ENERNOC

from energy

Monitoring-Based Commissioning Energy Efficiency Program Proposal

In Response to:

Request for Independent Program Administrators
Energy Efficiency Portfolio Standard
Program Opportunity Notice (PON) 1259

Presented to:

NYSERDA

Presented by:

EnerNOC, Inc.
24 West 40th Street
16th Floor
New York, NY 10018

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Executive Summary

Pursuant to Ordering Paragraph 8 of the New York State's Commission June 23, 2008 Order Establishing Energy Efficiency Portfolio Standard and Approving Programs in Case 07-M-0548, EnerNOC hereby submits its proposal to NYSERDA to act as an independent program administrator. Specifically, EnerNOC is proposing to offer Monitoring-Based Commissioning (MBCx) services to appropriate customers throughout the state. MBCx assists commercial customers to better understand their energy usage, participate in a comprehensive audit, implement cost-effective energy efficiency measures and engage in an ongoing, monitoring-based commissioning process that will generate substantial energy efficiency savings.

Working Group IV carefully considered this innovative and cost-effective approach to energy efficiency and recommended that the Commission approve MBCx as an eligible EEPS measure. We are confident that MBCx is exactly the sort of measure that the Commission was referring to when it solicited "innovative proposals brought forward by competitive suppliers." EnerNOC's national experience uniquely qualifies us as "capable of administering and delivering programs" and our performance-based pricing demonstrates that we are "willing to be held accountable for results."

The implementation budget of $15,021,525 assumes that the program will be implemented for a total of 53 customers who will conserve an estimated 277,000 MWh, 9.3 Million Therms, and reduce peak demand by 4.8 MW, through 2015. The budget is an initial estimate and EnerNOC is prepared to modify this target to meet NYSERDA's program objectives. Customers will be enrolled in 2009-2011, and each customer will receive three years of ongoing monitoring. As designed, the program has a TRC Benefit/Cost ratio of 1.65(excluding carbon benefit).

Following the receipt of the proposal, EnerNOC is looking forward to cooperatively working with NYSERDA to refine the design and deployment of the MBCx program to meet your specific program objectives. EnerNOC expects to work with NYSERDA to provide additional information, including estimates of ratepayer bill impacts and, to the extent possible, other information, as provided for in the Order.

1 Program Description

1.1 Program Summary

EnerNOC is proposing to implement a unique **Monitoring-Based Commissioning** program for NYSERDA, to target existing commercial customers in the New York service territory. The objective of the program is to help commercial customers gain a better understanding of their energy usage, participate in a comprehensive audit, implement cost-effective energy efficiency measures (with possible help from incentives, if deemed appropriate and necessary), and engage in an ongoing, monitoring-based commissioning process that will generate substantial energy efficiency savings for customers and NYSERDA.

Monitoring-Based Commissioning (MBCx) is a relatively new energy efficiency application. Broadly speaking, it refers to the combination of remote retro-commissioning and continuous commissioning activities, coupled with ongoing, technology-based monitoring to ensure the persistence of savings. In our proposed approach, targeted customers are carefully screened and selected for participation in the program. We are not seeking to enroll a very large number of customers with this program; rather, we want to carefully select customers that are likely to yield the greatest savings and are able to fully participate in the program.

Once customers have been selected and enrolled, EnerNOC will install monitoring technology at each facility to capture energy usage data from interval meters, install sub-metering or data loggers where appropriate and necessary, and interface with building control and energy management systems (BCS/EMS). At NYSERDA's discretion, the cost of installing this equipment may be covered in part or in whole by the program, to offset this initial customer cost barrier. The data collected will then used to continuously track building operation and performance, and to create benchmarks for optimal building operations. At the same time, all participating facilities will go through a comprehensive audit remote monitoring based commissioning process to identify inefficient operations, as well as opportunities for system or capital upgrades that could lead to a cost-effective reduction in energy usage. Upon receipt of the comprehensive audit, and at the discretion of NYSERDA, participating customers will have access to per-kWh incentives to offset the cost of implementing some of the proposed measures. Once all measures have been installed or implemented, the program will measure and verify the impact of the installed measures, and transition the customer to the ongoing monitoring phase of the program.

Since all buildings invariably drift away from optimal operations, the ongoing monitoring ensures that building managers are alerted to any deviations from the optimal range of operation, as well as to any maintenance or scheduling issues as they arise. With help from the program, building managers can then take the appropriate remedial action on a timely basis, and ensure that the buildings continue to perform at an optimal level, and that the savings are persistent.

For this program, EnerNOC will provide a technology solution (PowerTrak®), expertise in commercial building energy efficiency, and assistance with implementation, as well as overall program management. For each enrolled customer, EnerNOC will integrate with meter and BCS/EMS data, monitor and analyze energy usage, perform a comprehensive audit, manage customer implementations, provide follow-through monitoring, and deliver monthly MBCx Scorecards that provide recommendations for changes or upgrades and track savings from already-implemented measures.

1.2 Scope of Work

For the purpose of clarity, the implementation plan has been broken out into seven major phases:

1: Program Design
2: Program Setup
3: Program Launch
4: Customer Enrollment
5: Installations & Scorecards
6: Measurement and Verification
7: Program Termination.

These phases are described in more detail below.

1. Program Design

As a first step in implementing this program, EnerNOC will revise its initially proposed program design to incorporate comments and recommendations from NYSERDA staff, and adjust for any recent developments in the market. EnerNOC will develop a revised program design that will incorporate all of these factors, and also include adjustments to address tie-ins with any other applicable programs. The final program design will address all of the following major design components: marketing and outreach, customer selection, enrollment process, incentive levels, interface with other programs, verification plan.

2. Program Setup

Once the program design has been finalized and approved, EnerNOC will move to the program setup phase, where we will build all of the processes, documents and materials necessary to launch and operate the program. During this phase, we will focus on the following key aspects:

- Development of **marketing materials** (see below), which will include a website, a descriptive program brochure, a short program narrative, frequently-asked questions, and other material as appropriate.
- Development of **comprehensive program process documents** to address the following key processes:
  - Customer Selection
  - Customer Screening
  - Customer Enrollment
  - Customer Comprehensive Audit
  - Delivery of MBCx Scorecards
  - Measure Installation
  - Measure Verification
  - Incentive Calculation
  - Incentive Payment
  - Customer Complaint Resolution
  - Customer Feedback
  - Program Termination
  - Program Reporting
- Development of **key forms and materials** associated with the above processes (i.e. customer enrollment form, incentive payment form, audit report form, etc.)

During this setup phase, EnerNOC will work closely with NYSERDA and its representatives to ensure that all program elements follow established guidelines, are in line with other program processes, and do not lead to customer confusion.

3. Program Launch

Once the program design and setup has been approved, EnerNOC will officially launch the program and perform customer outreach. EnerNOC's outreach efforts will be focused on identifying the right customers for the program. EnerNOC will reach out to eligible customers in several ways, according to the marketing plan described in Section 1.7 below. EnerNOC will initially focus its primary outreach efforts on identifying customers within its existing customer base, and that present a good fit for this proposed program. EnerNOC will use its existing sales capabilities in place in New York to reach out to customers via traditional marketing channels.

4. Customer Enrollment

All prospective customers will be screened initially to determine whether they meet the program eligibility requirements, and that the facilities in question are good candidates for the program. Careful screening will ensure that the program does not invest in facilities that are not going to produce substantial savings. Screening requirements will include, but will not be limited to: appropriate BCS/EMS system, adequate levels of staffing, and program buy-in from building owners and facilities staff. Approved candidates will be required to enter into an agreement with the program to ensure that they remain committed to the program. During the screening phase, EnerNOC will meet with the customer representative and perform a simple site assessment to ensure that the customer is a good fit for the program.

Once a customer has been identified and screened to ensure compatibility with the program eligibility and requirements, the customer will then be enrolled in the program. As part of enrollment, the customer will be required to enter into an agreement with the program to ensure proper commitment. The enrollment agreement will essentially guarantee that the customer is willing to dedicate some internal resources to comply with program requirements, and acknowledges that there will be some customer costs. If applicable, the agreement will also require the customer to implement certain measures before obtaining any incentive funds from the program.

5. Installations & Audits

Once any system upgrades required for integration have been completed, the program engineers will install additional permanent monitoring equipment at the customer location(s) to integrate EnerNOC's PowerTrak® application with the interval data recorders and BCS/EMS systems. The installed equipment may include additional meters for sub-metering, where appropriate, as well as connectivity equipment. Please see Appendix A – Technical Documentation, for a complete description of PowerTrak, as well as technical information on the equipment used to connect to these systems. At NYSERDA's discretion, the program may bear some or all of the costs to install this equipment.

EnerNOC will then collect and store meter data, along with building BCS/EMS data, in PowerTrak, EnerNOC's internet-based energy management platform. EnerNOC will augment this data with weather data, and building specific data collected from databases such as IFMA (International Facility Management Association), APPA (Association of Physical Plant Administrators) and CBECS (Commercial Buildings Energy Consumption Survey). EnerNOC may also integrate with other systems to capture square footage data, average building occupancy, building type, schedules, and other relevant data.

EnerNOC's program engineers will monitor the buildings remotely, create baselines for the customer facilities, and review energy usage against those baselines. The program will also process all building data through PowerTrak filters, to uncover any equipment issues, schedule issues, or set point issues. All data and analysis will be performed using PowerTrak, and will be accessible to the customer, the utility, and to authorized third-parties via PowerTrak's web-based interface. In addition, program engineers will conduct a thorough and comprehensive audit of the participating facilities to uncover any areas of inefficiency. On a monthly basis EnerNOC will deliver Scorecard reports to the participating facilities. The Scorecard will include recommendations to the customer on equipment and operational upgrades that could result in energy efficiency improvements, as well as track the savings from previously-implemented efficiency measures. These recommendations will distinguish between three types of measures: 1) measures that require simple maintenance or repairs, 2) measures that require enhancements to the controls systems, and 3) measures that require major repairs or the investment in new equipment. The recommendations will also include estimate savings and costs for each measure identified.

Upon review of the Scorecard, the customer will then enter into an agreement to implement specific and approved measures, based on the recommendations of the program. Based on the design of the program, the costs of improvement measures may be offset by pre-determined incentives. Measures will be implemented either by the customer, or by a contractor approved by the program. Measures with payback times of less than 1 year will only be eligible for incentives if approved by the program.

6. Measurement and Verification

EnerNOC will track and capture energy usage information before and after implementation to provide baseline data that will assist with the Measurement and Verification of the implemented measures. The objective of this process is to ensure that the savings realized through the program are persistent and to calculate the program impact and incentive payments. This information is displayed in the Scorecard report and is updated monthly.

7. Program Termination

The process outlined above will be employed for the duration of the program until the last customer is selected and enrolled in the program. EnerNOC will begin to ramp the program down after the last customers have gone through the process and develop the necessary reports and documents to assist with the final evaluation of the program.

Throughout the process outlined in the seven stages above, EnerNOC will also ensure that a reporting process is put in place with NYSERDA to provide the necessary program reports and administrative oversight. EnerNOC will maintain all records associated with customer participation for the duration of the program. Once the program is terminated, EnerNOC will turn over required documentation to NYSERDA and will continue to keep records for a period of 5 years.

1.3 Targeted Customers

The program will target large electric customers in the commercial, educational, healthcare, government and commercial real estate sectors. A typical customer will have a peak load of 1.5 MW or greater, will consume on average 10 million kWh per year or more, and will have multiple facilities. All participating customers will have a building control or an energy management system with which EnerNOC will be able to interface. Examples of targeted customers include: public universities and community colleges, private schools and universities, commercial campuses, large commercial property, and government buildings.

EnerNOC has reviewed its existing customer base and has identified several customers that may be suitable for this program, primarily in the educational and government sector. EnerNOC has also performed a detailed analysis of NYSERDA's customer base, and has identified the potential for targeting this program in the service territory. This analysis is further detailed in Section 2 of this proposal.

1.4 Customer Eligibility

This program is a targeted program that, by design, is focused on a small set of customers. Eligible customers must meet the following initial criteria:

- Customers receive service from NYSERDA, with peak load (for all facilities) of 1.5 MW or greater (with some exceptions to accommodate smaller but well-suited customers).
- Customers are in the commercial segment and in the education, commercial property, healthcare or government sub-segments.
- Customers have an interval data recorder and use a BCS/EMS system.

1.5 The Customer Participation Process

To provide additional context to the program implementation plan described above, and to ensure that the program design does not overlook any key issues, EnerNOC has created a customer process to describe the steps that customers will take when they participate in the program. This process is illustrated in Figure 1 and described in more detail below.

Figure 1

1. **Customer Screening**: All prospective customers will be screened initially to determine whether they meet the program eligibility requirements, and that the facilities in question are good candidates for the program. During the screening, the customer will be introduced to the program and will receive quick on-site assessment to ensure compatibility with the program. There will be no obligation at this stage, which is expected to last **on average 1 month per customer**.

2. **Customer Enrollment**: Once an interested customer has been screened and found to be eligible, the customer will be enrolled. As part of enrollment, the customer will be required to enter into an agreement with the program to ensure proper commitment. The enrollment agreement will require that the customer is willing to dedicate some internal resources to comply with program requirements, and acknowledges that there will be some customer costs. If applicable, the agreement will also commit the customer to implementing measures in order to obtain any incentive funds from the program. This enrollment step is expected to last, **on average, 1 week per customer**.

