Management

One appealing aspect of the LBNL EMP approach is that it might attract a new set of energy service providers to identify energy efficiency measures to support customers in reducing energy use. In order to do that, LBNL provided a number of resources to help contractors develop the business case for their company. It's clear from discussions with the one contractor participating in this pilot that supporting their customers with energy manager services is already a part of their business model. They provide fast response when equipment and systems in the facility fail. They program and maintain advanced

[21] Data from the 2012 Commercial Buildings Energy Consumption Survey conducted by the U.S. Energy Information Administration, https://www.eia.gov/consumption/commercial/reports/2012/energyusage/index.php

[22] Data from the 2016 Chicago energy benchmarking report, https://www.cityofchicago.org/city/en/depts/mayor/supp_info/chicago-energy-benchmarking/Chicago_Energy_Benchmarking_Reports_Data.html

control platforms for technical pieces of equipment that provide all comfort and operational functions of the building. And they recommend advanced efficiency upgrades when appropriate for the customer. What they don't do well is quantify the specific opportunities for energy efficiency within a facility. This role, typically performed by an engineer or an energy auditor, hasn't fit with many contractor business models.

The LBNL EMP program sought to address the identification of specific energy efficiency opportunities for small commercial buildings by asking contractors to do some energy data collection and analysis, and then look in the building for opportunities. The intent here is good, but during this pilot research, the impact of those two aspects of energy management were lost in the hassle of collecting energy data and utilizing a tool that only identified a narrow set of opportunities.

Applied narrowly to medical clinics, it's not clear that there is the same market failure to serve this customer sector that occurs in other small commercial sectors. In food service or small retail, business owners frequently serve all their facility management functions. Those business owners are not experts in facility management and their utilities struggle to serve them because of their small size and small energy consumption. Contractors serving those small business segments might be the only contact for that business with knowledge of energy use and an ability to support their energy management. In comparison, the medical clinic sector is largely consolidated into large health care organizations. Expert facility managers oversee many buildings and supervise engineers, or at least qualified building operators, at each individual facility. Staff issues and funding may still be barriers, but access to information is not. Furthermore, utilities frequently provide deluxe programs for this sector because the organization overall is likely to be one of their larger customers.

Contractors could better serve this medical facility sector if they improved their use of data to understand and communicate about energy use in facilities, and if they had tools that allowed them to quickly quantify ROI of specific opportunities. Taking these steps could be a business opportunity for an entrepreneurial contractor, but a contractor would need to build it for themselves.

One last comment on this process is that health care facilities teams are, in general, understaffed to meet the opportunity for proactive energy management. Each of the facilities that participated in this project relied on contractors as partners to perform any major controls reprogramming or equipment installation. This means that contractors who work with medical facilities are already trusted energy partners, at times serving a role as a dedicated extension the facility team. One possible way to better serve this segment would be to more actively partner with the trade allies that service medical facilities. Utilities that want to better support these customers could increase efforts to partner with these contractors. Better education about rebates and programs is great, and in general happens to some extent already. A next step might be to equip trade allies (given the permission of the facility staff) with an energy report, or on-going monitoring of energy use, so that they could track the performance of any improvements they install on behalf of their customer and help interpret energy information to the customer.

On-Going Commissioning via an EIS

On-going commissioning helps facilities managers tweak implementation, find new opportunities, and show results to staff and leadership. This process relies on access to real-time energy data, which in this pilot was enabled by the Alerton Energy Manager EIS. Post-implementation measurement and verification (M&V) can be conducted by a third party at any point after implementation, but true "on-going commissioning" needs to happen via frequent touchpoints with the data. Facility staff need to develop a sense for baseline energy use, pay attention to facility performance, and make adjustments.

In this project, the level of engagement from the facility managers with their EIS did not meet the expected mark for "on-going." Facility managers for facilities 1 and 2 admitted to never logging into the EIS except for during the training session. Both of those facilities managers use other tools (a spreadsheet and EnergyCAP, respectively) to review their energy use. Both managers are responsible for a large number of facilities. They commented that a tool that only reports on one facility's use wasn't helpful enough for them. Facility 3's manager did log into the EIS a few times, but as is mentioned in the previous section, he did not implement any energy efficiency measures in that facility. He is in a situation where the majority of his time is spent on a large campus of facilities and very little time is spent at this facility in this study. He values the idea of energy monitoring on the remote facility and would like to see some solution work for him.

Part of the issue may be the specific EIS selected for this pilot project. The features of this tool are not as robust as other products on the market. A tool with more flexible features like project tracking, native M&V, data analysis, and reporting might win repeat visits from these extremely busy professionals. EIS, like any consumer software, get compared to Google and Facebook's very user friendly interface, which raises the bar for programming. Additionally, there were quite a few issues with data reliability, caused by meter reading errors and faults in the data collection from the EIS, which resulted in gaps in data.

Finally, delay kills momentum. From the initial kick-off of this project, it took over 12 months for some facilities to get their pulse meters installed and the EIS live. Then, in turn, facilities managers were not always able to move quickly on project implementation, and as evidenced by Facility 3, some never succeeded. These delays push the project to the back of facility managers' minds and can hurt the impression from facility managers that these tools are going to help them and make their lives easier.

