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Clean Energy to Communities

Technical Assistance for Region Five, MN

April 2024

Supriya Goel
Manan Singh

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
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1.0 Introduction

The Region Five Development Commission (“R5DC”) serves five counties in Minnesota, USA and received an Energizing Rural Communities Prize through the U.S. Department of Energy. Currently, R5DC is piloting projects in the City of Motley, for which two energy audits have been conducted. R5DC is seeking input regarding which options to pursue based on these two audits, as well a framework for future audits to be as effective and helpful as possible.

This report defines a framework for future audits for R5DC, by providing an overview of the requirements for different levels of audits and identifying available resources for conducting energy audits.

2.0 Energy Auditing Requirements

Current commercial building energy audit processes are defined in ASHRAE Procedures for Commercial Building Energy Audits (Second Edition, 2011) as well as ANSI/ASHRAE/ACCA 211-2018, Standards for Commercial Building Energy Audits (ASHRAE 2018). ASHRAE Standard 211 defines the minimum requirements and procedures for conducting Level 1, 2 and 3 audits and is the most widely used and referenced standard by jurisdictions specifying audit requirements through audit ordinances or building performance standards.

In order to support the process for defining audit requirements by R5DC, PNNL was tasked with defining minimum requirements for energy audits as well as developing a spreadsheet-based template which supports data collection and reporting for the same. This report summarizes the minimum audit requirements as well as minimum qualifications or certifications for auditors, as defined by ASHRAE Standard 211.

2.1.1 Levels of Assessment

ASHRAE Standard 211 defines three levels of assessment for energy audits for commercial buildings, namely Level 1, Level 2 and Level 3.

- A Level 1 assessment is intended as a preliminary assessment based on historical utility data and a site walk through which results in qualitative assessment for energy savings opportunities and does not include an energy use by end use breakdown.

- A Level 2 assessment is more detailed which includes an in-depth facility assessment including an assessment of all major building systems. In includes all components of a Level 1 assessment but also adds an energy use by end use breakdown requirement along with a quantitative assessment for energy savings opportunities where spreadsheet-based calculations or energy modeling is required for estimating potential energy savings.

- A Level 3 assessment builds on a Level 2 assessment and add a requirement for calibrated energy savings estimation, using either energy modeling or measured data.

A Level 1 assessment might be more appropriate for a less cost and time intensive assessment of a building, to identify potential upgrade opportunities. A Level 2 assessment is most commonly used in the industry and also required by a large number of audit ordinances and building performance standards. The following jurisdictions have a requirement for a Level 2 energy audit for commercial buildings exceeding a specific size threshold:

- New York, NY[1]
- San Francisco, CA[2]
- Berkeley, CA[3]
- Atlanta, GA[4]

[1] https://www1.nyc.gov/site/buildings/codes/energy-audits-retro-commissioning.page
[2] https://sfenvironment.org/article/how-to-comply-and-report-to-sf-environment
[3] https://www.cityofberkeley.info/BESOassessor/
[4] https://atlantabuildingbenchmarking.wordpress.com/compliance/audit/

- WA state[1]
- City of Brisbane, CA[2]
- City of Denver, CO[3]

The following sections describe the reporting requirements for both a Level 1 and a Level 2 energy audit.

2.2 Level 1 Energy Audit Requirements

2.2.1 Level 1 Audit Procedures

The Level 1 audit comprises of a simple assessment which includes a site walkthrough, examination of utility bills and relevant operational data, and interviews with operational personnel. Its primary purpose of a Level 1 audit is to identify significant issues in the building which might be responsible for high energy use. Through this initial evaluation, cost-effective enhancements are suggested, energy efficiency initiatives can be ranked in importance, and the necessity for a more comprehensive audit is assessed. The key procedures and reporting requirements for a Level 1 assessment are documented below.