3. **Monitoring Equipment Installation**: Program engineers will then go onsite to install monitoring equipment at the customer's premises. Depending on NYSERDA's direction, the program may bear the cost of installing this equipment. EnerNOC will then collect and store

meter data, along with building BCS/EMS data, EnerNOC may also integrate with other systems to capture additional data, such as square footage, occupancy, building type, and schedules. This process also includes an initial site assessment audit, which is used to determine the customer's operational conditions, such as equipment and systems, operational profiles and special customer requirements (for example: the labs must run 24/7/365 and maintain a constant temperature of 72°F). During this audit EnerNOC will also make note of general equipment conditions and take note of equipment or systems that should be considered for upgrades or replacement. The expected duration of this step is, **on average, 2 months per customer.**

4. **Comprehensive Audit, Ongoing Monitoring and Scorecard Report** After the equipment has been installed and data begins to flow, the customer will undergo a comprehensive audit to uncover any areas of inefficiency. EnerNOC will also deliver a monthly Scorecard report to each customer. The Scorecard will include and receive recommendations for equipment and operational upgrades that could result in energy efficiency improvements. These recommendations will distinguish between three types of measures: 1) measures that require simple maintenance or repairs, 2) measures that require enhancements to the controls systems, and 3) measures that require major repairs or the investment in new equipment. The recommendations will also include estimated savings and costs for each measure identified. The comprehensive audit is expected to last, on average, 3 months per customer. The Scorecard will be provided on **a monthly recurring fashion throughout the term of the contract.**

5. **Measure Implementation:** Upon review of the comprehensive audit Scorecard report, the customer will then enter into an agreement to implement specific and approved measures, based on the recommendations of the program. If deemed appropriate, the cost of measures *with a simple payback time greater than one year* will be offset by incentives. Measures will be implemented either by the customer, or by a contractor approved by the program. This step is **a monthly recurring event throughout the term of the contract.**

6. **Measurement and Verification:** Following Measure Implementation, EnerNOC will perform a verification of the measure installation, and initiate the process for the customer to receive incentives, if NYSERDA elects to offer incentives. The expected duration of this step is, **on average, 1 month per customer.** If incentive payments are to be used, the customer will receive an incentive payment once the verification has been completed and NYSERDA has approved the installation.

7. **Ongoing Monitoring**: Enrolled customers will receive ongoing monitoring for their enrolled facilities to ensure that the savings are persistent and to uncover any new opportunities. These new opportunities will be processed as described through Steps 5 and on above. The customer will receive a monthly report and review proposed measures with the program on a quarterly basis. Please see Appendix A – Technical Documentation for a sample of the report. The program will support the customer in this phase for 3 years. At the end of this period, the customer will have the opportunity to continue participating in an ongoing monitoring phase by contracting directly with EnerNOC.

1.6 Examples

The MBCx concept was successfully pioneered as part of the UC/CSU/IOU Energy Efficiency Partnership, which demonstrated that the installation of permanent energy monitoring equipment, combined with retrofit activities, results in robust and more persistent energy efficiency savings[1]. Several recent studies have evaluated the impact of this program, most notably Brown, Anderson and Harris, *How Monitoring Based Commissioning Contributes to Energy Efficiency for Commercial Buildings,* published in the Proceedings of the American Council for an Energy Efficient Economy. The analysis shows that MBCx can deliver cost-effective energy savings for higher-education campuses and other commercial facilities.

EnerNOC is also currently implementing a similar version of the program proposed here with some of the California State University campuses involved in the UC/CSU/IOU partnership. The program is currently under development..

1.7 Marketing Materials & Outreach

The program marketing will include the development of specific program materials, along with customer enrollment and screening forms and a program website. EnerNOC will also explore recruiting potential customers through proven marketing channels, such as trade allies, industry organizations, and trade shows.

Customer Outreach

Given our strong presence in the New York demand response marketplace, EnerNOC has a dedicated and robust sales team that will reach out to prospective customers daily and attract new participants. In addition, EnerNOC has found that working with NYSERDA account managers can be a very effective strategy to identify eligible customers. EnerNOC therefore proposes to work with NYSERDA account representatives to identify the initial set of prospective customers.

Based on our experience in a variety of programs with utilities across North America, EnerNOC has consistently found that the most successful programs are those where we work in "partnership" with our utility client in program marketing and customer recruitment. While EnerNOC takes on the ultimate responsibility for recruiting customer participants, we have learned that branding the program as a utility offering – and having active participation by the utility's account executives in promoting the program – enhances customer satisfaction and delivers increased value to the utility.

Marketing Materials

EnerNOC's will work closely with NYSERDA to design an appropriate branding and messaging strategy for the program. As mentioned above, we recommend that the program marketing materials focus on NYSERDA's brand identity and identify EnerNOC as the "program implementation contractor." We are happy to discuss other marketing strategies as well. All marketing materials and messaging will be sent to NYSERDA for approval before use.

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[1] Anderson, M., McCormick, A., Meiman, A. and Brown, K. 2007. *Quantifying Monitoring-Based Commissioning in Campus Buildings: Utility Partnership Program Results, Lessons Learned, and Future Potential.* National Conference on Building Commissioning: May 2 – 4, 2007

In most of our monitoring-based commissioning program implementations, EnerNOC has utilized materials that provide an overview of the program and describe the key benefits of participation. We have found that a "frequently asked questions" insert can also be very useful.

In line with our targeted recruitment strategy, EnerNOC will produce a small set of materials and distribute them either via mail or through in-person meetings. Materials will also be available for download via the program website. Figure 2 illustrates some EnerNOC marketing materials.

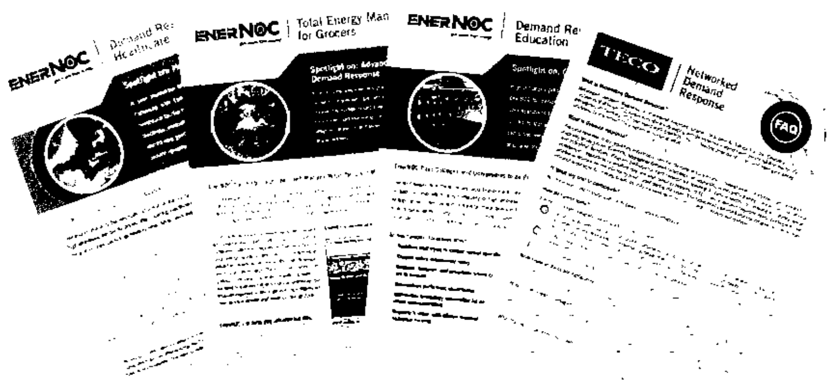

Figure 2: Examples of EnerNOC's Program-specific Marketing Collateral

Program Website

In addition to printed marketing materials, EnerNOC will create a program-specific website where customers can obtain more information about the program, download program documentation and get more information. The website branding will align with all other marketing materials to create consistency and reduce customer confusion. For an example of such a site developed by EnerNOC, please visit http://www.keeplibertyalight.com/.

2 Company Information

EnerNOC, Inc. is a leading developer and provider of clean and intelligent energy solutions for commercial, institutional, and industrial customers, as well as for electric power grid operators and utilities. Our technology-enabled demand response and energy management solutions help optimize the balance of electric supply and demand. As part of our energy efficiency offering, we provide monitoring-based commissioning services, and work with customers to implement energy efficiency solutions that achieve measurable and reliable energy savings.

General Information (Headquarters)	
Company Name	EnerNOC, Inc.
Mailing Address	24 West 40th Street 16th Floor New York, NY 10018
Telephone Number	212.624.0000
Fax Number	212.624.0001
Website	http://www.enernoc.com
Contact Information	
Contact Name	Lance Charlish
Mailing Address	24 West 40th Street 16th Floor New York, NY 10018
Telephone Number	617.895.8471
Fax Number	212.624.0001
Email Address	lcharlish@enernoc.com
Business Information	
Nature of Business	Developer and Provider of Clean Energy Solutions for Energy Efficiency and Demand Response
Ownership Structure	C Corporation
Date Business Formed	December 2001
Parent Company	None
Affiliates	None
Subsidiaries	MDEnergy, South River Consulting
For Profit of Tax-Exempt	For Profit
Management Information	
Chief Executive Officer	Tim Healy
President	David Brewster
Chief Operating Officer	Darren Brady
Chief Financial Officer	Neil Isaacson
General Counsel	David Samuels

3 Experience and Qualifications

3.1 Overall Project Experience and Results

Since 2001, EnerNOC has been working closely with end-use customers to enable superior demand response solutions. As our demand response efforts have grown, many customers have asked us to provide additional energy management services. Our engineers and project managers routinely identify equipment upgrades and process improvements that not only reduce peak loads but save energy year-round. Until recently, these demand side activities were conducted separately by different entities. In New York, EnerNOC has worked with NYSERDA to disseminate an integrated demand response and efficiency solution for end-use customers.

At the end-use customer-level, EnerNOC provides customers with monthly reporting and analysis of energy usage in the form of a "Scorecard" report. This type of "hands-on" approach allows EnerNOC and the end-use customer to identify and track specific energy efficiency opportunities and activities including process changes and equipment upgrades. These reports are further detailed in the Appendix. For one particular customer, EnerNOC has identified, through monitoring based commissioning, and in less than a year, measures that effectively translated in a reduction in energy usage of approximately 13%.

EnerNOC is also currently implementing a pilot version of the MBCx program with the California State University (CSU) as part of the UC/CSU/IOU partnership. This pilot targets six campuses and seeks to identify permanent energy efficiency savings based on a process that is very similar to the one outlined in this abstract. This pilot installation phase is in full gear and as such has not yet returned any results.

4 Program Staffing & Planning

4.1 Staffing Plan

Key Personnel

The key personnel supporting this proposed program, along with their primary responsibilities, are:

- **Account Executive** – Noel King will manage the relationship between EnerNOC and NYSERDA, and be involved as an account executive representing EnerNOC.
- **Program Manager** – Bill O'Connor will manage all aspects and day to day operations of the program.
- **Marketing Manager** – Taj Ait-Laoussine will manage program design, and will develop and manage the marketing plan.
- **Customer Manager** – Our staff of Business Development Managers will meet with potential customers to pre-qualify them for the program, develop and manage the relationships with customers, and handle the interface with subcontractors.
- **Energy Analyst** – Rick Paradis will review and analyze collected submeter and building management system data to determine potential energy efficiency projects.

The qualifications of the personnel described above are listed below. In addition to the key personnel above, various other EnerNOC personnel will fulfill specific tasks related to this project. These roles include:

- **Site Technician & Energy Auditors** – EnerNOC will provide personnel to perform on-site system auditing, site walk-through, and engineering analysis, and manage the energy efficiency project installation and system upgrades as necessary.
- **Program Administration** – EnerNOC staff with experience administrating energy efficiency programs for utilities will provide general administrative support to address reporting, document management, invoicing, customer service and other administrative tasks.

4.2 Qualifications of Key Staff Members

The following table lists the qualifications of all key personnel that will participate in this program implementation.

Staff Members	Qualifications
Gregg Dixon **Senior Vice-President, Sales**	Gregg will lead EnerNOC's marketing and sales team to successfully engage customers in the program, as he has in similar programs for utilities across North America. Prior to joining EnerNOC, Gregg was Vice President of Marketing and Sales for Hess Microgen, the leading provider of commercial onsite cogeneration systems and services in the US. As a recognized expert in distributed generation, Gregg pioneered efforts to bring more than 20 MW of cogeneration to leading grocery, hospitality, commercial property, and manufacturing customers and developed Hess Microgen's leading-edge, Internet-based monitoring system, CONIFER. Gregg was also a partner at Mercer Management Consulting where he advised global Fortune 1000 technology, consumer products, and energy clients on customer and product strategy, economic choice analysis, and new business model development. Gregg graduated from Boston College with bachelor's degrees in Business Administration and Computer Science.