From a strict M&V function, the EIS served its purpose of data collection (with the exception of some gaps in data). But, all of the M&V math functions (identifying variables that drive energy consumption, producing a regression, and graphing the CUSUM) happened outside of the EIS in a spreadsheet. Facility managers commented that they appreciated the visual display of the CUSUM chart – but as a static chart displayed months after implementation, it had severe limitations. The EIS needed to provide this kind of data analysis immediately and automatically to truly support on-going commissioning.

A Perfect Case Study

Facility 2's waste of energy because of a small setpoint adjustment provides a phenomenal case study. Facilities who use a sophisticated EIS on an on-going (daily or weekly) basis can shift energy performance to another level. In this case, to solve a humidity problem in the building, the facility staff decided to adjust the system to run off the highest call for cooling, rather than the average call of all temperature zones. Since at least one zone in the building is always calling for cooling, that meant the supply air was overcooled and then reheated so the space temperature was comfortable. The humidity problem was solved, and building occupants didn't notice because the space temperature was being met.

As is human nature, the facility staff forgot to adjust the setpoint back. As a result, the building operated like this for many months, until the gas use for the building was scrutinized during a meeting to discuss the RCx implementation and to review the CUSUM graph for the facility. In this case, the cost to the building was at least $1,500 of wasted natural gas for reheating and some amount of electricity. The specific costs of this situation are less relevant than the opportunity to prevent that kind of error in the future.

Facility 2 is run by an extremely smart and capable facility manager, who knows energy use and how to efficiently manage buildings. Not all commercial buildings can claim to have as talented a staff leading energy efficiency. This facility manager frequently told the project team that a major part of his job is telling a good story to corporate leadership to get them engaged in paying for energy upgrades. In order to complete projects in competitive environments, a facility team needs data to quantify impacts and show results of their past work. When he saw these results, he immediately knew that there was an interesting story to tell leadership about how to improve energy management in his facility.

Finally, one more lesson learned in this case study, is that no computer system replaces some good-ole cajoling by another human being. Without the EIS, the facility manager probably would have caught this specific instance of energy waste, if he had been prompted to look. Extremely busy staff don't have spare time to look for possible issues when they know about so many real issues. A fault diagnostic and detection type feature could possibly fix this – but most facility managers are unwilling to receive hundreds of emails about the oddities of their building. So, the alternative might be more human oriented. By hiring an energy manager, or developing an energy team, and setting goals for performance and projects, people will be reminded to take a look at energy performance and track down possible faults. These kinds of steps form the basis of strategic energy management programs that utilities increasingly offer for their customers.

Recommendations

As a result of this research, there are a few key conclusions.

1) The comparison of building benchmark data shows that Minnesota's outpatient health care market may contain untapped potential for energy efficiency. In addition to the benchmark data, the facility studies conducted during this research, found that all the facilities had opportunity to save energy with cost-effective measures.

2) Surgical suites, with their specific demands for humidity and fresh air, present opportunities for strategic energy reduction. As a result of this research, protocols have been developed with the Minnesota Department of Health. As of publication of this report, the required form for relative humidity reduction is available on its website[23], and the letter for ventilation adjustments in the process of being published. Copies of these forms are also included in Appendix C and Appendix D.

3) Data-based on-going commissioning can play a role in improving facility performance. The technology to implement this strategy via an EIS exists and is affordable.

4) Data is not a panacea. Access to data was not enough during this pilot to motivate engaged use of data. And raw data without analysis is not valuable to facility staff. Vet EIS tools carefully before selecting one. EIS companies should be able to demonstrate the features in advance. Be aware that installation and tuning of the EIS can take quite a long time, perhaps as long as a year.

5) Organizations need to pair an EIS with a holistic approach to managing energy. Facilities need to make a commitment to managing energy, set goals, assign staff to the task, and then use the EIS tool to track outcomes and conduct on-going commissioning. Without this strategic commitment to energy efficiency, the data collected in an EIS will be neglected.

Energy Management in Health Care

Barriers and Competing Priorities

Within the outpatient medical facility sector, ambulatory surgical centers in particular have other priorities competing with energy management. The surgical areas in ASCs have strict air change, humidity, and pressurization requirements that restrict the operation of energy-using equipment serving the spaces during occupied hours. Users of those spaces – surgeons, nurses, and other medical staff – also have specific comfort preferences to perform their tasks. Tight control of occupied temperature

[23] MN Department of Health, Engineering Services Checklists and Waivers, http://www.health.state.mn.us/divs/fpc/engineering/documents.html

setpoints in surgical suites requires oversized equipment with high controllability. These requirements often edge out energy efficiency.

Beyond operational characteristics of medical facilities, management priorities are not focused on energy efficiency. Throughout discussions with facility staff and managers, the project team realized that facilities are not only constrained by operational requirements, but by financial considerations as well. Organization leadership typically views energy spend as a fixed operating cost, and not an area for investment or improvement. Capital improvements and facility upgrades for mechanical and electrical systems are often driven by ageing equipment, or outright passed over to meet business operation needs. Facility staff are not empowered to make energy efficiency a top priority. Too often their time is consumed by daily maintenance and repair tasks at multiple facilities, with little time left to pay attention to energy use on a weekly or even monthly basis.