2.2.1.1 Review of Historical Utility Data

In the initial phase of the audit, the audit team is required to collect both monthly and yearly utility data, ensuring a comprehensive analysis spanning a minimum of 12 consecutive months and potentially up to three successive years. This data is required to be analyzed to detect any irregular patterns in monthly energy consumption, allowing for the identification of potential underlying causes. Each energy source required to be assessed, with a focus on understanding the delivered fuel rate and tariff schedules associated with them. A review of monthly utility bills is also required, to uncover opportunities for cost reduction by leveraging utility rate classes and exploring possibilities for load shifting.

Standard 211 requires calculation of two key metrics: Energy Use Intensity (EUI) and Energy Cost Index (ECI).

EUI = Total Annual Building Energy Use/ Gross Floor Area
(Equation 1)

ECI = Total Annual Building Energy Cost (including taxes)/ Gross Floor Area
(Equation 2)

Where,

- Total Annual Building Energy Use = either building energy or site energy.
  - Building energy = imported energy + on-site renewable energy generation – exported energy – increase in stored energy

[1] https://www.commerce.wa.gov/wp-content/uploads/2021/06/Clean-Buildings-Incentive-Program-Guidelines.pdf
[2] https://www.brisbaneca.org/bbep/page/beyond-requirements
[3] https://denvergov.org/files/assets/public/climate-action/documents/energize-denver-hub/ed-technical-guidance-nov-2022-with-alt-text.pdf

- Site energy = imported energy - exported energy – increase in stored energy

Additional details and explanation of the boundaries for each energy type is explained in ASHRAE Standard 211.

2.2.1.2 Benchmarking

The benchmarking process requires the auditor to compare the building's EUI to peer sample using one of the following methods:

- ASHRAE/ IES 100, CBECS Summary Data, CIBSE Benchmarks
- ENERGY STAR Portfolio Manager benchmarking tool
- ASHRAE Building Energy Quotient (BuildingEQ) in Operation Rating
- DOE Building Performance Database (BPD), produced by LBNL.
- Another benchmarking system that can be demonstrated to provide a reasonable sample for comparison.

2.2.1.3 Facility Site Survey:

A facility site survey requires the following:

- Gathering building data to determine basic facility characteristics,
- Conducting a walk-through survey, accompanied by building operator or maintenance staff member.
- Review of as-built drawings and equipment schedules to identify efficiency opportunities.
- Review of previous energy audit reports, if available.
- Identification and reporting of operating problems, malfunctioning equipment, maintenance costs, and maintenance needs, including revisions to operations and maintenance (O&M) procedures.
- Identification of major energy use systems and review control strategies.
- Interviews of owner/ operator and occupants to identify operational parameters, special problems, and planned improvements.

2.2.1.4 Space Function Analysis:

A space function analysis requires the auditor to identify the specific building use types (office, retail, multifamily, city hall etc.) in a building, their gross floor area as well as the principal lighting type and HVAC system type for each space function. Space functions >20% of the area are required to be identified and the intention of this assessment is to provide a high-level overview of the various space functions in a building and the predominant HVAC and lighting types for each.

2.2.1.5 Identification of Energy Efficiency Measures

A level 1 audit requires an auditor to:

- **Identify Low-Cost and No-Cost Energy Efficiency Measure (EEM) Recommendations:** Determine measures by space function and energy system which are implementable within the O&M budget and estimate approximate economic return from savings.
- **Identify Potential Energy Efficiency Measures (EEM) Capital Recommendations:** Recommendations to include a preliminary qualitative estimate of the level (high, medium, or low) of potential costs and energy cost savings.
- **Review EEMs with Building Owner's Representative.**

2.2.2 Reporting Requirements for a Level 1 Assessment

The reporting requirements of a L1 assessment include the following and are also documented in Normative Appendix C of ASHRAE Standard 211[1]:

- Facility description: Site information and notable conditions
- Monthly and Annual Utility data
- Annual EUI and ECI
- Benchmarking results
- Energy targets and estimated savings based on benchmarking results
- Low-cost & no-cost recommendations
- Potential Capital EEM Recommendations

2.3 Level 2 Energy Audit Requirements

2.3.1 Level 2 Audit Procedures

A Level 2 audit includes all the requirements of a Level 1 audit, as documented in Sections 2.2.1.1, 2.2.1.2, 2.2.1.3, 2.2.1.4 and 2.2.1.5. In addition to the Level 1 audit requirements, a Level 2 audit includes the following:

1. **Energy Cost Component Breakdown.**
   A breakdown of the annual total energy cost by component is required to be developed, which at a minimum should include, electric use cost, electric demand cost, other energy use cost (as applicable), other energy demand cost (as applicable)
2. **Facility Site Survey.**
   A Level 2 audit requires the auditor to conduct a walkthrough survey of the facility (as described in Level 1) and subsequently review the mechanical, electrical, envelope and other building systems that impact energy use, based on direct observation, interviews, testing and as-built documentation. The minimum reporting requirements for each of the systems are documented in Standard 211 Normative Appendix C.
   - A key component of a Level 2 facility site survey includes an equipment inventory which identifies all major equipment on site, their capacities, efficiencies, fuel type and year of installation. This information is helpful in identifying equipment which might need replacement in the near future.
   - The envelope assessment includes evaluation of all envelope components, including the roof, wall, windows, floor and an assessment of their construction properties, thermal performance and condition.
   - The lighting assessment requires detailed evaluation of the predominant lighting systems, inventory of lighting types and a listing of lighting controls. This is required for both interior and exterior lighting.
   - The plug and process load assessments requires all major plug loads and process loads to be listed, shall be listed, including their approximate installed power density. Conveyance equipment (elevators, escalators, and automated people movers) are also required to be identified, including their condition.

3. **Review Current O&M Procedures.**
   The O&M of building systems impacting energy use and indoor environment quality are required to be reviewed and discuss with owners. The review should account for general O&M information and any past issues associated with building systems.

[1] https://xp20.ashrae.org/211-2018/

4. **Determine Key Operating Parameters.**
   The operational parameters should include the setpoint for HVAC systems, operational schedules, equipment efficiencies and qualitative assessment of duct networks, piping as well as other losses in building systems.
5. **Conduct End Use Breakdown.**
   The auditor is required to quantify the energy use allocation for each energy use system and separated by energy source type. The quantification shall be obtained using either building energy model, sub metered energy use or a calculation method that accounts for size, loads, control, efficiency and hours of operation. Additionally, a qualitative assessment of distributed energy resources (DERs) and renewable energy resources (RERs) should be conducted.
6. **EEM Assessment:**
   a. **Develop an Initial Measures List:** An auditor is required to list potential energy saving opportunities for each system and conduct preliminary calculations to estimate savings and associated costs.
   b. **Calculate Energy Savings:** The auditor is required to:
      i. Identify key energy use categories that will be impacted by each measure.
      ii. Determine appropriate calculation method (stipulated values, engineering calculations, building energy model, or other).
      iii. Evaluate individual measures using preliminary cost estimates while accounting for interactions among different measures.
   c. **Estimate EEM Costs:** The auditor is required to estimate the total expected cost of implementation of each measure.
   d. **Conduct Economic Analysis:** The auditor is required to first evaluate each measure for financial benefits, followed by development of packages of measures, based on the discussion with building owners. The auditor is required to perform the following tasks:
      i. Identify and quantify available local incentives and tax credits.
      ii. Calculate simple payback and ROI for each measure or groups of measures.
      iii. Note the ancillary benefits of each measure including but not limited to thermal comfort, reliability, aesthetic and IEQ benefits.
7. **Quality Assurance Review:** The auditor is required to evaluate the feasibility and appropriateness of identified measures as well as the reasonableness of energy savings projections, implementation cost estimates, and all observations and findings of the energy audit. Where building energy modeling is used, the model shall be calibrated per the methodology in ASHRAE Guideline 14 with respect to the building's actual energy use.
8. **Review EEMs with Owner's Representative:** The auditor is required to provide and review with the owner, a list of identified measures and their implications on energy use, energy costs, and nonenergy cost savings, available incentives, simple ROI and simple paybacks. The audit shall be revised to include changes (if any) to the recommended measures.