Staff Members	Qualifications
Noël King **Senior Director, Utility Sales**	Noël will serve as NYSERDA's point of contact through implementation of this program. Noël has over twenty years of experience in the utility and energy field. Prior to joining EnerNOC, Noel was a Director of Mercer Management Consulting's Energy Utilities practice, where he worked with utilities to develop business strategies and improve operational performance. Noël received a B.S. in Geology from Yale University and an M.S. in Applied Economics and Finance from MIT's Sloan School of Management.
Olav Hegland **Director of Energy Services**	Olav will act as an adviser to the program. Olav oversees the engineering and execution component of PowerTrak at EnerNOC. Olav has over 17 years of experience in the electricity consulting industry, including demand side management, performance contracting,. measurement & verification and continuous commissioning. Prior to joining EnerNOC, Olav was Director of Services with Cimetrics, Inc in Boston, MA, Director of Project Development for Abacus Engineered Systems in Seattle, WA and held positions with Coneco Corporation, ERI Services and XENERGY Inc. Olav holds a Master of Science in Mechanical Engineering at the University of Massachusetts, Amherst, and did his undergraduate work at the University of Manchester Institute of Science and Technology in England and at the University of Massachusetts, Amherst. Olav is a registered Professional Engineer in the State of Massachusetts and a Certified Energy Manager (AEE).
Rick Paradis **Senior Energy Analyst**	Rick will be the primary program engineer for this project, performing the main analyses to identify opportunities and estimate the potential impacts. As Senior Energy Analyst, Rick is responsible for EnerNOC's Total Energy Management service offering, which includes monitoring-based commissioning and identification and M&V of energy efficiency projects. Rick has been in energy efficiency since 1978. Rick has experience writing technical assistance audit reports; developing design alternatives for HVAC, lighting, thermal storage, and alternative energy projects; providing construction observation and review services and monitoring and verification protocols. Rick has also managed and supervised technical potential studies and various technical assessments of end-use equipment for natural gas utilities in Massachusetts and New Jersey to develop utility demand side management (DSM) programs. Rick graduated from Clark University. Rick is also a MEOER Certified Energy Auditor and a Certified Energy Manager. He co-authored two publications: "Intelligent Use of Energy at Work: A detailed account of Saving Energy and Cost at the Wellness Center of the University of Miami" and "How to Automate Strategies That Make Companies Energy Savvy" both in AEE publications.
TajAit-Laoussine **Senior Marketing Manager**	Taj will oversee the program planning and design and manage the marketing for this project. Taj will also help to project manage the project during its initial year. As Senior Marketing Manager Taj Ait-Laoussine is responsible for setting the marketing strategy and coordinating all of EnerNOC's marketing activities related to energy efficiency. Taj has over twelve years experience working with utilities and large end-use customers, with a focus on energy efficiency, demand response and energy management software applications. Prior to joining EnerNOC, Taj was a Senior Product Manager for Nexus Energy Software, where he managed the development of meter data and energy management applications. He also held positions at Silicon Energy and Hagler Bailly Consulting. Taj has extensive experience designing, managing and implementing and evaluating energy efficiency programs. Taj has a B.A. in Physics for the University of California at Berkeley, and an M.S. in Energy and Resources, also from the University of California at Berkeley.

5 Program Impact, Deliverables, Budget and Pricing

5.1 Market Potential

In developing this proposal, EnerNOC has performed a detailed analysis of the market potential in NYSERDA's service territory. To perform this analysis, we have used the following criteria to identify qualified customers:

- **Market Segments**: our experience has shown that the most attractive MBCx targets are in the higher education, healthcare and owner-occupied commercial property (including the government sector). We therefore focused our analysis on these particular segments.
- **Customer Size**: MBCx is also most applicable to the larger commercial customers. EnerNOC typically targets customers that use, an average, 10 million kWh per year or more. While smaller customers may be eligible and benefit from an MBCx program, we have found that the best targets are in the 10 million kWh range.
- **Customer Characteristics**: ideal MBCx customers will have multiple buildings, and will manage at least part of those building using a BCS/EMS. We impose the presence of a BCS/EMS as a requirement, and only consider campus-like or multi-building customers as part of our targets.

5.2 Per Customer Impacts

EnerNOC has developed a comprehensive analysis of the MBCx process, and of its impacts and associated costs. This analysis is documented in a Technical Work Paper included in this proposal as Appendix A. The Work Paper provides a detailed example of how MBCx is implemented, drawing on examples from past EnerNOC experience, as well as a review of the existing literature. Table 1 highlights the impacts and costs associated with performing MBCx at a typical customer. The data is supported by the Work Paper. Note that this data is based on actual EnerNOC implementations of MBCx, and that this data was adjusted specifically to address customer in the New York climate zones.

Table 1

Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Customer Annual Therms Savings (Thm/unit)	Measure Installed Cost ($/unit)
Monitoring Based Commissioning	893,000	92	30,000	$83,230

The costs shown in Table 1 are the costs associated with implementing measures identified as part of the MBCx process, but do not include the installation cost associated with enabling an MBCx customer. In past implementations, EnerNOC has had part or all of this cost borne by the program budget, since these costs are often barriers to the customer enrolling in the program. EnerNOC will look to NYSERDA's guidance in how to address these costs, which are estimated to be approximately $25,000 per customer for a typical customer, and which are highlighted in the budget.

5.3 Proposed Program Impacts

Using the data presented in Section 5.2, we can calculate the proposed program impacts, as documented in Table 2. This table shows the analysis of the estimated program impacts, assuming that the customers are enrolled over a period of 3 years (2009-2011), and that each customer is then monitored by EnerNOC for a period of 3 years. After that three year monitoring mark, the customer can elect to extend the monitoring beyond 3 years by contracting directly with EnerNOC, but those costs are not covered by the program. EnerNOC is happy to provide NYSERDA with a program design that uses a different length of time for the ongoing monitoring. We have initially settled on a 3-year duration for the monitoring because it extends the impacts of the program through 2015.

Table 2

Overall Program Impact Analysis	2009	2010	2011	2012	2013	2014	2015
Avoided Energy(MWh)	11,609	29,469	47,329	47,329	47,329	47,329	47,329
Avoided Demand (kW)	1,196	3,036	4,876	4,876	4,876	4,876	4,876
Avoided Gas(Therms)	390,000	990,000	1,590,000	1,590,000	1,590,000	1,590,000	1,590,000

5.4 Reliability and Persistence of Savings

There have been several studies that have documented that MBCx programs result in persistent energy efficiency savings. In particular, Brown, Anderson and Harris reviewed the UC/CSU/IOU Energy Efficiency Partnership, and concluded that "enhanced monitoring capabilities have proven valuable in identifying, diagnosing, and quantifying measures to reduce energy use. Monitoring also provides a means to increase persistence of commissioning-related savings."[2]

There have also been numerous studies on the success of retro-commissioning in increasing the efficiency of facilities, and in realizing persistent savings. For instance, Bourassa, Piette and Motegi, in a study of a retro-commissioning program at SMUD, found substantial, energy savings persistence well into the fourth year after the program[3]. In our analysis, we have assumed that the measure lifetime, on average, will be 5 years. We believe a measure lifetime of 5 years is appropriate, and is in line with the desired results of this program.

In addition to the efficient way in which savings can be identified and implemented, the thrust of EnerNOC's MBCx process is the built-in persistence associated with the long term monitoring of all critical building parameters. Once a building has reached the most optimum efficiency level, the fault detection filters and applications continue to work on the customers behalf. Instead of relying on measures not drifting back after 5 years, EnerNOC's remote monitoring and analytics ensures that all measures that recur or drift back as a result of operator adjustments are quickly brought back to it efficient state.

The intent with the MBCx offering presented here is that EnerNOC's data center and analytics will remain in full effect throughout the 5 year performance persistence period.

5.5 Customer Deliverables

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[2] Brown, K., Anderson, M. and Harris, J. 2007. *How Monitoring Based Commissioning Contributes to Energy Efficiency for Commercial Buildings*. Proceedings of the 2006 ACEEE Summer Study, Asilomar, CA.

[3] Bourassa, N., Piette, M.A., Motegi, N. 2004. Lawrence Berkeley National Laboratory, Berkeley, CA.

As described in Section 1 above, the energy savings will be captured through the implementation of energy efficiency measures by the customer, based on the recommendations coming out EnerNOC's Comprehensive Audit and Scorecard Report. We expect that multiple recommendations will be provided per customer, and that the customer will be responsible for implementing the measures, with help as needed from the program. Our experience has shown that, on average, a customer going through this process may receive over 40 recommendations in the first year, and about half of that in subsequent years. Not all measures are implemented, but those that are lead to savings on the order of 5% - 15% of the total energy usage.

The specific deliverables to the customer, as part of EnerNOC's Monitoring-Based Commissioning Program, include:

- **Comprehensive Audit** Each customer will receive a comprehensive audit, which will identify recommendations on equipment and operational upgrades that could result in energy efficiency improvements. These recommendations will distinguish between three types of measures: 1) measures that require simple maintenance or repairs, 2) measures that require enhancements to the controls systems, and 3) measures that require major repairs or the investment in new equipment. The recommendations will also include estimate savings and costs for each measure identified.
- **Ongoing MBCx Scorecard Report**: For each customer, EnerNOC will provide an MBCx report, as illustrated in Appendix A – Technical Documentation. This Scorecard will provide a list of all identified measures, corrected measures, building profiles, benchmarks, as well as an ongoing summary of the results of program participation. Customers will receive this report on a monthly basis. The Scorecard also tracks the savings that have accrued from previously-implemented measures.
- **An Annual M&V Report:** This report will be an annual roll-up report of actual performance achieved through the implementation of energy efficiency measures.
- **Portfolio M&V Report:** This report represents a NYSERDA view of the performance of the participating customers, with a roll-up of portfolio results and performance.

5.6 Project Time Line

EnerNOC is proposing a project timeline that completes the NYSERDA contract over 3 years (2009-2011), but allows for monitoring over a 3-year period beyond that time frame. This time line is reflected in Table 4 of the proposal. If selected, EnerNOC will work with NYSERDA to develop a detailed project plan and time line to ensure that the program milestones and deliverables are in line with NYSERDA's expectations.

5.7 Program Budget

Table 3 below provides a breakdown of the proposed budget for this program. Please note the following assumptions that were employed in arriving at that budget:

- The budget assumes that the program will be implemented for a total of 53 customers. As noted above, EnerNOC is using this figure as an initial estimate, and is prepared to modify this target to meet NYSERDA's preferred objectives.

- Customers will be enrolled in 2009-2011, and each customer will receive three years of ongoing monitoring. The budget shown below accounts for future monitoring costs (i.e. those costs incurred in 2012 and 2013) having been brought forward to 2009-2011.
- The budget does not include any incentives or offsets to the customer: this budget only reflects EnerNOC costs.
- The impacts associated with this budget are shown in Table 4.

Table 3

Program Budget Analysis	2009	2010	2011	Total
EnerNOC Program Administration	$662,500	$662,500	$662,500	$1,987,500
EnerNOC Customer Enablement	$585,000	$900,000	$900,000	$2,385,000
EnerNOC Customer Monitoring	$1,398,357	$3,549,675	$5,700,993	$10,649,025
Total EnerNOC Budget	**$2,645,857**	**$5,112,175**	**$7,263,493**	**$15,021,525**

As illustrated in Table 3, our budget is broken down into the following categories:

- **Program Administration –** The administrative costs designated for this project encompass all the program overhead costs associated with the program design, implementation, and management.
- **Customer Enablement** – These costs included the costs associated with enabling the customers being targeted for this program. These costs only represent EnerNOC costs, and do not include any incentives to the customers, or any offsets of the costs required for installing the monitoring equipment. The costs shown in this category represent steps 1 through 6 of the customer process outlined in Section 1.5.
- **Customer Monitoring –** The Customer Monitoring Costs represent the costs of performing the ongoing monitoring for 3 years with each customer. Note that although these costs extend beyond the 3-year program window, they have been brought forward to facilitate the budgeting process. EnerNOC is open to considering different arrangements whereby the monitoring costs are incurred in line with when the monitoring occurs.

The overall budget for the EnerNOC MBCx program is designed to maximize the kWh and kW savings from each project undertaken in the program. While this proposal is based on a total of 53 implemenrations, this is only an approximate target. EnerNOC will be happy to adjust the budget to reflect a different scope for this program.

6 Selection Criteria

6.1 Cost/Benefit Ratios and Program Impacts

TRC Analysis

EnerNOC has conducted a cost-effectiveness analysis using the TRC test to provide some guidance on the cost-effectiveness of the proposed program. The TRC analysis presented here is based on input obtained from the New York State Department of Public Service, and may need to be adjusted pending additional or updated data to be provided by NYSERDA. The assumptions behind the TRC analysis are documented below. Note that the avoided cost numbers we used are statewide numbers, without the inclusion of Long Island.

- **Discount Rate:** 5.5%, per New York State Department of Public Service input
- **Measure Life:** 5 years, as documented in Appendix B – Technical Work Paper
- **Ongoing Monitoring:** 3 years
- **TRC Benefits:** we assumed TRC benefits attributable to the following sources:
  - **Avoided Energy Costs:** we obtained avoided energy costs, inclusive of line losses, from the New York State Department of Public Service. These costs are listed in Appendix B.
  - **Avoided Capacity Costs:** we obtained avoided capacity costs, which included T&D and line losses, also from New York State Department of Public Service. These costs are also listed in Appendix B.
  - **Avoided Gas Costs:** finally, we obtained avoided gas costs, also from New York State Department of Public Service. These costs are also listed in Appendix B.
- **TRC Costs:** we assumed TRC costs attributable to the following sources:
  - **Program Administration Costs**: these costs correspond to the EnerNOC budget described in Section 5.7. We have not included any administrative costs attributable to NYSERDA managing the program.
  - **Customer Costs**: which include the measure costs of $83,230, as highlighted in the Appendix B – Technical Work Paper, and the $25,000 monitoring equipment installation costs, for a total of $108,230 per customer.

The analysis shows that the proposed program has a **TRC Benefit/Cost ratio of 1.65**, when calculated using the assumptions documented above. This TRC ratio does not include any incentives or customer installation costs, as these are transfers and therefore do not factor into the analysis. This analysis also does not include any benefits attributable to avoided CO2 emissions. Those are included and described later in this section.

Our calculations do not include the program administrator costs other than those budgeted for EnerNOC. We assume that there are no increases in supply costs, since this program do not results in any increases in supply.

Electric Rate Impact

As noted in the footnote of Appendix A of the RFP, NYSERDA indicates that there may not be sufficient information in the RFP to perform this calculation. Once additional information is available, EnerNOC will be happy to conduct this analysis for NYSERDA.

Electric Rate Impact per MWh saved

As noted in the footnote of Appendix A of the RFP, NYSERDA indicates that there may not be sufficient information in the RFP to perform this calculation. Once additional information is available, EnerNOC will be happy to conduct this analysis for NYSERDA.