Despite these challenges, efficiency opportunities exist throughout the sector. Aforementioned lighting upgrades, reductions in operation of HVAC for non-critical spaces, and novel HVAC setbacks for surgical areas lead to significant energy savings for outpatient medical facilities. The key factor becomes not identifying opportunities for these facilities, but communicating benefits and encouraging a culture of implementation and continuous improvement. Success in this sector requires approaches that build a culture of energy leadership in organizations.

Energy Efficiency Opportunities in Surgical Suites

Because they consume high amounts of energy, surgical suites represent one of the best energy efficiency opportunities in ASCs. However, surgical spaces also produce much of a facilities revenue and profit, are governed by more than just energy code, and are occupied by highly paid experts, who can be demanding about the space conditions in which they work. This makes energy efficiency very complicated. Just because an energy-based justification can be presented does not mean a measure will be successful. One unexpected condition was the storage of surgical supplies, which often require a specific humidity by the manufacturers. If one sterile bandage requires 40% RH, all the surgical spaces in that area must be kept at 40% RH.

Nevertheless, relative humidity and ventilation reduction for surgical suites presents an excellent opportunity for energy saving. Both measures are worth pursing in any ASC and even many low-occupancy hospitals. Energy savings can be fairly significant, around 15,000 kWh and 10,000 therms assuming 80% efficient gas steam boilers for humidification and a 5,000 square-foot surgical area. With potentially low cost to implement depending on the existing control system and ventilation setup, payback can be quite fast. Implementing these measures can be done by following the MDH recommendations.

Waiver Publication from the MN Department of Health

The project team discussed the two topics presented in the ASC Regulatory Requirements section with the Minnesota Department of Health (MDH) – namely, air change rates during unoccupied hours and humidity requirements for surgical suites. The regulatory environment for ambulatory surgical centers in in Minnesota is less straightforward than for medical clinics and hospitals. Many of the statutes that apply to hospitals do not directly apply to ASCs. Specifically, certain waiver processes laid out for hospitals (section 144.6535 of the Minnesota Statutes) are not in place for ASCs. The project team and MDH came to conclusions about how both measures could proceed and meet regulatory requirements.

The Minnesota rules for ASCs do not specify that air change rates are required at all times. ASHRAE 170 notes that, during unoccupied times, air change rates can be reduced so long as pressure relationships are maintained. Based on conversations with MDH, the Engineering Services section will publish a "notification letter" for ASCs to submit if the facility plans on reducing air change rates for surgical suites during unoccupied hours. A notification letter was developed to ensure that facility staff understand that pressure relationships between surgical and adjacent areas must be maintained at all times, as required by ASHRAE 170.

Regarding humidity level reduction, a "request for equivalency" will also be published by MDH. ASCs considering reducing humidity levels in surgical spaces can use the request in the same manner as a waiver for hospitals. The request document will be required as relative humidity is specifically controlled by Chapter 4675, section 1600 of the *Minnesota Statutes*.

Drafts of both letters are included in Appendix C and Appendix D.

Utility Program Recommendations

Given the potential for energy efficiency, health care sector needs and opportunities must be considered in the design and implementation of energy efficiency programs. However, dedicated programs for the sector are probably not necessary. ASCs can be well served in programs designed for all commercial customers. Some end-uses are unique, like MRIs and operating rooms, but programs like recommissioning and custom efficiency will be able to capture those savings opportunities.

The LBNL EMP approach for small business energy efficiency has some strengths, but based on this pilot it doesn't seem likely to take off among contractors serving the medical sector. Nor is there a specific un-met need among medical clinics. These facilities are more sophisticated energy users than the program was designed to serve. Clinics are also usually part of a larger network and have access to knowledgeable staff and resources beyond the norm for small businesses.

Since initiating this pilot study, a large utility in Minnesota launched an EIS program pilot that covers many of the recommendations of this report. The pilot program includes an emphasis on strategic energy management so that the customer has organizational support for using the EIS. The program pre-qualifies EIS vendors to ensure that the tools can provide necessary analysis. The program also offers consulting support so that customers have a supplemental source of energy analysis, coaching, and project tracking.

One barrier in this pilot was access to data and speed of meter installation. Both of those elements delayed parts of this study. Utilities could support customers by making access to interval data the default. One solution to this problem would be installation of advanced metering infrastructure (AMI). Fortunately, the largest of the state's utilities do plan to install AMI in the near future.

As that data becomes more accessible, utilities should not assume that the presence of the data alone will be sufficient to save energy. In reality, in this program, most facilities did not look at their data without project team prompting. And leveraging insight from the data took additional support. So, utilities considering an on-going commissioning oriented program, should be sure to include help for the customer in learning how to manage energy as an organization. That means learning how to utilize an EIS, but it also means learning how to create management structure around their use of energy. Development of leadership within the customer to create and achieve energy objectives, coupled with access to and analysis of data will produce the best results.