2.3.2 Reporting Requirements for a Level 2 Assessment

The reporting requirements of a L2 assessment include the following and are also documented in Normative Appendix C of ASHRAE Standard 211[1]:

[1] https://xp20.ashrae.org/211-2018/

1. EXECUTIVE SUMMARY
    a. Overall assessment of benchmarking and energy performance
    b. Aggregated savings and costs of recommended measures
    c. Table of recommended measures with savings and costs
2. INTRODUCTION
    a. Audit scope
    b. Key dates
    c. Contact information
3. Facility description:
    a. Building Information (type, use, floor area, commissioning history, schedules and energy sources)
    b. Building envelope details
    c. HVAC system details
    d. SHW system details
    e. Interior and exterior lighting
    f. Process and plug loads
4. Historical utility data
    a. Monthly utility data
    b. Delivered bulk fuels
    c. Annual data
    d. Submetering
    e. Utility rates
5. End-use breakdown report
    a. Methodology
    b. Compiled end-use energy data
6. EEM summary
    a. Low-cost and no-cost EEMs
    b. Capital EEMs
    c. DERs and RERs
    d. EEMs considered but not recommended.
7. EEM Cost estimate report
8. Hazardous materials
9. EEM economic analysis report
10. Quality assurance appendices
    a. Tabulated utility data
    b. Utility rate schedules
    c. Calculation methodology
    d. Savings calculations
    e. Cost estimates
    f. Lighting and equipment inventory tables
    g. Operations and maintenance (O&M) logs
    h. Equipment specifications

3.0 Auditor Qualifications

3.1 ASHRAE Standard 211

ASHRAE Standard 211 requires the following for a 'Qualified Energy Auditor':

1. Certification from a credentialing program approved by the U.S. Department of Energy Better Buildings Workforce Guidelines for Building Energy Auditors or Energy Managers[1]. These include:
    a. Energy Auditors:
        - ASHRAE, Building Energy Assessment Professionals (BEAP) certification[2].
            - Certified Building Energy Assessment Professionals (BEAP) are individuals who assess building systems and site conditions, analyze and evaluate equipment and energy usage, and recommend strategies to optimize building resource utilization.
        - Association of Energy Engineers, Certified Energy Auditor (CEA)[3]
            - Certified Energy Auditors are individuals who evaluate and analyze how energy is being used in a facility, identify energy conservation opportunities and make recommendations where consumption can be reduced or optimized.
    b. Energy Manager
        - Association of Energy Engineers, CEM[4]
            - Certified Energy Managers are individuals who optimize the energy performance of a facility, building or industrial plant. The CEM is a systems integrator for electrical, mechanical, process and building infrastructure, analyzing the optimum solutions to reduce energy consumption in a cost-effective approach.
        - Energy Management Association, EMP[5]
            - Energy Management Professionals utilize energy efficiency and data driven system analysis to optimize performance in facilities. The EMP incorporates commissioning, energy management and testing, adjusting and balancing (TAB) procedures to ensure effective and sustainable results.
2. A person approved as qualified by the authority having jurisdiction (AHJ). For example, according to Minnesota Energy Resources, this includes[6]:
    a. Association of Energy Engineers, Certified Energy Manager (CEM)
    b. Association of Energy Engineers, Certified Energy Auditor (CEA)
    c. Licensed as a Professional Engineer (PE) in Minnesota

ASHRAE Standard 211 states the requirements with respect to an auditor's experience as: Completion of five commercial (nonresidential) building energy audits within the past three years or a cumulative completion of ten or more commercial building energy audits.

[1] https://betterbuildingssolutioncenter.energy.gov/workforce/participating-certifying-organizations
[2] https://www.ashrae.org/education-certification/certification/beap-building-energy-assessment-professional-certification
[3] http://www.aeecenter.org/i4a/pages/index.cfm?pageid=4552
[4] http://www.aeecenter.org/i4a/pages/index.cfm?pageid=3351
[5] https://www.energymgmt.org/energy-management-professional-certification/
[6] https://www.minnesotaenergyresources.com/savings/business/audits

4.0 References

ASHRAE. 2011. Procedures for Commercial Building Energy Audits, Second Edition. Atlanta, GA.

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