Electric Rate Impact per MW Saved

As noted in the footnote of Appendix A of the RFP, NYSERDA indicates that there may not be sufficient information in the RFP to perform this calculation. Once additional information is available, EnerNOC will be happy to conduct this analysis for NYSERDA.

MWh Saved in 2015

As described in previous sections and in the supporting documentation, the program shows an estimated MWh savings for 2015 of 47,329 MWh. This figure is the same whether the program only functions for the period proposed, or if the program is extended, since we are performing ongoing monitoring until 2015. This figure, however, may change if the program is expanded to include more customers.

MW of Coincident NYSIO Peak Saved in 2015

As described in previous sections and in the supporting documentation, the program shows an estimated peak kW savings for 2015 of 4,876 kW. This figure is the same whether the program only functions for the period proposed, or if the program is extended, since we are performing ongoing monitoring until 2015. This figure, however, may change if the program is expanded to include more customers.

In order to perform this calculation accurately, EnerNOC recommends using load shape data to compare the load shape impact of the proposed measure to the NYSERDA system profile. We have deliberately chosen a conservative figure here absent any load shape information. This is reflected in our coincident factor calculation.

Peak Coincidence Factor

Using the figures noted above, the peak coincidence factor for this program is calculated to be 1.1. This derives from a measure kWh savings of 893,000 and a measure peak kW savings of 92. Given that this number is greater than 1, it implies that the savings accrue more frequently during the off-peak hours than the on-peak hours. As noted above, EnerNOC recommends using load shape date to compare the load shape impact of the propose measure to the NYSERDA system profile. In addition, the possibility exists for enrolling tbe customers targeted by this proposal into demand response programs, providing an additional peak demand reduction. This reduction is not calculated as part of this proposal, but EnerNOC can easily provide additional information or analysis if requested.

TRC Calculation with Carbon

To account for the environmental benefits associated with the program, we used a figure of $15 / ton of CO_2, as well as an average factor of 0.454 ton per MWh for the service territory. This is based on data obtained from the EPA E-Grid Database[4].

We performed the TRC calculation with Carbon benefits. The results of this analysis shows that the resulting **TRC Benefit / Cost Ratio climbs to 1.75**.

Number of Participants as Percentage of Customer Class

The proposed program will result in an implementation with 53 commercial customers in the commercial property, education, government, and healthcare industries. EnerNOC does not have access to the total number of customers in the customer class to calculate the percentage that this represents, but we would be happy to do so if provided with the data.

Gas Rate Impact

As noted in the footnote of Appendix A of the RFP, NYSERDA indicates that there may not be sufficient information in the RFP to perform this calculation. Once additional information is available, EnerNOC will be happy to conduct this analysis for NYSERDA.

Gas Rate Impact per MBTU saved

As noted in the footnote of Appendix A of the RFP, NYSERDA indicates that there may not be sufficient information in the RFP to perform this calculation. Once additional information is available, EnerNOC will be happy to conduct this analysis for NYSERDA.

6.2 Narrative Considerations

Demand Reduction and System Benefits

The demand reduction that we expect to achieve through this program is detailed Table 5 below. The determination of this impact is described in full in Sections 5.2 and 5.3 of this proposal.

Table 4

Overall Program Impact Analysis	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Avoided Energy(MWh)	11,609	29,469	47,329	47,329	47,329	47,329	47,329
Avoided Demand (kW)	1,196	3,036	4,876	4,876	4,876	4,876	4,876
Avoided Gas(Therms)	390,000	990,000	1,590,000	1,590,000	1,590,000	1,590,000	1,590,000

At this stage, the demand reduction impact proposed here is significant, but will probably not rise to the attention of the New York Independent System Operator. The overall energy savings impacts are more significant. As described above, the possibility exists for enrolling the customers targeted by this proposal into demand response programs, providing an additional peak demand reduction that could provide value for the ISO and could be relied on by T&D System Planners. This reduction is not calculated as part of this proposal, but EnerNOC can easily provide additional information or analysis if requested.

[4] http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

Evaluation

EnerNOC's approach to Measurement and Verification is to deploy a consistent approach between energy savings estimates and verified energy savings. Savings estimates presented to customers play an important role in the implementation decision-making process. The verified energy savings represent the true performance delivered to NYSERDA.

EnerNOC realizes that it is important for the estimated and verified energy savings to be consistent. Therefore we have devised an M&V approach that will use two IPMVP Options (B and C) to bring confluence between energy savings estimates communicated to the customer for implementation (Option B), and overall program performance delivered to NYSERDA (Option C). The following summarizes EnerNOC's approach to M&V.

The savings for this program are expected to be in the 10% range. According the IPMVP this is the threshold given for the effective use of Option C; whole building monitoring. In this savings range, factors such as occupancy schedules, production, and weather, and unaffected loads such as plug loads, can make it difficult to isolate the true measure impact. However, because the MBCx measures affect the whole building and often interact with other measures, the Option C approach is desirable, provided it can be combined with an effective mechanism for isolating external factors. Wherever the Option C approach introduces significant noise, EnerNOC intends to use Option B to document and fill in for factors that interfere with the accurate use of Option C.

The M&V plan can be summarized as follows:

- Option B - the combination of engineering computations and continuous measurement of energy proxies, will be utilized to determine the ongoing savings estimates to the customer.
- Option C - whole building metering, will be used to true-up the savings after the completion of measure implementation.
- Parameters monitored in the Option B approach will be used for mitigating external factors that affect energy consumption, and which are outside of the scope of the implemented measures. This includes the monitoring of system operating factors during, before, and after the Option C energy baseline is developed.
- A comparison between the "bottom-up" Option B results will be compared to the "top-down" Option C results. The Option C baseline and post-installation energy consumption will remain the primary performance criteria in EnerNOC's M&V approach, but whenever static or noise factors interfere, Option B results will be used to supplement measure isolated results for performance verification.
- In this program the aggregated Option B results will be considered equivalent to the Option C results whenever the two options are within ±10% confluence.

Market Segment Need

EnerNOC believes that this program provides an excellent fit into NYSERDA's existing portfolio of programs, and fills a previously unmet need for end-use customers. Opportunities deriving from Monitoring-Based Commissioning have not been substantially achieved in the state of New York, and present a significant need. The proposed program will seek to meet that need, and unlock an efficiency potential that is currently not being met.

Coordination

EnerNOC will coordinate this program with other programs offered in the state, to the extent appropriate. It is important to note that there is an opportunity to coordinate this program with other existing demand response programs, for which EnerNOC is a provider in New York State. This coordination may enable customers to use the same monitoring equipment to not only achieve the demand reductions and energy savings illustrated in this proposal, but also to enable a significant and additional demand-response load. That capacity is not included as part of this proposal. However, EnerNOC can provide additional information or analysis if requested.

Co-Benefits

EnerNOC has found that many of the commercial customers that participate in an MBCx program will generally experience additional value stemming from improved maintenance practices and reduced maintenance costs. The MBCx approach allows customers to keep their facilities running more smoothly: they are alerted to potential problems as soon as they occur, and have an opportunity to address those problems early on. Indeed, MBCx can be seen as a form of preventative maintenance, which can significantly reduce repair costs. At this stage, EnerNOC does not have quantitative information on the savings associated with this benefit, but we expect it to be significant to the customers considering this opportunity.

Portfolio Balance

NYSERDA offers a wide and comprehensive array of programs for energy efficiency. EnerNOC believes that this proposed program is an innovative approach to capture energy efficiency opportunities that will complement and balance the NYSERDA portfolio. EnerNOC will coordinate this program with other programs offered in the state, to the extent appropriate.

Depth of Savings

During the analysis and benchmarking phase, EnerNOC will not limit the process to a specific set of measures. The analysis will review all systems in use at the customer facilities and provide recommendations on a broad range of measures, from lighting to HVAC to process. While the objective of this program is to implement permanent measures, the analysis will undoubtedly uncover additional opportunities for efficiency that do not require any capital investment, but are primarily a result of incorrect settings, schedules or equipment operation. The reports provided to the customer will highlight those measures, and encourage the customer to implement additional energy efficiency opportunities. A sample customer report is included in Appendix A, and highlights the comprehensive nature of this offering. In addition, the analysis may uncover measures that are best addressed by other New York programs. We will refer the customer to those progtams as appropriate.

Underserved Markets

This program is not targeted at underserved markets.

Commitment

The process for obtaining customer commitment is described in detail in Section 1.5 of this proposal. In summary, customer will be required to enter into an agreement with the program to ensure proper commitment. The enrollment agreement will essentially guarantee that the customer is willing to dedicate some internal resources to comply with program requirements, and acknowledges that there will be some customer costs. If applicable, the agreement will also commit the customer to implementing measures in order to obtain any incentive funds from the program. The customer will then receive ongoing monitoring for a period of 3 years, along with all the customer deliverables described in Section 5.5 of this proposal.

Customer Outreach

The focus of the program outreach will not be on finding all customers, but on finding the *right* customers. As discussed above, this program will target a select group of customers in the commercial sector. Our implementation plan contains a very extensive customer screening and enrollment process to ensure that the customers that participate will deliver the most value to NYSERDA and successfully meet the program objectives. A key part of this process will center on the identification of a program champion within each customer. In our experience, we have found that program champions are key facilitators of customer engagement, swift implementation, and successful kWh reductions. The selection criteria described below are designed to ensure that the program enrolls eligible and desired customers:

- **Basic Selection Criteria**: First we ensure that the customer meets the basic selection criteria, i.e. size, type of facilities, presence of building control systems, history of energy efficiency efforts.
- **Customer Commitment**: We screen customers for their ability to commit to the program. This will be based on their willingness to dedicate time and resources, their ability to identify a program champion, and their openness to meeting with EnerNOC program managers. During the screening phase, we will evaluate prospective customers against these criteria.
- **Empowered Champion:** Our experience shows that one of the keys to a customer's success is that the decision-maker with which we interface is empowered to make decisions about elements that will affect the program. For example, we will make sure that the proposed program champion will be able to clear any barriers regarding the installation of monitoring equipment and the use of resources' time.
- **Customer Stability**: The last element we will evaluate when selecting a customer is whether the customer and project champions are likely to remain stable and in place during the implementation. We have experienced changes in management in the past that have affected the outcome of our programs. We will determine, ahead of enrollment, whether such changes are likely to occur and develop strategies to address challenges should there be turnover during the program.

The program will seek to gain commitment from the program champion and explore, *before enrollment,* the willingness of the champion to agree to and implement the cost effective measures identified in the Scorecard Report.

Collaborative Approach

This program proposal was developed in a short time-frame which precluded extensive cooperative discussions. However, the EnerNOC staff has held numerous conservations and discussions about this program with the various New York Utilities, NYSERDA, the New York State Public Commission, and the New York Department of Public Service. If our proposal is accepted EnerNOC will conduct additional conversations with other administrators, customer representatives, and community organizations to ensure that the program is delivered through a collaborative approach.

Fuel Integration

The program will focus on both electricity and gas, and generate savings for both fuels. The approach does not favor one fuel over another. The electric impacts will be more significant, given that the end-uses targeted are more weighted towards electricity. The program will address both electric and gas savings through a single customer contact.

Transparency

The data identified in Appendix A (i.e. the Sample Scorecard report) will be made available to end-users as well as program administrators, to ensure full transparency.

Procurement

EnerNOC will perform all functions specified in this proposal and will not procure any functions through a competitive bid.

Appendix A - Technical Documentation

1 The EnerNOC Solution

EnerNOC's full-service solution is built on non-proprietary, open-architecture, scalable, and economical technology. This platform is used to design, customize, and quickly deploy a variety of energy management solutions that deliver reliable and economical results. EnerNOC's solution has three main components:

- The EnerNOC **Network Operations Center**, or NOC, our centralized communication infrastructure where we manage and store data, and from which we are remotely connected to all our customers sites;
- Remote **EnerNOC Site Servers** (ESS) and **BMS Gateways**, advanced metering and communications nodes located at each end-user site, and that collect local data from meters and building controls systems;
- **PowerTrak®**, EnerNOC's proprietary web-based energy management platform, hosted at the NOC and available to any users with an Internet connection.

1.1 The Network Operations Center (NOC)

Much like a utility control center, the NOC combines advanced software, internet communications, and highly-skilled professionals to collect and present end-user energy consumption and process data, initiate remote commands, and continuously monitor the status of remote sites. The NOC connects to each site through a communications node called the EnerNOC Site Server, or ESS.

The NOC utilizes a comprehensive security infrastructure, including firewalls, intrusion detection systems, and encryption for transmissions over the Internet. The NOC, illustrated in Figure 1, is staffed around the clock, 365 days a year.

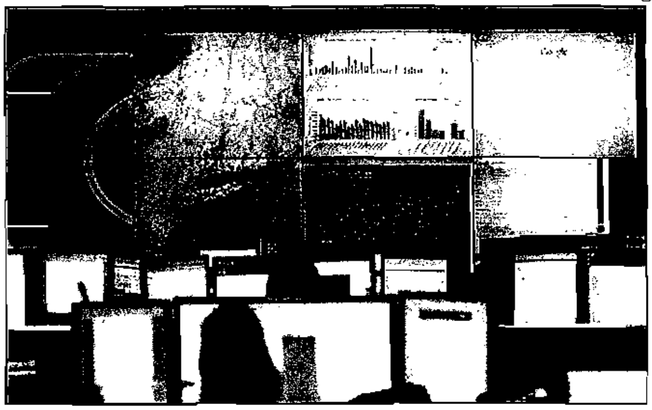


Figure 1 - EnerNOC Network Operations Center

1.2 The EnerNOC Site Servers and BMS Gateways

EnerNOC Site Servers

The ESS serves as a gateway to connect the NOC with a variety of data collection systems and equipment at end-use customer sites. The ESS is typically installed in the electrical room at a customer's site. It is connected to the site's local network, and it includes a Web service software application which enables the secure, bi-directional transfer of data across firewalls and over the Internet. In some instances, EnerNOC may need to install multiple ESS's per building.