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Appendix A: LBNL EMP Fact Sheet

BERKELEY LAB
Environmental Technologies Area

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Energy Management Package Demonstration Factsheet

The Package

While buildings smaller than 50,000 square feet account for nearly half of the energy used in US commercial buildings, energy efficiency programs to-date have primarily focused on larger buildings. Interviews with stakeholders indicate interest in energy efficiency from the small commercial building sector, provided solutions are simple and low-cost. In this approach, HVAC contractors deliver energy management services to small commercial buildings as part of service contract offerings. The energy management package (EMP) developed includes five technical elements: benchmarking and analysis of monthly energy use; analysis of interval electricity data (if available), a one-hour onsite walkthrough, communication with the building owner, and checking of results. This data-driven approach tracks performance and identifies low-cost opportunities, using guidelines and worksheets for each element to streamline the delivery process and minimize the formal training required. This energy management approach is unique from, but often complementary to conventional quality maintenance or retrofit-focused programs targeting the small commercial segment.

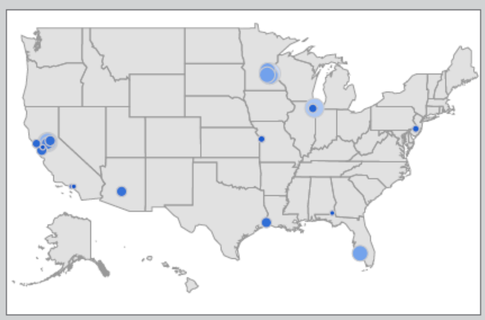
The Business Model

The Energy Management Package is designed to be delivered by HVAC contractors as part of a maintenance contract. Because HVAC contractors already serve small commercial clients, the transaction cost to market and deliver energy management services can be reduced to the order of hundreds of dollars per year by adding this service to conventional offerings. This business model enables the offering to benefit the contractor and client even at the modest expected energy savings in small buildings. Results from a small-scale pilot of this approach validated that the EMP could be delivered by contractors in 4-8 hours per building per year, and that energy savings of 3-5% are feasible through this approach.

The Demonstration

The 2014 demonstration of the Energy Management Package was designed to refine the business model for the package: specifically, to validate whether contractors and their clients find value in this offering. 16 partner contractors nationwide identified a total of 24 sites for the demonstration. Sites included office, retail, food service, and food sales buildings, ranged from 2,000 to 49,000 square feet and totaled over 400,000 square feet.

The majority of demonstration sites are owner occupied, which was preferred, with the remainder having a single tenant. A number of contractors chose to include their own office buildings as demonstration sites to pilot the EMP.



Demonstration sites identified by partner contractors. Circle size scales with building floor area.

1

Energy Management Package in Action

Economics of the Business Model

Benefits to the contractor include:

- Value-add to service contracts
- Differentiation relative to competitors
- Strengthen customer relationships
- Credibility
- Additional service/labor opportunities

Benefits to the customer include:

- 3-5% energy savings
- 200-900$ annual utility cost savings

Contractor Experiences

"This has been a great learning experience. In the beginning, it was hard to attract a customer. Now I am utilizing energy saving opportunities for every customer I am involved with, which has also helped our customers.

I've noticed the energy usage has skyrocketed in the last month, month and a half at the building that I've been monitoring, so I've now had to actually go and find out what's going on, because it's almost doubled in the last month and a half. So I have a tech scheduled to go check that out and I'll find out next week. The energy use now is the highest it's been in the last three years: last year at the same time frame was way lower. So something's going on, we just have to figure out what's going on. I know a new unit was put in around December, and it brought the energy usage down a little bit, but we have to figure out what's going on with the equipment so that I can move forward and figure out which measures to implement.

Interval data visualizations used to identify chiller schedule problem

One partner contractor used heat map visualizations of interval data to identify that the chiller was running each weekend. Note how the load is somewhat elevated all weekend, and then during the week shuts down each evening.
This visualization was available as part of a web-based tool provided by the local utility. Heat maps provide a quick way to identify patterns in interval data that may correspond with equipment scheduling or setback issues.

2

Demonstration Findings

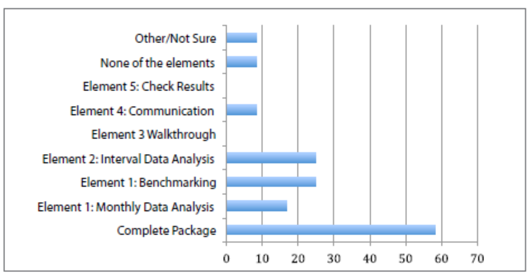
Demonstration Progress

Of the initial 16 recruited contractors, 4 remained highly engaged with the program over the course of the demonstration while 4 others were moderately engaged. Of the highly engaged contractors, two groups stood out: individuals who served as energy efficiency specialists within larger HVAC firms, and individuals in small firms who had high personal interest in energy efficiency. Factors reported for slow progress included: high summer business load, and difficulty generating interest from clients, difficulty accessing data, and difficulty prioritizing demonstration action items over daily urgent issues.

To provide technical advice and peer learning opportunities, the LBNL team offered 5, 60-90 minute workshops by web-conference. Participation in the workshops was strongly correlated with progress at sites.

Value to Contractor Partners

To gain insight into the experiences of partner contractors in the demonstration, a web-based survey was conducted, and initial results are based on 12 responses. Overall, the feedback has been positive, with strongly favorable feedback from highly engaged partners.

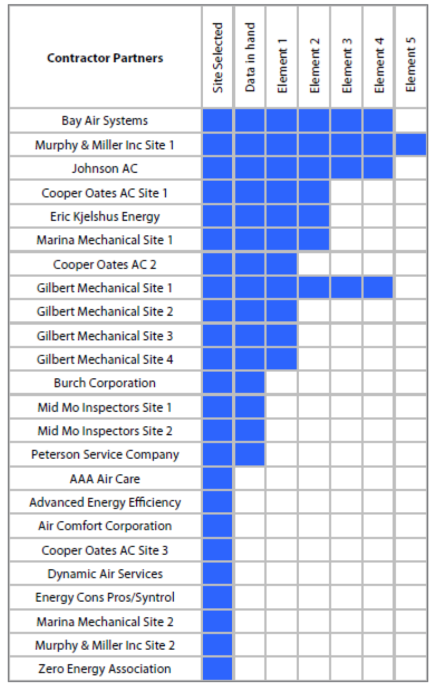


Which components of the package do you plan to offer in the future?

When asked how they agreed with the statement "Offering the package was worth the effort," 5 said they strongly agree, and 4 were neutral, 2 agree and 1 had no opinion

5 respondents strongly agreed that offering the package strengthened their relationships with their customer, and 3 were neutral.

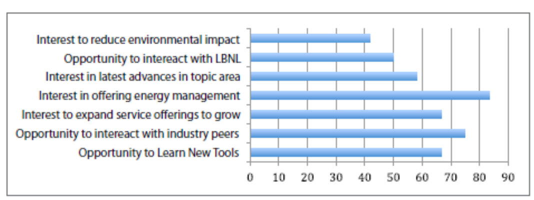
75% of respondents rated the quality and utility of Energy Management Package materials as 'high' or 'exceptional'.



Participating contractors.

"I think for me a lot of [the EMP] dovetails with things that I have been doing with benchmarking and monthly utility bill analysis but it formalizes it, and puts it all together in one place. It has a nice flow to it, it's putting a lot of resources together in one place, and then brings in the interval data analysis piece which wasn't always top of mind… So this is definitely something that I will continue to be interested in and continue to use."

Demonstration Partner Contractor



What attracted you to participate in the program?

EMP: Looking Ahead

Fall and Winter 2014:
Completion of contractor demonstrations

Spring and Summer 2015:
Continue facilitating owner-driven market pull through collaboration with the 2030 Commercial Districts and associated Small Commercial Toolkit, and publish findings in the efficiency literature.

Winter 2014-2015:
Dissemination of final findings in webinars and contractor training courses in collaboration with the 2030 Commercial Districts.
http://www.2030districts.org/

Find Out More About the EMP

Download the Energy Management Package with instructional guidance and worksheets, and access project overviews and associated slide decks: http://eis.lbl.gov/smallcomm.html

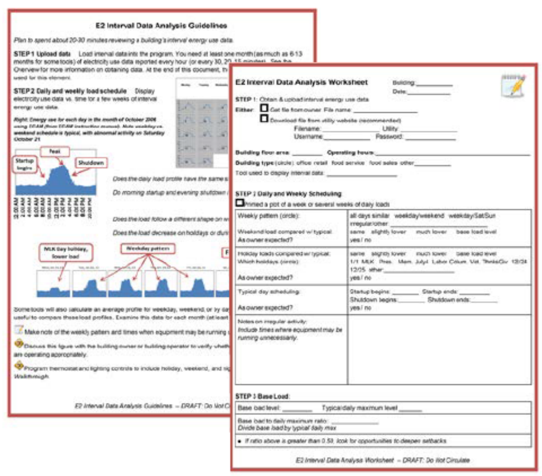
Read the business model document to get an overview of the value proposition to contractors and customers: http://eis.lbl.gov/pubs/emp-business-model.pdf

Read more about the EMP development effort, and 2014 Demonstration: http://eetd.lbl.gov/news/article/58166 berkeley-lab-develops-kit-to-he

Access a short article on the EMP, published in the Journal of RSES, "The HVACR Training Authority™": http://www.rses.org/journal.aspx

Find the introductory training presentation here: http://eis.lbl.gov/pubs/emp-training-11-13-2014.pdf

Access the Small Commercial Toolkit from the 2030 website here: http://www.2030districts.org/small-commercial-toolkit-login



For more information contact members of the Berkeley Lab team:

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BERKELEY LAB
Environmental Technologies Area

4

February 2015
15-EE-1458

A copy of this Energy Management Package Demonstration Factsheet is available on LBNL website (http://eis.lbl.gov/pubs/emp-factsheet-02-2015.pdf)