All meters involved in this implementation will be connected to the ESS via pulse block connections or via Modbus protocol. The ESS will collect and store all data captured by the meters, and will make that data available, in near real-time, to EnerNOC's Network Operations Center via PowerTrak.

Figure 2 - ESS Gateway

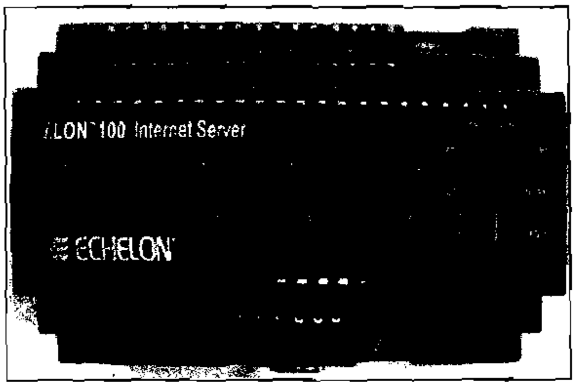


Figure 3 - Echelon iLon

This universal connectivity allows us to leverage a customer's existing infrastructure investment, lowering our overall cost of enablement and making data available to corporate networks and the Internet through industry standard communication protocols. Figure 2 and Figure 3 illustrate the installation of an ESS at a customer site.

BMS Gateway

If data from a building management system (BMS) is required, then a BMS Gateway will also be installed at each location, and will be connected to the local Intranet. This gateway will collect BMS point information via a standard open protocol called BACnet/IP. The Gateway will typically be located at the campus control room where the BMS workstation is located.

1.3 PowerTrak

PowerTrak is a Web-based enterprise energy management software platform used for power measurement, load control and energy analysis. Powertrak is built on Linux, Java and Oracle technologies, and operates an open Web services architecture. PowerTrak handles many vital data acquisition tasks. PowerTrak is a hosted application, meaning that it requires no installation of any physical hardware or software. Users with access to an Internet connection have access to PowerTrak. The diagram in Figure 4 provides an overview of the PowerTrak system architecture.

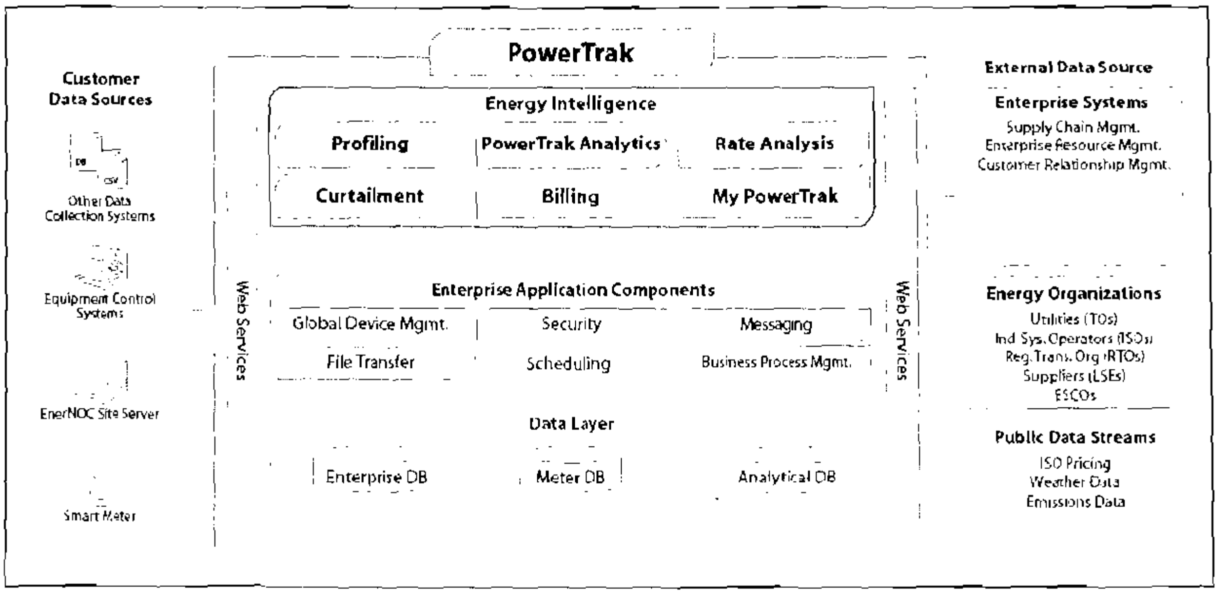


Figure 4 - PowerTrak Architecture

PowerTrak collects facility consumption data on a 1-minute, 5-minute, 15-minute and hourly basis, and integrates that data with real-time, historical, and forecasted market variables. PowerTrak can be used to measure, manage, benchmark, and optimize end-use customers' energy consumption and facility operations. In particular, PowerTrak supports the following business processes:

- Analyzing energy consumption patterns;
- Forecasting energy demand;
- Measure the real-time performance of sites during demand response events;
- Continuously monitoring building management equipment to optimize system operations;
- Model rates and tariffs to turn energy data into cost data;
- Creating energy scorecards to benchmark similar facilities.

In addition, PowerTrak enables us to track each end-use customer's greenhouse gas emissions by mapping their energy consumption with the generation fuel mix in their location (e.g., coal, nuclear, natural gas, and fuel oil).

1.4 PowerTrak Data Layer

The PowerTrak data layer is a relational database that is designed for query, analysis and transaction processing. It contains historical energy data and data from other sources. It separates analysis workload from transaction workload and enables us to consolidate data from several sources. These records include customer demographics, interval energy information (e.g. 1-minute, 5-minute, 15-minute), building management system data, weather data, emissions data, aggregated summary data, and pricing data.

1.5 PowerTrak Data Warehousing and Scalability Capabilities

The PowerTrak application is built on Linux, JAVA and Oracle technologies. We are using Oracle RAC (Real Application Clusters) as the data warehouse. As we scale to ten's of thousands of points, Oracle RAC enables the deployment of a single database across a cluster of servers, which is the foundation for grid computing. This strategy offers the following advantages:

We can expand capacity by simply adding low-cost commodity hardware (e.g. servers and disk arrays to our cluster on demand);

No PowerTrak application changes are necessary;

The application does not have to be taken offline, providing 24/7 availability for continuous uptime for database applications.

PowerTrak is a tiered Service Oriented Architecture. The Presentation Tier provides browser-based (HTML, AJAX or RSS) user interfaces or a service interface for any business process using SOAP, as well as Java calls. The Middle Tier implements business processes using application server, Business Process Workflow (BPEL or JBI) and Enterprise Application Integration (EAI) technologies. The Enterprise Tier provides access to data, services and security.

1.6 PowerTrak Functional Capabilities

PowerTrak offers extensive energy management and analysis capabilities. A general overview of these capabilities is provided below, organized by functional area.

Meter Aggregation

Using a tree-based hierarchical structure the user can assign metering/monitoring devices to a group and view aggregated reports on the virtual/aggregated group. These groups can represent geographical regions, business units, utility territories, etc.

Energy Profiling

Energy Profiling displays various types of energy data, and provides the capability to merge, overlay, and compare it with other key data streams such as energy pricing, weather, and energy budgets. In addition, data summarization features allow users to understand the implications of facility activities over defined intervals. Multiple facilities and data streams can be easily compared using a powerful, graphical user interface.

Bulk Data Export

Bulk Data Export allows the user to export detailed energy interval data for a user-specified period of time for any meter or set of meters, in aggregate or individually, from PowerTrak into a .csv (comma separated value) file. various file. This data can be used for many purposes, including detailed analysis, third-party commodity procurement negotiation, etc.

Alerts and Alarms

PowerTrak's alerting and alarming capabilities allow users to set static thresholds for any incoming data sources (e.g., temperature, kW, kWh, therms, GPM, etc.). Notification can be configured to deliver emails and pages. Notification types are user defined and can include certain information, including time, alarm type, and actual monitored data value at time of alarm. All alerts and alarms are delivered in real-time to ensure a prompt resolution.

External Data Feeds

PowerTrak integrates publicly-available data streams such as energy market real-time prices, weather data (e.g., wet-bulb temp, humidity, atmospheric pressure), and other subscription-based data streams as users request. This data can be used to normalize commodity data (e.g., electricity usage per degree day) across facilities and provide insight into energy usage.

Forecasting

PowerTrak provides a powerful forecasting tool that allows users to forecast any commodity consumption and demand against past consumption using sophisticated stochastic and historic variables. Forecasts can also be created for actual bills, based on a combination of user-defined tariffs and consumption data, which provide monthly and annual plans.

Tariff Builder

The Tariff Builder allows users to replicate utility tariffs (e.g., gas bill, electric bill) in order to generate shadow bills, forecasted bills, and to track against actual bills received. Because PowerTrak captures actual utility meter interval data in real-time, the data is identical to what the utility captures. However, the utility may not always bill correctly and this functionality provides powerful fact checking functionality. Additionally, the Tariff Builder provides a bill presentment functionality that enables the generation, viewing, and exporting of estimated billing information.

Reporting

Reporting makes available a standard library of reports to centralize facility and customer data for benchmarking and financial analysis. The following are a sample of available reports:

- Load Duration Curve
- Load Factor Peak Demand Variance
- Hourly Demand vs. Temp
- Building Rankings by Usage per Sq. Ft
- Daily Min/Max Demand Chart
- Billing Report
- Emissions Footprint
- Usage vs. Baseline

Cognos ReportNet

Cognos ReportNet is one of the most advanced business intelligence reporting applications available. PowerTrak has integrated the full power of Cognos ReportNet into the system, allowing users to view powerful reports developed from any available data source in PowerTrak. Reports can be scheduled to run at user-defined times and be distributed to user-defined groups and individuals.

Emissions Reporting

PowerTrak calculates a facility's "emissions footprint" by capturing regional power generation emissions statistics, as reported directly from the Environmental Protection Agency. Using a facility's State, Utility and real-time energy consumption, PowerTrak is able to provide detailed particulate emissions profiles from the power consumed by the facility.

Data Capture and Storage

PowerTrak stores data for a minimum of three years. Customers can choose to archive data after this time frame or simply pay for continued data storage at a predetermined price.

2 Sample EnerNOC Monitoring Based Commissioning Report

The following pages contain a sample report detailing the information that EnerNOC provides to its MBCx customers on a monthly basis. Note that the reports provide information on the overall energy picture, along with specific recommendations for measures. These reports form the cornerstone of the MBCx approach. They provide the necessary visibility to the customer on all of their energy cost drivers, and provide recommendations for continuing to reduce energy usage and ensuring persistence of savings. Please note that EnerNOC has obtained permission from the customer to use the data and reports shown below.

Redacted ScoreCard

Appendix B - Technical Work Paper

EnerNOC, Inc.

Monitoring Based Commissioning (MBCx)

August 1, 2008

1 At a Glance Summary

Measure Name	Monitoring Based Commissioning (MBCx)
Savings Impacts Common Units	Customer
Customer Base Case Description	Existing building condition
Code Base Case Description	Same as Customer Base Case
Costs Common Units	Customer
ASHRAE Climate Zone	10B, 11B, 12B, 13A, 14A, 15, 16
Building Type	Educational, Commercial Property, Government
Building Vintage	1978 – 2004
Measure Equipment Cost ($/unit)	Not Applicable
Measure Incremental Cost ($/unit)	Not Applicable
Measure Installed Cost ($/unit)	Varies, see "Measure Installed Cost" column in next table
Effective Useful Life (EUL) in years	5 years
Program Type	Retrofit
Time of Use (TOU) AC Adjustment	0%
Important Comments	Measures, energy savings, and demand reduction are highly building and project specific. Although there are certain "standard" types of equipment and system configurations, HVAC and lighting systems in larger buildings are unique and "custom" for a specific building, with a specific occupancy, schedule, orientation, climate zone, etc.

Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Customer Annual Therms Savings (Thm/unit)	Measure Installed Cost ($/unit)
Monitoring Based Commissioning	893,000	92	30,000	$83,230

Table of Contents

General Measure and Baseline Data

1.1 Measure Description and Background

Monitoring Based Commissioning is a relatively new energy efficiency application. Broadly speaking, it refers to the combination of retro-commissioning and continuous commissioning & verification activities, coupled with ongoing, technology-based monitoring to ensure persistence of savings. Selected facilities are analyzed to identify and implement cost-effective retro-commissioning activities that typically require little or no capital investment. During the implementation phase, monitoring technology is installed at each facility to capture energy usage data from interval meters, as well as to interface with building control or energy management systems (BCS/EMS). This data is then used to create benchmarks for optimal building operations, and also to continuously track building operation and performance. Since all buildings invariably drift away from optimal operations, the ongoing monitoring ensures that building managers are alerted to any issues as they arise, and can then take appropriate remedial action on a timely basis.