Appendix B: Full LBNL Questionnaire

E3 Walkthrough Worksheet

Building:__________________ Date:__________

Facility contact name: _______________

Phone: _______________

Building operating hours:

Weekdays _________ to __________

Saturday: _________ to __________

Sunday: _________ to __________

STEP 1 Overview

List major energy consuming equipment in this building:____

	If issues were highlighted in:	Pay special attention to question number:
	E2 Step 3: High evening / weekend / base load	1, 5, 6, 7, 8, 11c, 11e, 12 (office), 13 (kitchen)
	E2 Step 2: Load schedule does not match occupancy schedule	8, 11a, 13 (kitchen)
	E2 Step 5: High peak, daytime loads	11b, 11d, 9
	E1 Step 5: High seasonal variability	10

Questions in **bold** below are the typically the most important to assess.

STEP 2 Look for these items throughout the building

#	Description	Yes	No	NA	Corrective Action / Comments	Solved?
1	**Are occupancy sensors installed and working? Are they placed appropriately?** Consult manager / occupant about functioning.					
2	**Are incandescents or T12 fixtures present?**					
3	Are fans or portable space heaters being used?					
4	Are radiators and air vents unobstructed?					

STEP 3 Consult with manager and/or occupants about these items

#	Description	Yes	No	NA	Corrective Action / Comments	Solved?
5	**Are employees trained in energy conservation measures?** Consult manager.					
6	**Are doors/windows kept closed during heating and cooling season?** Consult manager / occupant.					

E3 Walkthrough Worksheet -- DRAFT: Do not Circulate

7	Are computers and monitors set to sleep or off at night? Consult manager / occupant.					
8	Are lights scheduled? (time-based on/off control)? Consult manager.					
9	What is the most common HVAC complaint? Consult manager.					

STEP 4 Check specific equipment

#	Description	Yes	No	NA	Corrective Action / Comments	Solved?
10	Are vending machines set to turn off/sleep at off hours?					
11	**Are thermostats programmed? (see 8a-8e)** **Are thermostats manually setback during off-hours?**					
11a	Does the setback schedule match occupancy schedule?					
11b	Is heating setpoint for occupied hours 70°F or lower?					
11c	Is heating setpoint for off-hours 62°F or lower?					
11d	Is AC setpoint for occupied hours 75°F or higher?					
11e	Is AC setpoint for off-hours 78°F or higher?					
12	**Office: Are copy machines, printers & fax machines shut off at the end of the day?** Consult manager or occupant.					
13	**Kitchen: Do you have a start-up/shutdown schedule for all equipment?** **Is equipment running or idling longer than necessary?** Consult manager or occupant.					
14	**Kitchen: Is there a service maintenance schedule?** Consult manager.					
15	Kitchen: Are dishwashers only run when full? Consult occupant.					

E3 Walkthrough Worksheet -- DRAFT: Do not Circulate

Appendix C: Relative Humidity Request Documentation

Minnesota Department of Health
ENGINEERING SERVICES SECTION

Equivalency for 20% Relative Humidity in an Anesthetizing Location

FOR AMBULATORY SURGERY CENTERS

Enter Date

Enter Facility Administrator Name
Enter Facility Name
Enter Facility Address
Enter City, State, Zip

HFID #Enter HFID Number

This document is an equivalency for MN Rule 4675.1600, subp. 1, regarding the requirement that operating rooms and recovery rooms maintain 50 to 60 percent relative humidity. This waiver permits the facility to maintain a minimum 20 percent relative humidity (RH) in anesthetizing locations.

Survey & Certification (S&C) Letter: 13-25-LSC & ASC was issued by the Centers for Medicare & Medicaid Services (CMS) in response to concerns expressed by health care institutions relating to infrastructure maintenance associated with maintaining the higher level of relative humidity. This S&C letter set the minimum humidity standard at 20%. Review by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), based upon input from health care institutions, indicates that maintaining a relative humidity level over 20 percent is unduly burdensome. Maintaining relative humidity at 35 percent or more may result in:

1. Degradation of HVAC systems due to high relative humidity in supply, return, and exhaust air,
2. Degradation of exterior wall and roof assemblies due to higher levels of relative humidity present within the building envelope, and
3. Degradation of building fenestration due to condensation.

In 2009, ASHRAE incorporated the new 20 percent minimum humidity standard in Addendum “d” to ANSI/ASHRAE/ASHE Standard 170-2008.

WAIVER FOR EQUIVALENCY FOR 20% RELATIVE HUMIDITY IN AN ANESTHETIZING LOCATION FOR AMBULATORY SURGERY CENTERS

On February 20, 2015, CMS published a subsequent memorandum (“S&C: 15-27-Hospital, CAH & ASC”) advising that some supplies and equipment used in operating rooms may require minimum relative humidity of 30 percent. CMS notes that manufacturers are working to provide such supplies and equipment that can function at lower humidity levels, though this change will take time. Therefore, it is the responsibility of the ambulatory surgical center to understand and certify that the relative humidity levels maintained in its operating rooms is compliant with the instructions for use (IFUs) for all supplies and equipment located therein. In submitting this request for equivalency determination, this ambulatory surgical center facility certifies that all equipment and supplies used and stored in the operating rooms are compatible with a minimum relative humidity of 20 percent.

This ambulatory surgical center facility must keep this signed equivalency on record and available to provide to surveyors. This ambulatory surgical center facility also will monitor relative humidity in anesthetizing locations to ensure that it remains at or above 20 percent.

The signature of the facility’s administrator on this document constitutes acceptance of all conditions and limitations associated with this equivalency. This waiver will remain in effect indefinitely; however, all equivalencies are subject to review as deemed necessary by the Department. Please remember that all alternative measures or conditions attached to a variance or waiver shall have the force and provisions of Minnesota Statute. The period of time for correction and the amount of fines specified for the particular rule for which the equivalency was requested, shall apply.

____

Signature of Facility Administrator

Enter Facility Administrator Name
Enter Facility Name

For MDH Use Only:

This waiver is approved, approved with conditions or denied as indicated below:

Recommendation: _________________________ on ___/___/_____ □ Approval □ Approval w/conditions □ Denial

Final Action: _________________________ on ___/___/_____ □ Approved □ Approved w/conditions □ Denied
Manager, Engineering Services

Reasons for denial or conditions of approval: ____

____

____

____

Note: Please be aware that this waiver is subject to review as deemed necessary by MDH to prevent adverse effects on the health and safety of residents and personnel in the facility.

Appendix D: Ventilation Request Documentation

Facility logo goes here

Enter date

Mr. Robert Dehler, P.E.
Engineering Program Manager
Engineering Services Section
P.O. Box 64900
St. Paul, Minnesota 55164-0900

Re: Letter of Notification for Ventilation Setback of Ambulatory Surgical Centers **HFID #Enter HFID Number**

Enter Facility Name
Enter Facility Address
Enter City, State, Zip

As the administrator of the Ambulatory Surgical Center (ASC) listed above, I hereby submit a letter of notification of proposed ventilation scheduling changes. We intend to implement a HVAC setback strategy during unoccupied hours in our operating rooms in the ASC. However, pressure relationships in all rooms will be maintained at all times. We have hired a mechanical engineer (HVAC) to assist in the mechanical design to implement the setback strategy during unoccupied times to comply with current design considerations.

The full number of air changes will be re-established anytime the space becomes occupied. The proposed unoccupied period will begin a minimum of one hour after the building is completely vacated, and end a minimum of an hour prior to initial building occupancy. We have available balance reports for the HVAC system during occupied times and unoccupied times. Those balance reports show the pressure relationship and air changes are met during occupied hours and pressure relationships are always maintained.

Enter Facility Name will maintain written documentation that this letter of notification has been submitted to the Engineering Section of the Minnesota Department of Health. This ambulatory surgical center will continue to monitor air changes and pressure relationships to ensure compliance with MN Rule 4675.2800 for the ambulatory surgery center during occupied times. We will also monitor pressure relationships at all times. Our policy to set back the ventilation during unoccupied times will be reviewed annually by the facility and will take into account the following factors (at a minimum):

- Staff Usage
- Existing Conditions
- Air Change Rate
- Pressure Relationships
- Temperature Requirements
- Humidity
- Particulate Control
- User Needs and Interface Options
    - Time Schedule
    - Occupancy Sensors
    - Manual Switchover
    - Combined Control Methods

The following table indicates three things:

1. The hours the facility is open to the public
2. Current HVAC operating hours at full air change rate
3. Proposed HVAC operating hours at full air change rate

Enter Facility Name							
Surgical Suite HVAC, Ventilation Design and Weekly Schedule of Operation							
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Building Occupied Hours							
Current HVAC Full Operation							
Proposed HVAC Full Operation*							

* Must be one hour prior to first building occupancy, and one hour after building is completely unoccupied.
Example:

- Building is occupied 8 AM-5 PM Monday-Friday
- Current HVAC full operation is 24/7
- Proposed HVAC full operation is 7 AM-6 PM Monday-Friday

This ventilation schedule change will remain in effect until voluntarily withdrawn by this ambulatory surgical center facility, or until such time that a revision is necessary based on more up-to-date design standards. If you have any questions concerning our policy, please contact Enter name of knowledgeable staff at Enter phone number.

Please contact us if we may be of further assistance.

Sincerely,

____

Signature of Facility Administrator

Enter Facility Administrator Name
Enter Facility Name

Appendix E: Measure Lists for Audited Facilities

Recommissioning Studies

Table 13: Facility 1, ASC, 56,803 square feet

Measure	Electric Savings (kWh)	Gas Savings (therms)	Annual Energy Savings
AHU-1 Runtime Reduction	50,889	4,580	$5,568
AHU-2 Runtime Reduction	31,126	2,020	$2,964
SF-1 Runtime	86,708	5,460	$8,155
AHU-1 Unoccupied Setback	3,347	140	$273
AHU-2 Unoccupied Setback	2,486	110	$207
SF-1 Unoccupied Setback	3,246	3,450	$2,154
AHU-1 SA Reset	2,756	2,400	$1,527
AHU-2 SA Reset	1,995	1,740	$1,106
SF-1 SA Reset	0	5,950	$3,391
AHU-1 Humidification Reduction	6,927	0	$416
AHU-2 Humidification Reduction	5,016	0	$301
Lighting Retrofit	31,380	0	$2,510