EnerNOC has developed a unique and powerful approach to Monitoring Based Commissioning. We have pioneered this approach with some of our existing customers, and have been able to achieve significant energy savings. Our Monitoring Based Commissioning approach is as follows:

- EnerNOC will install the appropriate meters at all customer sites to collect electric and gas information on a campus/master meter-level, as well as electric and gas data at appropriate building or facilities, and BTU consumption for CHW and HW systems, also for select buildings. EnerNOC will also interface with the relevant points in the Building Management Systems (BCS) on these sites.

- The information will be collected in near real-time at user-adjustable sample rates, and warehoused at our Network Operations Center (NOC) via our PowerTrak® application. Any user with access to the Internet, and with the proper credentials, will be able to view both meter and BCS data using a simple browser interface.

- EnerNOC will establish benchmarks for all buildings monitored using data published by the International Facility Management Association or other appropriate sources. Once the benchmarks are established and calibrated, EnerNOC will compare building usage to benchmarks to identify potential areas of energy savings.

- The energy savings from MBCx is comprised of the aggregated savings from multiple measures. These measures are identified from anomalies or faults visible through the host facility BCS system. Since the BCS system is mostly controlling and monitoring facility HVAC systems the measures are typically identified in these end-use categories.

The following is a list of end-use systems and measures that are most commonly addressed by MBCx:

EnerNOC- Typical MBCx Measures*	
General Fault Detection and Diagnostics (FDD)	Setpoint Error Tracking Sensor range checking Operating parameter out of range Pinned or flatlined sensor Actual vs. Intended Schedule Analysis Equipment Manual Override Detection Excessive Equipment Cycling
Zones	Setpoint Analysis Heating Seback Cooling Setforward Air Starvation Analysis Zone Comfort Analysis Indoor Air Quality Analysis
Air Handling Units	Economizer Operation Simultaneous Heating and Cooling Excessive or inadequate ventilation Demand Ventilation Air starvation Static pressure analysis Schedule Heating/Cooling Coil Efficiency Leaking Valve Optimum Start/Stop Analysis Air Filter Analysis - Dirty Filter
Terminal Units	Variable Air Volume Analysis Zone Reheat VAV Box Damper Modulation
Cooling Plant	Chiller Performance analysis - kW/Ton Optimum Chilled Water Supply Temperature Optimum staging Optimum Condenser Water Supply Temperature Cooling Tower Fan Efficiency Low/High Temperature Differential Analysis Optimum Flow analysis Optimum Pump Utilization Optimum Thermal Storage Utilization
Heating Plant	Boiler Sequencing Optimization Boiler Air Preheat Boiler Combustion Controls Boiler Economizer Boiler Combustion Efficiency Boiler Burners Performance Boiler Blowdown Boiler Efficiency Optimum Pump Utilization

** Varies depending on point suffiency and anomaly detection*

1.2 Codes and Standards Requirements Analysis

The measures described here are not governed by codes and standards since they generally only involve adjustments to existing equipment. ASHRAE has a guideline for Commissioning but not for Retro-commissioning or Monitoring Based Commissioning. Examples of typical MBCx measures may include economizer control adjustments; excessive equipment runtime set-points vs. actual variations, VAV-Box hunting, heating/cooling valve hunting, chilled water temperature reset schedule modifications, pumps, flow adjustments, simultaneous heating and cooling, etc.

1.3 EM&V, Market Potential, and Other Studies

The most recent study on the evaluation, measurement and verification relevant to this measure was done by Brown, Anderson and Harris, 2007[1]. That study reviewed the energy savings results of the 2004-05 MBCx pilot program for UC/CSU/IOU. The median savings of 10% of the baseline source energy was cited for this program. The authors also concluded that colder climates tended to have slightly lower savings than higher or more humid climates.

1.4 Base Cases and Measure Effective Useful Lives

Since MBCx can be applied to a wide variety of building components and systems, and because of the wide range of potential measures, it is difficult to establish a common measure effective useful life (EUL). In general, the maximum measure life for an MBCx measure cannot exceed the life of the equipment or system undergoing improvement.

The literature cites a wide range of measure life estimates. In the paper by LBNL and SMUD on "An Evaluation of Savings and Measure Persistence from Retro-commissioning of Large Commercial Building", 2004[2], measures tended to retain 80% of their initial energy saving into the fourth year. Since the MBCx program is intended to continuously monitor the facilities for a three year period, this should delay the onset of diminished savings until after the Monitoring aspect is discontinued. Continuous or on-going monitoring is intended to maintain saving performance since any changes to the 'improvements' will be identified and addressed, thus minimizing the impact of inevitable drift. For the purpose of this Work Paper, the EUL will be set for five years.

2 Calculation Methods

2.1 Energy Savings Estimation Methodologies

As part of the MBCx measure, calculations for each indentified measure will be made. This measure specific or "bottom-up" approach builds on the traditional retro-commissioning approach by isolating specific measures or opportunities within building systems (central plant, air distribution, terminal devices) or sub-systems (chillers, air handlers, sensors and valves etc). Each opportunity is identified through fault detection (FD) using powerful automatic filters and visualization schemes to identify faults and optimization opportunities. Once an opportunity is identified, it is flagged for further evaluation, including validation, possible diagnostic and remediation. Energy savings are calculated on a stand-alone basis along with cost savings.

Since equipment is being continuously monitored a combination of engineering computations and continuous measurement of proxies for energy use is utilized as the base case. With this method, dynamic parameters, such as flow, temperatures, speeds, etc. will be measured directly and supplied to engineering equipment models which are developed around actual field conditions. Industry standard methodology, such as ASHRAE Standards is used to annualize energy consumption and savings. The BIN method, combined with Typical Meteorological Year (TMY3 data is now available and will be used for this program) data is most often used to determine the annual energy consumption or savings associated with recommendations identified through the MBCx process. As seasonal and annual consumption histories are complete, actual system energy consumption can be derived directly from the accumulation of the streaming data from the host facility.

Even when the Owner has not chosen the package of measures to implement yet, accounting for interactions is important because this simple payback calculation must be sufficiently accurate to determine which measures will be implemented and allow the Program to correctly allocate incentive payments. After measures are implemented, 'Updated Annual Savings' are calculated for the Implementation Summary Table including interactions of the selected group of measures.

For consistency between estimated and verified savings, MBCx deploys a measure calculation and verification approach using two industry standard calculation and verification methods. These are derived from the International Performance Measurement and Verification (IPMVP) where Options (B and C) are used to bring confluence between energy savings estimates communicated to the customer for implementation (Option B), and overall program performance delivered to SCE (Option C). The following summarizes the MBCx calculation and verification approach:

The savings for the MBCx program are expected to be in the 10% range. According the IPMVP this is the threshold given for the effective use of Option C: Whole Building Monitoring. In this savings range, factors such as occupancy schedules, production, and weather, and unaffected loads such as plug loads, can make it difficult to isolate the true measure impact. However, because the MBCx measures affect the whole building and often interact with other measures, the Option C approach is desirable, provided it can be combined with an effective mechanism for isolating external factors. Wherever the Option C approach introduces significant noise, The

MBCx program uses Option B to document and fill in for factors that interfere with the accurate use of Option C.

The plan can be summarized as follows:

- Option B, the combination of engineering computations and continuous measurement of energy proxies, will be utilized to determine the ongoing savings estimates to the customer.

- Option C, whole building metering, will be used to true-up the savings after the completion of measure implementation.

- Parameters monitored in the Option B approach will be used for mitigating external factors that affect energy consumption, and which are outside of the scope of the implemented measures. This includes the monitoring of system operating factors during, before, and after the Option C energy baseline is developed.

- A comparison between the "bottom-up" Option B results will be compared to the "top-down" Option C results. The Option C baseline and post-installation energy consumption will remain the primary performance criteria in EnerNOC's M&V approach, but whenever static or noise factors interfere, Option B results will be used to supplement measure isolated results for performance verification.

In this program the aggregated Option B results will be considered equivalent to the Option C results whenever the two options are within ±10% confluence.

A complete list of findings, derived for an actual customer, can be found in Appendix A, which is the source of the data presented in the various summary tables. The following are example of savings calculations for various findings typical of the MBCx measure. They are highlighted in yellow in the complete list of findings.

Example 1: AHU running continuously

An air-handler fan was found to be operating continuously during the month of April regardless of occupancy and programmed schedule. Using the general filter and parameter out of range (POOR) aspect of PowerTrak®, this air handler was flagged as violating it's scheduled rules and was investigated by analysts to verify that it was not a false positive and determine what the savings would be based on actual off-scheduled performance. The air-handler is equipped with a variable speed drive, so the average speed during the off-hours time period was used to calculate savings potential from turning off the unit during un-occupied hours.

Energy Savings are evaluated as follows:

$$kWh_{savings} = kW_{fan} \times (Hours_{pre} - Hours_{post})$$

The power draw of the air-handler fan motor was based on drive monitored output rather than using its nameplate rating since the motor was not running at peak capacity during the off-hours. Figure 1 shows the measurements for this measure:

AHU-3 Motor Size	25-hp
Power Reading from Drive	
kW_{max}	15.54-kW
$kW_{avg\text{-}offHrs}$	6.33-kW

	Existing Schedule		Proposed Schedule	
	Weekdays	Weekend	Weekdays	Weekend
StartTime	00:00	00:00	08:00	08:00
Stop Time	23:59	23:59	21:00	21:00
Hours	24	24	13	13
Days	260	104	260	104
Total Hours:	6236	2494	3380	1352

Figure 1 Fan motor Power Measurement (Example 1 Calculation)

Inserting the Figure 1 numbers into the savings equation, Figure 2 shows the following savings:

		Existing			Proposed			Savings	
		kW	Hours	kWh	kW	Hours	kWh	kWh savings	% of Savings
Summer	on-peak								
	off-peak	6.33-kW	1683	10,653	6.33-kW	0	0	10,653	41.9%
Winter	on-peak								
	off-peak	6.33-kW	2332	14,762	6.33-kW	0	0	14,762	58.1%
Totals			4015	25,415		0	0	25,415	100.0%

Figure 2 Measurement Savings (Example 1 Calculation)

Since the new schedule does not turn the fan motor off during the peak demand period, there are no demand reduction associated with particular measure.

<u>Example 2: Economizer not modulating / fixed at maximum position</u>

Using the general filter and parameter out of range (POOR) aspect of PowerTrak®, this air handler was flagged as violating it's economizer rules, mixed air temperature too high, and was investigated by analysis to verify that it was not a false positive and then determine what the savings would be based on intended operational performance.

With the Outside air damper stuck at 100% open, too much OA is used during all but the temperature Bins between the SAT of 55°F and the RAT of 75°F where 100% OA would be the norm. Figure 3 below shows the Bin temperature and Hours of occurrence at various 4-hour time intervals. This allows for a better match to actual occupancy usage than the standard three, eight-hour shifts. The bin data is based on the TMY2-8760 weather data used in EnergyPlus. Since TMY3 weather data is now available, the new 4-hour time intervals will be populated using this newest weather format. The calculations in the example used TMY2 since that was all that was available at the time. The technique shown will not change, only the source of the weather data will.

BIN Temp	Annual — Observation Hour Grp: 0 TO 4	4 TO 8	8 TO 12	12 TO 16	16 TO 20	20 TO 24	Free Clng/Htng	Un-Occupied Hours	Un-Occupied Avg Temp	Occupied Hours	Occupied Avg Temp
112.5											
107.5											
102.5				1							
97.5			1	12	1						
92.5			8	34	12						
87.5			41	80	34						
82.5		6	90	140	89	12					
77.5	18	37	126	119	100	49		39.5	77.9	970.5	82.0
72.5	56	62	104	95	102	83	Free Clng/Htng				
67.5	111	121	112	99	134	129					
62.5	161	156	142	127	151	197		Un-Occupied		Occupied	
57.5	146	169	113	100	105	134		Hours	Avg Temp	Hours	Avg Temp
52.5	170	130	109	113	91	118					
47.5	90	80	68	65	82	89					
42.5	99	110	96	92	111	108					
37.5	144	120	120	126	128	155					
32.5	156	134	111	109	116	108					
27.5	74	93	76	57	77	84					
22.5	77	79	55	44	52	68					
17.5	68	69	42	24	37	67					
12.5	45	28	18	15	21	28					
7.5	21	39	19	8	15	18					
2.5	13	15	7		2	10					
-2.5	11	11	2			3					
-7.5		1									
-12.5											
-17.5											
-22.5											
-27.5											
-32.5								1423	34.3	3419	35.5
Average OAT when MAT at min OAT of 25% would be less than 55°F										37.5	-0.8

Grey is Un-Occupied

White is Occupied

57.5°F to 72.5°F is free cooling/heating at 100% OAT

Figure 3 Hours and Avg OAT at 100% OA and at 25% OA (Example 2 Calculation)

The minimum economizer outside air fraction should be at 25% percent but is currently at 100%. The post-retrofit economizer will control the amount of outside air from the 25% minimum, when MAT is less than SAT or OAT is greater than RAT or otherwise be at 100%.