Table 14: Facility 2, ASC, 82,095 square feet

Measure	Electric Savings (kWh)	Gas Savings (therms)	Annual Energy Savings
AHU-1 Runtime Reduction	146,198	5,972	$8,814
OA Optimization	557	-1,120	-$619
SA Temp Reset	0	540	$308
AHU VAV Minimum Flow Reduction	-238	50	$911
Chilled Water Supply Temperature Reset	47,676	0	$2,793
Humidification Reduction	103,679	0	$3,764
Chiller VFD	158,651	0	$10,491
Power Factor Correction	0	0	$0

Table 15: Facility 3, ASC, 135,000 square feet

Measure	Electric Savings (kWh)	Gas Savings (therms)	Annual Energy Savings
Update HVAC Schedules & Controls	140,869	38,380	$44,035
Humidification Reduction	5,000	3,000	$2,700
Hot Water Pump VFD Controls	10,000	0	$400
Lighting Retrofit	52,920	0	$4,000

ASHRAE Level II Energy Audits

Table 16: Facility 4, ASC, 45,706 square feet

Measure	Electric Savings (kWh)	Gas Savings (therms)	Annual Energy Savings
Replace Exterior Lighting with LED Fixtures and Lamps	6,400	0	$580
Replace Common Area and Patient Room Lighting with LED Lamps	25,000	0	$2,300
Implement Scheduling Controls for RTUs Serving Clinic and Radiology Areas	73,000	1,600	$7,700
Install VFDs and Reduce Ventilation for Surgery Suites During Unoccupied Hours	63,000	2,900	$7,700
Reduce Ventilation for Level 1 During Unoccupied Hours	44,000	3,800	$6,600
Implement Scheduling Controls for VAV RTU	11,000	1,400	$1,900
Replace Steam Humidifiers with Atomizing	27,000	4,400	$5,500

Table 17: Facility 5, ASC, 67,334 square feet

Measure	Electric Savings (kWh)	Gas Savings (therms)	Annual Energy Savings
Replace Exterior Lighting with LED Fixtures and Lamps	39,000	0	$2,300
Replace Patient Room Lighting with LED Lamps	20,000	0	$2,600
Replace Common Area Lighting with LED Lamps	34,000	0	$3,000
Install Lighting Occupancy Sensors in Patient Exam Rooms	3,900	0	$230
Reduce Scheduled Hours for First Floor HVAC	21,000	200	$1,300
Reduce Unoccupied Ventilation for Surgery Center	68,000	2,100	$5,600
Reduce Unoccupied Ventilation for Extended Care Suites	29,000	600	$3,200

Table 18: Facility 6, Medical Clinic, 49,050 square feet

Measure	Electric Savings (kWh)	Gas Savings (therms)	Annual Energy Savings
Replace Exterior Lighting with LED	5,200	0	$360
Retrofit Common Area Light Fixtures with LED Lamps	20,000	0	$2,600
Install Lighting Occupancy Sensors for Common Areas	6,100	0	$430
Install Energy Management System to Control HVAC Equipment	41,000	8,700	$9,400
Install VFDs on AHU Supply Fans	120,000	0	$10,000
Replace Standard Water Heaters with High Efficiency Units	0	100	$100

Table 19: Facility 7, Medical Clinic, 31,400 square feet

Measure	Electric Savings (kWh)	Gas Savings (therms)	Annual Energy Savings
Replace exterior lighting fixtures with LED	23,000	0	$1,600
Replace common area T8 with LED	27,000	0	$3,300
Replace exam room lighting with LED	6,200	0	$740

Table 20: Facility 8, Medical Clinic, 32,823 square feet

Measure	Electric Savings (kWh)	Gas Savings (therms)	Annual Energy Savings
Retrofit Fluorescent Fixtures in Main Corridors with LED Lamps	13,000	0	$1,300
Retrofit Fixtures in Clinic Common Areas with LED Lamps	15,000	0	$1,500
Convert HVAC System to VAV with VFDs and New Controls	88,000	3,200	$9,700
Install Occupancy Controllers for Vending Machines	1,200	0	$100

Table 21: Facility 9, Medical Clinic, 46,300 square feet

Measure	Electric Savings (kWh)	Gas Savings (therms)	Annual Energy Savings
Replace Exterior Lighting with LED	39,000	0	$2,700
Replace Common Area Lighting with LED	75,000	0	$7,100
Implement HVAC Equipment Scheduling and Control Strategies	69,000	16,000	$13,000

Table 22: Facility 10, Medical Clinic, 10,014 square feet

Measure	Electric Savings (kWh)	Gas Savings (therms)	Annual Energy Savings
Retrofit Exterior Light Fixtures with LED Lamps	6,200	0	$430
Retrofit Fluorescent Fixtures with LED Lamps	10,000	0	$1,300
Install Power Factor Correction Equipment	0	0	$0