The savings will be as follows:

Existing

Eq1= [CFM x 1.1 x ΔT x Hrs] / (100,000 x 80%)
Eq2= SAT - OAT = ΔT (when OAT is less than 55F)

Heating Usage during Occupied Period

AVG CFM	ΔT	Hours - Healing Occ-Hours	Heating Therms	Existing Heating Cost
25,000	31.52	3,418.50	37,036.02	$25,924.52
SAT	OAT	ΔT		
67.00	35.48	31.52		

Proposed

Eq1= [CFM x 1.1 x ΔT x Hrs] / (100,000 x 80%)
Eq2= SAT - OAT = ΔT (when OAT is less than 55F)

Heating Usage during Occupied Period

AVG CFM	ΔT	Hours - Heating Occ-Hours	Heating Therms	Proposed Heating Cost
20,000	1.20	37.50	12.37	$8.66
SAT	OAT	RAT	MAT	ΔT
55.00	-0.80	72.00	53.80	1.20

Existing

Eq3= [CFM x 1.08 x ΔT x Hrs] / (12,000 x 0.8-kW/ton)
Eq2= OAT - SAT = ΔT (when OAT is greater than 74F)

Cooling Usage during Occupied Period

AVG CFM	ΔT	Hours - Heating Occ-Hours	kWh	Existing Cooling Cost
25,000	26.97	970.50	47,108.25	$7,537.32
OAT	RAT	SAT	ΔT	
81.97	75.00	55.00	26.97	

Proposed

Eq3= [CFM x 1.08 x ΔT x Hrs] / (12,000 x 0.8-kW/ton)
Eq2= MAT - SAT = ΔT (when OAT is greater than 74F)

Cooling Usage during Occupied Period

AVG CFM	ΔT	Hours - Heating Occ-Hours	kWh	Proposed Cooling Cost
20,000	21.05	970.50	29,410.83	$4,705.73
OAT	RAT	MAT	SAT	ΔT
81.97	75.00	76.05	55.00	21.05

Existing

Eq4= [kW x Hrs] when OAT is less than 55F
At full speed due to too high and SAT, Actual Data

Existing Fan Operation

kW	Hours - Heating Occupied	kWh Saved	Fan Cost Savings
15.54	4,389.00	68,212.38	$10,913.98

Proposed

Eq4= [kW x Hrs] when OAT is less than 55F
Assumes an 80% speed as an avg with a lower SAT

Proposed Fan Operation

kW	Hours - Heating Occupied	kWh Saved	Fan Cost Savings
9.30	4,389.00	40,829.13	$6,532.66

Savings

Existing Cost		Proposed Cost		Avoided Cost		Therms		Energy	
Heating	$25,924.52	Heating	$8.66	Heating	$25,915.86	Existing	37,035.02	Existing	115,320.63
Cooling	$7,537.32	Cooling	$4,705.73	Cooling	$2,831.59	Proposed	12.37	Proposed	70,239.96
Fan	$10,913.98	Fan	$6,532.66	Fan	$4,381.32	Avoided	37,022.65	Avoided	45,080.66
				Total	$33,128.76				

Average cost: $0.16/kWh and $0.70/Therm

Peak and Demand Savings

Month	Max Temp	RAT	MAT At 100%	MAT At 25%	DAT	ΔT At 100%	ΔT At 25%	Diff	kW
May	87.5	75.0	87.5	78.13	55.0	32.5	23.1	9.4	26.37
Jun	92.5	75.0	92 5	79 38	55.0	37.5	24.4	13.1	36.91
Jul	97.5	75.0	97.5	80.63	55.0	42.5	25.6	16.9	47.46
Aug	102.5	75 0	102.5	81.88	55.0	47.5	26.9	20 6	58.01
Sep	92.5	75.0	92.5	79.38	55.0	37.5	24.4	13.1	36.91
							Avergae Demand Reduction		41.13

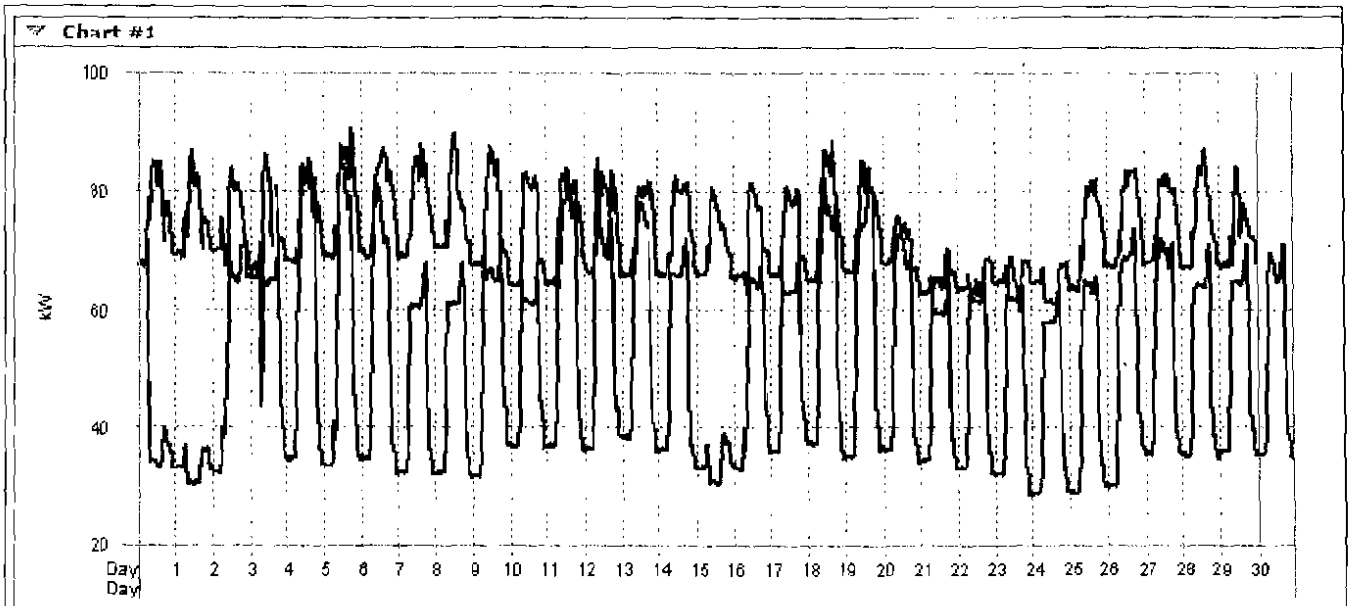
Uses Eq 3 and 25,000-cfm in both cases assuming that full speed is needed under peak conditions each month.

Figure 4 Electric and Thermal Savings from Fixing OA Damper (Example 2 Calculation)

Example 3: Building Load factor too high for building class at this site

Not all the buildings on a campus are connected to the BCS, but analyzing the interval meter data, a relative assessment of performance can be determined. In this example, one building designated as a classroom building consistently had a load factor of over 70% when all other classroom buildings at this site ranged between LFs of 50% and 60%. After review of the building's intended operation by scheduled building 'open' hours, it was determined that this building should have a lower load factor. By calculating the energy wasted by not being able to schedule lights and HVAC equipment off, the customer decided to expand the campus DDC controls into this space. The load factor/profile after implementation clearly shows the building performing to estimate. Continuous monitoring will flag the building if the load factor creeps above a 'high' threshold.

As can be seen in Figure 5 below, the Load Factor for November was 78% while in December, after implementing the BCS controls, the Load Factor dropped to 59%. To calculate annual savings, the actual previous 12-month usage was adjusted to the new load factor of 60%. Since all energy savings are off-hours, no demand savings were calculated.



Higgins Hall (Calculated Electricity Average Demand)	
Data Sample:	Please roll-over the chart above.
Source:	Higgins Hall
Property:	Calculated Electricity Average Demand: kW
Date & Time:	11/01/07 00:01 EDT ~ 12/01/07 00:00 EST
Data Read Interval:	1 Hour
Maximum:	90.81kW @ 11/06/2007 23:00 GMT
Minimum:	59.13kW @ 11/22/2007 20:00 GMT
Load Factor:	0.7819

Higgins Hall (Calculated Electricity Average Demand)	
Data Sample:	Please roll-over the chart above.
Source:	Higgins Hall
Property:	Calculated Electricity Average Demand: kW
Date & Time:	12/01/07 00:01 EST ~ 01/01/08 00:00 EST
Data Read Interval:	1 Hour
Maximum:	87.57kW @ 12/10/2007 18:00 GMT
Minimum:	28.53kW @ 12/25/2007 04:00 GMT
Load Factor:	0.5938

Figure 5 Load Factor too high/install BCS controls (Example 3 Calculation)

	Days	Actual kWh	Pk-kW	LF	New-LF	Proposed kWh	Reduction kWh
Dec-06	31	50,371	84.87	79.8%	60.0%	37,886	12,485
Jan-07	28	51,315	93.96	81.3%	60.0%	37,885	13,431
Feb-07	31	48,610	89.64	72.9%	60.0%	40,015	8,595
Mar-07	30	52,314	88.47	82.1%	60.0%	38,219	14,095
Apr-07	31	51,521	107.37	64.5%	60.0%	47,930	3,591
May-07	30	55,399	100.26	76.7%	60.0%	43,312	12,087
Jun-07	31	46,138	81.54	76.1%	60.0%	36,399	9,739
Jul-07	31	49,708	83.97	79.6%	60.0%	37,484	12,223
Aug-07	30	85,462	168.93	70.3%	60.0%	72,978	12,484
Sep-07	31	72,460	170.00	57.3%	57.3%	72,460	0
Oct-07	30	46,734	153.45	42.3%	42.3%	46,734	0
Nov-07	31	51,571	90.81	76.3%	60.0%	40,538	11,033
							109,763

After BMS installation

	Days	Actual kWh	Pk-kW	LF
Dec-07	31	39,016	87.57	59.9%

The above were examples of the techniques use to establish annualized savings for each finding that allows the customer to rank order implementation. Table 3 represents a roll-up of the aggregated measure impact of MBCx. The full list of measure comprising MBCx from an actual customer site can be found in the Appendix.

Table 2 Example of Annual Energy Savings Summary

Examples of Finding typical of the MBCx Measure	ASHRAE Climate Zone	Unit Definition	Gross Unit Saved	Gross kW Reduced	Affected Building Area	Gross Unit/ square foot
Monitoring Based Commissioning	12a	kWh	893,000	92	1,039,869	0.859
	12a	Therms	30,000	0	1,039,869	0.0289

2.2 Demand Reduction Estimation Methodologies

For the MBCx Program, demand reduction is defined as the reduction in the building's maximum demand during the peak demand period, i.e., average of 9 am to 5 pm during weekdays. All reductions in peak demand are reported in the Findings Workbook and supported by calculations or modeling.

For example, changing the set-points of an air-side economizer will probably not result in a peak demand reduction since it would only impact energy use during non-peak periods when the outdoor air temperature is well below peak temperatures. Changing the fan static pressure setting, fan speed limiting or space temperature reset will have an impact during the demand period. Savings can be documented based on regression or by the prevalent Demand Response program Baseline technique, while continuous monitoring of the BCS will ensure that IAQ stays within the acceptable norm albeit at the higher end during such time periods.

In 2007, the measures completed in our example most of the projects only saved energy during part-load conditions, and therefore, did not impact the peak demand. There are a few measures, such as the OA-damper stuck at 100% and other SAT/MAT set-point changes that will save peak demand and will be documented/calculated as shown in the example based on the TYM2 Bin data (TMY3 has only recently been available) for the appropriate time frame and average for the season.

3 Base Case and Measure Costs

3.1 Base Case Costs

Since the base case is the "as-is" condition of the building, there are no costs associated with the base case.

3.2 Measure Costs

The forecast cost basis for the MBCx Program is $0.51/sf based upon the paper by K. Brown, M. Anderson and J. Harris, 2007. In this study, the scope includes review the 13 buildings that participate in the MBCx pilot program during 2004-05 and calculates average cost and savings based on actual cost and savings per site as self reported. The focus on MBCx is low-cost operational and maintenance improvements rather than equipment replacement, but can include upgrades to existing equipment like expanding BCS DDC control. MBCx includes control programming, scheduling changes, control settings and set-point improvements, and some small material costs like the addition of critical sensors, BTU meters, and gas meters. It doesn't include such items as chillers, lighting, and motor replacements.

In this Brown et.al. study, the average MBCx cost for all of the buildings of different types was $0.51/sf. However, the MBCx costs vary dramatically with the objectives of the effort, the specific scope of services, and the size of the building. As noted in prior sections, the determination of the cost for MBCx projects will be made on a case-by-case basis.

For the College/University project completed in 2007, the total installed cost was $83,230. Note that the affected building area varied by measure. The Air Handler measures were limited to the area that each systems serves, while the Whole Building Control measure used the gross square footage and no other measures applied to that building. On aggregate this resulted in a measure cost of $0.080/square foot. Note that the costs per square foot are substantially lower than the forecasted cost. There are a number of possible reasons that include:

- The measures identified at the site were the most cost effective of a much larger pool of projects (selection of the "lowest hanging fruit" measures).
- The College-University is in a much different climate zone (CTZ 15-equivalent) than the projects in the Brown study (more energy savings due to higher overall energy use).

The measures were able to make use of in-house labor/parts which could be significantly less cost than outsourcing for the types of measures implemented Table 3 summarizes the measure savings and costs for 2007:

Table 3 Measure Cost Summary

Measure Name	Gross Therms Saved	Gross kWh Saved	Gross kW Reduced	Affected Building Area	Cost	Cost per Sq Ft
Monitoring Based Commissioning	30,000	893,00	92	1,039,869	83,230	0.080

Major equipment maintenance items that result in energy savings and have a greater tendency to persist are considered eligible measures if they are performed due to, or in conjunction with, the MBCx work. If major maintenance items that have long term persistence are found, such as fixing leaking or failed valves, actuator or damper operation, or leaks causing low refrigerant charge, is identified by the MBCx Provider, these should be included in the *Master List of Findings*.

Also, while testing, adjusting, and balancing (TAB) are not considered part of the scope of MBCx, it may be part of a larger scope of work negotiated with the Owner. In these cases, the MBCx Provider should record savings associated with the TAB work following these requirements:

- The TAB work is done because of the MBCx Program and would not otherwise be done.
- The TAB work corrects a deficiency and results in energy savings.

The Program may include limited controls enhancements such as variable frequency drives installed on existing motors to replace variable-pitch vane axial fan controls, occupancy sensors to permit advanced control of existing systems, and additional capabilities added to existing energy management systems. These may be eligible under the Program, if they meet the following qualifications:

- The measure must enhance or restore the operation of an existing piece of equipment or a system.
- The measure must have a simple payback of no more than four years.
- The cost of the measure must be no more than 10% of the cost of the existing system that it enhances, as estimated using the most recent version of the RS Means Building Construction Cost Data.

Note that the costs described here are the measure implementation costs, not the costs of installing the monitoring equipment associated with enabling sites for MBCx. These costs are considered to be outside of the measure costs, and are estimated to amount to about $25,000 per customer.

3.3 Incremental and Full Measure Costs

Since there is generally no base case costs, the measure costs would be equivalent to the installation costs of the MBCx measures.

Appendix

The appendix contains, on the next page, a table of all findings at a customer site which comprise the measure specific and overall MBCx program savings and costs.

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Report Parameters

Start Date. January 1, 2007

End Date: December 31, 2007

Number of Findings Identufued: 43

Building	System Type	System	Description	Recommendation	Annual Avoided Cost	Annual Avoided Therms	Annual Avoided kWh	Peak Avoided kW	Est. Implementation Cost
Science Building	AHU	AHU-3 C Wing	Units operating off Schedule.	Put system in Auto.	$11,130	659	66,681	0	$470.00
Science Building	AHU	AHU-7 Common Area	Units operating off Schedule.	Put system in Auto.	$22,640	1,395	135,397	0	$470.00
Science Building	AHU	AHU-7 Common Area	static pressure setting is higher than needed.	Reduce sp setting by 20%.	$22,110	0	138,190	6	$470 00
Library	Hot Water	HX	20°F-60°F OA to 140°F - 200°F reset schedule. At 45°F OAT, 161°F HWS and 157°F HWR Value is too high. Don't need water that hot.	Change control range to 0°F-60°F OA and 110°F-190°F HWS.	$270	380	0		$470.00
Library	AHU	AHU-3	Fan speed is always 100%. Can not get to 1 " set point. Low ZN temp is 71°F+. OAD is 100%. If 51°F OA, why is DAT over 67°F. Do dampers function properly?	Fix OAD and reduce DAT setpoint.	$17,000	13,986	45,081	41	$7,800.00
Library	AHU	AHU-2	AHU-2 DAT setpoint goes up to 90°F at night between 10pm and 6am. Hlg valve actually opens to 18.3% on average to maintain that setting.	Either disable heating valve at night, or change night setpoint value to equal day setpoint value	$780	1,114	0	0	$2,600.00
Library	VAV-Boxes	VAV03	On most day, the box goes to 100% damper and 1400-CFM late in the day.	Verify VAV damper controls are operating correctly	$80	64	240	0	$660.00
Student Center	VAV-Boxes	Corridor01	VAV box goes to a very high flow (1500-CFM) making space very cold 61°F, (with 71°F as its setpoint)	Fix VAV box so that it modulates correctly.	$90	69	260	0	$660.00
Student Center	VAV Boxes	MtngRm01	Mtg Room 01's CFM goes well above max CFM of 500-CFM (~900-CFM at peak).	Reset damper so that the air is limited to the designed max cfm.	$100	79	300	0	$660.00

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Student Center	VAV-Boxes	MtngRm02	Mtg Rm 02's air flow is always maxed out.	Verify VAV damper controls are operating correctly.	$60	42	160	0	$660.00
Student Center	VAV-Boxes	MtngRm05	Mtg Rm 5's air flow is always maxed out.	Verify VAV damper controls are operating correctly.	$50	36	135	0	$660.00
Student Center	AHU	AHU-3	Unit is currently operating off Schedule.	Put system in Auto.	$3,910	0	24,414	0	$0.00
Student Center	AHU	AHU-1	Calling for Cooling w/Chiller off.	Disable Chilled Water Valve while chiller is off	$160	0	1,018	0	$470.00
Student Center	AHU	AHU-2	Calling for Cooling w/Chiller off.	Disable Chilled Water Valve while chiller is off.	$60	0	370	0	$470.00
Student Center	Hot Water	HX	20°F-60°F OA to 140°F - 200°F reset schedule. At 45°F OAT, 161°F HWS and 157°F HWR. Value is too high. Don't need water that hot.	Change control range to 0°F-60°F OA and 110°F-190°F HWS.	$850	1,209	0	0	$470.00
Classroom-1	AHU	All	This building is a classroom facility and should not be operating from 2300 to 0600.	Check Controls to ensure that AHU equipment is being shut-off during unoccupied periods.	$40,880	0	255,500	0	$13,000.00
Library	AHU	AHU-1	AHU-1 DAT setpoint goes up to 90°F at night between 11pm and 6am. Htg valve actually opens to 3.5% on average to maintain that setting	Either disable heating valve at night, or change night setpoint value to equal day setpoint value.	$290	410	0	0	$470.00
Library	AHU	AHU-4	AHU-4 DAT setpoint goes up to 90°F at night between 11pm and 6am. Htg valve actually opens to 8.2% on average to maintain that setting.	Either disable heating valve at night, or change night setpoint value to equal day setpoint value.	$700	998	0	0	$470.00

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Building	System Type	System	Description	Recommendation	Annual Avoided Cost	Annual Avoided Therms	Annual Avoided kWh	Peak Avoided kW	Est. Implementation Cost
Library	AHU	AHU-5	AHU-5 DAT setpoint goes up to 90°F at night between 11pm and 6am. Htg valve actually opens to 9.7% on average, to maintain that setting.	Either disable heating valve at night, or change night setpoint value to equal day setpoint value.	$830	1,180	0	0	$0.00
Library	Hot Water	HX	The steam meter reads -148 MBtuH when flow/use should be 0.	Recalibrate meter. No energy savings are predicted, but readings are suspect until meter works properly.	$0	0	0	0	$5,200.00
Classroom-2	AHU	AHU-3	The CO2 Sensor is reading between 5-ppm and 110-ppm for the month. These values are too low.	Recalibrate sensor. No energy savings are predicted, readings are suspect until sensor works properly	$0	0	0	0	$2,080.00
Student Center	AHU	AHU-5	The status for this unit is showing the unit to be on continuously while the speed indicates that the unit is turing off on schedule	Recalibrate the status sensor. No energy savings are predicted, readings are suspect until sensor works properly.	$0	0	0	0	$880.00
Science Building	Chiller	Chiller	The gpm and ΔT readings at the Chiller and secondary loop often show supply temperatures greater than return temperatures when there is substantial flow.	Calibrate main and secondary loop temperature and flow sensors.	$0	0	0	0	$880.00
Student Center	Chiller	Chiller	The Chiller often show the ΔT between the supply temperatures and the return temperatures to be, at best, 5°F and on average ~2.8°F.	The chiller controls should be check to make sure it is unloading correctly. A 4°F rise in ΔT would save 8% energy use	$4,530	0	28,290	30	$3,120.00

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Library	AHU	AHU-1	Mixed air temperature does not vary as much as other units, averaging about 2°F higher	Verify that damper, setpoint and sensor are working correctly	$490	0	3,063	0	$660.00
Student Center	AHU	AHU-2	Mixed air temperature does not vary as much as other units, averaging about 2°F higher.	Verify that damper, setpoint and sensor are working correctly.	$0	0	0	0	$660.00
Student Center	AHU	AHU-3	The MAT and DAT "Actual" reading do not vary. Point may not be mapped correctly in the BMS.	Recalibrate the status sensor. No energy savings are predicted, readings are suspect until sensor works properly.	$0	0	0	0	$660.00
Classroom-2	Chiller	Chiller	The Chiller often show the ΔT between the supply temperatures and the return temperatures to be, at best, ~6°F and on average 3°F.	The chiller controls should be check to make sure it is unloading correctly. A 4°F rise in ΔT would save 8% energy use	$2,300	0	14,400	15	$3,120.00
Student Center	AHU	AHU-1	On Oct 27th, the schedule definition for 'on' was switched from 0 to 1, but the control logic for the AHU was not changed and promptly went "off". At the same time scheduled time frame of operation was altered. The unit was overridden to be "on" after	Complete the control logic so that the unit is following the intended occupancy schedule.	$2,920	1,645	11,075	0	$0.00
Student Center	AHU	AHU-2	Same as above.	Same as above.	$4,300	2,036	17,989	0	$0.00
Student Center	AHU	AHU-4	Same as above.	Same as above.	$4,300	2,036	17,989	0	$0.00
Student Center	AHU	AHU-5	Same as above.	Same as above.	$4,300	2,036	17,989	0	$0.00

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Number of Findings Identufued: 43

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Student Center	AHU	AHU-4	Parameter out of range issue: Static Pressure is close to 30 inH20	Recalibrate the status sensor. No energy savings are predicted, readings are suspect until sensor works properly.	$0	0	0	0	$660.00
Student Center	AHU	AHU-5	Parameter out of range issue: Static Pressure is ranging between +/- 70 inH20	Recalibrate the status sensor. No energy savings are predicted, readings are suspect until sensor works properly.	$0	0	0	0	$660.00
Library	VAV-Boxes	VAV Boxes: 14, 25, 50, 56, 75, 77, 88, 91, 92	VAV Box Hunting. Flow and Damper Positions vary more than ±20% for several 5-min intervals.	Find route cause and repair. Hunting can cuase early equip. failure. Potential Comfort/Energy waste issue.	$0	0	0	0	$660.00
Classroom-2	VAV-Boxes	VAV Boxes. 14, 26, 29, 30, 32, 34	VAV Box Hunting. Flow and Damper Positions vary more than ±20% for several 5-min intervals.	Find route cause and repair. Hunting can cuase early equip. failure. Potential Comfort/Energy waste issue.	$0	0	0	0	$1,770.00
Student Center	VAV-Boxes	VAV Boxes. Corridor-1, Director Off, MtngRm-5	VAV Box Hunting. Flow and Damper Positions vary more than ±20% for several 5-min intervals.	Find route cause and repair. Hunting can cuase early equip. failure. Potential Comfort/Energy waste issue.	$0	0	0	0	$880.00
Library	VAV-Boxes	VAV Boxes: 37, 39, 41, 43	VAV Box flow is hunting, but damper position is not.	Find route cause and repair Could be faulty Damper or Flow Sensor. Hunting can lead to early equipment failure. A potential comfort issue.	$0	0	0	0	$880.00

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Building	System Type	System	Description	Recommendation	Annual Avoided Cost	Annual Avoided Therms	Annual Avoided kWh	Peak Avoided kW	Est. Implementation Cost
Library	VAV-Boxes	VAV Boxes: 57, 63	VAV Box flow always reads 0-cfm	Find route cause and repair. Could be faulty Flow Sensor. Hunting can lead to early equipment failure. A potential comfort issue.	$0	0	0	0	$880.00
Haas Library	VAV-Boxes	VAV Boxes: 53, 57, 63	VAV Box damper position is hunting, but flow is not.	Find route cause and repair. Could be faulty Damper or Flow Sensor. Hunting can lead to early equipment failure. A potential comfort/energy waste issue.	$0	0	0	0	$880.00
Library	VAV-Boxes	VAV Boxes: Corridor-1, DirectorOff, InfoDesk, Library, Lounge, MtngRm-2, Off-3, OpenWorkArea, PrepArea, Pub, StorageRm	VAV Box Actual Space temperature is more than ±3°F of VAV Box Setpoint	Find Route Cause Analysis. Overcooling/underheating when 3°F lower and Undercooling/overheating when 3°F higher.	$1,250	633	5,030	0	$1,770.00
Classroom-3	Meter	hourly kW	The building hourly load profile had a Load Factor of 74% even though it is a classroom building and not 'open' at night.	Install time-clocks or implement other control strategies that allow for the building to be in un-occupied mode from 0:00 to 06:00 to reduce the LF to 60%.	$17,560	0	109,763	0	$26,000.00
				Total Avoided Cost	**$163,940**	**30,006**	**893,334**	**92**	**$83,230**

Of Total Electric for Site with Opportunity IDs 11.3%

4 References

[1] K. Brown, M. Anderson and J. Harris, "How Monitoring Based Commissioning Contributes to Energy Efficiency for Commercial Buildings", January 2007, June 2003, American Council for an Energy-Efficient Economy (Adobe Acrobat File: http://www.ucop.edu/ciee/mbcx/documents/MBCx_ACEEE_2006_revised_9jan07.pdf).

[2] N. Bourassa, M. Piette, and N. Motegi, "An Evaluation of Savings and Measure Persistence from Retrocommissioning of Large Commercial Buildings", 2004 (Adobe Acrobat File: 860310.pdf found at http://www.osti.gov/bridge/servlets/purl/860310-Q60uUq/860310.PDF)

APPENDIX C. ENSAVE, INC. PROPOSAL